

The Turbo Air[®] 6000 Centrifugal Compressor Handbook

About This Manual

This manual contains the basic information necessary for using and maintaining the Ingersoll Rand Turbo Air® Oil Free Centrifugal Compressor, from the original startup and operation to inspection and servicing. However, since installations may vary, these instructions may not cover all details or variations in the equipment supplied or every question which may possibly arise during use.

If a question or situation develops which is not answered directly in this manual, contact an authorized Ingersoll Rand sales or service representative for more information, or contact the factory directly for specific answers and/or advice.

All operating personnel should become familiar with the contents of this manual before the compressor is put into service. This is particularly important with regard to the safety precautions listed in the Introduction and those included at relevant points of the procedures described in other sections of this manual.



WARNING:

Read, be sure to clearly and completely understand, and then carefully follow all the directions included in this manual. Failure to adhere to the guidelines and specific instructions provided could cause equipment damage and/or serious personal injury or death.

Ingersoll Rand reserves the right to make enhancements or improvements to the equipment at any time, without notification. Such changes may have an impact on the accuracy of content in this document.

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Section One

Introduction

- ◆ About Ingersoll Rand
- ◆ The Turbo Air Centrifugal Compressor
- ◆ Safety Precautions
- ◆ Safety Labels
- ◆ Warranty
- ◆ Limitation on Liability
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About Ingersoll Rand

For over 150 years, Ingersoll Rand has provided a wide range of technologically advanced, highly reliable and low maintenance air compressors. We have a deep knowledge of the needs of the industry and the demands placed on productivity, making us leaders in the field. We use that experience and knowledge to provide you with the ideal air compressor solutions for your business. Our air compressors are made with superior components and are backed by our worldwide parts and service organization, providing the support you need to keep your business running. We stand behind our air compressors and beside our customers during planning, installation, and maintenance. Ingersoll Rand offers a full range of compressed air treatment products and services as well as air compressor parts and accessories that you need to be successful in all of your compressor related business needs.

To learn more, visit centrifugal.ingersollrand.com

The Turbo Air 6000 Centrifugal Compressor

The Turbo Air 6000 Centrifugal Compressor is a state of the art source of oil-free air manufactured with the user's needs in mind. The simple but rugged mechanical design provides many advantages. It combines the best features of aerodynamic technology to achieve optimum energy efficiency, and it delivers lower horsepower to cubic feet per minute (CFM) ratios than any other oil-free centrifugal compressor available.

The Most Advanced Compressor Components Available

The Turbo Air 6000 Compressor includes internal components which are unique to the industry. Superior pinion bearings designed for unlimited life and operation at any load. Non-contacting, non-wearing labyrinth air and oil seals that require no buffering to ensure oil-free compressed air. Impellers that are an advanced design which combines the best features of a sigma-radial impeller and a backward-leaning impeller. Vaned diffusers that are matched to the impellers for incomparable efficiency. Finally, inlet guide vanes that are mounted close to the impeller to achieve maximum benefit.

The Maestro Control System

The Maestro control system is standard on the Turbo Air Compressor package. Maestro provides the compressor owner with high performance solutions through faster response times, improved reliability and reduced energy costs. This state-of-the-art system is compatible with all other centrifugal, reciprocating, and rotary screw compressors.

The various control modes available provide optimal efficiency in even the most demanding applications.

NOTE: The Turbo Air 6000 Compressor package is not a complete, stand-alone compressed air system. To complete the system, additional components (such as main drive motor starter, oil pump starter, manifolds, inlet air filters, silencers, expansion joints, etc.) are also required. Ingersoll Rand offers a selection of optional equipment as part of the package or as add-ons after installation.

Other Design Features

Other outstanding design features of the Turbo Air 6000 compressor are shown in Figure 1—2 including:

1. Horizontally split gearbox casing
2. Mounted aftercooler (optional)
3. Built-in intercoolers
4. Mounted control panel
5. Self-contained lubrication system
6. Inlet guide vanes
7. Shaft driven main oil pump
8. Mounted water manifold (optional)
9. Mounted bypass valve (optional)

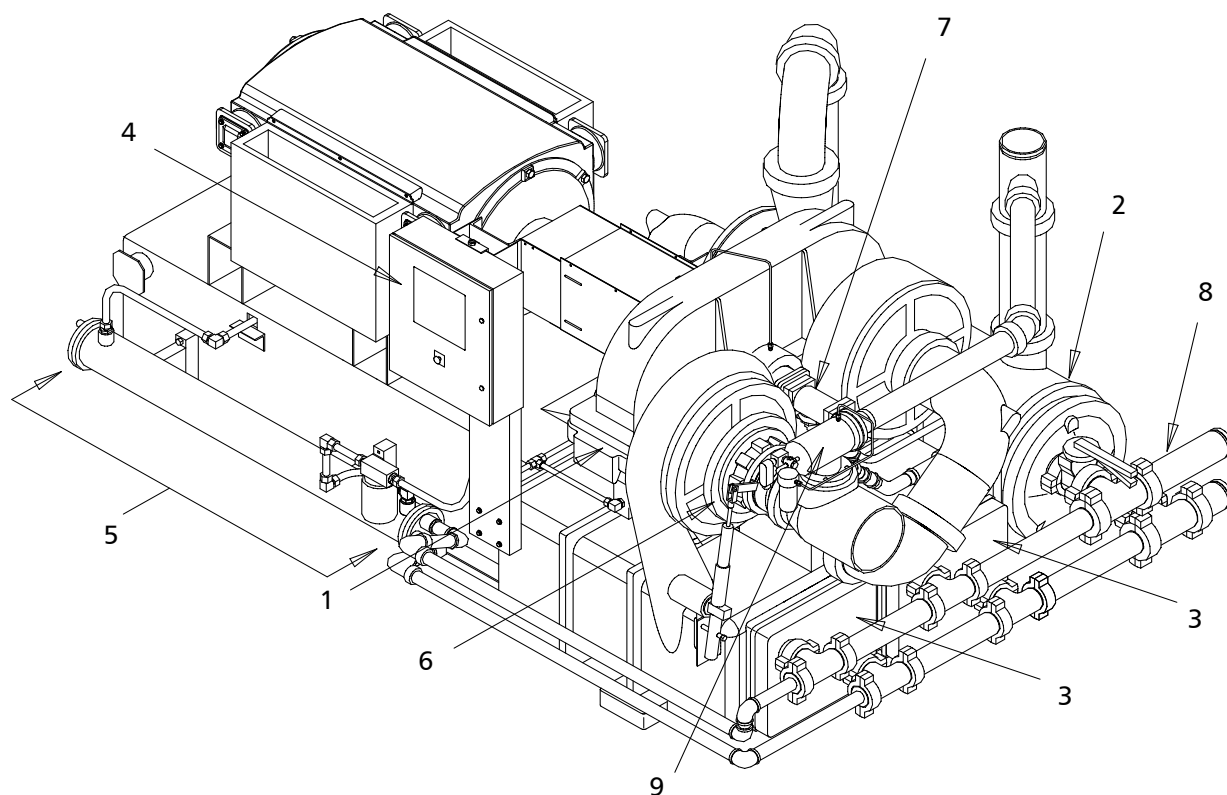


Figure 1—2 The Turbo Air 6000 Centrifugal Compressor

Safety Precautions

The Turbo Air 6000 Centrifugal Compressor is a powerful industrial machine that utilizes high-speed rotating elements and high voltages to produce high air pressures. Therefore, it is very important to use common sense and extra safety precautions whenever it is in operation as well as when performing maintenance or making repairs.

Ingersoll Rand expressly disclaims responsibility or liability for any injury or damage caused by failure to observe specified or other common safety precautions or failure to exercise ordinary caution, common sense, and due care required in operating the compressor even though not specified herein.

The alert messages shown here appear throughout this manual to indicate those situations and times when special care is necessary to prevent component harm or personal injury. There are three degrees of urgency:



CAUTION:

This indicates that there *may* be the possibility of minor equipment damage.



WARNING:

This indicates that there *could* be the possibility of minor equipment damage or personal injury.



DANGER:

This indicates that there *will definitely* be major equipment damage and/or personal injury or death if all proper safety precautions are not carefully followed.

The safety guidelines included here are also included on the safety labels affixed to various parts of the compressor. They alert the user to possible and probable hazards and serve to remind the user of specific safety precautions. Before using the Turbo Air 6000 Centrifugal Compressor, be certain to review the safety labels and the following safety guidelines.



WARNING:

Observe all safety precautions included in this manual and on the compressor safety labels. Failure to do so may cause equipment damage and/or personal injury.

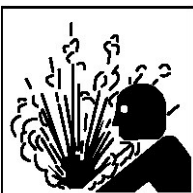
Safety Labels



WARNING

HAZARDOUS VOLTAGE. CAN CAUSE SEVERE INJURY OR DEATH

- *Disconnect all power supplies, lock-out and display signs before servicing equipment.*



DANGER

AIR UNDER PRESSURE. WILL CAUSE SEVERE INJURY OR DEATH

- *DO NOT operate the compressor at pressure in excess of the nameplate rating.*
- *Close the discharge block valve and relieve system of pressure before removing any caps or plugs, or servicing compressor.*
- *DO NOT play with compressed air.*
- *Wear eye protection when using compressed air.*



CAUTION

ELECTRICAL HAZARD. CAN SHOCK, BURN OR CAUSE DEATH.

- *All electrical enclosures and components must be installed and grounded in accordance with the National Electric Code and other local codes.*

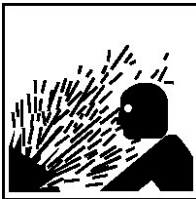
Safety Labels



WARNING

HIGH SURFACE TEMPERATURES. CAN CAUSE INJURY.

- *Some surfaces of the compressor and motor have excessive temperatures. To avoid burns, keep hands and other body parts away while unit is operating.*



DANGER

HOT OIL UNDER PRESSURE. WILL CAUSE SEVERE INJURY OR DEATH.

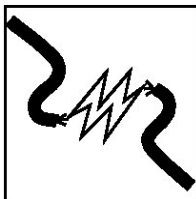
- *Shut down compressor and pumps before removing any caps or plugs, or servicing any parts.*



DANGER

DO NOT USE DISCHARGE AIR FOR BREATHING OR FOOD PROCESSING, AS IT WILL CAUSE SEVERE INJURY OR DEATH.

- *Air from the compressor used for these processes in the U.S.A. must meet OSHA 29 CFR 1910 or FDS 21 CFR 178.3570 filtration regulations.*

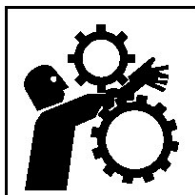


CAUTION

ELECTRICAL OR CONTROL HAZARD. COULD CAUSE INJURY OR MACHINERY DAMAGE.

- *DO NOT rewire or place jumpers in the control panel without written consent from the Ingersoll Rand Engineering or Service Departments.*
- *Periodically check all safety devices for proper operation.*

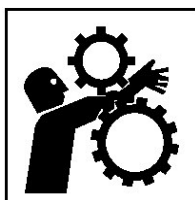
Safety Labels



WARNING

ROTATING SHAFTS COULD CAUSE SEVERE INJURY OR DEATH.

- *DO NOT* remove protective guards while the compressor is in operation.
- *DO NOT* attempt to service any part while the machine is operating.



WARNING

UNIT CAN AUTOMATICALLY RESTART CAUSING SEVERE INJURY OR DEATH.

- *Before removing the gearbox cover, lock the main power OFF, close the system block valve, turn the lube pump OFF, and remove the drive coupling.*



CAUTION

- *Exercise cleanliness during maintenance and when making repairs. Keep dirt away by covering parts and exposed openings with a clean cloth.*
- *Be sure no tools, rags, or loose parts are left on the compressor or drive parts.*
- *DO NOT* use flammable solvents for cleaning parts.



WARNING

- *DO NOT* operate the compressor in areas where there is a possibility of ingesting flammable or toxic fumes.

Warranty

Ingersoll Rand warrants that the compressor supplied conforms to applicable drawings and specifications and that the compressor will be free from defects in material or workmanship for a period of twelve (12) months from the date of initial operation or a period of fifteen (15) months from the date of shipment for North American Free Trade Agreement (NAFTA) countries or eighteen (18) months from shipment for other countries, whichever period expires first.

If, within that period, Ingersoll Rand receives written notice from the purchaser of any alleged defect in or nonconformance of the compressor and if, in Ingersoll Rand's judgment, the compressor does not conform to the original specifications or is found to be defective in material or workmanship, at its option Ingersoll Rand will make restitution in one of these ways:

1. By furnishing a service representative to correct the defective workmanship.
2. By repairing or replacing the component upon the component having been returned FOB to the Ingersoll Rand factory in Buffalo, New York, USA.
3. By returning the full purchase price of the compressor (without interest) to the purchaser.

Ingersoll Rand's sole responsibility and the purchaser's exclusive remedy hereunder is limited to such repair, replacement, or repayment of the full purchase price.

Equipment and accessories furnished by third parties that are not incorporated in the compressor package manufactured by Ingersoll Rand are warranted only to the extent of the original manufacturer's warranty to Ingersoll Rand.

There are no other warranties—express, statutory, or implied—including those of merchantability and/or fitness for purpose. Moreover, there is no affirmation of fact or representation that extends beyond the description of the face of this warranty.

This warranty shall be void and Ingersoll Rand shall have no responsibility to repair, replace, or repay the purchase price of defective or damaged compressors or component parts resulting directly or indirectly from:

1. The purchaser's use of repair or replacement parts or supplies not of Ingersoll Rand's manufacture or which have not been recommended by Ingersoll Rand.
2. The purchaser's failure to store, install, operate, and maintain the compressor according to Ingersoll Rand's written specifications, drawings, and good engineering practice.
3. Claims for shortages or damage in transit (obvious or concealed) are the purchaser's responsibility and should be made to the carrier. Ingersoll Rand will render reasonable assistance in securing satisfactory adjustment of claims.
4. Deterioration and wear occasioned by chemical and abrasive action or excessive heat shall not constitute defects.

Limitation on Liability

Ingersoll Rand's total responsibility for any claims, damages, losses, or liabilities arising out of or related to the performance of the products covered hereunder shall not exceed the original purchase price.

In no event shall Ingersoll Rand be liable for any special, indirect, incidental, or consequential damages of any character, including but not limited to:

1. Loss of use of productive facilities or equipment.
2. Lost profits, property damage, and/or expenses incurred in reliance on Ingersoll Rand's performance hereunder.
3. Lost production, whether suffered by the purchaser or any other third party.
4. Warranty work provided does not assure uninterrupted operation of the products. Ingersoll Rand does not assume any liability for damages caused by any delays involving warranty work.

Ingersoll Rand disclaims all liability for any and all costs, claims, demands, expenses, or other damages, either direct or indirect, incident to all property damage arising out of any cause of action based on strict liability.

Unauthorized Repair

In the event that the owner allows the compressor to be serviced or repaired by unauthorized personnel, the coverage of the original warranty policy will be automatically terminated.

Section Two

Specifications

In this section, the reader will learn about:

- ◆ General Compressor Specifications
- ◆ Alarm and Trip Specifications
- ◆ Compressor Lubricant Requirements

General Compressor Specifications

Installation Weights

Complete Package with Motor

Compressor Rating (hp)	800	900	1000	1250	1500
Weight (lbs) [A]	15000	16000	17000	18500	20000
Weight (kg) [A]	6750	7200	7600	8400	9000

Abbreviations: hp = horsepower, lbs - pounds, kg = kilograms

Notes: [A] The optional package - mounted aftercooler is not included

Maintenance Weights

(Approximate Values, lbs/kg)

Item	Weight	Item	Weight
Bullgear Cover	500 (227)	1st Stage Inlet	500 (227)
Bullgear Assembly	450 (205)	2nd Stage Inlet	500 (227)
Intercooler Bundles	270 (123)	3rd Stage Inlet	300 (136)

Connection Sizes

Connections are to American Standards (ANSI)

Connection	Size	Connection	Size
Air Inlet	10-inch (pipe) [A]	Condensate Drain	1/2-inch NPT
Air Discharge	6-inch (pipe) [B]	Air Ejector	3/8-inch NPT
Air Coolers (water)	3-inch (pipe) [B]	Control Panel	1-inch (conduit)
Oil Cooler(s) (water)	1 1/2-inch NPT	Pressure Transducers	1/4-inch (tubing)
Water Manifold (optional)	3-inch (pipe) typical [B]*		

* 4-inch (pipe) with optional package-mounted aftercooler [B]

Abbreviations: ANSI = American National Standards Institute, NPT = National Pipe Thread

Notes: [A] Standard 10-inch pipe has an outside diameter of 10.75 inches (275 mm). An optional slip-on rubber sleeve expansion joint is available as an extra cost option.

[B] This connection has been grooved to accept a Victaulic, or equivalent, pipe coupling.

Discharge Connection Load Limits

	English Units	Metric Units
Maximum Allowable Force	660 pounds	3000 Newtons
Maximum Allowable Moment	1000 foot-pounds	1350 Newton-meters

Bolt Torque Values

Unless otherwise noted, all bolts must be torqued to these values based on clean, unlubricated threads.

Bolt Size (Diameter)		Torque Range	
Inch	mm	Foot-Pounds	Newton-meters
3/4	20	143 - 157	195 - 210
7/8	22	192 - 212	260 - 285
1	25	285 - 315	385 - 425

General Compressor Specifications

Lubrication System		
Element	English Units	Metric Units
Reservoir Capacity	85 gallons (U.S.)	320 liters
Minimum Reservoir Temperature Before Start	60°F	15°C
System Operating Temperature	120°F	50°C
System Operating Pressure	120 psig	8.3 barg
Air Ejector Pressure Range *	20-50 psig	1.7-3.5 barg

* NOTE: Adjust air ejector pressure so gearbox vacuum is between 8-12" of water column.

Other Package Electrical Requirements	
Main Drive Motor*	Furnished separately
Oil Pump Motor*	5 hp (3.5 kw) 3Ph/50-60Hz ***
Oil Heater (optional)**	1.5 kw 3Ph/50-60Hz ***

*Starter Required.

**Magnetic contactor required above 480 volts.

***Voltages must be specified at time of order entry.

Alarm and Trip Specifications

The tables below show the Alarm and Trip values of the key parameters for the Turbo Air 6000 compressor.

If an Alarm value is reached, the compressor will continue to run but the control system will show the item that generated the alarm.

If a Trip value is reached, the control system will shut down the compressor.

ALARM and TRIP Setpoints (English Units)				
Condition	ALARM		TRIP	
	Low	High	Low	High
Standard:				
Compressor Stage Vibration (mils)	-	1.5	-	2.0
Oil Pressure (psi)	100	180	80	200
Oil Temperature (°F)	70	135	60	145
Stage Inlet Air Temperature (°F)	-	130	-	140
Optional:				
Inlet Air Filter Pressure Drop (inches of water)	-	10	-	-
Oil Filter Pressure Drop (psi) Single	-	15	-	20
Oil Filter Pressure Drop (psi) Duplex	-	30	-	50

ALARM and TRIP Setpoints (Metric Units)				
Condition	ALARM		TRIP	
	Low	High	Low	High
Standard:				
Compressor Stage Vibration (μm)	-	38	-	50
Oil Pressure (bar)	6.9	12.4	5.5	13.79
Oil Temperature (°C)	21	57	16	63
Stage Inlet Air Temperature (°C)	-	55	-	60
Optional:				
Inlet Air Filter Pressure Drop (mm of water)	-	250	-	-
Oil Filter Pressure Drop (bar) Single	-	1.0	-	1.4
Oil Filter Pressure Drop (bar) Duplex	-	2.0	-	3.4

Compressor Lubricant Requirements

The user must obtain the following required lubricants for use with the Turbo Air 6000 Compressor:

- Acceptable turbine oil
- Acceptable motor bearing lubrication
- Acceptable inlet guide vane assembly drive screw grease
- Acceptable coupling grease

Complete information about these lubricants is included in this section. Specific instructions for procedures involving their use are included in Section Five, Maintenance, of the Turbo Air 6000 Compressor Operator's Manual.

It is the user's responsibility to provide all lubricants (including turbine oil, motor grease, and coupling grease) at the initial startup and during subsequent operation. It is very important for all compressor users to follow specific guidelines regarding lubricant selection and proper use in order to assure optimal performance of the Turbo Air 6000 Compressor.

Compressor Oil Selection

The correct lubricating oil is critical to satisfactory overall compressor performance. When operating the Turbo Air 6000 Compressor, use only high-quality, rust- and oxidation-inhibiting oil that resists foaming and that does not break down under severe operating pressures and temperatures. Incorrect or poor quality lubricating oil can adversely effect high-speed shaft dynamics and seriously damage critical compressor components.

While there are many quality oil products on the market today, not all have been demonstrated to function optimally in situations involving high-speed rotordynamics. For this reason, Ingersoll Rand has formulated a lubricant that is as advanced as today's high-tech compressors. *TurboBlend™ Lubricating Oil* is an exceptional lubricant formulated using a hydrocracked base stock and performance enhancing additives.

Hydrocracking is an advanced oil processing technology that is far superior to solvent refining. It converts crude oils into base stocks of unparalleled purity. So pure, in fact, and so highly refined that this new class of lubricant is free of the contaminants that cause lubricant breakdown ensuring longer-lasting compressor performance. The only additives in *TurboBlend Lubricating Oil* are those selected exclusively by Ingersoll Rand scientists and engineers to increase performance. In test after test of standard quality indicators, *TurboBlend Lubricating Oil* outperforms solvent refined, commercially available oils.

TurboBlend Lubricating Oil is available through your authorized Ingersoll Rand representative or directly from the Ingersoll Rand Parts Department. Refer to Section Seven of this manual for part numbering and ordering information.

Standards

Excellent operating performance will be achieved when using TurboBlend Lubricating Oil. However, if the compressor owner or user chooses to pursue a near equivalent substitute, the subject oil must conform to the following characteristics:

- Refined from high-quality mineral oil stock.
- Free from any contaminants or impurities that may be abrasive or have a lapping action.
- Contain additives to provide:
 - a high level of oxidation stability,
 - a high degree of wear protection,
 - rapid separation from entrained gases,
 - foam-free operation,
 - rust-free and corrosion-free operation, and
 - resistance to the formation of sludge and harmful resin-like deposits.
- capable of maintaining high flow strength and not break down under extremes of pressure and temperature.

Animal, vegetable and mineral oils of poor quality must be avoided as these oils would tend to oxidize, develop acids, and form sludge or resin-like deposits on rotating elements. Such deposits may be of sufficient volume to cause very high, localized loadings that will lead to a premature breakdown of the load-carrying capacity of the oil. This will result in worn gears and scored bearings.

Specifications

TurboBlend Lubricating Oil meets or exceeds the performance standards listed in Table 2—1. Any substitute or equivalent oil selected for use in the Turbo Air 6000 Compressor by the compressor owner must exhibit similar results.

Property	Test Method	Performance
Viscosity:		
at 40°C	ASTM D445	46 Cst
at 100°C	ASTM D445	7 Cst
Viscosity Index:	ASTM D2270	>100
Four Ball Wear Test:		
(40 Kg, 1200 RPM, 75°C, 1 Hour)	ASTM D4172	≤ 0.4 mm
Water Separability:		
(54°C and 82°C)	ASTM D1401	<3 ml at 15 minutes
Foaming Characteristic - Sequences I, II & III:		
Tendency/Stability	ASTM D892	<10 ml / 0
Gas Bubble Retention Time:		
at 50°C	ASTM D3427	≤ 5 minutes
Rust Test:		
Distilled Water	ASTM D665A	Pass
Synthetic Sea Water	ASTM D665B	Pass
Rotating Bomb Oxidation Test:	ASTM D2272	> 400 minutes
Base Oil is to be refined from high-grade mineral oil stock.		

Table 2—1 Ingersoll Rand Oil Specification

Other Oil Selection Considerations

Incorrect or poor quality lubricating oil can seriously damage the compressor's rotating and mechanical elements. Do not merely rely on an oil dealer recommendation when selecting turbine oil, and do not compromise quality in an attempt to economize. Many reputable brand name oil products exist, but not all perform effectively in the demanding world of high-speed turbomachinery.

Do not mix different brands of oil. This is inadvisable because some oils are incompatible, and a wrong combination of additives could cause serious machine damage and/or poor overall performance. The lubrication requirements of the Turbo Air 6000 Compressor are not so severe as to require the qualities of high-cost synthetic oil. In addition, Ingersoll Rand products are not designed to use synthetic oils. Therefore, use of such products is not recommended and is done at the owner's risk.



CAUTION:

To ensure optimum performance and to avoid possible compressor damage, always be certain to follow the guidelines listed below.

- Use only Ingersoll Rand *TurboBlend™ Lubricating Oil* or a high-quality turbine oil that meets the specifications in Table 2—1.
- Do not mix different oils.
- Do not use synthetic oils.
- Remember that use of unspecified oil is done at the owner's risk.

Inspection and Testing

Oil samples from the compressor reservoir should be visually inspected and tested for viscosity and freedom from contamination at regular intervals. This will insure that proper lubricant properties are always being provided and early deterioration of the gearing and bearings is diminished.

- **Color and Appearance**
Compare an oil sample from the reservoir with new oil. Any color change suggests some type of deterioration. Darkness implies contamination from acid buildup while muddiness is an indication of water.
- **Viscosity, Acid and Particle Count**
Tests for these properties required qualitative analyses by a reputable laboratory. Follow the recommendations of the laboratory with regard to oil replacement.

Ingersoll Rand offers an oil analysis service. Sampling kits and information about this service are available through an authorized Sales and Service Representative, or directly through the Ingersoll Rand Aftermarket Department. (See Table 7-1 of this manual for sampling kit part number information.)

Other Required Lubricants

The user must also provide an array of other lubricant products as specified.

Motor Bearing Lubricants

The user must provide lubricants for the main drive motor and the oil pump motor. To ensure long life of the bearings of both motors, it is necessary to maintain both proper alignment and proper lubrication levels at all times. The large, squirrel cage inductor motor of the Turbo Air 6000 Compressor employs (depending on the specific type of motor used) either anti-friction bearings or sleeve bearings. Each type of bearing has different lubrication requirements.

Refer to the motor manufacturer's instructions provided separately for complete information regarding correct oil bearing lubrication maintenance procedures for each type of motor.

Anti-Friction Bearings—Grease

For best results with anti-friction bearings, only use greases recommended by the motor manufacturer.

Sleeve Bearings—Oil

It is the user's responsibility to fill the motor bearing oil reservoir and to maintain the correct oil level at all times. When lubricating sleeve bearings, use only a high quality, petroleum-based oil with a viscosity of 200-220 SSU at 100° F (40°C). Since motor bearings require the same type of oil as used in the compressor itself, it is not necessary to maintain two separate supplies of oil if this type of bearing is used.



CAUTION:

Before aligning or using this type of motor, always verify that the correct amount of oil is in the reservoir. Motors with sleeve bearings are sometimes shipped without oil in their reservoirs.

Inlet Guide Vane Assembly Drive Screw Grease

Use a high quality, synthetic grease when lubricating the actuator drive screw. Do not use a non-synthetic grease for lubrication of this assembly, since such greases tend to thicken during cold operating conditions. Consequently, they tend to hinder or possibly even prevent proper operation of the inlet guide vane assembly

Section Three

Installation

- ◆ General Considerations
- ◆ The Installation Work Schedule
- ◆ Site Considerations
- ◆ Process Air Piping
- ◆ Utility Piping
- ◆ Electrical Interface
- ◆ Receiving, Lifting, Moving & Bolting
- ◆ The Installation Inspection
- ◆ Preparing for Startup
- ◆ Initial Compressor Startup

General Considerations

Advance planning and preparation help simplify and expedite the compressor installation process. This Section gives an overview of the entire process, from preliminary site preparation to the final preparations before the initial startup of the compressor.

The Installation Work Schedule lists the various considerations that the owner must address before and during the installation process, up to and including the initial startup procedure.

During the initial compressor startup, a factory-trained and authorized Ingersoll Rand service representative checks the completed installation work, including peripheral piping and electrical work. The service representative also checks the lubrication system, verifies the control system configuration, verifies motor alignment, starts the compressor and provides operating instructions.

Installation Work Schedule

Before beginning the actual compressor installation process, review the steps below for an overview of the various considerations and procedures.

Before delivery, review all the technical documents provided, including this handbook and all the relevant specifications and drawings supplied separately.

1. Select a well-suited location in accordance with the minimum recommended space and ambient requirements for the compressor package.
2. Review the list of parts, supplies, tools, and labor required at installation, and arrange for them all to be available.
3. Be sure that all required preparations and provisions have been made with regard to the foundation, piping, and electrical connections.
4. Upon its arrival, inspect the compressor and check loose-shipped equipment against the packing list; if any damage or shortage is noted, report it to the carrier immediately.
5. Set the compressor on the foundation and secure the compressor on the foundation bolts. If temporary storage is necessary before installation can be completed, place the compressor in a properly heated, indoor storage area. Store for a period of no more than three months.
6. At least two weeks before the projected initial startup date, contact your authorized Ingersoll Rand service representative to schedule startup service.
7. Install the external air piping per the instructions in this section.*
8. Fabricate a manifold to connect to the coolant supply and return on the intercoolers and the oil cooler. *
9. Install all piping between the compressor and the main coolant lines.
10. Fabricate the condensate drain pipes and control devices as indicated elsewhere in this section.*
11. Connect the clean, dry instrument air line to the reservoir vent ejector system and control valve actuators (if applicable).
12. Make all electrical connections, in compliance all applicable electrical codes.
13. Check the site a final time for conformance to all applicable codes and all installation requirements.

** Various factory-installed piping configuration options are available through Ingersoll Rand and can lead to considerable savings for the installer.*

Labor, Supplies, Equipment, and Tools

It is the owner's responsibility to prepare the site properly and to provide any necessary labor, supplies, tools, or additional equipment needed to meet the compressor installation requirements.

The following list includes the typical items necessary for site preparation, installation, and future maintenance.

Materials Required for Compressor Installation	
Supplies	
Foundation bolts	
Shims (for leveling)	
All external piping supplies	
All external wiring and electrical conduits	
TurboBlend oil (or suitable alternative - see Section 2, Lubricant Requirements)	
Motor bearing lubricant	
Equipment *	
Main drive motor starter	
Oil pump motor starter	
EVC Starter (if necessary)	
Oil heater contactor (if necessary)	
Specified inlet air filter	
Specified Inlet startup screen	
Expansion joints (for inlet and discharge piping)	
Blow off valve silencer (if applicable)	
Air system block valve	
Cooling water control valves	
Air dryer (if necessary)	
Tools	
"Port-a-Power" or hydraulic jack	
Allen wrenches and Drive sockets with extensions	
Digital multimeter	
Pipe wrenches, Adjustable wrenches, and Vise grips	
Torque wrench (to 800 ft-lbs. or 1100 NM)	
Screwdrivers	
Open end and box wrenches	
Drill motor	
31/64", "S", or 12.30 mm drills (for doweling of motor)	
0.499", or 12.67 mm reamer (for doweling of motor)	
<i>*Some equipment may have been purchased with the compressor. Refer to engineering documents provided separately for definition of Ingersoll Rand's scope-of-supply.</i>	

Table 3—1. Materials Required for Compressor Installation

Site Considerations

Review the installation requirements specified both in this manual and in the model-specific drawings, supplied separately. Select your installation site and make the required preparations prior to the compressor's delivery.

The standard Turbo Air Compressor is designed for indoor installation. For outdoor installation, both the NEMA-4 electrical option and TEFC motor package are necessary.

Environment

A clean environment is important for optimal performance. Locate the compressor inlet air filter away from chimneys, cooling towers, steam exhausts, or any other possible sources of air contamination with foreign matter. In particular, be sure to locate the air filter at least 10 ft. (3.3 m) above ground level and at least 6 ft. (2 m) from any window, wall, or roof to further isolate it from any airborne contaminants.

When selecting an outdoor installation site, consider prevailing and local ground wind patterns as well as the immediate atmospheric conditions surrounding the unit. Such factors may have long-term effects on overall compressor operation.



CAUTION:

Select the compressor site carefully with regard to possible contamination by foreign matter. Dust, corrosive vapors, or other airborne foreign matter will adversely affect compressor performance and motor insulation life.

Acoustics

Compressor operation will affect sound levels in the surrounding area. If hard walls and low, hard ceilings surround the installation site, they are likely to reflect and amplify noise to levels that exceed the published levels of the compressor package. Proper sound abatement procedures should be applied where needed.

Inlet and discharge air piping are major sound emitters in any compressor installation. For greater sound suppression, insulate local surfaces with sound absorbing materials. For maximum sound suppression, apply insulation to components throughout the entire air path:

For more information about piping insulation and noise control consult Ingersoll Rand.

Foundation

The Turbo Air 6000 Compressor can be installed directly on a floor that meets the following minimum requirements:

- Construction must be of a high quality continuous reinforced concrete.
- The slab must have a minimum thickness of 6-8 in. (150-200 mm).
- The floor must have minimal ambient vibration.

Compressor mounting

Secure the compressor on its mounting bolts and shim properly to achieve a level of flatness at 0.010 inches per foot (1 mm per meter). If necessary use the appropriate vibration isolation hardware to ensure that the compressor is isolated from vibrations transmitted by nearby equipment.

Envelope

Provide an adequate envelope (space allowance) around the unit. Figure 3—1 illustrates the typical dimensions of a standard compressor. Allow an additional 3 ft. (1 m) around the sides and back of the compressor to provide adequate clearance for installation, inspection, and future maintenance. In the front, allow at least 6 ft. (2 m) for intercooler and aftercooler bundle removal.

Ventilation

If installing the unit in a confined area, be certain to provide adequate ventilation to dissipate heat generated by the package. **The temperature immediately surrounding the compressor package should not exceed 100°F (38° C).** The main drive motor is particularly susceptible to damage in areas of high ambient temperatures or poor ventilation.

Water Supply and Drains

If the compressor is water-cooled, make every effort to provide clean cooling water with a low mineral content.

Also, be sure to provide adequate open drains to carry away condensate from the intercoolers and aftercooler. (Refer to the Utility Piping subsection for additional information and requirements for water supply and condensate drain piping.)

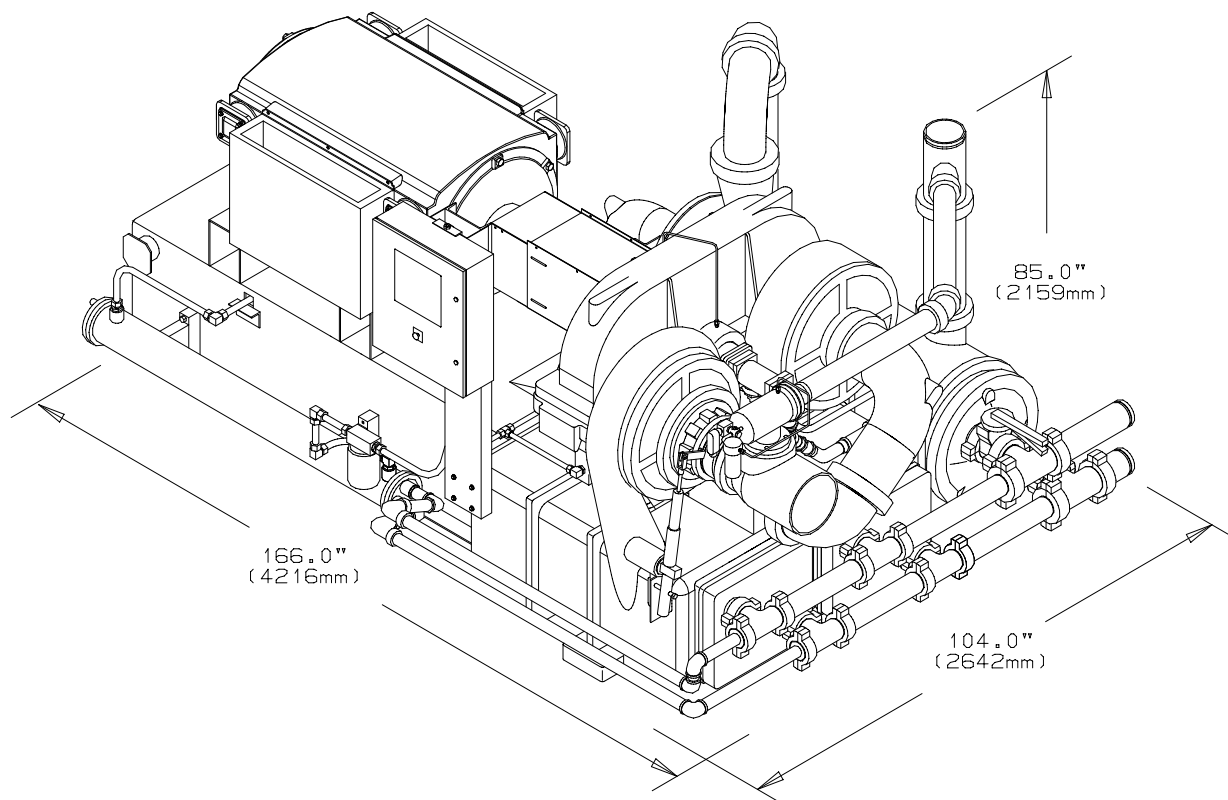


**Figure 3—1 Turbo Air 6000 Compressor Envelope
With Optional Aftercooler**

Process Air Piping

Figure 3—2 is a schematic illustration of the typical piping arrangement for a standard Turbo Air compressor.

The process air system includes the inlet air piping, the discharge air piping, and the compressor discharge valve piping arrangements. The Ingersoll Rand Process and Instrumentation Diagram (P&ID) drawing illustrates the required location for the various compressor system components. The user must design and provide all external process air piping accordingly.

Improperly designed piping systems may cause later problems. **Failure to follow the discharge piping installation requirements, as shown on the model-specific drawings, is the most frequent cause of compressor control problems.**

To ensure a successful process air piping installation, be sure to:

- Use clean pipes to be sure that no foreign material enters the compressor.
- Keep the piping as short and direct as possible.
- Clean the piping thoroughly after fabrication.
- Install the isolating discharge block valve as indicated.
- Support the piping properly so that the supports (rather than the compressor) carry the load.
- Provide drains at low points to carry away any collected condensate.



DANGER:

Failure by the owner and installer to provide correct piping to and from the compressor, following the requirements and recommendations listed, will result in mechanical failure, property damage, serious injury or death.

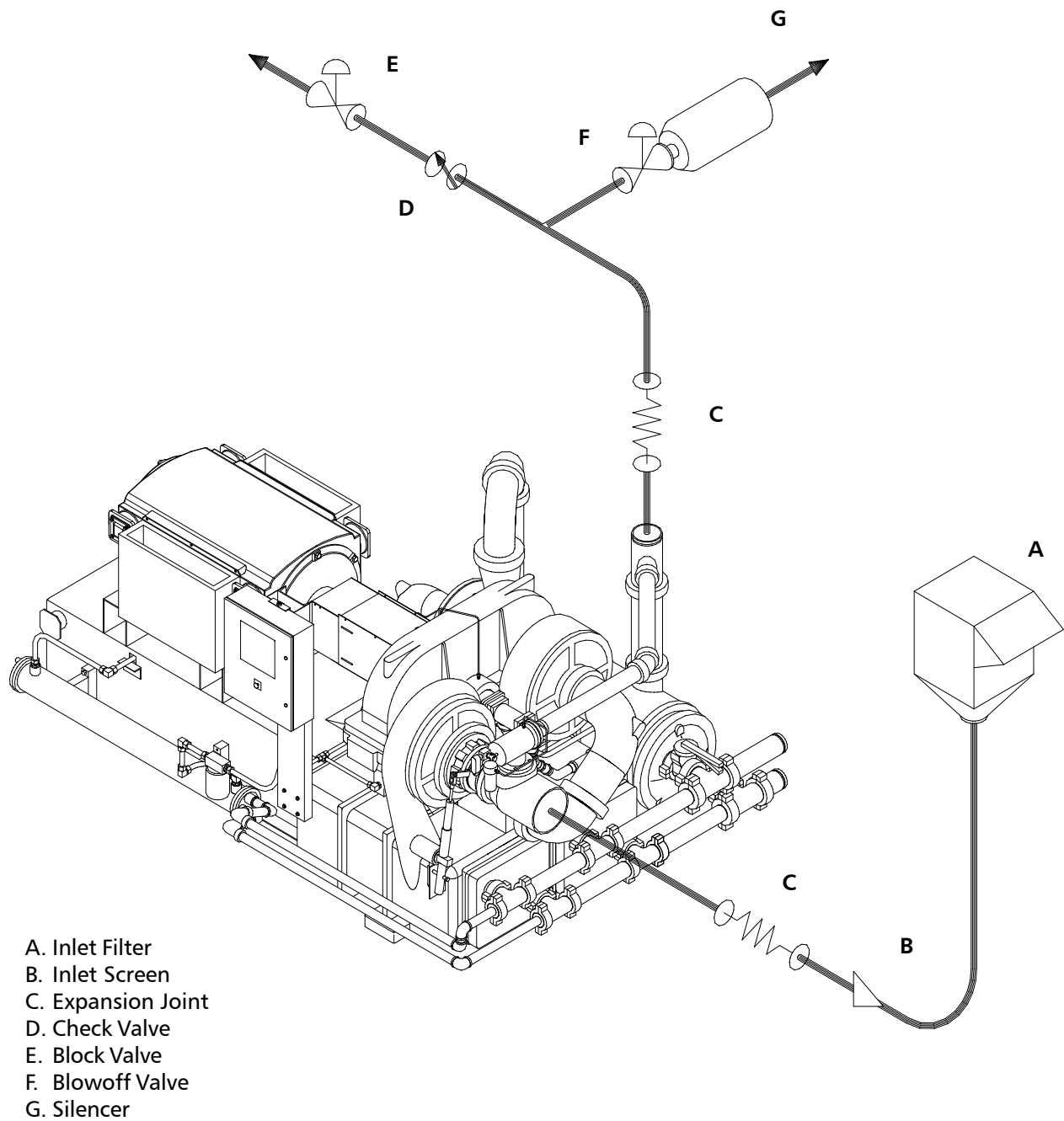


Figure 3—2. Typical Process Air Piping for a Turbo Air 6000 Standard Compressor

Inlet Air Piping

Figure 3—3 shows a typical inlet piping arrangement with various standard and optional components.

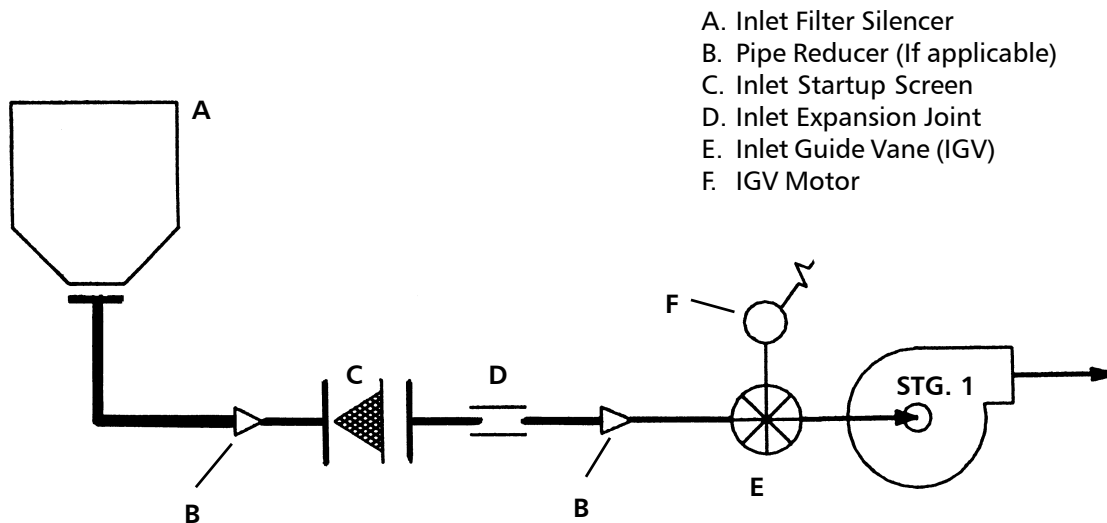


Figure 3—3 Inlet Air Piping

Inlet Pipe Connection

The standard inlet air connection is a cast iron reducer, the outside of which matches standard steel pipe. (American National Standards Institute: ANSI B36.10). This inlet reducer may be removed and machined to accept a number of different style inlet air piping connections.

Figure 3—4 shows a detail of a typical inlet air piping arrangement.

Do not connect the final inlet air pipe to the compressor until the Ingersoll Rand representative inspects the piping during the startup service call.

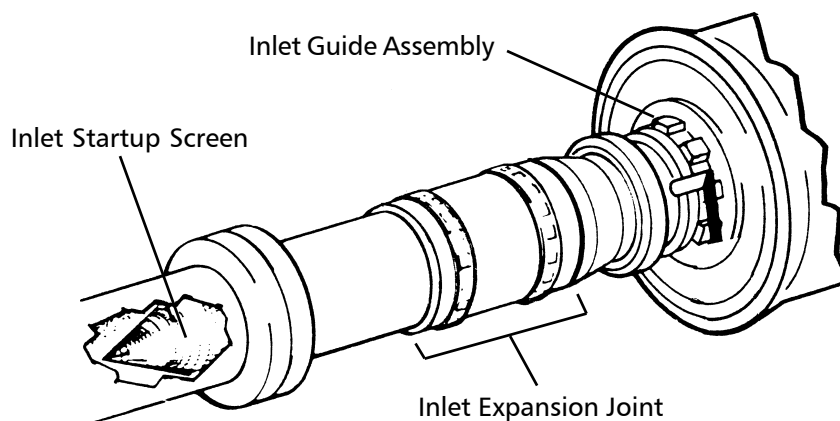


Figure 3—4 Detail of Inlet Air Connection with options

Inlet Piping Material

When selecting inlet piping material, it is advisable to either select corrosion-resistant piping or treat the piping with additional corrosion protection. Also, be sure to provide suitable support to isolate the piping forces from the compressor itself.

If you are considering fiberglass piping for the inlet air lines, be sure to:

- Select pipe material that can tolerate bypass air temperatures of up to 350°F (175°C).
- Use pipe and fittings that are filament wound with continuous glass filaments and epoxy resin.
- Provide the fiberglass piping with additional reinforcement for even load distribution.
- Insulate the pipe to minimize noise.

Fabrication

Use 10-inch (250 mm) or larger pipe size to connect the inlet air filter to the compressor. Smaller sizes reduce inlet air pressure and impair compressor performance.

Provide a straight run of at least four pipe diameters before the inlet guide vanes (IGV's) to minimize flow distortion. Also, avoid using many elbows and sharp bends in the compressor inlet piping.

Drains

Provide adequate drains at low points of the inlet piping to facilitate condensate removal. This deters rusting which can eventually impede the aerodynamic characteristics of the components.

Inlet Filter/Silencer

The required inlet filter/silencer must be of the proper design and located according to the instructions from Compression Systems. Failure to use a proper inlet filter voids any existing warranty.

Inlet Air Startup Screen

Inlet piping must prevent any solids from entering the compressor inlet. When long runs of inlet piping are required, or when visual/physical inspection of the finished piping is difficult, the conical inlet air startup screen must be installed before the initial compressor startup. In such instances, it is important to locate the screen as close as possible to the compressor inlet. The correct inlet air startup screen is available through your authorized Ingersoll Rand representative.



CAUTION:

Be certain to remove the Inlet Air Startup Screen after approximately 40-50 hours of compressor operation. If it is not removed, the pressure loss across the screen can significantly reduce overall compressor performance.

Inlet Expansion Joint

Ingersoll Rand recommends the use of the Inlet Expansion Joint option (which consists of a rubber sleeve with stainless steel clamps) as a means of joining the inlet air pipe to the compressor. (See Figure 3—4.) When making this connection, do not use pipe smaller than the recommended pipe size. Larger pipe is preferable since the greater volume reduces both noise and pressure loss.

Discharge Air Piping

The discharge air piping system, shown schematically in Figure 3 — 5, consists of the piping after the discharge flange including the expansion joint, discharge check valve, and isolating block valve plus any accessory items for the specific installation (dryer, receiver, etc.).

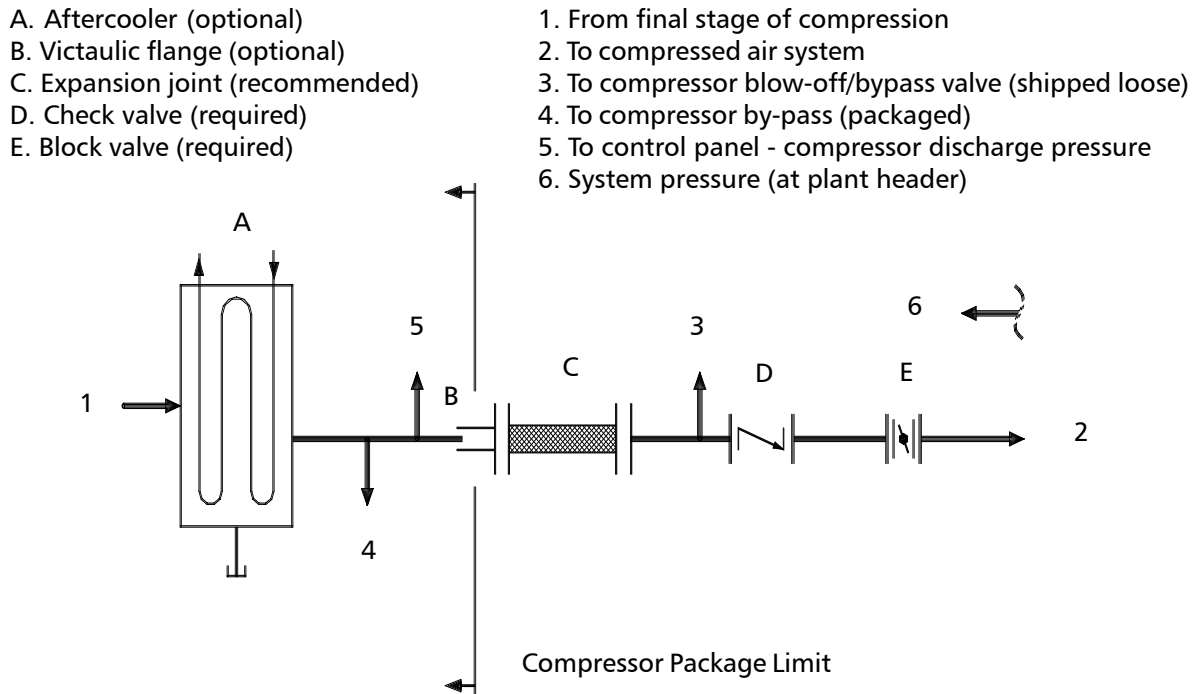


Figure 3—5 Typical Discharge Air Piping Arrangement

Discharge Connection

The compressor discharge air connection is machined to accept a Victaulic pipe coupling. When attaching the discharge pipe, refer to the model-specific Installation Arrangement Drawings supplied separately for specific size information.

Ingersoll Rand offers the following optional types of connections:

- Straight Coupling
- Vic-Flange Adapter

Piping Material

While corrosion on the discharge air side does not present the same problem as it does on the intake air piping, it is still a concern. Rust can damage delicate instrumentation, pneumatic tools, or processes that require non-contaminated air.

The principal consideration in the selection of piping materials should be safety. The United States, Canada, and most other countries strictly prohibit the use of unprotected polyvinyl chloride (PVC) piping to transport compressed air or other compressed gases. Ingersoll Rand also advises against using soldered copper fittings and rubber hoses in discharge air piping. If fabricating the air piping with flexible joints and flexlines, be sure that they meet the operating parameters of the system.

Ingersoll Rand recommends that all pressure-holding pipe be in accordance with the standards established by the American National Standards Institute (ANSI) as well as the American Society of Mechanical Engineers' (ASME) Standard B31.8-1986.

**CAUTION:**

Be certain to follow all specified requirements and guidelines. Failure to correctly follow specified discharge air piping design guidelines can cause compressor malfunction and/or damage.

Drains

It is necessary to provide drains at all low points to remove any condensate that collects in the discharge system.

Fabrication

The combination of high pressures, accessories, and long piping runs require more detailed design considerations in the discharge air line than with the intake air lines.

It is best that the pipe lengths from the compressor discharge connection to the discharge check valve and from the discharge check valve to the blow-off or bypass valve are as small as practical. **For proper operation of the discharge check valve, straight piping runs of four pipe diameters each in length, should immediately precede and follow the valve.**

**CAUTION:**

To assure proper compressor unloading, do not allow the pipe volume to exceed 0.1% of the design volume flow of the compressor. Excessive volumes may cause compressor surging during unloading.

Refer to the specific requirements in the engineering drawings supplied separately for your system.

**CAUTION:**

Do not exceed the 660 lb. (3000 Nm) Maximum Allowable Force or the Maximum Allowable moment of 1000 lbs. (1350 Nm) on the compressor discharge connection. Excess weight may cause pipe connection failure.

Discharge Expansion Joint

Ingersoll Rand recommends installation of a discharge expansion joint in line (vertically) directly at the discharge flange of the compressor. Braided type expansion joints require sufficient pre-tension to counteract any collapsing force. For “tied” expansion joints, make sure the mounting hardware permits full joint flexibility axially and laterally.



WARNING:

Be certain that the discharge expansion joint is installed correctly to avoid serious injury that can result from the sudden release of high-pressure discharge air.

Discharge Check Valve

A discharge check valve is necessary to prevent the reverse flow of air through the compressor during unloaded operation. (Refer to the Engineering drawings, supplied separately, for the exact location of the discharge check valve.)

Ingersoll Rand supplies a specifically sized, check valve for installation in a horizontal run of piping where it can properly open and close. Be sure to install this check valve with a minimum of four pipe diameters of straight pipe before and after the check valve. If the valve is not correctly sized (particularly if it is oversized) the potential for shut-off failure is increased. Before installing the check valve, refer to the Check Valve Installation drawing and locate the top marking on the valve itself to determine the correct orientation.



WARNING:

Before operating the compressor, examine the top of the check valve to be sure that the orientation of the valve is correct. Ingersoll Rand cannot be held responsible for damage or personal injury due to improper installation of the discharge check valve.



CAUTION:

Never use an oversized discharge check valve. Incorrect sizing can cause incorrect operation and lead to failure of compressor components.

Discharge Block Valve

All compressor installations must include a discharge block valve, installed after the discharge check valve, to isolate the compressor from the rest of the plant air system. This block valve provides additional protection to the compressor in the event of a discharge check valve malfunction.



WARNING:

When servicing the compressor, close and lock the block valve. Failure to do so can cause damage to compressor and personal injury.

Automatic Block Valve Option

Ingersoll Rand strongly recommends installation of an automatically actuated isolation block valve. This available option fits between two 150-lb. ANSI raised-face flanges in the discharge air piping and quickly isolates a stopped or unloaded compressor from the plant air system, providing additional protection in the event of a power disturbance or emergency shutdown.

Placement should be at least four pipe diameters after the discharge check valve. Be sure to allow room for access if the automatic block valve is to serve as a lockout device during compressor service. (See Ingersoll Rand publication AAEDR-A-008 , *Automatic Block Valve* for additional information)

Compressor Discharge Valve Installation

If the owner/installer is installing the bypass valve or the modulating blow-off valve, the installation must be in a branch of the discharge piping upstream from the discharge check valve. (Refer to the model-specific P&ID drawings for details regarding the correct location in your system.)

The bypass or blow-off valve piping must be the same size as the valve itself. Figure 3—6 shows the correct orientation of the discharge valve in relation to other components in the discharge line.

A. Compressor Discharge Flange

B. Check Valve

C. Block Valve

D. Modulating Blow-Off Valve (MBOV)
or Bypass Valve (BPV)

E. I/P Transducer*

H Vent Silencer*

M. Stepper Motor

*BOV only

1. To compressed air system

2. Control signal from control panel

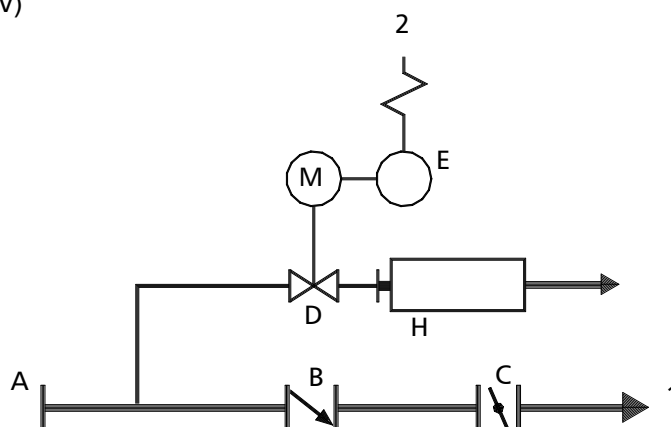


Figure 3—6 Compressor Discharge Valve Piping Detail

Compressor Discharge Valve Piping

Depending on the control method, the Turbo Air compressor will either completely or partially unload whenever the capacity of the compressor exceeds the compressed air system's demand. Upon a reduced demand in the system, one control method uses a pop-action bypass valve (BPV) to fully unload the compressor. Other control methods use a modulating blow-off valve (MBOV) to regulate the amount of vented excess air pressure.

Bypass Valve (BPV)

The BPV operates in either a fully open or fully closed position. The compressor owner/installer is responsible for the proper installation of this control valve (shipped separately) unless the compressor includes the Mounted Bypass Valve option.

Modulating Blow-Off Valve (MBOV)

The MBOV operates in any position from fully closed to fully open. A 48 volt DC stepper motor actuator with positioner is mounted to the valve body. The owner/installer is responsible for the proper installation of the MBOV (shipped separately).



CAUTION:

To assure proper compressor unloading and to prevent surging, keep a minimal pipe volume between the compressor connection and the blow-off or bypass valve. Calculate the maximum piping unit volume by multiplying the inlet volume flow per minute by 0.001 (one-tenth of 1%).

BOV Silencer

The high-pressure air expansion across the modulating blow-off valve creates considerable noise. Ingersoll Rand recommends the BOV silencer option to reduce noise produced during compressor operation.

For maximum effectiveness, the silencer must be properly connected directly to the blow-off valve. Any additional piping after the silencer should be no smaller in diameter than the silencer discharge flange. The exhaust piping from the silencer should be sized to create a back pressure on the silencer less than 5 psig (0.3 bar).

To further reduce sound at the discharge, increase the outlet opening area by cutting the pipe end at a sharp angle as shown in Figure 3—7. Avoid directing the exhaust pipe toward hard surfaces or noise-sensitive areas.

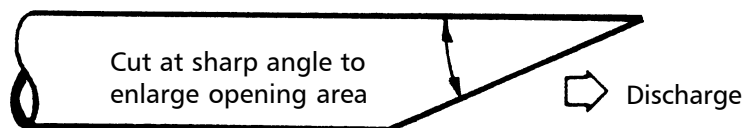


Figure 3—7 Angled Pipe End

Utility Piping

The utility piping is any external piping, tubing, or electrical conduit that supports subsystems required to complete the installation of a compressor. Utility piping includes:

- Cooling water (coolant) piping for heat exchangers
- Condensate drain piping from the intercooler and aftercooler
- Instrument air piping for the reservoir vent ejector system
- Instrument tubing from the discharge and system pressure sensors
- Electrical conduit for the main drive motor, control system, oil pump motor or optional lube oil heater
- Other tubing or conduit required for connecting any accessory sensors to the control panel

The user/installer is responsible for providing all external piping, tubing and conduit, as well as for the basic design of the utility piping. Typical arrangements for some of the utility piping are included in this section.

Installation Tips

Ingersoll Rand recommends the following for successful utility piping installations:

1. Keep the piping, tubing or conduit as short and direct as possible.
2. Clean the piping and conduit thoroughly after fabrication or assembly.
3. Support the piping and conduit properly.
4. Provide drop legs or drains at all low points to carry away any collected condensate.



WARNING:

The owner and installer are responsible for providing proper utility piping to and from the compressor. Failure to follow good industrial practices and the requirements and recommendations listed may result in poor compressor performance, mechanical failure, property damage, and/or personal injury.

Cooling Water (Coolant) Supply Piping

The typical Turbo Air 6000 Compressor package includes four water-cooled heat exchangers (two intercoolers, an aftercooler, and the oil cooler). Figure 3—8 illustrates the location of the heat exchangers. Refer to Section Two, Specifications for cooling water (coolant) requirements. The values in Section Two represent requirements for average usage. Actual requirements may differ depending on variables such as temperature, humidity, and the condition of the heat exchangers.

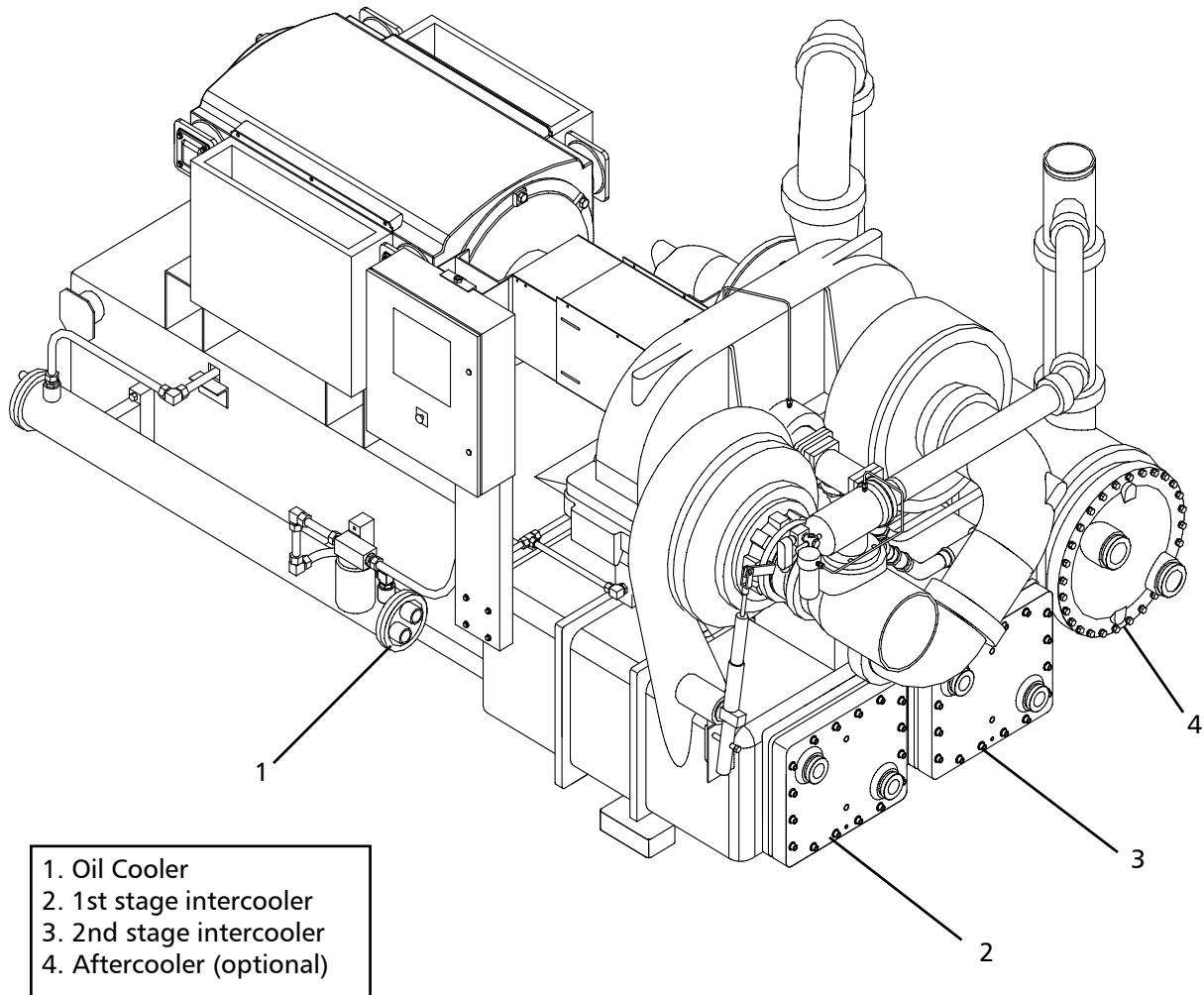


Figure 3—8. Heat Exchanger Locations

Supply and Return Lines

Figure 3—9 illustrates a typical coolant supply and return piping arrangement.

The installer must consider the distance and routing of the coolant piping when determining the appropriate sizing for the piping. Ingersoll Rand also recommends installing, when necessary, a pressure regulator to allow for pressure control of the cooling water.



CAUTION:

When fabricating the coolant supply piping (Figure 3—9), install the throttle valve on the discharge side rather than the inlet side. This ensures that the coolers are always flooded and that air locks do not form to restrict flow.

Flushing the Lines

After completing fabrication and installation of the coolant piping, and before connecting to the compressor, clear the piping of any foreign matter that might clog the heat exchangers and reduce system efficiency.

Install temporary filter screens in each of the supply branch lines, at the connection to each heat exchanger. Flush the pipes thoroughly to remove all foreign matter from the pipes.

After flushing, remove the screens, reconnect the piping and verify there are no external leaks.



CAUTION:

The owner and installer are responsible for providing properly cleaned coolant piping. Contaminated piping can result in fouling and blockages within the heat exchangers that can cause inadequate cooling and subsequent damage to the compressor.

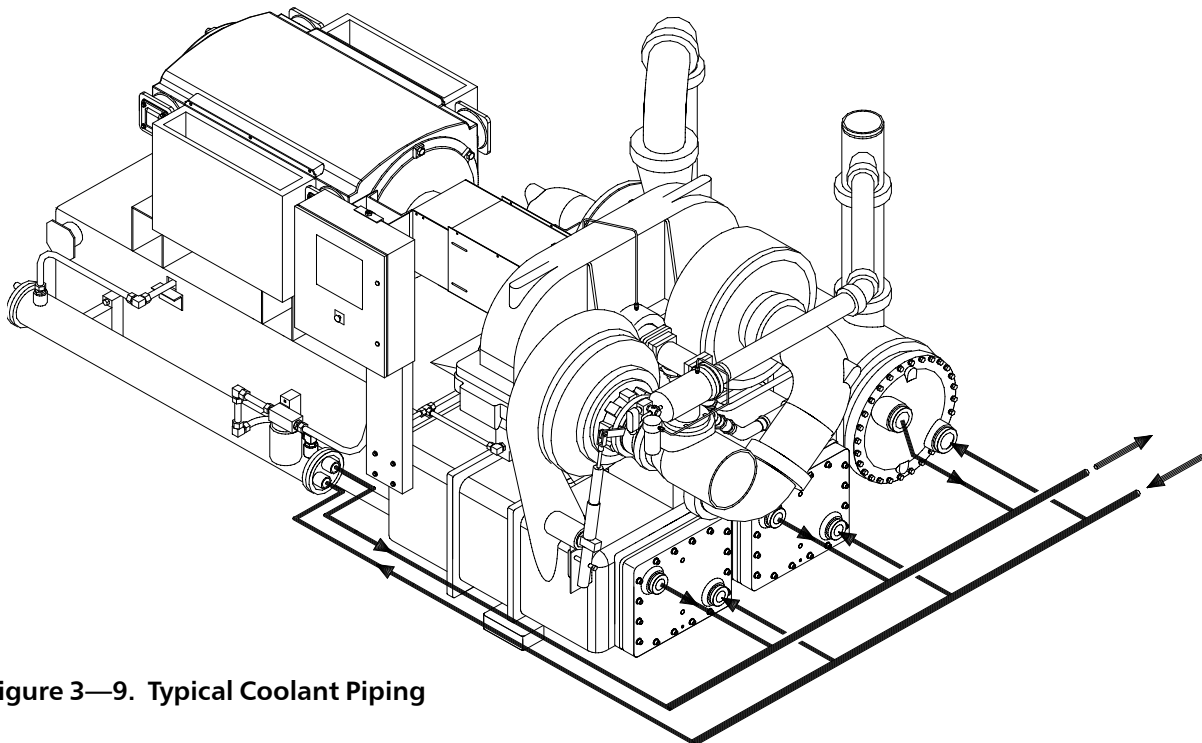


Figure 3—9. Typical Coolant Piping

Cooling Water Piping Options

Ingersoll Rand offers several coolant piping and condensate drain options that can help simplify the installation of the compressor and enhance its overall operation. Any of these features may be easily retrofitted if not included at the time of the original machine order.

Cooling Water (Coolant) Manifold Option

When this option is selected, the intercoolers, aftercooler, and oil cooler are manifolded to single inlet and outlet connections.

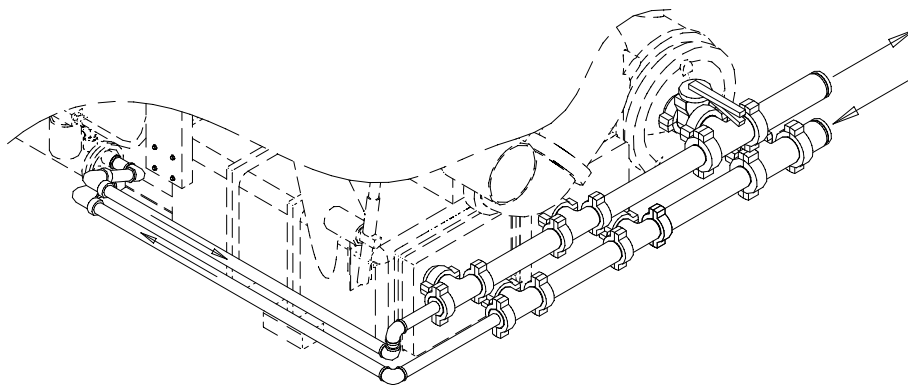


Figure 3—10. Cooling Water Manifold Option

Automatic Cooling Water Shutoff Valves

This option includes a solenoid operated (air actuated) valve, installed at the outlet connection point of the water manifold. The control system can shut off the valve whenever the compressor is not running, to stop cooling water flow.

Automatic Coolant Water Flow Control Valves

This option includes a temperature sensor/controller installed in the compressed air stream and a throttling valve installed in the cooling water stream; thus reducing water consumption during compressor unloaded operation.

Condensate Drain Piping

During air compressor operation, condensate collects in the intercooler and aftercooler chambers as the air cools. To remove the condensate and prevent its migrating into the next stage of compression, each intercooler chamber must be individually drained into an open drain or trough. An open drain allows visual verification of condensate removal while ensuring that it is not drawn back into the compressor when the compressor is unloaded.



CAUTION:

Do not manifold the three drain assemblies. This is the single most common error made at the time of compressor installation. Each must discharge individually into an open drain or trough to prevent condensate from higher-pressure chambers being forced back into lower pressure chambers.

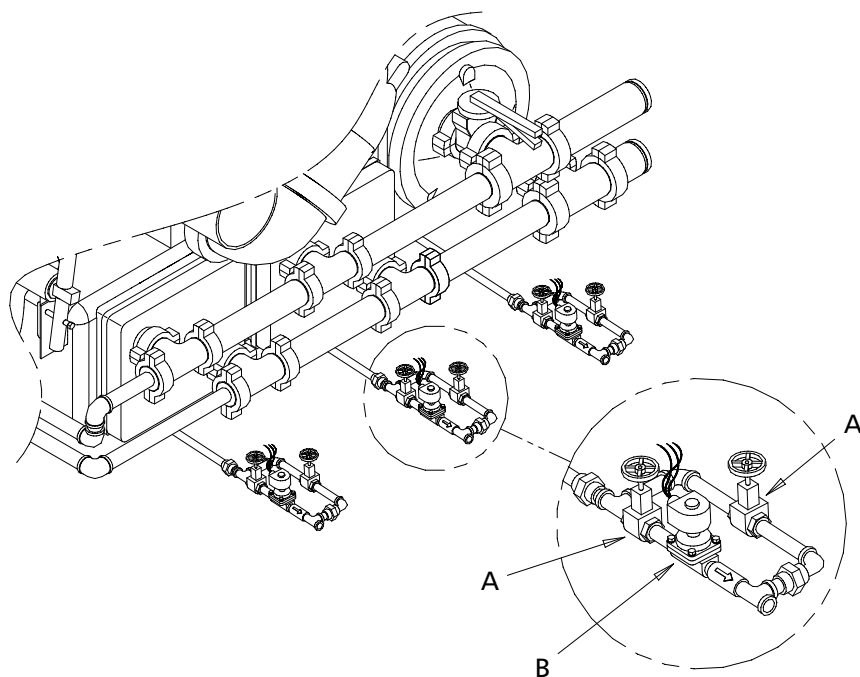


Figure 3—11. Typical Condensate Removal Piping Arrangement

Several different types of control devices are appropriate for use in the condensate removal piping system. Among the most common are the following:

- Standard gate valves, operated by hand
- Float traps that are self-actuating
- Solenoid valves, operated by the control system

Three ½" NPT condensate drain connections (one for each cooler cavity) are located at the front of the compressor. It is necessary to include a manual bypass valve (A) and piping for each selected drain control device (B). Figure 3—11 shows a typical condensate drain piping arrangement.

ReliaDrain Electronic Solenoid Condensate Drain Option

The ReliaDrain™ option is a zero loss condensate removal drain for compressed air systems. It features an electronically controlled level sensor with integrated alarm function. Its purpose is to automatically drain condensate from a compressed air system at natural collection points, without loss of compressed air. See Ingersoll Rand Engineering Data Release, AAEDR-D-006, for additional information.

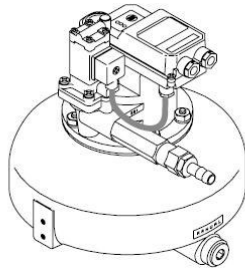


Figure 3—12. ReliaDrain™

Solenoid Condensate Drain Piping Option

The solenoid-operated drain valves are wired to the control system, which opens and closes the drain valves at user set intervals. When the valve opens air pressure within the cooler chamber expels the condensate to the open drain. See Figure 3—13 below

Pneumatic Condensate Drain Option

The Liquidator™ Pneumatic Condensate Draining System option is a demand-operated trap that automatically drains condensate without any loss of compressed air. Energy savings can be realized using this system over other, time-based, draining systems. See Ingersoll Rand Engineering Data Release, AAEDR-D-005, for additional information.



CAUTION:

The owner is responsible for properly maintaining the intercooler and aftercooler condensate removal system. Failure to provide regular maintenance can damage intercooler components and the compressors air handling parts.

- A. Solenoid Drain Valve
- B. Check Valve
- C. Manual Bypass Valve
- D. Manual Block Valve

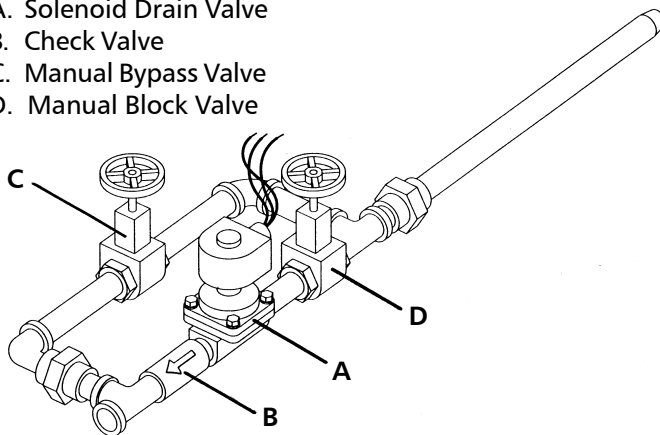


Figure 3—13. Condensate Drain Piping Assembly

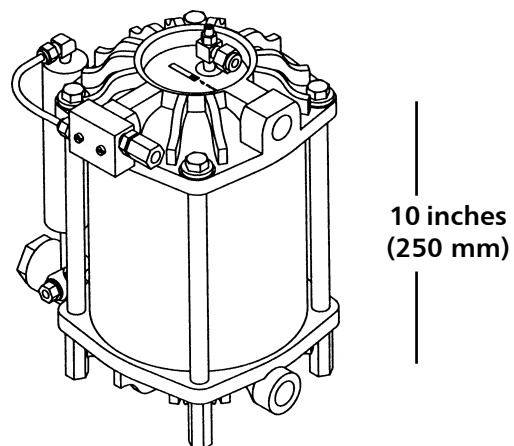


Figure 3—14. Liquidator™ Pneumatic Condensate Drain Trap

Oil Reservoir Vent Ejector Piping

The compressor gearbox and oil reservoir require proper venting to prevent the migration of oil and/or oil mist to the surrounding area or other parts of the compressor. Turbo Air compressors use a simple ejector (venturi-tube) powered by clean, dry, filtered air to create a slight vacuum within the gearbox oil reservoir.

The ejector and filter assembly is located at the top of the oil reservoir. Engineering drawings (supplied separately) define the precise connection point and specific air requirements. It is recommended that a pressure regulator with gauge be installed for control of pressure to the ejector.

The installer is responsible for correctly sizing the ejector air supply piping. (Section Four, The Lubrication System, includes additional information about the operation of the ejector/filter system.)



CAUTION:

The supply air for the ejector must come from a clean and dry source. Water in the oil reservoir will have adverse effects on the lubricating oil and can cause severe damage to the compressor.

Instrument Tubing

The external instrument tubing required to complete the installation of your compressor is shown on the contract-specific drawings.

Instrument tubing includes the connections from the required air pressure sensors and accessories to the control panel. To ensure a successful instrument tubing installation, always:

- Use steel tubing in order to avoid kinks or other common problems that are inherent with copper tubing. (Stainless steel is preferred to be sure that no foreign matter such as rust or scale can enter the pressure instruments.)
- Keep the tubing runs as short and direct as possible.
- Do not include any block or shut-off valves that can interrupt the pressure signal.
- Provide drop legs at low points with drains to carry away any collected condensate.
- Check for leaks at the connection points in order to avoid faulty sensor readings.

Electrical Interface

The user is responsible for the proper electrical connection of several components at the site installation, including the control system, the oil pump motor, the main drive motor, and the oil heater option (if applicable). Refer to the model-specific engineering drawings and other technical information supplied with your system to determine the correct power supply requirements.



CAUTION:

Do not energize or start up the compressor until a Ingersoll Rand authorized service representative has given full approval. Failure to follow this requirement will compromise any applicable warranties.

General Wiring Requirements

When planning and installing the electrical interface, it is necessary to meet the following minimum requirements:

- Be certain that the main power supply meets specifications, including voltage, frequency, and (most importantly) the current-carrying capacity of the wires.
- Provide an appropriate separate compressor earth ground that meets local and national code. (In the United States, refer to Section 250-26 of the National Electrical Code for earth ground definition.)
- Include proper disconnects such as switches or circuit breakers (either fusible or non-fusible) to provide complete isolation from the electrical supply.
- If the main power switch that controls the compressor is remotely located or if it is difficult to lock out the main switch, install a local switch that allows maintenance personnel to isolate the unit safely.



WARNING

Install and use a lockout system, including the isolating block valve, whenever performing maintenance procedures on this or any other such type of machinery.



WARNING:

Be certain that all electrical work is performed only by qualified personnel, in accordance with product specifications, and in compliance with all applicable local or national codes. Failure to follow this requirement may result in equipment damage, personal injury, or death.

Electrical Conduit

The typical Turbo Air Compressor installation requires that medium voltage, and possibly high voltage, electrical power is delivered to complete the compressor installation. The standard package-mounted components requiring electrical power are the main drive motor, the oil pump motor and the Control Panel. Other optional equipment, such as the oil heater, will also require electrical power. The National Electrical Code in the United States, as well as most other national codes, requires that the electrical wiring for this type of industrial service be encased in rigid conduit.

The user/installer is responsible for providing and designing the installation of all external electrical conduit runs. To ensure successful electrical conduit installation always:

- Use clean, non-corrosive conduit and fittings with no burrs or sharp edges.
- Keep the conduit runs as short and direct as possible.
- Support the conduit properly so as to not impart any unnecessary loads on the components to which it is being connected.
- Provide drop legs at low points with drains to remove any collected condensate.



WARNING:

The owner and installer are responsible for applying correct wiring practices. Failure to follow local electrical codes and good industrial practices could cause property damage, personal injury, or death.

Main Drive Motor Controls

The major functions of a motor-control system are:

- Starting and stopping of the motor.
- Governing motor acceleration, torque, output (power/amps), and other characteristics.
- Protecting personnel and equipment.

Ingersoll Rand Engineering Specification AAEDR-K-108, *Requirement for Starter to Main Motor Controls*, completely details the minimum requirements for proper interface between the compressor control system and the owner-supplied motor control equipment.



CAUTION:

The compressor inlet valve must be in the closed position throughout the period of motor startup. The owner is responsible for maintaining control settings that accomplish this. If the inlet valve opens before the compressor and drive motor have reached full speed, equipment damage can occur.

There are three general categories of starters for single speed, induction drive motors:

- Full-voltage starters
- Reduced-voltage starters
- Solid state starters.

When selecting the motor controls, consider the following information about these starter types.

Full Voltage Starters

The conventional full voltage starter applies full line-voltage directly to the motor terminals. These starters are available in many types, including manual, magnetic, combination, and reversing. It is also possible to add several other functions to improve protection or increase monitoring capability.

Reduced Voltage Starters and Solid-state Starters

The two commonly used types of reduced voltage starters are reduced voltage and solid state. These starter systems limit the drive motor inrush current to provide more efficient power management and better motor control than full voltage starters. Starting times for these systems may last up to 30 seconds. As above, the compressor's inlet guide vanes must not be cycled open until the motor and compressor have reached full speed.

Refer to the manufacturer documents supplied separately for more specific details on your compressor's motor controls.

NOTE:

Refer to Ingersoll Rand Engineering Specification AAEDR-K-108, *Requirement for Starter to Main Motor Controls*, for more information on minimal requirements for solid state starting equipment.

Auxiliary Oil Pump Motor

The Turbo Air Compressor electric motor driven oil pump is controlled by the control system. Once the compressor is started and the shaft-driven main oil pump is supplying the necessary pressure, the control system shuts down the electric auxiliary pump. Figure 3—16 illustrates typical oil pump motor and control system contact wiring. (The user/installer is responsible for supplying the oil pump motor starter unless it was included at the time of order)

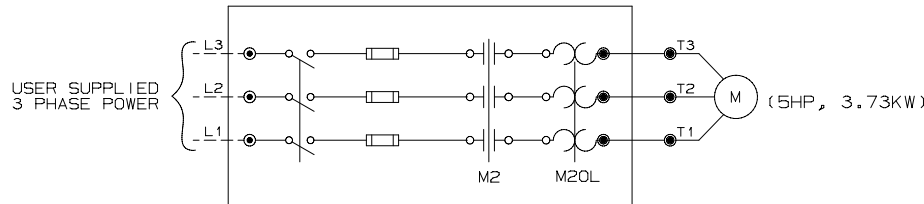


Figure 3—16. Auxiliary Oil Pump Motor Wiring

EVC Pump Motor Starter

The Turbo Air Compressor EVC motor is not controlled by the control system. After the compressor control system is energized, and before the compressor is started, the EVC should be started. Figure 3—17 illustrates a typical motor contactor wiring. (The user/installer is responsible for supplying the motor starter unless it was included at the time of order entry.)

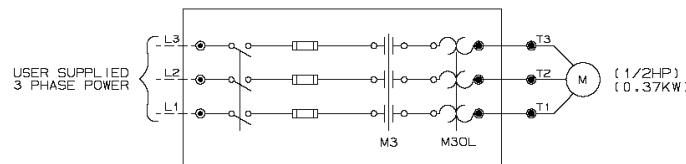


Figure 3—17. EVC Pump Motor Starter Wiring

Oil Heater Option

The supply voltage determines the wiring method for the Oil Heater option. For typical wiring for voltage applications of 480 VAC or less, refer to Figure 3—18. With voltage applications greater than 480 and below 600 VAC, refer to Figure 3—19 for a typical wiring diagram.

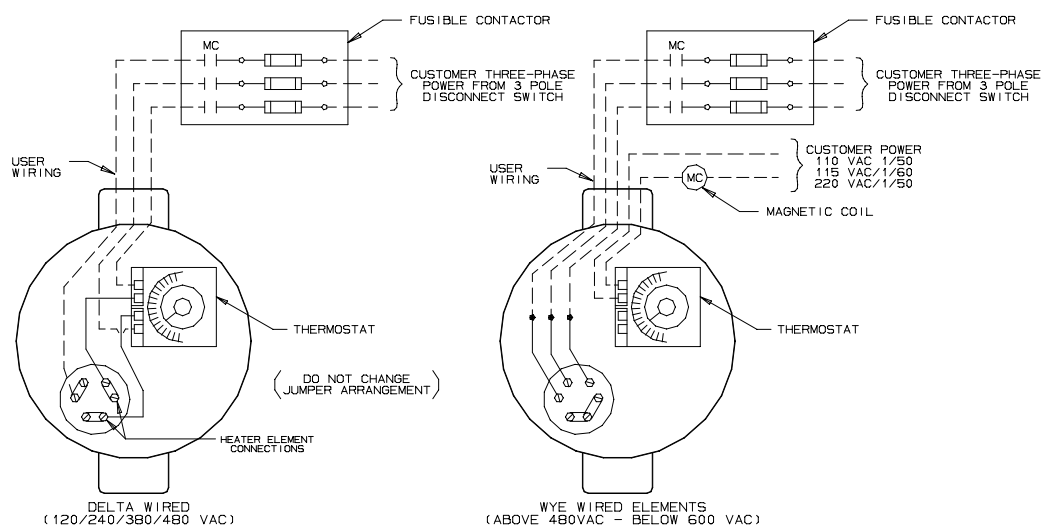


Figure 3—18. Oil Heater Option Wiring
(480 VAC or less)

Figure 3—19. Oil Heater Option Wiring
(above 480 VAC and below 600 VAC)

Receiving, Lifting, Moving, and Bolting

The time after the order for a new compressor has been placed and before the actual delivery of the equipment can be spent planning for the installation. Much of the work described earlier can be performed or planned for prior to the arrival of the compressor at the installation site.

The Turbo Air 6000 Centrifugal Compressor is shipped as a single assembly. The airend, lubrication system, and control system are packaged with the compressor on a single skid. The main drive motor, when supplied, may be installed or shipped loose depending on the size and weight of the driver. However, since there are many package and accessory options, it is important to refer to the model-specific engineering drawings supplied separately for a complete listing of equipment included in Ingersoll Rand's Scope-of-Supply.

Receiving

Ingersoll Rand personnel inspect each compressor thoroughly at the factory before shipment. They then supervise the loading to be sure that no damage occurs and document all loose-shipped equipment.

It is the responsibility of the purchaser to inspect the compressor for possible damage during transit. Therefore, **plan to inspect the compressor immediately upon delivery**. If there appears to be any damage, report it to the carrier and have the carrier inspect the compressor. After determining the extent of the damage, have the carrier complete and submit a Concealed Damage Report.

Also, be sure to check all loose-shipped parts and equipment against the packing list. If anything is missing, report the shortage to the carrier.

Lifting

The Turbo Air 6000 Compressor is a heavy and durable high technology product, but it can be damaged as a result of improper treatment. It requires careful handling during all lifting and moving. The unit includes clearly indicated lifting and moving points. Never use any other areas for lifting and moving.



WARNING:

To avoid personal injury or compressor damage, always follow the proper procedures as described in this manual. Personnel safety and compressor protection must always be foremost concerns when lifting or moving the compressor.

The Turbo Air 6000 Compressor is designed to be moved with an overhead hoist and chain. Be sure that both are properly rated for a maximum package weight of 20,000 lbs. (9072 kg) plus the weight of the driver, and be certain that they are in good working order before attempting the move. Use the clearly designated lift points on the compressor as shown in Figure 3—20. (In some instances it may be necessary to use spreader bars to clear certain main drive motors.)



WARNING:

Be certain to use properly rated equipment and lift the compressor only as shown at the lift points indicated. Improper lifting may cause compressor damage and/or personal injury.

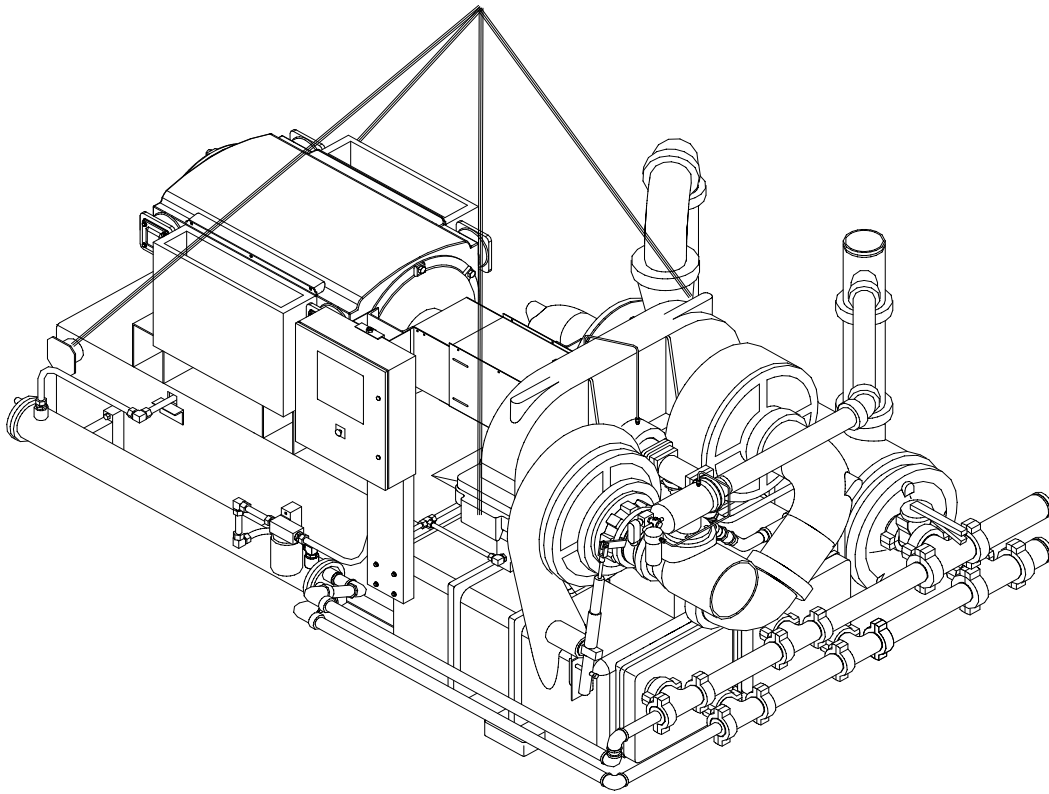


Figure 3—20. Compressor Lift Points

Moving

If an overhead hoist is not available, the compressor may be moved on dollies or casters. Alternatively, if a forklift is used to move the compressor, be certain to place the entire compressor on a substantial pallet that supports the base between the liftpoints and lift only under the base between the lift points indicated. Rollers are not recommended.



WARNING:

Before moving the compressor, verify that the moving device is the appropriate size and sufficiently strong to bear the weight of the compressor. Use of improper moving devices and/or improper moving may cause compressor damage, personal injury and/or other property damage.

Bolting

If the foundation has been properly prepared, the compressor may be put in place at this time. Ingersoll Rand recommends placing the compressor over foundation bolts, with the nuts tightened to the recommended torque value. (Refer to Section Two, Specifications, for specific information).

Take special care not to rack or twist the base of the compressor when placing it on the foundation. If necessary, use shims to level the installation package.

Closed Top Containers

The compressor may be secured to a wooden pallet and loaded into a closed top container using a pallet lift truck with extended forks. Removal from the container should include similar properly rated equipment rated as shown below. Be sure to lift only under the pallet straddling the center runner of the pallet.

Refer to the contract specific Engineering drawings supplied for the compressor weight. The compressor is to remain secured to the pallet until removed clear of the shipping container.

The compressor may also be moved on rollers, dollies, or casters.

WARNING: Before moving the compressor, verify the moving device is the appropriate size and sufficiently strong to bear the weight of the compressor. Improper moving may cause compressor damage and/or personal injury.

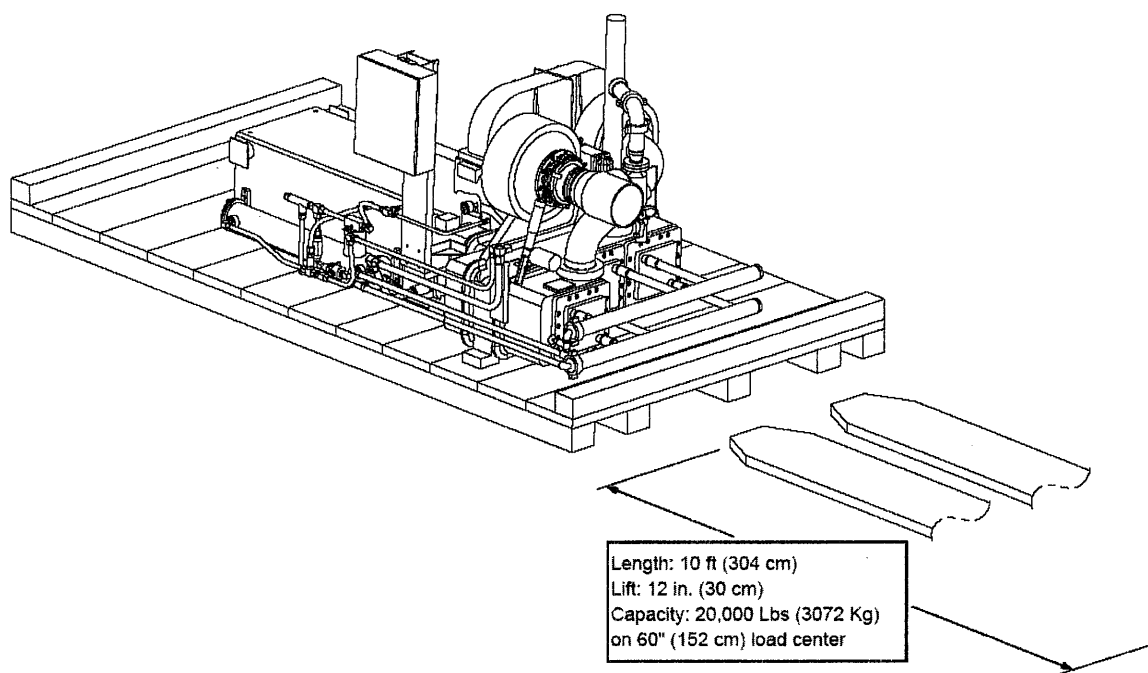


Figure 3—21. Closed Top Container

The Installation Inspection

Before performing the installation inspection, review the Turbo Air 6000 Compressor installation instructions again. Also, be sure to review any other applicable manufacturer's instructions for installation, operation, and maintenance of various other components and equipment including the main drive motor, the main drive motor controller, the air dryer, etc.

After reviewing the previous items, thoroughly inspect the compressor installation using the Installation Inspection Checklist in Table 3—2.

Inspection Prior to Initial Startup

As part of the initial startup service, your authorized Ingersoll Rand service representative verifies that the compressor is ready to be placed in full operation. The service representative should perform the following inspections and tasks as part of the initial compressor startup service.

1. Check the compressor package for possible transit or handling damage.
2. Verify that the compressor installation is in accordance with the requirements of Ingersoll Rand.
3. Verify that the inlet and discharge air piping complies with the instructions in this manual and on the contract-specific drawings.
4. Check the water and condensate drain piping for completeness.
5. Check that all electrical connections have been made correctly.
6. Verify that the compressor oil reservoir is filled with the correct amount of TurboBlend™ Lubricating Oil.
7. Rotate the compressor bullgear and main drive motor shaft (while uncoupled) by hand to verify that both rotate freely.
8. Verify the correct rotation of the main drive motor and auxiliary oil pump motors.
9. Complete the final alignment of the motor shaft to the compressor shaft within the tolerances in all planes.
10. Verify that the oil reservoir venting system is receiving the proper, clean, dry air supply.
11. Complete the 8-hour lubrication system flush procedure (Change oil filter element afterwards).
12. Verify the temperature setting of the oil heater option (if included).
13. Make any necessary control system adjustments to satisfy the user's expected requirements.
14. Oversee the reassembly of the main drive coupling.
15. Complete the Installation Inspection Checklist shown in Table 3—2 with customer's installation personnel before the initial compressor startup.

Installation Inspection Checklist	
Foundation	
✓	Meets the material and thickness requirements
✓	Compressor leveled within specification, foundation bolts properly torqued
Cooling Water (Coolant) Piping	
✓	Correctly routed and strain-free
✓	Shut-off valves installed
✓	Inlet and outlet correctly connected
✓	Cleaned and flushed free of dirt and/or other foreign matter
Condensate Drain Piping	
✓	Automatic or manual traps or valves installed
✓	Piped individually into open drains
Inlet Air Piping	
✓	Sized correctly, with minimal use of elbows
✓	Properly supported, with flexible connections at the compressor
✓	Startup screen correctly in place (if required)
✓	Clean and free of dirt and/or other foreign matter
Inlet Air Filter/Silencer	
✓	Located properly with proper surrounding clearance
✓	Elements installed according to manufacturer's instructions
✓	Clean and free of dirt and other foreign matter
Discharge Air Piping	
✓	Correct pipe material and size
✓	Properly supported, without excessive loads
✓	Block valve installed
✓	Check valve installed with recommended pipe volume
✓	Bypass or Modulating Blow-Off Valve installed with recommended discharge pipe volume
✓	Silencer installed (if required)
✓	Clean and free of dirt and other foreign matter
Oil Reservoir Vent Ejector	
✓	Properly connected to the correct amount of clean, dry air

Table 3—2 The Installation Inspection Checklist

Installation Inspection Checklist <i>continued...</i>	
Electrical Interface	
✓	Earth ground installed at control panel
✓	All applicable codes met
✓	Motors wired according to manufacturer's instructions
✓	Motor controllers and starters wired according to manufacturer's instructions
✓	Control panel wired properly
Shaft Freedom	
✓	Motor shaft freely moved when turned by hand
✓	Compressor shaft freely moved when turned by hand
Main Drive Motor	
✓	Motor manufacturer's instruction manual reviewed
✓	Motor bearings properly lubricated
✓	Motor rotation direction checked
✓	Motor 'rough' alignment completed
Lubrication System	
✓	Reservoir filled with correct type and quantity of oil
✓	Reservoir vent filter trap filled with oil
✓	Optional oil reservoir heater thermostat set to 100° F (40° C)
✓	Oil pump rotation checked
Control System	
✓	Air pressure sensors properly connected
✓	Monitoring points checked for faults
✓	Current transformer scale factor
✓	Vibration probe wiring checked

Table 3—2. The Installation Inspection Checklist

Main Drive Motor Installation Items

Before coupling the compressor and main drive motor, it is necessary to perform the following verifications:

1. Carefully follow all of the motor manufacturer's instructions (provided under separate cover) regarding preparation and installation.
2. Verify that the rating voltage and frequency shown on the motor nameplate match the power supply.
3. "Bump" (energize and quickly de-energize) the motor so that the shaft rotates only a few revolutions, and verify the direction of rotation using the directional arrow on the compressor gearbox cover. If required, change the phase wiring to reverse the direction of rotation.
4. Perform a 'rough' motor alignment, using a straight edge.
5. Verify that motor fastening bolts are properly torqued as listed in Section Two, Specifications.
6. Final motor alignment will be performed by authorized service representative. Tolerance specifications in Section Two must be achieved.
7. Dowel motor feet, per motor manufacturer requirements.

Oil Pump Motor Rotation Verification

It is necessary to verify the correct rotational direction of the auxiliary oil pump motor as follows:

1. Note the arrow indicating the correct rotation direction on the mounting flange between the pump and the motor.
2. Turn on the oil pump motor and observe the rotation direction of the motor fan. (The correct rotation is clockwise, as indicated by the arrow.)
3. If the rotation of the motor fan is not clockwise, correct the pump rotation by interchanging two of the three power phases connected to the motor.

EVC Motor Rotation Verification

It is necessary to verify the correct rotational direction of the EVC motor as follows:

1. After powering the panel, observe the air flow from the discharge downspout of the EVC unit.
2. If the air does not discharge, correct the rotation by interchanging two of the three power phases connected to the motor.

Preparing for Startup

Each compressor undergoes comprehensive testing before it leaves the manufacturing facility. However, after transit and installation, it is necessary to recheck certain items on site. Before the initial startup procedure, several inspections and adjustments are required to verify that the compressor has been installed correctly and to be sure that all subsystems are functioning correctly.

To ensure a proper and safe compressor startup and correct operation, a Ingersoll Rand factory trained and authorized service representative should be present to inspect the site, supervise the final installation steps, and assist with the startup procedure.

The Installation Inspection Checklist lists the items that the user or installer should complete prior to the arrival of the Ingersoll Rand authorized startup representative. Should any concerns or questions develop while executing this list, contact your representative.



WARNING:

Personnel safety and equipment protection must always be primary considerations during compressor installation, startup, and operation. Failure to follow the safety precautions throughout this document can result in equipment damage or personal injury

Avoiding Startup Problems

It is the owner's responsibility to plan for the inspection and initial startup service. Contact your local authorized Ingersoll Rand service representative several weeks prior to the anticipated on-site date to arrange for startup service.

Table 3—3 lists common problems or situations that can delay the installation and initial compressor start-up. The owner installer should be aware of these items and correct them, if possible, prior to the arrival of the authorized service representative.

Potential Installation Problems
• Damage during shipment
• Damage from improper lifting or from mishandling
• Earth grounds not in place
• Incorrect or incomplete electrical interface with motor controls
• Incorrectly installed bypass or blow-off valve piping
• Condensate drain piping manifolded together
• Incorrect location of cooling water supply and return piping
• Bypass valves not included on condensate drain piping
• Reservoir vent ejector piping improperly installed
• Excessive stresses on inlet, discharge, or water piping
• Temporary inlet pipe screen not available on site (if applicable)
• Correct quantity of TurboBlend™ Lubricating Oil not available on site
• Correct type of motor and/or coupling grease not available on site
• Necessary equipment, tools, supplies, and parts, not available on site
• Necessary labor not available on site
• Technical information (manuals and drawings) not available on site

Table 3—3 Potential Compressor Installation Problems

Initial Start-up Checklist

The authorized service representative uses the checklists below during initial compressor startup.



WARNING:

Do not attempt to start up the Turbo Air Centrifugal Compressor until a Ingersoll Rand authorized service representative has fully checked and approved the compressor installation. Ingersoll Rand recommends that a trained and authorized service representative perform the initial startup procedure.

Before Applying Power

✓	Verify that power to the drive motor is locked out.
✓	Push in the control panel Emergency Stop button.
✓	Verify that the isolating block valve is closed.
✓	Verify the proper location of the discharge and system pressure sensors.
✓	Check the control panel wiring for correctness, tight connections and secure harnessing.
✓	Verify that earth grounding is present and secure.
✓	Check motor starter interface wiring from control panel.
✓	Check Main motor and auxiliary oil pump overload settings.

Powered Pre-Start Checks

✓	Check the supplied panel power.
✓	Verify that the control configuration matches the job site parameters.
✓	Verify that vibration probe gaps are correct.
✓	Verify the monitoring points for correct instrument locations and secure wiring.
✓	Verify proper compressor inlet and discharge valve operation.
✓	Verify that all control setpoints are in accordance with Ingersoll Rand guidelines.
✓	Turn-on the oil reservoir vent ejector.
✓	Turn on the auxiliary oil pump motor starter.
✓	Verify proper oil pump operation. Adjust oil pressure regulator, if required.
✓	Rack in the main drive motor starter.
✓	Pull out the Emergency Stop button on the control panel.
✓	Turn on coolant.
✓	Verify the start sequence status. Correct if necessary.

Initial Compressor Startup

Following completion of all installation procedures and pre-start checks, an authorized Ingersoll Rand Service representative uses the checklist below as a guide for conducting the initial compressor startup.

Preparation	
✓	Rack in main power to compressor and control panel.
✓	Verify status using the control panel screens
✓	Verify that the isolating air system block valve is closed.
✓	Verify proper operation of compressor inlet and discharge control valves.
✓	Establish required vacuum in oil sump by adjusting regulated clean, dry air supply to the air ejector, (or turning on EVC).
✓	Turn on coolant supply.
✓	Close the condensate drain manual bypass valves.
✓	Press Unload on the control panel to prevent automatic loading.
Startup	
✓	Press Start on the control panel.
✓	Measure and make a note of the acceleration time to full speed. When able, adjust the starting sequence accordingly.
✓	Run the compressor unloaded for at least 30 minutes.
✓	Perform walk-around inspection to check for any air, water, or oil leaks.
✓	Periodically check that all operating parameters are at acceptable levels.
Manual Load	
✓	Open the isolating system block valve, if it is a non-automatic type.
✓	Manually load the compressor to its design point and allow to warm up for one hour. Do not run into the system yet.
✓	Verify proper operation of condensate removal system.
✓	Check again for any leaks and for correct values of all parameters.

Offline Loop Tuning and Surge Testing

- ✓ Run compressor loaded for approximately 1 hour to achieve thermal equilibrium. Perform the Natural Surge Test and record the results.
- ✓ Perform the surge line tests per established service procedures and record the results.
- ✓ Tune the 'non-system' control loops to optimum responses.

Performance Control Parameter Entries

- ✓ Unload the compressor.
- ✓ Enter all Performance Control parameters into the Maestro configuration, including all surge test values.
- ✓ Review all control parameters and check for input errors.
- ✓ Set the proper Operator settings for Maestro.

System Mode Tuning

- ✓ Load the compressor in Automatic control and verify proper response to control set points.
- ✓ Tune the System Pressure control loops to achieve optimum response.
- ✓ Prepare to shut down the compressor.
- ✓ Press **Stop** on the Maestro panel and verify the correct stopping sequences.

Saving the Control Configuration

- ✓ Make final adjustments to Control parameters, if required.
- ✓ Reset the Maestro Operation History.
- ✓ Save/document the final Maestro Configuration.

Section Four

Routine Operation

- ◆ General Considerations
- ◆ Routine Startup
- ◆ Routine Shutdown
- ◆ The Operating Data Record
- ◆ General Lubrication Considerations
- ◆ The Compressor Lubrication System
- ◆ Oil Pump Operation
- ◆ Gearbox and Reservoir Venting
- ◆ Optional Features

General Considerations

After successful startup, the operator should keep detailed compressor operation and maintenance records. (Refer to Section Five, Maintenance, for schedules and instructions for routine and periodic preventive maintenance procedures.)

To assure long life and optimal output from the Turbo Air Centrifugal Compressor, always follow the prescribed maintenance procedures. If problems arise, contact a factory trained and authorized service representative for technical assistance.

The Operating Data Record

It is recommended to keep an Operating Data Record to list inspections and store operating data for trend analysis. Proper use of the record form ensures that each item or procedure receives the recommended periodic maintenance.

Routine Startup

After the initial compressor commissioning and control loop tuning, use the following procedure for routinely starting the compressor.

Optional features such as Automatic Start, Automatic Block Valve, or other remote features may affect individual steps below or otherwise have an effect on the procedure in general. Refer to the instructions supplied with the specific option to determine the appropriate variation(s) of this routine startup procedure.

Startup procedure

1. Close the intercooler condensate drain bypass valves.
2. Open the main coolant supply valve.
3. Check the oil level in the compressor oil reservoir.
4. Turn on the air ejector supply pressure and adjust appropriately; if necessary.
5. Rack in the drive motor starter disconnect.
6. Start up the electric oil pump and verify correct pressure and temperature.
7. Check for any water or oil leaks.
8. Verify correct control mode and setpoints.
9. Press the **applicable** key to view and verify that the starting sequence parameters are ready. (See Controls Section for specifics.)
10. Pull out the red **EMERGENCY STOP** button.
11. Open the discharge air system block valve.



CAUTION:

Do not open the air system isolating block valve before this step. Operation under such conditions may cause compressor damage.

12. Press the **Start** key. The compressor will go through its starting sequence. (See Controls Section for specifics.)

Routine Shutdown

Use the following procedure for shutting down the compressor under normal operating conditions.

Optional features such as Automatic Start option, Automatic Block Valve, or other remote features may affect individual steps below or otherwise have an effect on the procedure in general. Refer to the instructions supplied with the specific option to determine the appropriate variation(s) of this routine shutdown procedure.

Shutdown Procedure

1. Unload compressor by pressing the applicable control key.
(See Controls Section for specifics.)
2. Allow the compressor to fully unload, then press **STOP**.



WARNING:

Never attempt to restart the compressor unless it has completely stopped. Refer to the drive motor instruction manual regarding the permissible time interval between motor starts.

3. Close the air system isolating block valve.
4. Open the condensate drain bypass valves.
5. Allow the cooling water and the oil to circulate for at least 30 minutes to remove heat.
6. Turn off the cooling water supply, if desired.
7. Stop the electric oil pump, if desired.
8. Rack out the drive motor starter disconnect, if desired.
9. Turn off the air ejector supply pressure, if desired.



CAUTION:

If the compressor is to be shut down for an extended period in a cold environment, drain all water from the system after shutdown or, alternatively, continue to maintain some flow through the coolers. Even small amounts of water remaining in the heat exchangers can freeze and damage the tubes.

Operating Data Record	
General Information	
Compressor Number:	Turbo Air Model:
Serial Number:	Recorded By: Date:
Air System	
✓ System Air Pressure:	
✓ Discharge Air Pressure:	
✓ Inlet Air Filter Pressure Drop:	
✓ Stage 1 Inlet Temperature:	
✓ Stage 2 Inlet Temperature:	
✓ Stage 3 Inlet Temperature:	
✓ Discharge Air Temperature:	
Vibration	
✓ Stage 1 Vibration:	
✓ Stage 2 Vibration:	
✓ Stage 3 Vibration:	
Cooling	
✓ Coolant Temperature In:	
✓ Coolant Temperature Out:	
✓ Coolant Pressure In:	
✓ Coolant Pressure Out:	
Lubrication System	
✓ Oil Temperature:	
✓ Oil Pressure:	
✓ Oil Filter Pressure Drop:	
✓ Oil Tank Vacuum:	
Drive Motor	
✓ Motor Current:	
✓ Ambient Temperature:	
✓ Motor Bearing Temperatures:	
✓ Motor Stator Temperatures:	
Miscellaneous	
✓ Total Running Time:	
✓ Control Mode:	

Table 4—1 Operating Data Record (Typical)

General Lubrication Considerations

Unlike some other types of rotating equipment, high-speed, geared compressors cannot operate without the correct lubrication. The Turbo Air Compressor lubrication system provides the specified supply of cooled, filtered lubricating oil to the compressor bearings and gear sprays continuously.

The main oil pump is driven by an extension of the bullgear shaft. The auxiliary oil pump is driven by a separate electric motor. The system contains all of the necessary components required to regulate, cool, filter and monitor the oil before it enters the compressor gearbox. Optional features such as dual filters, automatic temperature regulation, and reservoir heaters are available as specific conditions justify.

Helpful information about operating, maintaining and troubleshooting the lubrication system is included throughout this manual. Also refer to Section Two, Specifications, and Section Seven, Parts & Service, for replacement part details.

The Compressor Lubrication System

Figure B—1 is a schematic illustration of the compressor lubrication system showing the normal circulation of the oil through the compressor system. A description of the normal sequence of operation follows.

Normal Operation

1. The main oil pump [B], driven off of an extension of the bullgear shaft, draws oil from the reservoir [A], through check valve [N], and cycles it through the lubrication system and the compressor gearbox. Check valve [C] prevents the oil from being pumped back into the reservoir through the auxiliary oil pump [M].
2. Excess heat is removed from the oil as it passes through the oil cooler [D]. The throttle valve [E] in the return water line regulates the flow of the cooling water through the oil cooler, thereby keeping the temperature of the oil within the normal operating range.
3. The oil continues on to the oil filter [F] where impurities are removed.
4. In the gearbox [G], the oil flows through a manifold [H] where it is distributed to the bullgear bearings [I], the pinion bearings [J], and the two gear-mesh spray nozzles [K].
5. The oil flows from the bottom of the gearbox to the oil reservoir, passing around a baffle arrangement that breaks down any foam.
6. The pressure regulator valve [L] maintains the correct operating pressure throughout the lubrication cycle and returns any excess oil to the reservoir.
7. The air ejector [Q] provides the correct vacuum in the gearbox to prevent oil leakage from the pinion oil seals.

NOTE: The auxiliary pump [M] does not run during normal operation. The main oil pump provides full compressor oil flow and pressure requirements.

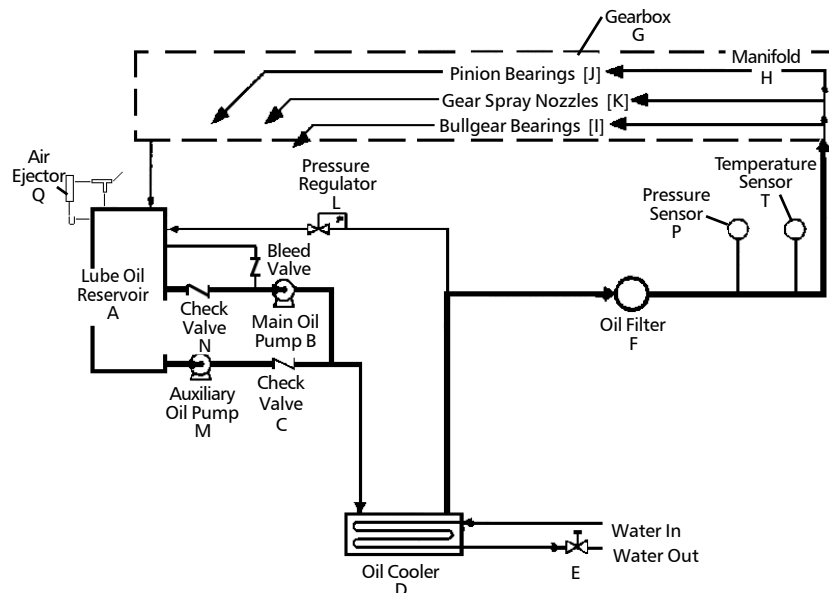


Figure 4—1 Compressor Lubrication System Schematic

Oil Pump Operation

Many customers elect to keep the auxiliary oil pump in continuous operation (even during compressor shutdown) to ensure proper lubrication at all times. However, in order for this to be done, the oil pump must be electrically isolated from all other compressor systems.

In instances when the oil pump is not kept in continuous operation, it should be kept running for a minimum of 30 minutes after compressor shutdown. This allows any excess heat to be removed from the bearings and gearing.



CAUTION:

Always maintain the proper air supply pressure to the reservoir vent ejector/filter system whenever the oil pump is in operation. Failure to do so will cause oil leaks.

Gearbox and Reservoir Venting

During centrifugal compressor operation, the action of meshing gears and the rotation of the bullgear cause air to become entrapped in the lubricating oil. As this air is released from the oil, it forms an oil-laden mist in the gearbox and the oil reservoir. It is very important that both the gearbox and oil reservoir are properly vented so that this oil mist is not allowed to escape.

Ejector/Filter

A simple venturi-type ejector/filter system creates a slight vacuum inside the gearbox and oil reservoir. The required vacuum (8 to 10 in H₂O / 200 to 250 mm H₂O) prevents oil or oil mist from migrating out into the atmosphere and/or creating other oil leaks. The ejector/filter system is illustrated in Figure 4-2.



CAUTION:

Supply air to the ejector must be clean and dry and the filter must be properly maintained. Water in the oil reservoir has adverse effects on the lubricating oil that, in turn, can cause severe damage to the compressor.

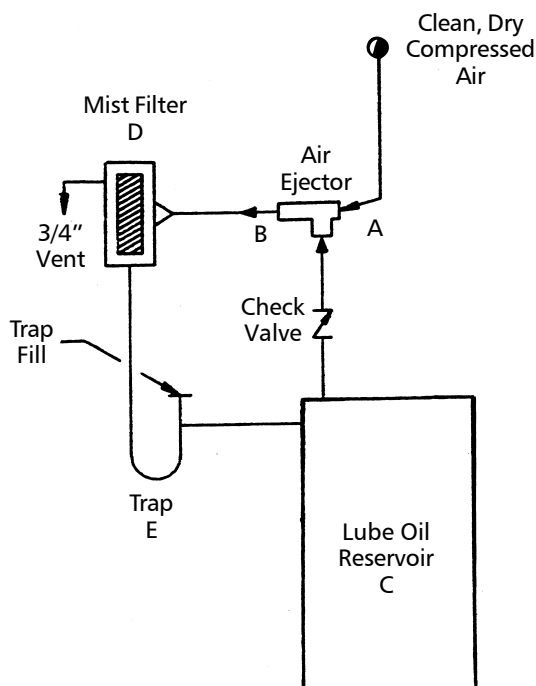


Figure 4—2 The Ejector/Filter System

Ejector/Filter Operation

Under normal operating conditions, the Ejector/Filter Arrangement operates as follows:

1. Dry, filtered, compressed air enters the ejector inlet (A) and is transformed into a high velocity stream in the ejector nozzle (B).
2. Air from the main oil reservoir (C) becomes entrained in this high velocity stream.
3. The resulting pumping action draws the oil-laden air from the reservoir and gearbox and delivers it to the filter (D), where droplets of oil accumulate and are then returned to the main oil reservoir.
4. The oil return line includes a mist trap (E) before the oil reservoir. This mist trap serves as a vapor lock to prevent the oil mist from bypassing the filter and escaping to the surrounding area.

Optional Features

Although the following components are not required for safe operation of the Turbo Air 6000 Compressor, they will bring added convenience to the overall operation of the lubrication system. If not included with the initial compressor package, they may be added at any time.

Oil Reservoir Heater

The minimum startup oil temperature for the compressor lubrication system is 60°F (15° C). Therefore, compressors that are installed outdoors or in unheated buildings may require the use of the Oil Reservoir Heater option. Such immersion heaters are rated at 1.5 kW and are available in any standard three-phase voltage up to 600 volts. The heater is installed in the oil reservoir. Figure 4—3 shows the Oil Heater option.

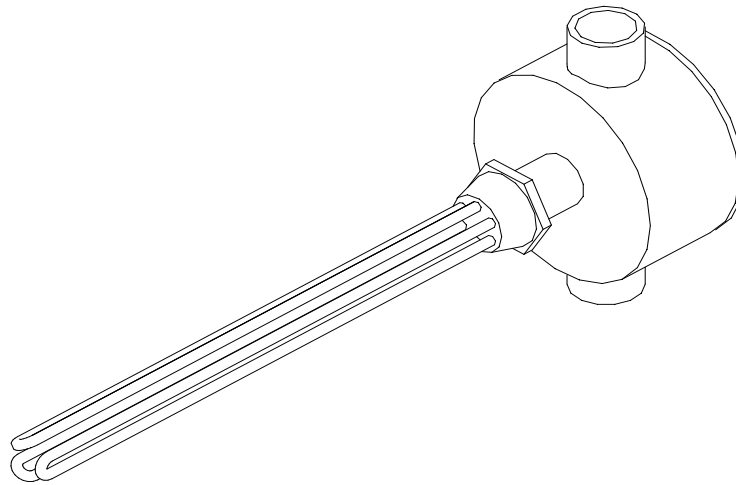


Figure 4—3 The Oil Heater Option

Thermostatic Mixing Valve

With the standard package, oil temperature is maintained by regulating the flow of cooling water through the oil cooler. This method, though effective, may require seasonal adjustments. Including the Thermostatic Mixing Valve option will automatically control oil temperature by regulating the oil flow around the oil cooler, thus keeping the temperature of the oil entering the compressor constant. The Thermostatic Mixing Valve option is shown in Figure 4—4.

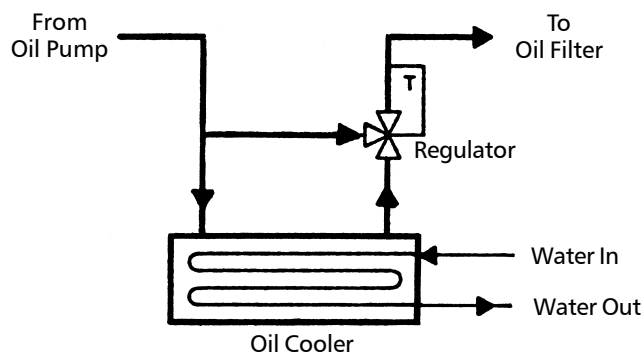


Figure 4—4 The Thermostatic Mixing Valve Option

Duplex Oil Filter

In many instances, compressed air systems operate on a continuous basis. Since it is frequently inconvenient to completely shut down compressor operation to perform a simple maintenance task, Ingersoll Rand offers the Duplex Oil Filter option. The duplex oil filter eliminates the necessity for compressor shutdown during filter maintenance. (Refer to Section Five, Maintenance, for full instructions regarding this procedure.) The Duplex Oil Filter option is shown in Figure 4—5.

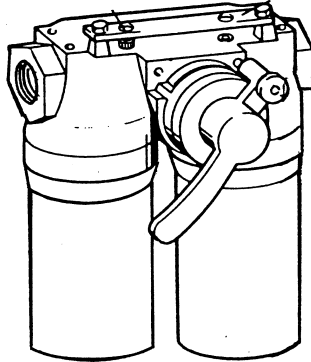


Figure 4—5 The Duplex Oil Filter

Oil Filter Differential Pressure Monitoring

With this optional feature, a second pressure transducer is installed before the oil filter. (The system's standard pressure transducer is located between the filter and the gearbox.) In such instances, the Maestro Control System is programmed to calculate the differential pressure across the oil filter and to provide Alarm and Trip functions. The Oil Filter Differential Pressure Monitoring option is particularly useful when included as part of a predictive maintenance program. Figure 4—6 shows the Oil Filter Differential Pressure Monitoring option.

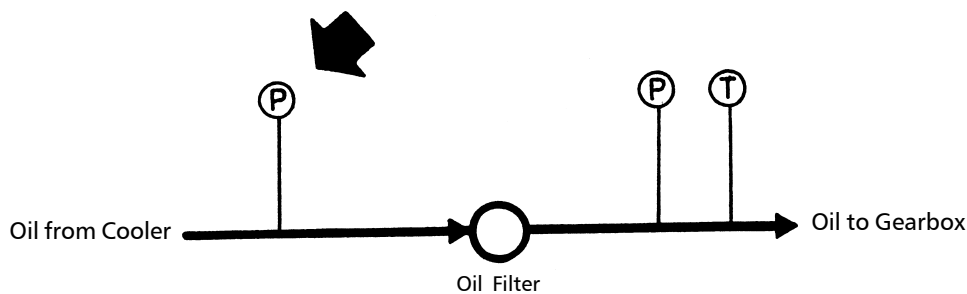


Figure 4—6 Oil Filter Differential Pressure Monitoring Option

Low Oil Level Indicator

With the installation of the Low Oil Level Indicator option (a switch located in the main oil reservoir) the Maestro Control System will report any oil level in the reservoir that is below a pre-defined level. The control system then indicates an Alarm condition to alert the operator of the problem.

Electric Vacuum Coalescing (EVC) Mist Eliminator

In place of an air driven mist eliminator for gearbox and oil reservoir venting, an Electric Vacuum Coalescing filter assembly may be supplied. This optional device includes an electric motor driven vacuum pump to induce a vacuum in the compressor gearbox and oil reservoir. This device features a coalescing filter element to separate the fine oil mist/vapor from the air being pulled from the compressor. The oil drains from the filter canister back into the oil reservoir; the air is discharged to atmosphere. To control the vacuum being pulled a ball valve with filter is used to draw outside air through the filter canister.

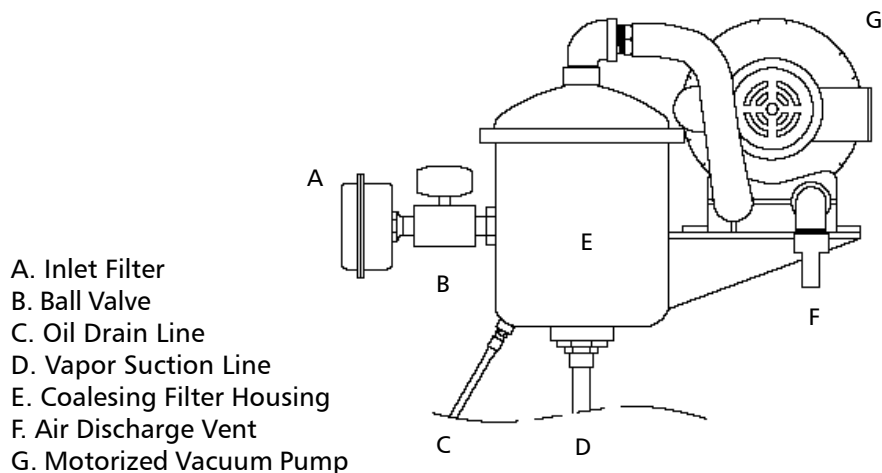


Figure 4—7. EVC

Section Five

Maintenance

- ◆ General Considerations
- ◆ Daily Inspection
- ◆ Scheduled Maintenance
- ◆ Professional Inspection
- ◆ Filter Maintenance
- ◆ Lubrication
- ◆ Heat Exchanger Maintenance
- ◆ Control Valves

General Considerations

The Ingersoll Rand Turbo Air Centrifugal Compressor requires minimal maintenance. However, monitoring operating conditions on a daily basis is good practice. It allows the operators to become familiar with a smooth running machine, which enables early detection of potential problems.

As with other types of highly developed machinery, compressors are subject to operational changes resulting from environmental conditions, wear, or neglect. A plugged condensate drain, unusual noises, increases in temperature or vibration, and fluid leaks are some examples of operational changes that signal potential problems. By recognizing and responding to changes in operation you can prevent unscheduled shutdowns and the expense of unanticipated repairs.

**CAUTION:**

Do not attempt service procedures other than those described in this manual. Even a minor adjustment, incorrectly performed could cause serious damage. Contact an Ingersoll Rand trained and authorized service representative for help with all other procedures.

Daily Inspection

A proper daily inspection allows the operator to develop a sense for the appearance, sounds, and other operating conditions of a smoothly performing compressor.

Daily Operator Inspection Checklist	
WARNING: Exercise care when in the vicinity of hot surfaces, pressurized air, and high voltages. Procedures accompanied by the alert symbol  require special precautions as indicated.	
Operating Data Log	
✓	Operating Parameters recorded and within specifications
✓	Setpoints Checked
Gearcase	
✓ 	External surfaces wiped clean
✓	No unusual noise or vibrations
✓	No oil leaks
✓	No air leaks
✓ 	No frayed or worn electrical cables
Intercoolers and Aftercooler	
✓ 	External surfaces wiped clean
✓ 	Condensate drains functioning properly
✓	No cooling water leaks
✓	No air leaks
Lubrication System	
✓	External surfaces wiped clean
✓	Proper oil level in oil reservoir
✓	Proper oil color
✓	No mist from ejector system
✓	No oil cooler water leaks
✓	No oil leaks
✓ 	No frayed or worn electrical cables
Compressor Drive Motor <i>(Inspect visually only—high voltages, temperatures)</i>	
✓ 	External surfaces wiped clean
✓	Properly ventilated
✓	No erratic or noisy operation
✓ 	No frayed or worn electrical cables
✓	Inspected in accordance with manufacturer's recommendations

Table 5—1 Daily Operator Inspection Checklist

Scheduled Maintenance

Table 5—2 lists the intervals for prescribed scheduled maintenance procedures. These intervals may vary with operating conditions and/or actual hours of machine operation. Some items may require attention more or less frequently as circumstances dictate.

NOTE: For maintenance of any compressor accessory not shown, refer to the specific maintenance instructions for that item

Scheduled Maintenance Procedures <i>When servicing the Turbo Air 6000 Centrifugal Compressor, use only genuine Ingersoll Rand replacement parts and recommended supplies available through Ingersoll Rand and/or authorized representatives.</i>	
Daily:	
✓	Operating data logged and reviewed
Monthly:	
✓	Inlet air filter elements inspected, replaced if required
✓	Oil reservoir venting system filter elements inspected, replaced if required
✓	Compressor bypass valve filter checked (if applicable)
✓	Control system operation checked
✓	Intercooler/Aftercooler condensate removal system checked
Quarterly:	
✓	Drive Motor ball lubricated per manufacturer's instruction*
✓	Condensate traps cleaned and inspected
✓	Compressor operational data analyzed
✓	Intercooler, aftercooler, and oil cooler performance verified
✓	Lubrication system oil analyzed
✓	Verify oil heater operation (if applicable)
✓	Verify correct operation of compressor inlet and discharge valves
✓	Verify discharge check valve operation
✓	Control setpoints checked

**Refer to the motor instructions for specific interval guidelines.*

Table 5—2 Scheduled Maintenance Procedures

Continued on next page.

Scheduled Maintenance

Table 5—2 continued.

NOTE: For maintenance of any compressor accessory not shown, refer to the specific maintenance instructions for that item

Scheduled Maintenance Procedures <i>When servicing the Turbo Air 6000 Centrifugal Compressor, use only genuine Ingersoll Rand replacement parts and recommended supplies available through Ingersoll Rand and/or authorized representatives.</i>	
Every Six Months:	
✓	Lubricate main drive motor (see motor manual)*
✓	Main drive motor maintenance checks completed*
✓	Main drive coupling checked
✓	Verify proper motor alignment
✓	Lubrication system oil tested and changed if required
✓	Oil pump motor lubricated with recommended grease (if required)
✓	Verify operation of main and aux pumps
✓	Oil system filter element changed
✓	Oil reservoir venting system filter element changed
✓	Coolant and condensate chemically tested
✓	Intercooler / Aftercooler condensate removal system cleaned and inspected
✓	Inlet guide vane assembly inspected and drive screw lubricated
✓	Bypass valve air filter replaced, if applicable
✓	Inspect compressor discharge valve
✓	Discharge air check valve inspected
✓	Verify vibration gap voltage
✓	Test E-stop circuit
✓	Verify proper control panel set up
✓	Perform surge test and record results

**Refer to the motor instructions for specific interval guidelines.*

Table 5—2 Scheduled Maintenance Procedures - continued

Professional Inspection

An effective preventive maintenance program includes a professional inspection after an established interval based on jobsite conditions. Table 5—3 lists items that are typically performed with a professional service inspection. Contact an Ingersoll Rand trained and authorized service representative for those procedures as they are not intended for unauthorized personnel.

Service Inspection Checklist	
<i>To be performed with an Ingersoll Rand authorized representative:</i>	
Operating Data Log	
✓	Recent data logs and maintenance history reviewed with customer
Gearcase*	
✓	Impellers, inlets, and diffusers cleaned and Inspected
✓	Gearing visually checked
✓	Gearing backlash clearances measured
✓	Axial pinion floats measured
✓	Clearances between impellers and inlets checked
Intercoolers* and Aftercooler*	
✓	Bundle tubes inspected, cleaned if required
✓	Bundle fins inspected, cleaned if required
✓	Cooler cavities cleaned and inspected
✓	Condensate removal system cleaned and inspected
✓	Cooling sensors checked
Lubrication System*	
✓	Piping connections checked for leaks
✓	Oil visually inspected
✓	Oil cooler inspected
✓	Oil pumps inspected
✓	Oil system sensors checked
Filters	
✓	All filter elements inspected and replaced as required
Control Panel	
✓	Inspected for proper configuration and operation (adjust as required)
Control Valves	
✓	Inlet Guide Vane inspected and adjusted
✓	Discharge air check valve inspected
✓	Compressor modulating blow off or bypass valve inspected and adjusted
✓	Auto block valve inspected (where applicable)
Drive Motor	
✓	Main drive coupling inspected
✓	Motor inspected in accordance with manufacturer's instructions

**Replacement parts required. Use only genuine Ingersoll Rand parts and supplies available through the Ingersoll Rand and/or authorized representatives.*

Table 5—3 Service Inspection Checklist

Filter Maintenance

Different types of filters are located in various parts of the compressor package. The operator must regularly monitor the condition of these filters and clean or change them as required.

Table 5—4 lists the various filters along with recommended inspection intervals for typical operating environments. Instructions for each procedure are included in this section.

Filter Maintenance Schedule		
Filter:	Inspect:	Clean or Change:
Inlet air filter elements*	Monthly	When dirty or after 12 months
Bypass valve air supply filter*	Monthly	When dirty or after 6 months
Oil reservoir venting system*	Monthly	With misting or after 6 months
Oil system filter element*	N/A	At Alarm level or after 6 months

**When replacing filter elements, use only genuine Ingersoll Rand products. Refer to Section Seven, Parts and Service, for more information on parts that are available through your Ingersoll Rand representatives.*

Table 5—4 Filter Maintenance Schedule

Inlet Air Filter

The standard inlet air filter is a two-stage unit. The primary filter may be removed, cleaned, and reinstalled but the secondary filter element is not serviceable and must be replaced when it becomes dirty.

Note: Special optional primary filters may not be cleanable

Since compressor operation without the action of the primary filter will contaminate the secondary filter very rapidly, Ingersoll Rand recommends that you keep a complete set of replacement filters on hand.

Standard Primary Filter Cleaning

The only reliable method to determine whether cleaning or replacement is necessary is to monitor the pressure drop across the filter elements. Use this procedure:

1. Install a differential pressure gauge in either the inlet filter housing or the inlet pipe.
2. Measure and record the current pressure drop. Compare that with the one initially taken when the new filter elements were installed. A pressure drop that is 4" (100 mm) WC, or more, greater than the original reading means the filters require maintenance.
3. Remove and inspect the primary filter element.
4. When If the primary filter is dirty, clean it using either of these methods:
 - Blow 30 psi (2kg/cm² or bar) of air from the clean side, or...
 - Soak and periodically agitate the filter in hot water containing a non-volatile cleaning agent. Be sure to air dry the filter completely before installation.
5. Measure and record the pressure drop with the new filter element installed.
6. If, after cleaning or replacing the primary air filter, the air pressure drop remains high with the clean or replacement primary filter, replace the secondary filters.



CAUTION: Do not operate the compressor for more than 2 minutes without the primary filter. Operation without proper filtration may cause compressor damage or malfunction.

Bypass Valve Air Supply Filter

(For solenoid unloading bypass valves only)

The solenoid bypass discharge control valve requires clean dry supply air for proper control. The line filter in the pilot air supply prevents water and other contaminants from entering the valve and fouling its control mechanism. **Use only an Ingersoll Rand replacement filter.**

Filter Element Replacement

The replacement procedure is as follows:

1. Shut down the compressor and exhaust any pressure in the bypass valve air supply line.
2. Unscrew the filter canister from its base and separate the filter element by removing the filter retaining nut.
3. Inspect the canister o-ring seal and replace if worn or damaged.
4. Install the new replacement filter element.
5. Replace the retaining nut (finger-tighten only) and screw the filter canister to its base.

Oil Reservoir Vent Filter

The oil reservoir is vented through an air ejector-filter system that requires a clean dry air supply to function properly. Moisture that can accumulate in the filter element eventually drains back into the reservoir, contaminating the lubricating oil. The filter element must be replaced at least every six months. **Use an Ingersoll Rand replacement filter only.**



CAUTION:

Water in the oil reservoir adversely affects the lubricating oil and can cause severe damage to the compressor. Be sure the ejector's supply air is clean and dry and the filter is properly maintained during periods of high humidity.

Filter Element Replacement

Check the exhaust port at least daily. If an oil mist is evident, that is an indication of a clogged filter element. Using the following procedure, replace the element.

1. Remove the trap line between the bottom of the filter housing and the oil reservoir.
2. Unscrew the retaining nut at the bottom of the housing.
3. Catch any excess oil in a separate container.
4. Slide down the lower housing section to expose the filter element.
5. Remove the nut holding the filter element in place, remove the element, and (being careful not to over-tighten the retaining nut) install a new replacement element.
6. Inspect the o-ring seals at the top of the lower housing section and in the retaining nut. Replace the seals if worn.
7. Wipe the housing clean.
8. Begin filter reassembly by pouring a small amount of oil into the fill connection at the top of the trap line to restore the mist filter trap. The ejector cannot function without this trap.
9. Complete the reassembly.

Standard Oil Filter Element Replacement

Ingersoll Rand has specially designed bearing and gearing configurations, not found on other compressors. Regular maintenance of the oil filtration system is critical to the lasting operation of these sophisticated components. Use the following procedure to replace the standard oil filter element.



CAUTION:

Use only Ingersoll Rand original equipment replacement filters. Use of improper filters can damage internal compressor components and will void any existing warranties.

Filter Element Replacement Procedure

1. Shutdown and lock-out the compressor.
2. Close the manual isolating block valve.
3. After the compressor is completely stopped, verify that the discharge air pressure is zero, and then shut off the oil pump.



WARNING:

Do not attempt to remove any oil filter until oil pressure is at zero (0). Hot oil under pressure presents a safety hazard to personnel.

4. Remove the spin-off oil filter and catch any excess oil in a separate container.
5. Inspect the new filter and then, using clean oil, lightly lubricate the gasket.
6. Install the new filter element by threading it on and continuing to turn it until hand tight, plus an additional 1/4 turn.
7. After verifying that the oil level is correct, start the pump and inspect for possible leaks.

Duplex Oil Filter Element Replacement

The Duplex Oil Filter option allows for oil filter replacement without shutting down the compressor. When required, replace the duplex oil filter elements as follows:



WARNING:

Be sure the chamber to be serviced is not being used. Do not attempt to remove the oil filter element until the oil pressure in the chamber is at zero (0). Hot oil under pressure presents a safety hazard to personnel.

Filter Element Replacement

1. Using an Allen wrench, turn the bleed screw counterclockwise until the screw head touches the safety plate on the side not in use (opposite the locking pin).
2. Inspect the new filter and then, using clean oil, lightly lubricate the gasket.
3. Unscrew the filter bowl, and remove the old filter element. Catch any spillage in a separate container.
4. Install the new filter element and replace the filter bowl. **Use only an Ingersoll Rand replacement filter.**
5. Depress the balance valve lever until oil begins to bleed through the bleed screw.
6. Turn the bleed screw clockwise until tight. Depress the balance valve lever once more to pressurize the filter bowl.

Lubrication

Table 5—5 lists recommended intervals and the products necessary for proper lubrication of various Turbo Air Compressor components.

Instructions for these periodic lubrication procedures are included in this section.

Compressor Lubrication Schedule		
Element	Interval	Lubricant
Main oil reservoir Change only as required.	Monitor daily.	Ingersoll Rand TurboBlend™ Lubricating Oil
Auxilliary Oil pump motor bearings (If applicable)	Six months	Refer to Section Two
Drive motor ball bearings	[A]	[A]
Drive motor sleeve bearings	[A]	[A]
Inlet guide vane actuator drive screw	Six months	High quality synthetic grease

[A] Refer to the motor manufacturer's instructions for specific interval guidelines.

Table 5—5 Compressor Lubrication Schedule

Compressor Lubricating Oil

Ingersoll Rand cannot specify a fixed interval between lubrication system oil changes because of the wide variety of operating conditions that exist. Therefore, daily the operator should check the oil visually to monitor changes and/or possible deterioration.

If the oil appears darker than normal, there is probably some contamination.

If the oil appears muddy or contains any white emulsion, there is some contamination with water.

Quarterly or as the situation requires, have the oil tested for viscosity, acid, water and other contamination. A reputable commercial laboratory can easily detect the presence of any such contamination.

Whenever the performance of the lubricating oil is suspect, Ingersoll Rand recommends additional testing for the presence of enhancing additives in accordance with The American Society for Testing and Material (ASTM) as defined in Table 2—1, Oil Specification.



CAUTION:

Be certain to use only Ingersoll Rand TurboBlend™ Lubricating Oil for optimum performance. Use of any incorrect oil can cause extensive damage to internal components and will void any existing warranties.

Auxiliary Oil Pump Motor Bearing Lubrication

Examine the electric oil pump motor to determine the type of bearings it has. The standard Turbo Air compressor oil pump motor uses sealed bearings that do not require lubrication. However, the bearings in some non-standard motors do require lubrication.

Periodic lubrication is necessary if the oil pump motor bearings have grease fittings. Use a good quality, polyurea-based grease, adding 1/4 oz. (7 gm.) to each fitting. It is not necessary to lubricate the oil pump coupling.

Drive Motor Ball Bearing Lubrication

Most Turbo Air Compressors are driven by a squirrel-cage induction motor with ball bearings. The ball bearing grease must be changed in accordance with the motor manufacturer's recommendations. Be aware that many motor manufacturers require lubrication every three months.



CAUTION:

Do not use excessive amounts of grease. Over-greasing may cause premature bearing wear and motor failure.

Drive Motor Sleeve Bearing Lubrication

Some Ingersoll Rand Turbo Air Compressors have drive motors equipped with sleeve bearings. Most of these have oil reservoirs in the motor bearing housings. Fill the reservoirs and maintain per the motor vendor's recommendations. Other sleeve bearing motors are lubricated directly from the compressor's lubrication system; periodically check the oil pressure to the motor and adjust to read 20 to 30 psi.

Inlet Guide Vane Assembly Drive Screw

Most Turbo Air 6000 compressors have an electrically driven inlet guide vane assembly with a drive screw mechanism.

NOTE:

Inlet guide vanes driven by a pneumatic actuator do not have drive screws.

Drive Screw Lubrication

The inlet guide vane assembly drive screw requires lubrication every six months using the following procedure:

1. Unscrew the cover tube at the motor bracket.
2. Carefully pull away the cover tube, just enough to expose the drive screw.
3. Using a clean cloth, wipe off all the old grease from the drive screw surface.
4. Work fresh grease into the drive screw by hand, being sure to use sufficient grease to cover all surfaces thoroughly.



WARNING:

Use only the recommended high quality, synthetic grease for this procedure. Under certain conditions, other products may contribute to mechanism malfunction.

5. After greasing is complete, replace the cover tube and screw it back to the original position.

Additional Maintenance Procedures

In addition to periodic inspections and maintenance of the filter and lubrication systems, some maintenance will also be necessary on an “as required” basis.

Instructions for each follow.

Other Maintenance Procedures	
Procedure:	When Required:
Intercooler/aftercooler cleaning*	With elevated interstage air temperatures
Condensate drain cleaning	Quarterly or sooner, if required
Oil cooler cleaning*	With elevated oil temperature
Main Drive Coupling	Annual
Inlet guide vane and blow off valve inspection	At 6-month intervals
Discharge air check valve inspection	At 6-month intervals
Additional main drive motor items	Per manufacturer’s instructions

* Indicated procedures require the use of parts available through your authorized Ingersoll Rand representative.

Table 5—6 Other Maintenance Procedures

Intercooler and Optional Aftercooler Cleaning

In most cases, the coolers should be cleaned when the interstage air temperatures increase significantly. Before doing so, check for other possible causes of an increase in air temperatures:

1. Verify that ambient conditions are not above compressor design parameters.
2. Be sure the temperature sensors are functioning properly.
3. Verify proper coolant temperature and flow.
4. Be sure that all condensate drains are functioning properly.

The best indicator of the performance level of the intercoolers and aftercooler is the approach temperature. This is the difference between the temperature of the *air* leaving the cooler and that of the coolant entering it. Record that information for each cooler when the compressor is first installed and running at full load. If an approach temperature exceeds the original value by 15°F (8°C), the coolers should be inspected, and cleaned if required.

The Ingersoll Rand compressors have tube-and-fin style intercoolers and aftercoolers, with coolant flowing through the tubes. A U-tube design is standard for intercoolers. Straight tubes are available as an option on intercoolers, standard on aftercoolers.

The following pages provide the recommended procedures for proper disassembly and thorough cleaning of the tube-and-fin cooling units.

Intercooler and Aftercooler Disassembly

Follow this procedure to separate the tube bundle from its casing:

1. Shut down the compressor and exhaust all air pressure. Lockout the main motor starter and close the system block valve.
2. Shut off the cooling water supply and remove the supply piping at the compressor.
3. Drain the coolant, and then remove the intercooler front headers.
4. Remove the intercoolers from the cooler cavity. Referring to Figure 5—1, determine the type of bundle (U-tube or straight tube). If it is a straight tube type, remove the rear header.
5. Inspect the cooler casings for corrosion.
6. Remove all loose scale from the interiors of the cooler cavity, water headers, and manifold pipes.



CAUTION:

Do not allow the loose debris to enter the condensate drain lines. This could cause plugging of the drains.

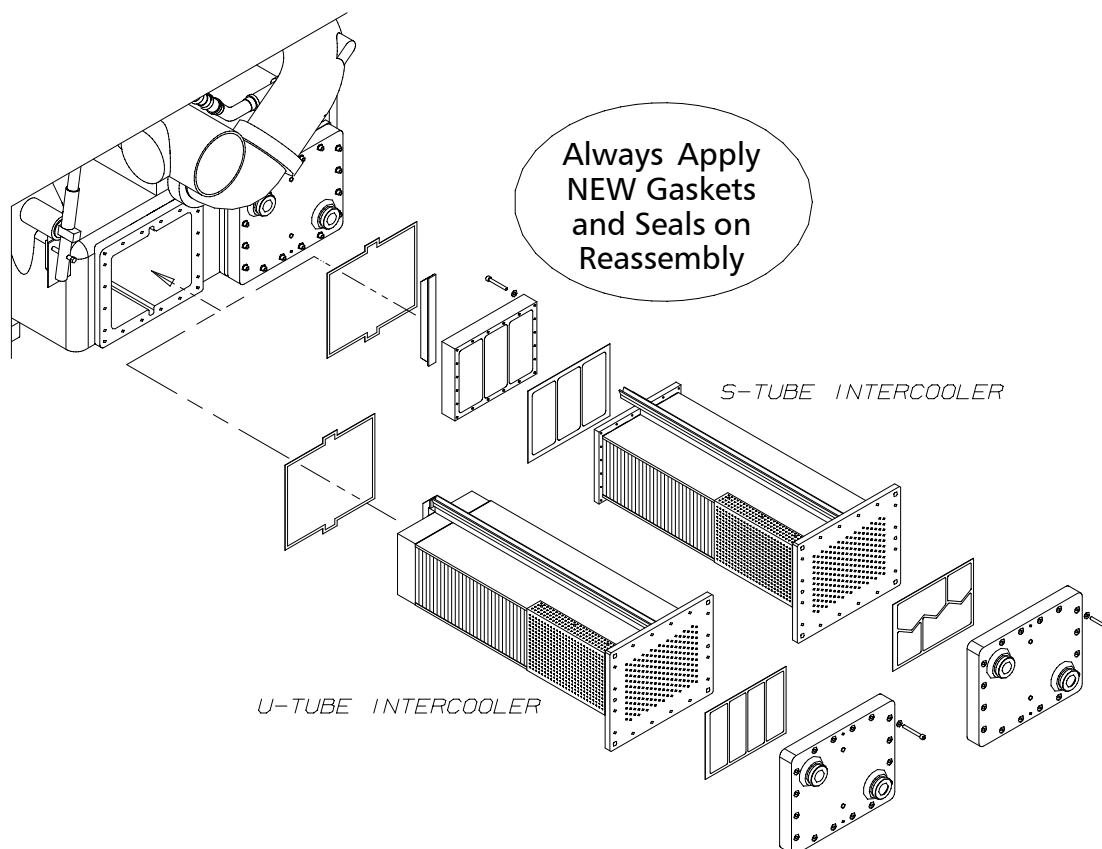


Figure 5—1 Intercooler Disassembly
(Aftercooler not shown, similar to S-tube intercooler)

Water Side Cleaning

After disassembly, proceed with the cleaning as directed below:

1. Using a 1/8" (3 mm) rod, probe the length of the intercooler tubes to check and clear for any blockage.

NOTE: If the cooler has U-tubes do not force the rod into the U-bend.

2. For straight-tube bundles, attempt to rod them out per steps 5 through 7 below. If successful proceed to step 11, below; otherwise continue with the next step.
3. Stand the bundles with the tube openings up, and fill the tubes with commercial descaling agent such as *Rydlyme*.
4. Allow the tubes to stand for 2 hours with the descaling agent inside; then completely drain the descaling agent from the tubes and flush them thoroughly with water.



WARNING:

Be sure to follow the manufacturer's instructions for safe handling and disposal of such products. Failure to do so could cause personal injury and/or create a biohazard.

5. Attach a 1/4" (6 mm) diameter soft bristle brush (nylon or brass) to a 20" (500 mm) long rod and connect the assembly to a drill motor.
6. Power the rod/brush assembly in and out of the tubes, while continuously flushing with water throughout the procedure to clear loose debris from the tubes.)

NOTE: If the cooler has U-tubes do not force the rod into the U-bend.

7. Repeat the previous step with the next larger brush size, progressing (using the same procedure with each brush) until the largest size is reached.
8. When the brush cleaning is complete, drain all the water from the tubes and then fill them to the top with a descaling agent. Allow the descaling agent to remain in the tubes for 1 hour.



CAUTION:

Do not leave the descaling agent in the tubes for more than 1 hour, and do not allow the descaling agent to make contact with the intercooler fins

9. Drain the descaling agent and thoroughly flush the tubes with clean water.
10. Again using the drill motor and the rod/brush assembly, brush in and out of the tubes using the largest brush (3/8" or 10 mm) while simultaneously flushing out the tubes with clean water.
11. If necessary, clean the air side of the heat exchanger. (Refer to the procedure that follows for complete instructions.)
12. Clean all gasket and seal surfaces, reassemble the unit using all new gaskets and seals, and then reposition it in the cooler cavity of the compressor.

Air Side Cleaning

It may also be necessary to clean airborne contaminants from the air side of the coolers. To clean the intercooler fins on the air side, use compressed air, pressurized water, or steam. Loosen any dirt or debris as follows:

1. Remove the upper and lower baffle plates to expose the complete finned surface.
2. Clean the fins by passing a 30 psi (2 kg/cm² or bar) air stream across them. If air is not available, use a low-pressure steam or water spray to clean the fins.
3. If necessary, clean any contaminant buildup from the aluminum fins by using a chemical cleaning agent such as *Coil Boil*. Make sure the cleaner is safe to use on aluminium.



WARNING:

Be sure to follow the manufacturer's instructions for safe handling and disposal of the chemical cleaning product. Failure to follow proper safety procedures may cause personal injury and/or create a biohazard.

4. If any bent fins are visible after the cleaning procedure, carefully straighten them out by hand before replacing the baffle plates.
5. Clean all gasket and seal surfaces, reassemble the unit using all new gaskets and seals, and then reposition it in the cooler cavity of the compressor.

Condensate Drain Cleaning

All the components within all condensate removal lines on the compressor should be inspected regularly and cleaned as needed. Proper operation of the condensate removal system is among the most commonly overlooked preventive maintenance items in compressed air systems and as a result, condensate build-up within intercooler chambers is likely to damage aluminum fins of the bundle.

Furthermore, condensate carry-over from one stage can harm inlets, diffuser plates, and impellers of stages downstream.



CAUTION:

Always clean and inspect the condensate removal system following any intercooler cleaning procedures.

Oil Cooler Cleaning

Deterioration in oil cooler performance may be an indication that it is time to remove the mineral scale buildup within the oil cooler tubes. When that occurs, clean the tubes as follows:

1. Shut down the compressor, lockout the main motor starter and close the system block valve.
2. Turn off the water and disconnect the two water pipes.
3. Remove the lower plug on the rear header and allow any remaining coolant to drain from the cooler before replacing the plug.
4. Remove the front and rear headers to expose the tubes. Retain the gaskets.
5. Using a 1/8" (3 mm) rod, probe the tubes to check for blockage. (Since this is a straight tube cooler, any blockages that are loosened can be safely and easily pushed through and out the end.)
6. When rod cleaning is complete, flush the tubes thoroughly with water.
7. Replace the water headers (using the original gaskets) and then fill all the cooler tubes with a descaling agent such as **Rydlyme**.



WARNING:

Be certain to follow the manufacturer's instructions for safe handling and disposal of such products. Failure to do so could cause personal injury and/or create a biohazard.

8. Allow the descaling agent to remain in the tubes for 1 hour.



CAUTION:

Do not allow the descaling agent to remain in the tubes for more than 1 hour. Failure to follow these instructions will cause component damage.

9. Remove the front and rear headers to again expose the tubes.
10. Allow the descaling agent to completely drain from the tubes, and then flush out the tubes thoroughly with water.
11. Reassemble the headers, this time using new replacement gaskets.
12. Recharge the cooler, being sure to loosen the vent plug on the rear header to prevent air entrapment in the cooler.

Main Drive Coupling Maintenance (Dry coupling style)

Main motor couplings do not require any specific periodic maintenance, but it is recommended that the following checks are carried out on an annual basis:

1. Verify that axial and parallel alignments are still within the acceptable limits of the coupling and that no major machinery movement has occurred (refer to Section Two of this handbook for limits).
2. Verify that all bolts are still correctly tightened (refer to Section Two of this handbook for torque specs).
3. Visually inspect the disc packs for signs of fatigue cracking local to the washer anchor points or general signs of fretting corrosion. Although slight bowing or 'S' like distortion of the lamination is not detrimental to the operation of the unit, make sure it is not excessive.
4. Visually inspect the condition of the fixed hubs on the compressor and motor shafts, making sure that there is no degradation in their keyway fits. If any is found, the hubs must be replaced.

Control Valve Inspections

At six-month intervals, inspect the inlet guide vanes (IGV) and compressor blow-off valve (BOV) to verify proper operation and position.

1. Shut down the compressor and lockout the main motor starter.
2. Close the system block valve and exhaust any pressure remaining in the check valve line.
3. Clean the external surface of both the guide vane assembly and the blow-off valve.
4. Verify the fully-open and fully-closed positions of the BOV by stroking it in each direction from the control panel,
5. Remove the inlet expansion boot to view the inlet guide vanes.
6. Stroke the IGV, using the control panel, to check the proper closed and fully-open positions of the vanes. Verify each position visually.

Discharge Air Check Valve Inspection

At six-month intervals, use the following procedure to inspect the discharge air check valve to determine whether it is still in good working order or whether it must be replaced.

1. Shut down the compressor and lockout the main motor starter.
2. Close the system block valve and exhaust any pressure in the check valve line.
3. Remove the check valve from the piping.
4. Remove both plugs and the hinge pin, and then inspect the hinge pin, disc, and seat for wear.
5. If any parts are worn or damaged, replace the valve.

— or —

If wear is not apparent, clean, reassemble, and reinstall the valve, being sure that the valve disc operates freely.

6. To verify correct orientation of the discharge air check valve, use the following criteria:
 - The check valve should be located downstream of the blow-off valve and upstream of the system block valve.
 - The arrow should be pointing in the direction of flow (away from the compressor).
 - For horizontal installation (the recommended position) the hinge pin must be above the centerline, which is assured when the metal label can be seen from the top of the valve.



WARNING:

When installing a new discharge check valve or reinstalling a valve, always be certain of proper orientation. Incorrect orientation will cause equipment damage.

Additional Main Drive Motor Maintenance

Preventive maintenance must be performed on the main drive motor, in addition to those motor bearing lubrication items described in the Lubrication portion of this Section.

Refer to the motor manufacturer's supplied instruction for specific requirements and procedures.



CAUTION:

Failure to comply with the motor manufacturer's-specified preventive maintenance requirement can result in extensive equipment damage. Improper or inadequate motor maintenance procedures can void all existing warranties.

Section Six:

Troubleshooting

- ◆ General Considerations
- ◆ How to Request Assistance
- ◆ Alarm and Trip Functions
- ◆ Drive Train
Troubleshooting
- ◆ Lubrication System
Troubleshooting
- ◆ Air System
Troubleshooting
- ◆ Control System
Troubleshooting

General Considerations

This section provides a guide for troubleshooting compressor system malfunctions. Because of the variety of compressed air system applications, it is not possible to isolate the cause of every single problem using this guide alone.

The troubleshooting charts that follow are arranged by compressor system and indicate the likely and most-frequent causes of common problems.

Whenever an Alarm or Trip condition occurs, use logical thinking in conjunction with the listings in the following troubleshooting tables to determine the cause and prevent reoccurrence of the condition.

Section Two, Specifications, may also be helpful along with any separately supplied engineering drawings.



CAUTION:

The Turbo Air 6000 compressor is a unique, highly-engineered design. If a problem occurs that is beyond the experience of operating personnel, always request assistance from a factory-trained, authorized service representative.

How to Request Assistance

There is an established established network of factory trained and authorized service representatives throughout the United States and around the world. When additional guidance or help is required, contact your regional authorized representative.



WARNING:

For specialized service procedures, always use the services of an Ingersoll Rand trained and authorized service representative and only genuine Ingersoll Rand replacement parts. Improper servicing may cause equipment damage or personal injury. Ingersoll Rand will not accept responsibility for problems resulting from improper service procedures.

Alarm and Trip Functions

When the operating parameters of a compressor deviate beyond the defined range of normal tolerances, the control system activates one of two levels of compressor protection.

- **Alarm.** An Alarm condition is a warning about a compressor operating condition that is outside of normal operating limits. The purpose of the alarm is to alert the operator of a condition that merits investigation, but does not prevent the compressor from operating.
- **Trip.** A Trip condition is a protective measure initiated by the controller that shuts down the compressor. A Trip condition requires correction before the compressor can be placed back into operation.

When either type of event occurs the control system automatically displays the Protection History screen, see Controls Section for specific details on how your controls system displays Alarms and Trips.

Drive Train Troubleshooting

Conditions	Possible Causes
Motor Starter Problems	
	Refer to manufacturer's instructional materials
Motor Overheating	
	Incorrect motor control setpoint Ambient temperature too high Ventilation inadequate Motor Overload / Improperly sized relay Incorrect motor bearing lubrication Incorrect motor supply voltage Inadequate grounding Improper wiring terminations Improper wiring Starter malfunction Dirt in air gap Windings shorted Single phasing Motor seized
Motor Vibration/Unusual Sounds	
	Motor mounting bolts loose Incorrect motor bearing lubrication Other mechanical part(s) loose Excessive or unbalanced voltage Misalignment Dirt on fan Dirt in air gap Motor bearings worn Drive coupling worn
Main Drive Coupling Problem	
	Improper lubrication (if applicable) Incorrect alignment Incorrect assembly Incorrect Start/Stop procedures
Compressor Vibration/Unusual Sounds	
	Faulty vibration sensor component Control panel not grounded (earth ground) Incorrect control setpoints Incorrect or contaminated oil Operating in unstable aerodynamic conditions Operating with high oil temperature Incorrect motor alignment Main drive coupling damaged Internal components worn or damaged

Lubrication System Troubleshooting

Condition:	Possible Causes:
Oil Leak(s)	
	Loose piping connection Oil filter cartridge loose Insufficient vacuum (see below) Pump shaft seal worn or damaged Gearbox cover loose or improperly sealed
Oil Mist	
	Incorrect air ejector air supply Air ejector vent filter dirty or water-laden Air ejector vent filter trap not filled Insufficient vacuum for other reasons
Low Oil Pressure	
	Oil level too low Oil filter element dirty or clogged Sensor reading faulty Pressure regulator set improperly or malfunctioning Oil leaking (see above) Incorrect wiring to oil pump motor or starter Oil pump motor starter overloads tripped Fuses in pump motor starter blown Oil pump coupling damaged Oil pump seized
High Oil Pressure	
	Sensor reading faulty Improper pressure regulator setting Oil pump problem
High Oil Temperature	
	Insufficient coolant flow Coolant temperature too high Sensor reading faulty Thermal mixing valve faulty (if applicable) Oil cooler headers oriented improperly Oil cooler tubes fouled or damaged Oil heater thermostat faulty
Low Oil Temperature	
	Compressor area ambient too low Sensor reading faulty Oil heater thermostat faulty or missing

Air System Troubleshooting

Condition:	Possible Causes:
High Compressor Output	
	Low air demand Control setpoints incorrect Pressure sensor faulty Faulty current, power, or flow sensor Faulty control valve(s) Ambient conditions beyond design limits Impeller clearances too tight
Low Compressor Output	
	Air demand excessive Control setpoints incorrect Pressure sensor faulty Faulty current, power, or flow sensor Ambient air temperature excessive Interstage air temperature too high (see below) Inlet air filter dirty or restricted Faulty control valve(s) Impellers dirty Condensate removal problem Impeller clearances too large Worn or damaged inlet diffuser or impeller
High Interstage Air Temperature	
	Ambient air temperature excessive Water flow to cooler(s) insufficient High coolant temperature Inter cooler(s)/aftercooler fouled or damaged Hot air bypassing intercoolers/aftercooler Compressor surging (see below)
Compressor Surging	
	Incorrect control setpoints Incorrect control valve tuning parameters Faulty current, power, or flow sensor Inlet air filter dirty or restricted Faulty control valve(s) Air temperatures excessive Compressor discharge valve or check valve improperly located or improperly sized Ambient conditions beyond design limits Condensate removal problem Incorrect impeller clearances Worn or damaged compressor components

Control System Troubleshooting

The most effective troubleshooting tool is clear, logical thinking. Most “control panel” problems are the result of wiring errors, incorrect control settings, or a fault in a device connected to the panel.

Condition:	Possible Causes:
Control Panel Inoperative	
	Power to panel interrupted or incorrect Improper grounding Wiring error or connection problem
Display Inoperative	
	Power to display interrupted or incorrect Contrast set incorrectly Display backlight failure Faulty display
Improper Control of Compressor Operation	
	Incorrect control configuration Incorrect monitoring point scale factor(s) Incorrect control setpoints Incorrect control tuning parameters Improper electrical grounding Wiring problem Faulty power supply to sensors Control board failure
Other Compressor Operation Problems	
	Incorrect location or sizing of inlet or discharge valve Incorrect adjustment of inlet valve or discharge valve ‘stroke’ Incorrect location or sizing of discharge check valve Worn check valve or bypass valve (if applicable) Damaged control valve

Section Seven: Parts and Service

In this section, the reader will learn about:

- ◆ Aftermarket Support
- ◆ The Parts Ordering Procedure
- ◆ Parts Availability
- ◆ The Returned Goods Policy
- ◆ The Periodic Maintenance Parts Inventory
- ◆ The Professional Inspection Parts Requirement
- ◆ Control System Sensors
- ◆ Lubrication System Parts
- ◆ Main Drive Coupling Parts
- ◆ Heat Exchanger Parts
- ◆ Air Piping Parts

Aftermarket Support

As an important part of its commitment to its products and customers, Ingersoll Rand offers full aftermarket support. The array of aftermarket services includes on site service, inspection and repair, availability of genuine Ingersoll Rand parts and recommended supplies, and customer training seminars.



WARNING:

Since the Turbo Air 6000 Centrifugal Compressor is a high technology product, do not attempt inspection, maintenance, or service procedures other than those described in this manual. For any service of a more specialized nature and service of internal parts, it is necessary to contact an Ingersoll Rand trained and authorized service representative.

For parts and/or service, always contact your local authorized Ingersoll Rand sales and service representative, or contact the factory directly.

Parts Coordinator
or
Field Service Department

Ingersoll Rand
3101 Broadway PO Box 209
Buffalo, NY 14225-0209 USA
Phone: (716) 896-6600
Fax: (716) 896-1233

Parts Ordering Procedure

Since specific compressor models and installations may vary, always be sure to have the following information available when placing an order:

1. The compressor serial number (included on the compressor nameplate located on the gearbox).
2. The compressor model: **Turbo Air 6000**
3. The part description (name).
4. The part reference number.

Parts Availability

When ordering replacement and some spare parts, keep in mind that some parts are not available on an individual basis, and must always be purchased in sets. Also, in certain instances Ingersoll Rand may change the part number and/or may substitute a part of equal or greater reliability without notice.

The Returned Goods Policy

It is necessary to contact Ingersoll Rand for authorization before the return of any goods to the factory. All approved returns are immediately assigned a tracking number to prevent processing delays or loss of materials. This ARG (authorization to return goods) tracking number is then recorded at the factory. Senders must include the assigned ARG tracking number on the outside of the shipping container whenever goods are being returned.

No goods may be returned to the factory without prior authorization and an assigned ARG tracking number.

The Periodic Maintenance Parts Inventory

Ingersoll Rand recommends keeping a basic inventory of replacement and spare parts and stocking of all the recommended supplies mentioned in this operator's manual. This will eliminate or help reduce unanticipated shutdown time during those occasions when it may be necessary to maintain or replace one or more compressor parts. Table 7—1 is a recommended list of materials and parts that should be in active inventory for routine maintenance activities.



CAUTION:

When replacing parts or ordering supplies, always use genuine Ingersoll Rand replacement parts and Ingersoll Rand approved supplies. Ingersoll Rand will accept no liability for damages caused by use of non-authorized parts, supplies, or service.

Recommended Periodic Maintenance Parts & Supplies

Description	Qty	Ingersoll Rand Part Number
Filters:		
• Inlet Air Filter, Primary and Secondary Elements	[A]	[A]
• Bypass Valve Air Line Filter Element	1	[B]
• Oil Reservoir Vent Filter Element	1	AAP1404987-00014
• Oil System Filter Elements:		
- Single Filter Only	1	AAP1404040-00217
- Duplex Filter [D]	2	AAP1401435-01233
- Dual Filter / Dual Cooler Configuration	2	AAP1404040-00207
Lubricants:		
• TurboBlend™ Lubricating Oil (5-gallon / 20-liter pail)	[C]	AAP1405340-00294
• TurboBlend™ Lubricating Oil (55-gallon / 210-liter drum)	[C]	AAP1405340-00295
• Oil Sample Kit	1	AAP1797385-00000
• Oil Pump Motor & Main Drive Motor Ball Bearing Grease	1	AAP1405340-00289
• Inlet Guide Vane Drive Screw Grease	1	AAP1405340-00288
Parts:		
<i>Heat Exchangers (Figures 7—9 & 7—10)</i>		
• K-Seal	2	AAP1408800-04952
• Y-Gasket	3	AAP1408800-04953
• Header Gasket	2	AAP1408531-03811
• Front Tubesheet Gasket	2	AAP1408530-03800
• Rear Header Gasket (S-Tube Type Only)	2	AAP1408531-03801
• Oil Cooler Gasket Kit	1	AAP1405680-00001
<i>Bypass Valve (Figure 7—17)</i>		
• Seal Kit (>1000 HP)	1	AAMB408539-00301
• Seal Kit (<1000 HP)	1	AAMB408539-00207
<i>Discharge Air Check Valve (Figure 7—20)</i>		
• Check Valve, 5" (>900 HP)	1	AAP0540024-00186
• Check Valve, 6"	1	AAP0540024-00187
<i>Condensate Drains (Figure 7—11)</i>		
• Solenoid Valve, 110/120-Volt	1	AAP1401581-01302
• Solenoid Valve, 220/240-Volt	1	AAP1401581-01341
• Check Valve	1	AAP1401581-01303
• Gate Valve	2	AAP1401581-00757
<i>Instrumentation (Figure 7—1)</i>		
• Vibration Probe	1	AAP1407030-02006
• RTD (Temperature Transducer)	1	AAP3403629-01585
• Pressure Transmitter	1	AAP0540089-00210
• Drive Motor Current Transducer	1	Consult Factory
Notes: [A] Refer to Figure 7—16, Inlet Air Filter Assembly [B] Refer to Figure 7—17, Bypass Valve Assemblies [C] Reservoir capacity is 85 gallons. [D] Refer to Figure 7—5, Duplex Oil Filter Option. [E] The below quantities are required for each heat exchanger, including the mounted aftercooler option.		

Table 7—1 Periodic Maintenance Parts and Supplies

The Professional Inspection Parts Requirement

Table 5—3, Service Inspection Checklist outlines the in-depth examination procedures to be performed with a Ingersoll Rand trained and authorized representative. These important preventative maintenance tasks involve removal of the gearbox cover to examine the gears, bearings and seals and exposing of the heat exchanger bundles and the aerodynamic components for cleaning and inspection. Certain gaskets, o-rings and seals must be ordered well in advance of the scheduled visit. Table 7—2 lists the parts and supplies necessary for the Professional Inspection of the compressor. Some of these parts may already be on-hand as part of the Periodic Maintenance Parts Inventory.



CAUTION:

When replacing parts or ordering supplies, always use genuine Ingersoll Rand replacement parts and Ingersoll Rand approved supplies. Ingersoll Rand will accept no liability for damages caused by use of non-authorized parts, supplies, or service.

Professional Service Inspection Parts & Supplies		
Description	Qty	Ingersoll Rand Part Number
Gearbox:		
• O-Ring, First Stage Inlet	1	AAP1406702-00388
• O-Ring, Second Stage Inlet	1	AAP1406702-00389
• O-Ring, Third Stage Inlet	1	AAP1406702-00385
• Seal, First Stage Diffuser	1	AAP1794323-00006
• Seal, Second Stage Diffuser	1	AAP1794323-00005
• Seal, Third Stage Diffuser	1	AAP1794323-00005
• O-Ring Lubricant	1	AAR1409584-00000
• Gearbox Splitline Sealant	1	AAR1405571-00012
Heat Exchangers: (Figures 7—9 & 7—10)		
• K-Seal	2	AAP1408800-04952
• Y-Gasket	3	AAP1408800-04953
• Head Gasket	2	[F]
• Front Tubesheet Gasket	2	AAP1408530-03800
• Rear Header Gasket (S-Tube Type Only)	2	AAP1408531-03801
Lubrication System:		
• Oil Cooler Gasket Kit	1	AAP1405680-00001
• Oil Reservoir Vent Filter Element	1	AAP1404987-00014
• Oil System Filter Element (Single Filter Type)	1	AAP1404040-00217
• Oil System Filter Element (Dual Filter Type)	2	AAP1401435-01233
Filters:		
• Inlet Air Filter, Primary Element	[B]	[B]
• Inlet Air Filter, Secondary Element	[B]	[B]
Control Valves:		
<i>Inlet Guide Vane (Figure 7—15)</i>		
• Gasket, Inlet Guide Vane, 6" (150 mm)	1	AAP1409511-00005
• Gasket, Inlet Guide Vane, 8" (200 mm)	1	AAP1409511-00001
• Grease, Inlet Guide Vane Drive Screw	1	AAP1405340-00288
<i>Bypass Valves (Figure 7—17)</i>		
• Seal Kit	1	[D]
• Bypass Valve Air Line Filter Element	1	[D]
Notes: [B] Refer to Figure 7—16, Inlet Air Filter Assembly [D] Refer to Figure 7—17, Bypass Valve Assemblies [F] Refer to Figure 7—9, 7-10.		

Table 7—2 Professional Service Inspection Parts and Supplies

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Control System Sensors

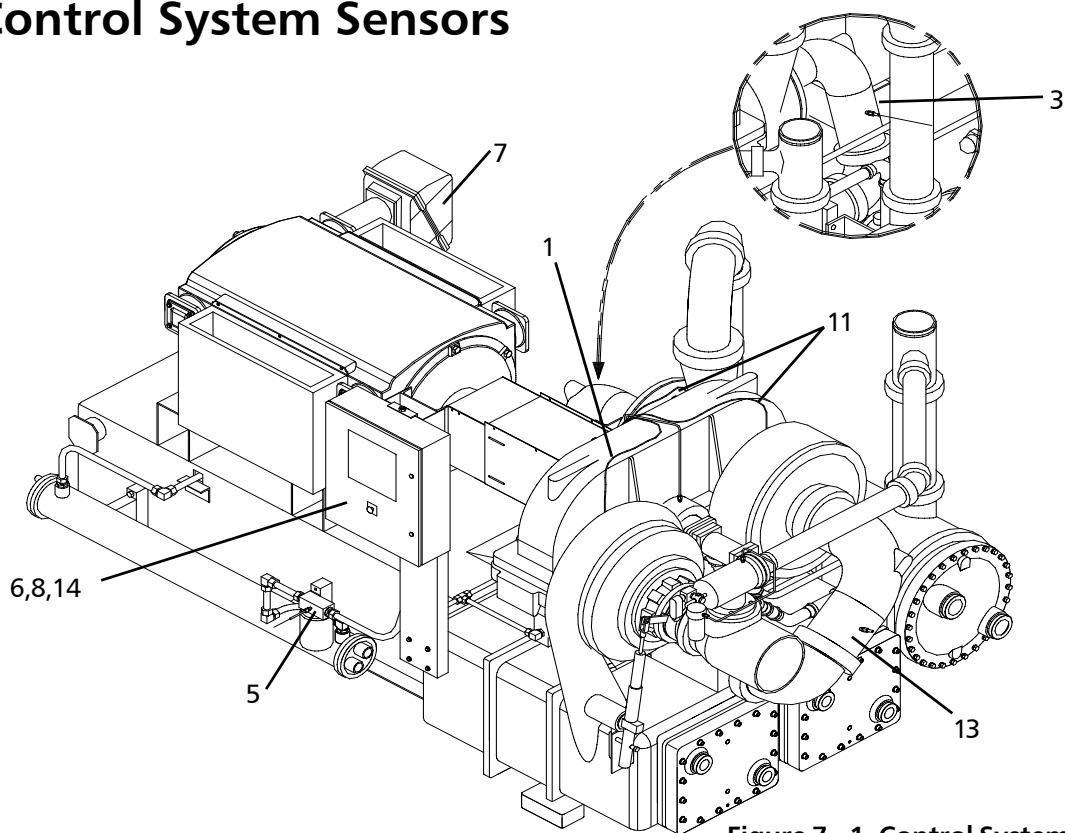


Figure 7—1. Control System Sensors

Item No.	Description	Qty	Ingersoll Rand Part Number
Standard Instrumentation:			
01	Vibration Probe, Stage 1	1	AAP1407030-02006
03	RTD, Inlet Air Temperature, Stage 3 [A]	1	AAP3403629-01585
04	Transmitter, System Pressure [D]	1	AAP0540089-00216
05	RTD, Oil Temperature	1	AAP3403629-01585
06	Transducer, Oil Pressure after the Filter [B]	1	AAP0540089-00210
07	Tranducer, Drive Motor Current (In Motor Term Box)	1	Consult Factory
08	Transmitter, Compressor Discharge Pressure [B]	1	AAP0540089-00210
Optional Instrumentation:			
11	Vibration Probe, Stages 2 and/or 3	1-2	AAP1407030-02006
13	RTD, Inlet Air Temperature, Stage 2 [A]	1	AAP3403629-01585
14	Transducer, Oil Pressure before the Filter [C]	1	AAP0540089-00210
15	RTD, Miscellaneous Temperatures (Not Shown) [D]	1-5	AAP3403629-01585
16	Switch, Oil Reservoir Level (Figure 7-6)	1	AAP0540061-00199
17	Transducer, Air Filter Differential Pressure [D]	1	AAP1794463-00127
Notes: [A] Air temperature into the last stage of compression is standard. Alternate locations are supplied as options. [B] Required for all control methods. [C] Required for filter differential pressure measurement. [D] Shipped loose for field installation.			

Table 7—3. Control System Sensors

Control System Sensors

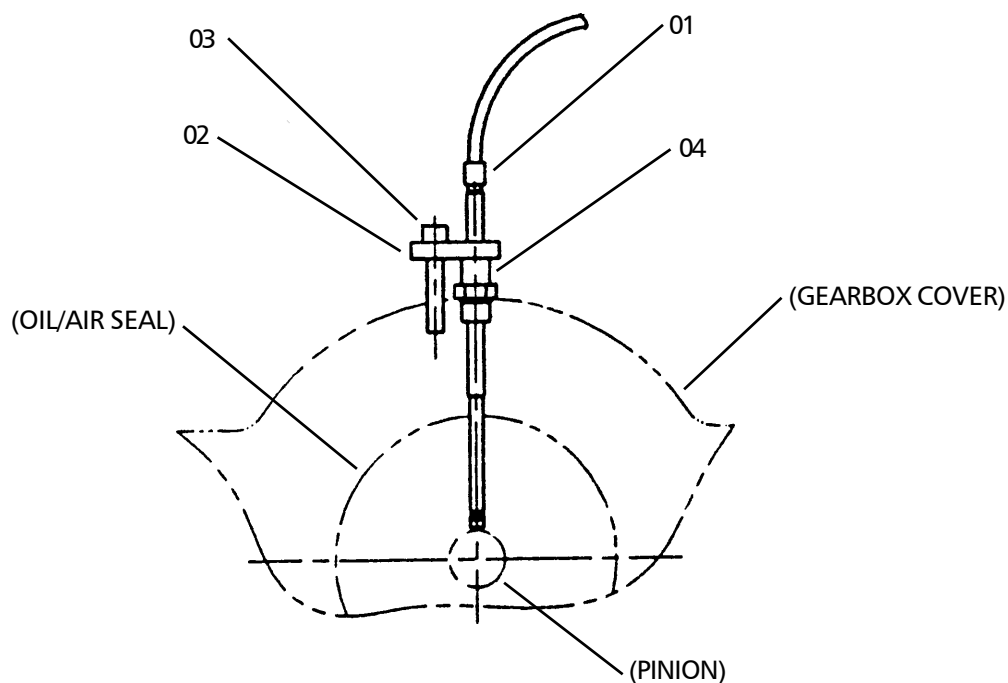


Figure 7—2. Vibration Probe Installation

Item No.	Description	Qty	Ingersoll Rand Part Number
01	Vibration Probe	1	AAP1407030-02006
02	Retaining Plate	1	AAP1407301-00003
03	Capscrew	1	AAP0902224-00512
04	Tube Fitting	1	AAP1791399-03539
05	Adhesive [A]	1	AAR1405571-00005
Notes: [A] Apply adhesive to threads of capscrew and tube fitting.			

Table 7—4. Vibration Probe Installation

Lubrication System Parts

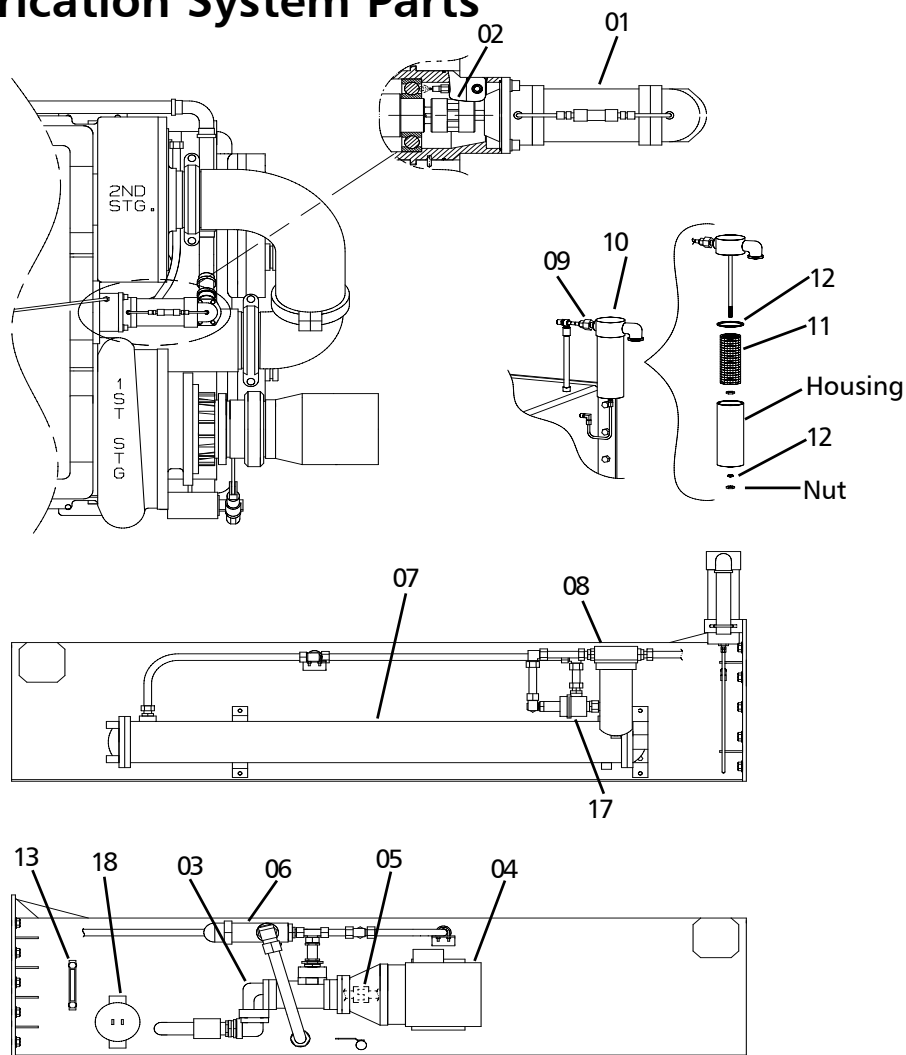


Figure 7—4. Reservoir Vent Filter Assembly

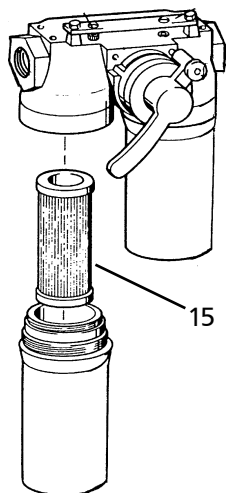


Figure 7—5. Duplex Oil Filter Option

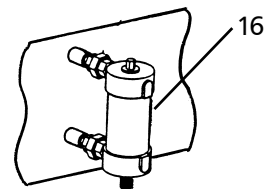


Figure 7—6. Reservoir Level Switch Option
Replaces Standard Sight Gauge

Lubrication System Parts

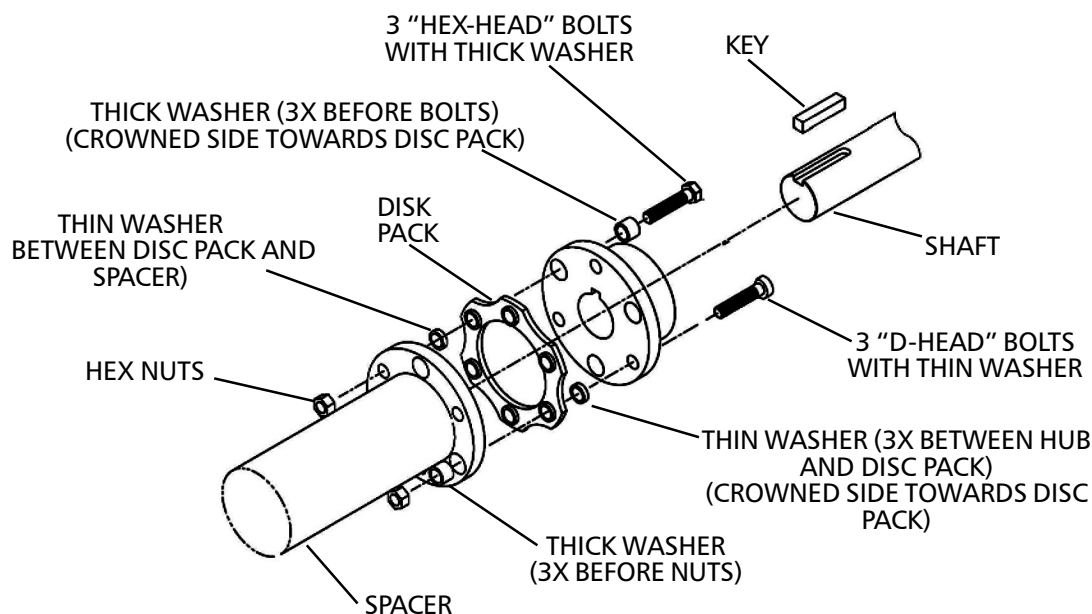
Item No.	Description	Qty	Ingersoll Rand Part Number
01	Main (shaft-driven) Oil Pump	1	AAP1401428-00624 or (-622) 50 Hz
02	Drive Coupling, Main Oil Pump	1	AAP1402070-00256
03	Auxiliary (motor-driven) Oil Pump	1	AAP1401428-00623 or (-621) 50 Hz
04	Motor, Auxiliary Oil Pump		
	- 230-460 Volt / 60 Hz	1	AAP1402068-00751
	- 220-380 Volt / 50 Hz	1	AAP1402068-00728
	- 380 Volt / 60 Hz	1	AAP1402068-00716
	- 400, 415 & 440 Volt / 50 Hz	1	AAP1402068-00728
	- 440 Volt / 60 Hz	1	AAP1402068-00769
05	Drive Coupling, Auxiliary Oil Pump	1	AAP1402070-00187
06	Pressure Regulator (Relief Valve)	1	AAP1401581-01329
07	Cooler, Oil-to-Water (Heat Exchanger):		
	- Standard unit with 0.375" (10 mm) dia. copper tubes	1	AAP1401429-01004
	- Maintenance Gasket Kit	1	AAP1405680-00001
08	Single Filter:		
	- Complete Assembly	1	AAP1401435-00291
	- Replacement Element	1	AAP1404040-00217
	Reservoir Vent Assembly:		
09	- Ejector	1	AAP1403262-00107
10	- Filter (complete assembly)	1	AAP1401435-00228
11	- Replacement Filter Element	1	AAP1404987-00014
12	- Filter Seal Kit	1	AAP1401435-00229
13	Sight Level Gauge	1	AAP1401582-00014

Table 7—6. Standard Lubrication System Components (See Figure 7-4)

Item No.	Description	Qty	Ingersoll Rand Part Number
	Duplex Filter (Figure 7—5): [A]		
	- Complete Assembly	1	AAA3401435-00232
15	- Replacement Element	2	AAP1401435-01233
16	Level Switch (Figure 7—6) [A]	1	AAP0540061-00199
17	Temperature Regulator [A] (Figure 7-4)	1	AAP1401581-01347
18	Oil Heater: [A] (Figure 7-4)		
	- 230 Volt	1	AAP0540063-00379
	- 380 Volt	1	AAP0540063-00365
	- 400 Volt	1	AAP0540063-00384
	- 415 Volt	1	AAP0540063-00380
	- 440 Volt	1	AAP0540063-00385
	- 460/480 Volt	1	AAP0540063-00363
	- 575 Volt	1	AAP0540063-00156
Notes: [A] Not all lubrication systems are equipped with these optional features. Most of these features can be retrofitted after the compressor has been shipped from the factory.			

Table 7—7. Optional Lubrication System Components (See Figures 7-4, 7-5 and 7-6)

Main Drive Coupling Parts



TYPICAL EACH END

BOLT TORQUE
VALUES:
Refer to Section 2

Figure 7—8B. Main Drive Coupling Assembly (Dry Type - "Bibby")

Item No.	Description	Qty	Ingersoll Rand Part Number
01	Standard Disk Pack & Fasteners (Model DC163)	2	AAP1406064-03601
* Over size drivers may use model DC193, consult factory if driver shaft size larger than 4.125 (105mm).			

Table 7—8B. Main Drive Coupling Maintenance Parts

Heat Exchanger Parts

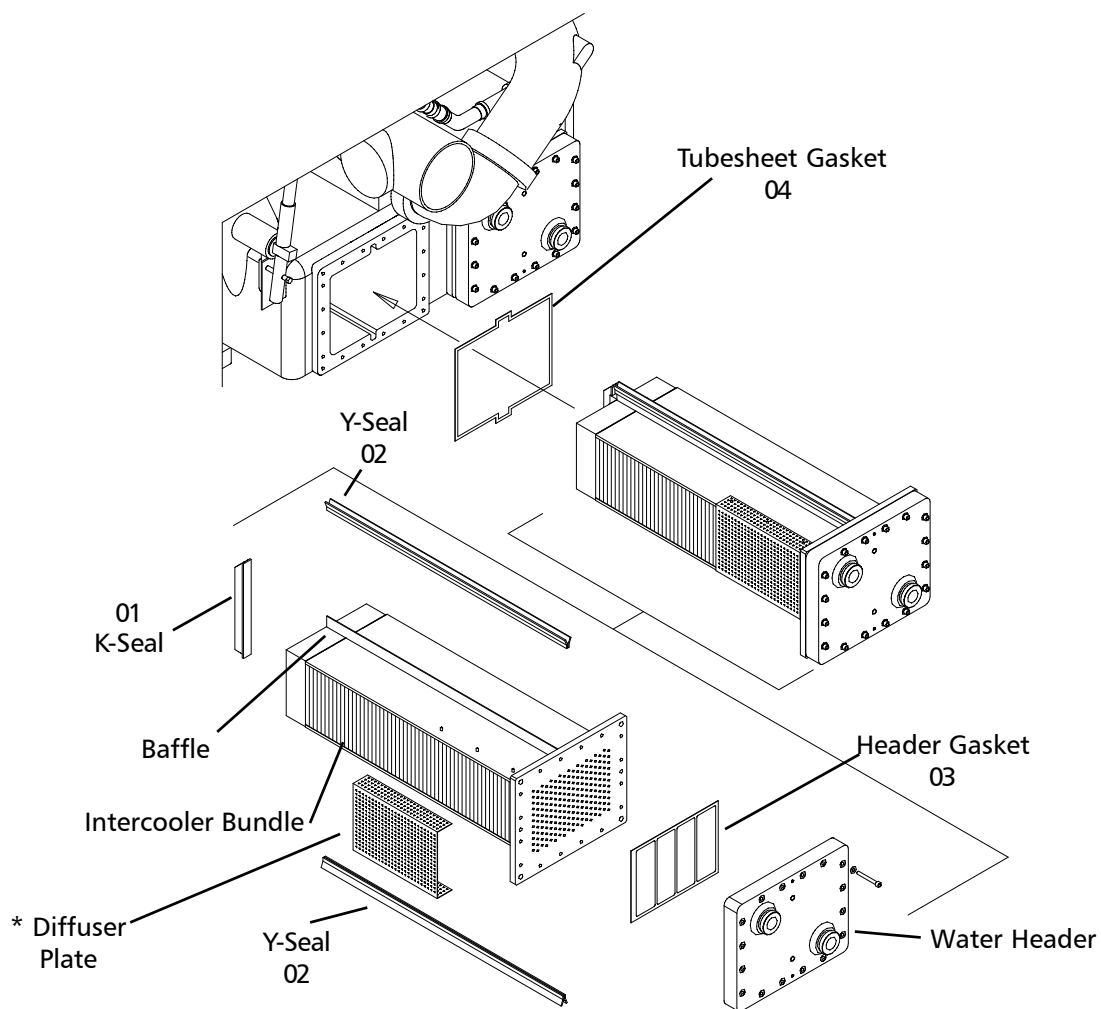


**Figure 7—9. Intercooler/Aftercooler Bundle Assembly
Standard U-Tube Model**

Item No.	Description	Qty	Ingersoll Rand Part Number
01	K-Seal	2	AAP1408800-04952
02	Y-Seal	4	AAP1408800-04953
03	Header Gasket	2	AAP1408531-03811
04	Tubesheet Gasket	2	AAP1408530-03800

* Diffuser Plate supplied on 1st Stage Intercooler Only

Table 7—9. Intercooler Maintenance Parts - Standard U-Tube Model

Heat Exchanger Parts

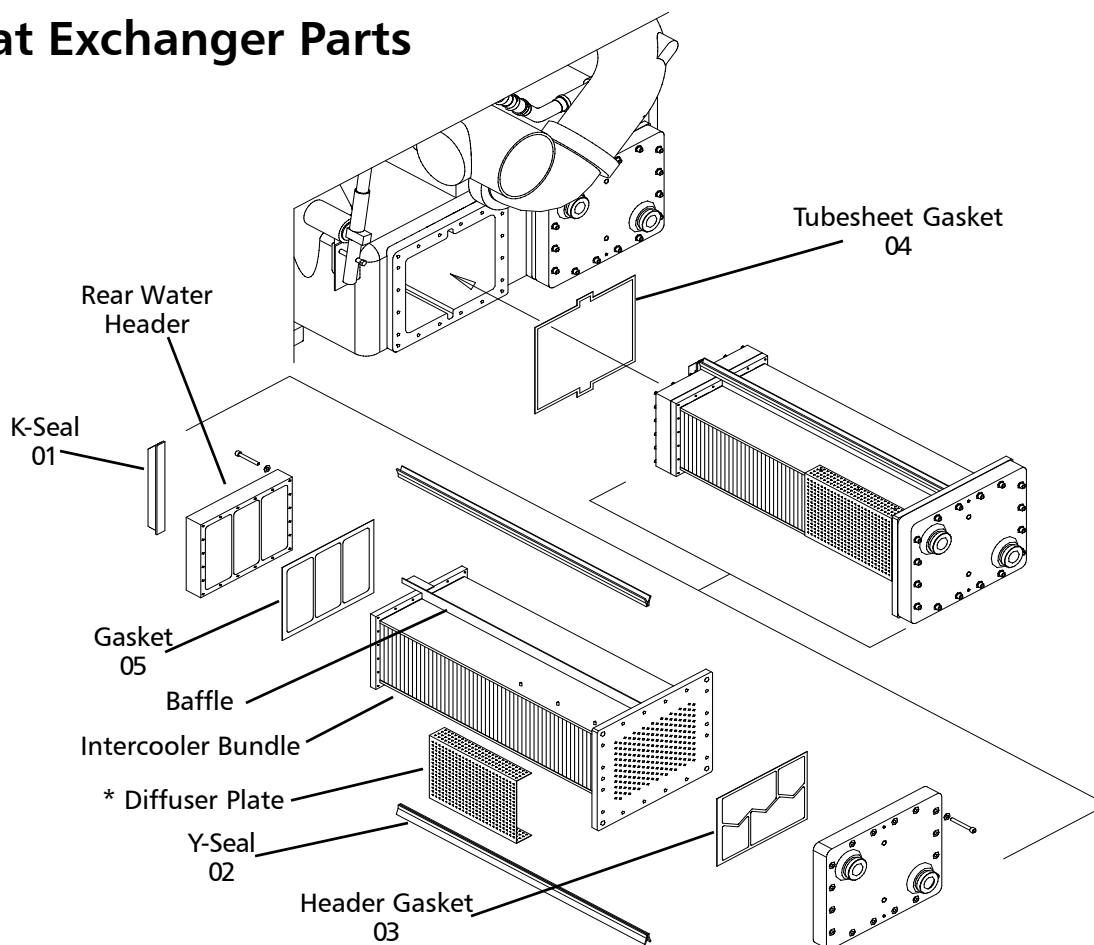


**Figure 7—10. Intercooler/Aftercooler Bundle Assembly
Optional S-Tube Model**

Item No.	Description	Qty	Ingersoll Rand Part Number
01	K-Seal	2	AAP1408800-04952
02	Y-Gasket	4	AAP1408800-04953
03	Header Gasket	2	AAP1408531-03801
04	Tubesheet Gasket	2	AAP1408530-03800
05	Rear Header Gasket	2	AAP1408529-03800

*Diffuser Plate Supplied on 1st Stage Intercooler Only

Table 7—10. Intercooler Maintenance Parts - Standard S-Tube Model

Item No.	Description	Qty	Ingersoll Rand Part Number
	4 Ft. Mounted Aftercooler		
01	- K-Seal	1	AAP1408800-04930
02	- Y-Seal	2	AAP1408800-04928
04	- Front Tubesheet Gasket	1	AAP1797269-04830
03	- Header Gasket	1	AAP1797269-02700
	6 Ft. Mounted Aftercooler		
01	- K-Seal	1	AAP1408800-04930
02	- Y-Seal	2	AAP1408800-04929
04	- Front Tubesheet Gasket	1	AAP1797269-04830
03	- Header Gasket	1	AAP1797269-02700

Table 7-11. Aftercooler Maintenance Parts – (No illustration)

Condensate Drain Parts

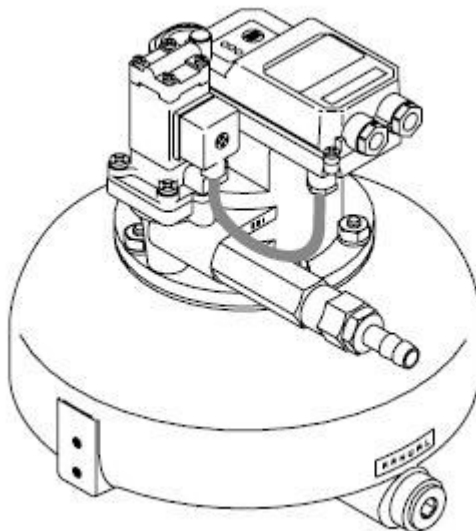


Figure 7—11. ReliaDrain™ Zero Loss Condensate Removal Drain
(One set required for each heat exchanger)

Item No.	Description	Qty	Ingersoll Rand Part Number
--	ReliaDrain Model 6000/110, 110 VAC	1	AAP0540025-00134
--	ReliaDrain Model 6000/220, 220 VAC	1	AAP0540025-00145
--	ReliaDrain 6000 Rebuild	1	AAMB540025-00145
--	110v Heater	1	AAP0540025-00146
--	220v Heater	1	AAP0540025-00147

Table 7—11. ReliaDrain™ Zero Loss Condensate Removal Drain

Condensate Drain Parts

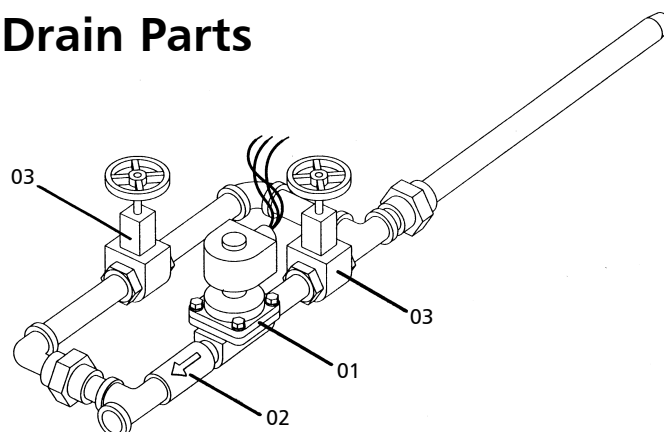


Figure 7—12. Solenoid-Operated Condensate Draining System
(One set required for each heat exchanger)

Item No.	Description	Qty	Ingersoll Rand Part Number
01	Solenoid Valve, 1/2" NPT, 110/120-Volt	1	AA P1401581-01302
01	Solenoid Valve, 1/2" NPT, 220/240-Volt	1	AAP1401581-01341
02	Check Valve, 1/2" NPT	1	AAP1401581-01303
03	Gate Valve, 1/2" NPT	2	AAP1401581-00757

Table 7—12. Solenoid-Operated Condensate Draining System
(One set required for each heat exchanger)

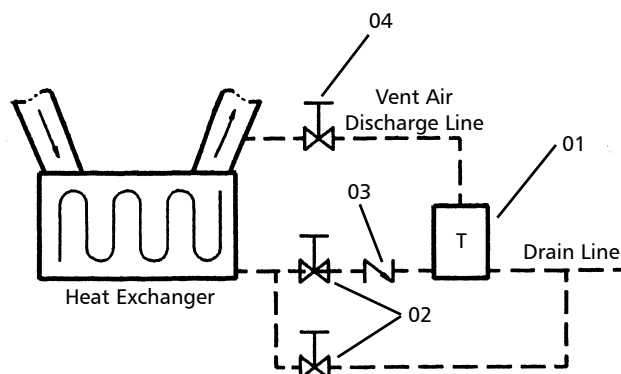


Figure 7—13a. Liquidator™ Pneumatic Condensate Drain System

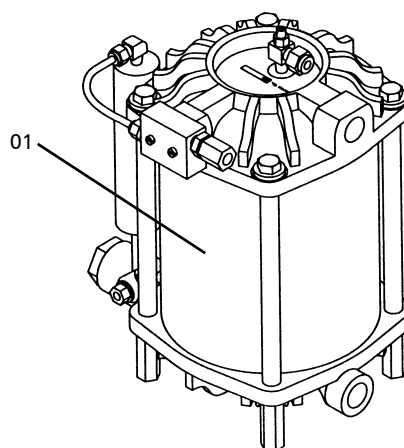


Figure 7—13b. Liquidator™ Pneumatic Condensate Drain Trap

Item No.	Description	Qty	Ingersoll Rand Part Number
01	Liquidator Drain Trap	1	AAP1797145-00000
02	Gate Valve, 1/2" NPT	2	AAP1401581-00757
03	Check Valve, 1/2" NPT	1	AAP1401581-01303
04	Ball Valve, 1/4"-NPTF	1	AAP1401581-01450
05	Tube Fitting, 1/4"-TUBE / 1/4"-NPTM	3	AAP0902962-00044
--	Condensate Kit (containing all the above parts)	1	AAMB408187-00100

Table 7—13. Liquidator™ Pneumatic Condensate Draining System Components
(One set required for each heat exchanger)

Air Piping Parts

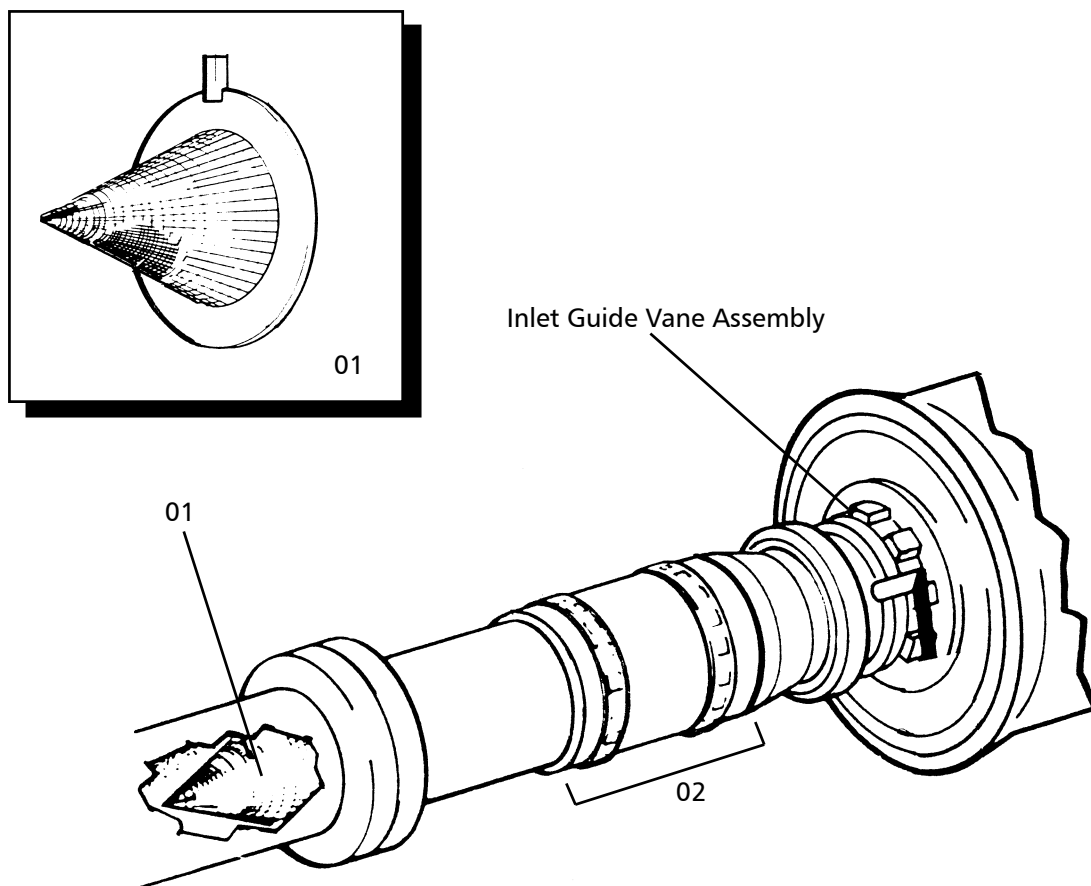


Figure 7—14. Inlet Air Piping Components

Item No.	Description	Qty	Ingersoll Rand Part Number
01	Startup Screen (for 10" pipe)	1	AAP1405344-00017
02	Expansion Joint (for 10.75" O.D. pipe)	1	AAA3404999-00001

Table 7—14. Inlet Air Piping Components

Air Piping Parts

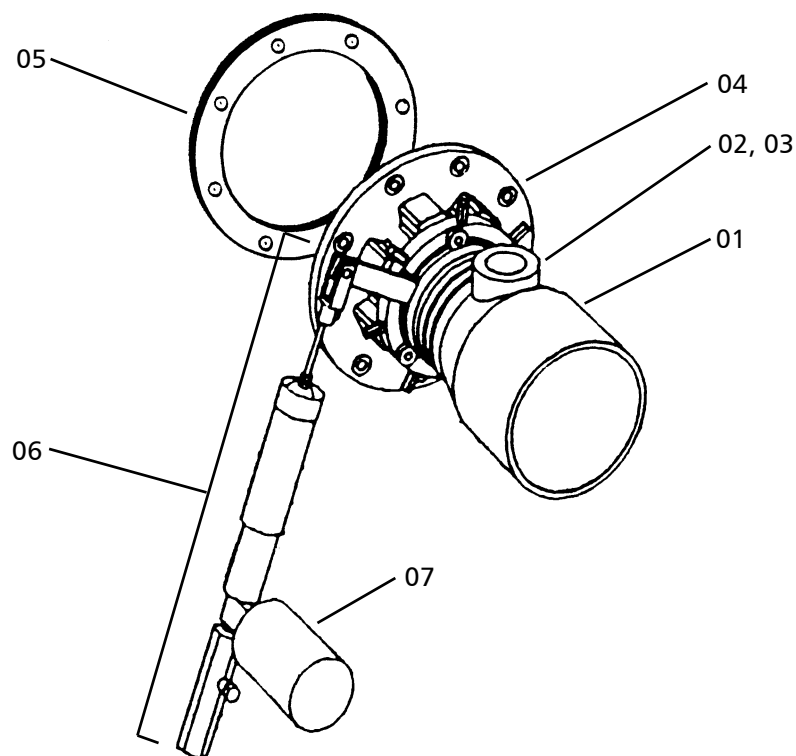


Figure 7—15. Inlet Guide Vane and Actuator Assembly

Item No.	Description	Qty	Ingersoll Rand Part Number	
			10" (250 mm)	8" (200 mm)
01	Inlet Pipe Reducer	1	Consult Factory	Consult Factory
02	Pipe Coupling	1	AAP1404961-00217	AAP1404961-00209
03	Gasket, Pipe Coupling	1	AAP1404961-00108	AAP1404961-00607
04	Inlet Guide Vane Assembly	1	AAA3409140-06010	AAA3409140-06008
05	Gasket, Inlet Guide Vane	1	AAP1409511-00005	AAP1409511-00001
06	Actuator Assembly, 110/120-Volt	1	AAP3408596-00001	AAA3408596-00001
	Actuator Assembly, 220/240-Volt	1	AAP3408596-05001	AAA3408596-06001
07	Actuator Motor, 110/120-Volt [A]	1[A]	AAP1408596-00100	AAP1408596-00100
	Actuator Motor, 220/240-Volt [A]	1[A]	AAP1408596-00500	AAP1408596-00500
Notes: [A] The actuator motor is included in the actuator assembly.				

Table 7—15 Inlet Guide Vane and Actuator Components

Air Piping Parts

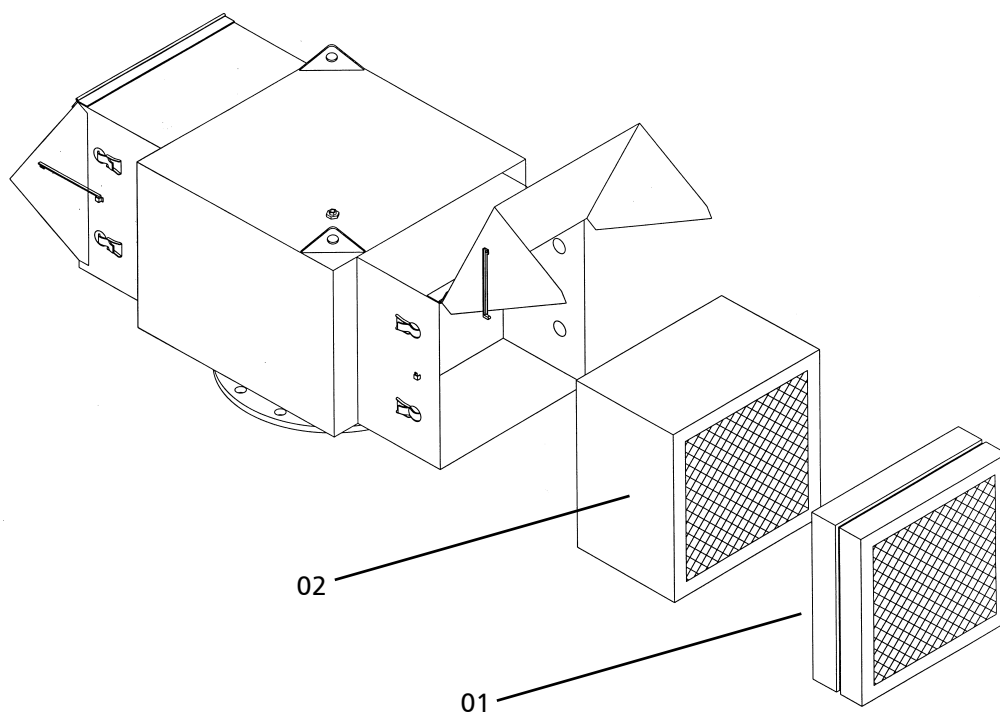


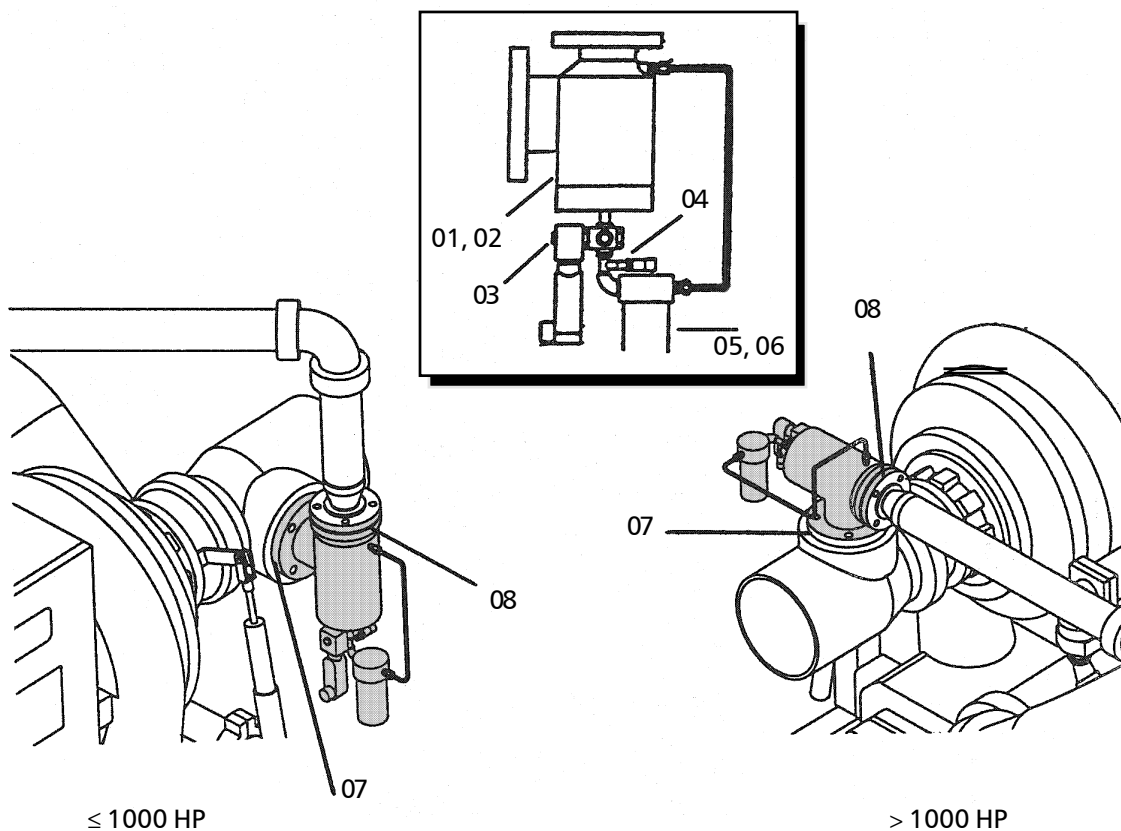
Figure 7—16. Inlet Air Filter Assembly

Item No.	Description	Qty	Ingersoll Rand Part Number
CTF Type [A]			
01	Primary Filter Element	[C]	AAP1400009-00770
02	Secondary Filter Element	[C]	AAP1400009-00871
AI-128 Type [B]			
01	Primary Filter Element	[C]	AAP0540009-00089
02	Secondary Filter Element	[C]	AAP0540009-00090
Notes: [A] Characterized by 18" x 18" (450 mm x 450 mm) elements [B] Characterized by 24" x 24" (835 mm x 835 mm) elements [C] Quantity could be 2, 3, 4, or 6 dependent upon the number of inlet ports on the filter housing.			

Table 7—16. Inlet Air Filter Replacement Elements

Air Piping Parts

Figure 7—17 Bypass Valve Assemblies and Packaging Options
(Bypass Valves are employed in Auto-unload Control only applications.)



Item No.	Description	Qty	Ingersoll Rand Part Number	
			≤1000 Hp	> 1000 Hp
01	Bypass Valve:			
	- 120 V / 60 Hz	1	AAP1401581-01501	AAP1401581-01503
	- 220 V / 50-60 Hz	1	AAP1401581-01501	AAP1401581-01503
02	Kit, Seal	1	AAMB408539-00207	AAMB408539-00301
03	Solenoid Valve:			
	- 60 Hz	1	AAP1401581-01166	AAP1401581-01166
	- 50 Hz	1	AAP1401581-01233	AAP1401581-01233
04	Metering Valve	1	AAP1409585-00000	AAP1409585-00000
05	Air Line Filter	1	AAP0540016-00073	AAP0540016-00073
06	Air Line Filter Element	1	AAP0540016-00074	AAP0540016-00074
07	Flange Gasket, Bypass Valve Inlet	2	AAP0907411-00008	AAP0907411-00010
08	Flange Gasket, Bypass Valve Discharge	2	AAP0901597-00006	AAP0901597-00008

Table 7—17 Bypass Valve Assemblies and Packaging Options Components

Air Piping Parts

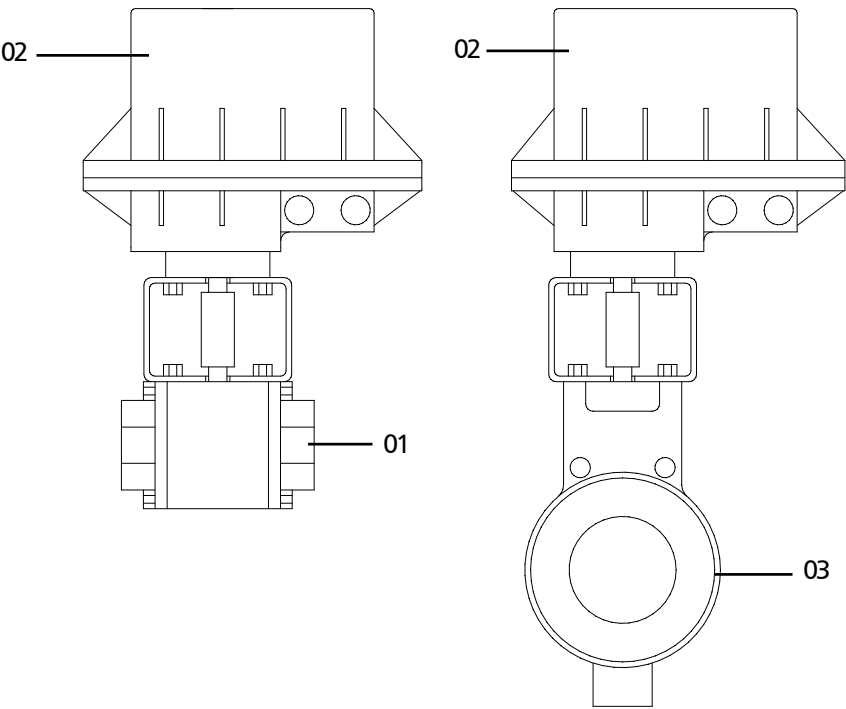


Figure 7—18. Modulating Blow-Off Valve (MBOV) Assembly

Item No.	Description	Qty	Ingersoll Rand Part Number
	Modulating Blow-Off Valve Assembly [A]		
01	- 2.0" (50 mm) Ball Valve	1	AAP1401581-02037
02	48 VDC Actuator with Positioner	1	AAP3408596-02203
03	- 3.0" (75 mm) Butterfly Valve	1	AAP0540008-01119
03	- 4.0" (102 mm) Butterfly Valve	1	AAP0540008-01118
03	- 6.0" (132 mm) Butterfly Valve	1	AAP0540008-01117
Notes: [A] Valve assemblies are complete with components mounted and integrally piped.			

Table 7—18. Modulating Blow-Off Valve Assemblies

Air Piping Parts

Figure 7—19. Blow-Off Silencer

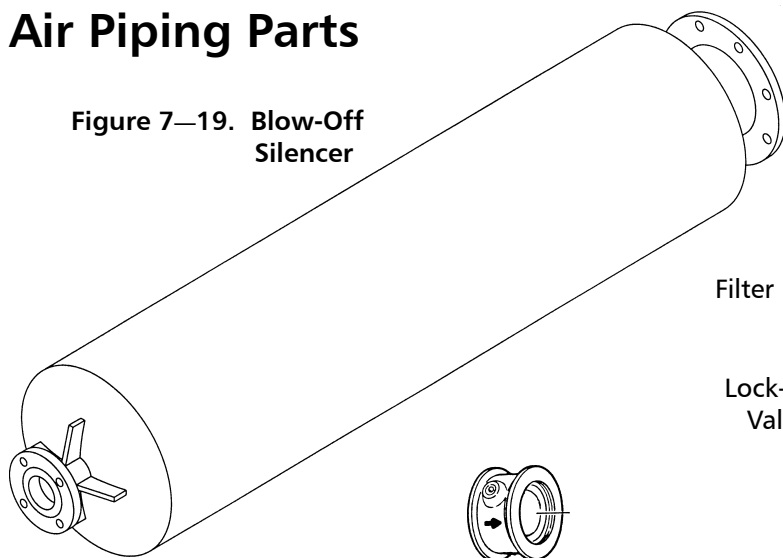


Figure 7—20. Discharge Air Check Valve

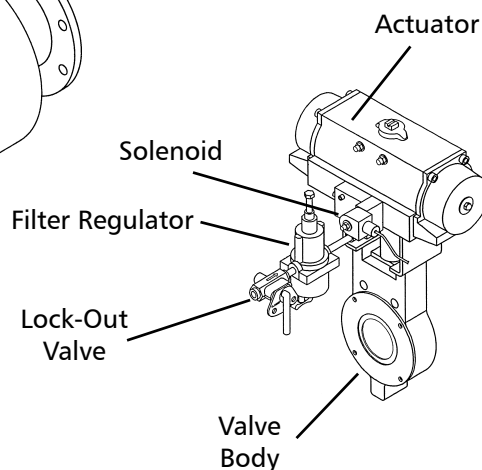
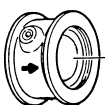


Figure 7—21. Automatic Block Valve Assembly

Model	Connections		Overall Length	Ingersoll Rand Part Number
	Inlet [A]	Discharge [A]		
BMSV-6	2" (Flanged)	8" (Flanged)	78" (2000 mm)	AAP0540010-01302
BMSV-8	3" (Flanged)	10" (Flanged)	71" (1800 mm)	AAP0540010-01303
LCV-10	4" (Flanged)	10" (Flanged)	71" (1800 mm)	AAP0540010-01304
	6" (Flanged)	14" (Flanged)	96" (2438 mm)	AAP0540010-07335
Notes: [A] Expressed per ANSI (USA) Standards for piping (in inches).				

Table 7-19. Blow-Off Silencers

Description	Ingersoll Rand Part Number
5" Valve (for > 900 HP)	AAP0540024-00186
6" Valve (2 Stage)	AAP0540024-00187

Table 7-20. Discharge Air Check Valves

Description	Ingersoll Rand Part Number
6" Valve, 110/120-Volt	AAP0540008-00927
6" Valve, 220/240-Volt	AAP0540008-00928
4" Valve, 110/120-Volt	AAP0540008-00800
4" Valve, 220/240-Volt	AAP0540008-00823

Table 7—21. Automatic Block Valve Assemblies

Glossary

Air End — *the part of the compressor package that includes the gearbox and the air moving components.*

Airflow — *the movement of air or process gas through the compressor or the compressed air system.*

Aftercooler — *a heat exchanger that cools the process air after the final stage of compression.*

Alarm — *a warning about a compressor operating condition that is outside of normal operating limits.*

Blow-Off Valve — *an airflow control device that vents compressor discharge air to the atmosphere. (Also see Modulating Blow-Off Valve.)*

BOV — *the abbreviation for Blow-Off Valve.*

BPV — *the abbreviation for Bypass Valve.*

Bypass Valve — *an airflow control device that vents compressor discharge air back into the inlet pipe of the compressor.*

Bullgear — *the main input gear that drives the higher speed pinions.*

Bundle — *refers to the intercooler or aftercooler heat exchanger core. Consists of the tubesheet, tubes and baffles..*

Check Valve — *a device that permits the flow of air, water or oil in one direction only.*

Controller, Motor — *(See Motor Controller.)*

Control Method — *the specific technique used by the control system to deliver compressed air to meet specific process demands.*

Control Setpoints — *those setpoints that supervise routine compressor operation.*

Cooler — *device used to remove heat. (See Aftercooler, Intercooler, Oil Cooler, or Panel Cooler.)*

Coupling, Main Drive — *the device that connects the motor shaft to the bullgear shaft.*

Data Log — *(See Operator's Data Log.)*

DCS — *the abbreviation for Distribution Control System.*

Design Standard — *the operating condition of the compressor to which the aerodynamic performance is rated, generally a "worst case" or "hot summer day" condition.*

Distribution Control System — *a functionally related group of electronic devices used for industrial machine sequencing and operation.*

Diffuser — *the component of a compressor stage that helps convert the high velocity airflow into a pressure rise.*

Discharge Pressure — *the air pressure measured between the compressor exit and the compressor discharge check valve.*

Display — *the screen that presents operating information on the Maestro Control Panel.*

Drive End — *the end of a rotating machine that contains the drive shaft extension.*

Drive Train — *the part of the compressor package that contains the main drive motor, the main drive coupling, and the gearbox.*

Ejector — *the component that creates a slight vacuum inside the gearbox and oil reservoir to properly handle oil mist.*

EMERGENCY STOP Button — *the device on the Maestro Control Panel that serves to immediately interrupt power to the main motor causing the compressor to stop operating. (For emergency use only.)*

EVC — *the abbreviation for Electric Vapor Coalescer.*

FLA — *the abbreviation for Full Load Amperage.*

Full Load Amperage — *the amperage rating of a motor (less Service Factor), the value of which is listed on motor nameplate.*

Gearbox — *the parts of the compressor package that contains the gears, bearings, and seals.*

Heat Exchanger — *a device that is used to cool air or oil during compressor operating. (See Aftercooler, Intercooler, or Oil Cooler.)*

IGV — *the abbreviation for Inlet Guide Vane.*

Impeller — *the aerodynamic component that rotates at a very high speed, thereby increasing the airflow velocity and imparting energy into the airstream.*

Inlet — 1. *the component of a compressor stage that covers the impeller and diffuser, thus creating a very tightly tolerated air passage.*
2. *the point of the compressor stage at which the air enters.*

Inlet Air Filter — *a device that removes dirt, dust, and other airborne contaminants from the intake air before it is allowed to enter the compressor.*

Inlet Air Startup Screen — *a conical-shaped screen that is placed in the inlet air piping at the initial startup of the compressor, when required, to stop larger airborne particles from entering the compressor.*

Inlet Guide Vane — *a device that throttles inlet airflow to the compressor, while also imparting a pre-whirl to the airstream.*

Intercooler — *the heat exchangers that cool the process air between stages of compression.*

LED — *the abbreviation for Light Emitting Diode.*

Light Emitting Diode — *a status indicating light on the Maestro Control Panel.*

Load or Loaded — *any number of compressor operating points where airflow, discharge pressure, and power consumption are at or near rated values.*

MANUAL Control Method — *an operating condition during which the position and movement of the inlet guide vane and blow-off valve are controlled solely by the compressor operator.*

MBOV — *the abbreviation for Modulating Blow-Off Valve.*

Mist Filter — *a device that collects the oil vapor that is vented from the oil reservoir.*

Modulating Blow-Off Valve — *an airflow control device that vents compressor discharge air to the atmosphere.*

Motor Controller — *a device that is used to start, stop and protect electric motors. (Also referred to as a Motor Starter.)*

“Off Design” Operation — a compressor operating condition when the ambient environment is other than the design standard.

Oil Cooler — the heat exchanger that cools the lubricating oil.

Operator’s Data Log — a periodic record of compressor operation.

Opposite Drive End — the end of a rotating machine that is opposite of the drive shaft extension.

Optical Coupler — an electronic device similar to an electrical relay (also referred to as OPTO).

OPTO — the abbreviation for Optical Coupler.

Panel Cooler — an optional heat exchanger that is used to cool the interior of the Maestro Control Panel.

Pinion — the gear element to which the impeller(s) are mounted.

PLC — the abbreviation for Programmable Logic Controller.

Programmable Logic Controller — a computer-based device typically used to administer plant-wide production information.

Potentiometer — an electronic device that varies resistance in an electrical circuit.

Receiver — a storage device (such as a tank, extended length of system piping, etc.) in the compressed air system used to hold compressed air.

Reservoir, Oil — the tank on the compressor package that is used to hold lubricating oil.

Reservoir Vent — the filtration system comprised of the ejector and mist filter.

Resistive Temperature Detector — a device that is used for temperature measurement.

RTD — the abbreviation for Resistive Temperature Detector.

Scroll — the component of a compressor stage that “collects” the high velocity air exiting the impeller.

Sensor — a device that is used to measure parameters such as, temperature and vibration.

Service Factor — as applied to motors, a factor whereby a motor can be loaded beyond its horsepower rating without overheating or suffering insulation damage.

Setpoint — a control measurement that protects the compressor or the compressed air system. (It may or not be capable of being changed by the operator.)

Shaft Alignment — the relative position of the drive train components to each other.

Shutdown — the process of unloading and stopping the compressor.

Silencer — the device that is used to reduce sound levels.

Stage — a set of aerodynamic components including the scroll, inlet, impeller and diffuser.

Starter, Motor — (See Motor Controller.)

Startup — the process of starting and loading the compressor.

Startup Screen — a device that is temporarily installed in the inlet air piping to prevent foreign material from entering the compressor.

Surge — a compressor operating condition characterized by a momentary reversal of airflow back through the compressor.

System Pressure — the pressure of the compressed air measured after the compressor check valve.

Transducer — a sensor that converts a measured parameter (such as pressure or temperature) to a voltage output in an established way.

Transmitter — a specific type of transducer that converts a measured parameter (such as pressure) to a current output (typically 4-20 mA).

Trip — a shutdown initiated by the Maestro Control System to protect the compressor.

Trip Recall Function — a Control Panel Diagnostics function that allows the operator to review compressor operating data at the time of a compressor Trip condition.

Turndown Range — the extent to which the airflow through the compressor may be throttled without encountering surge while maintaining setpoint pressure.

Unloaded — an operating condition where airflow through the compressor, and thus power consumption, are at a minimum.

User Interface — the part of the Maestro Control Panel that allows the user to view data, monitor compressor operating, and adjust operating parameters (such as setpoints).

"Worst Case" Operating Condition — the ambient circumstances (also referred to as a "hot summer day") when the air is less dense and filled with water vapor resulting in adverse compressor performance.

Revision History:

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01	1938315	January 2005		Initial Release
02	2127389	September 2006		
03	2318415	October 2008		
04	2561476	June 2011		
05	4775599	January 2016	Jason M. Smythe	

	Department	Approval	Date
Prepared By: J. Smythe	Project Management		
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Approved By: C. Impastato	Engineering		
Approved By:			

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