APPLICATION AND INSTALLATION GUIDE

Air Compressor Used on Selected Petroleum and Industrial Engines

CAT®

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Foreword

This section of the Application and Installation Guide generally describes Electric Power Application, Engine and Generator Selection for Cat® engines. Additional engine systems, components and dynamics are addressed in other sections of this Application and Installation Guide.

Engine-specific information and data are available from a variety of sources. Refer to the Introduction section of this guide for additional references.

Systems and components described in this guide may not be available or applicable for every engine.

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Air Compressor Used on Selected Petroleum and Industrial Engines

The function of the air compressor is to provide and maintain air under pressure to operate auxiliary air systems. The compressor can be either a single cylinder or two cylinder single stage reciprocating piston compressor. For the Swept Displacement and the Free Air Delivery for the various compressors see the Installation Specifications chart at the end of this document.

The compressor is driven by the engine and is operating continuously while the engine is running. A governor and the air compressor's unloading mechanism control actual compression of air. The governor maintains the air pressure to preset maximum and minimum pressure levels. The air compressor is cooled by the engine coolant system and is lubricated by the engine oil supply.

As the atmospheric air is compressed, all the water vapor originally in the air is carried along into the air system, as well as a small amount of the lubricating oil as vapor. If an air dryer is not used to remove these contaminants prior to entering the air system, the majority, but not all, will condense in the reservoir. The quantity of contaminants that reach the air system depends on several factors including installation, maintenance, and contaminant handling devices in the system. These contaminants must either be eliminated prior to entering the air system or after they enter.

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Air Compressor Specifications

Air Induction

One of the single most important aspects of compressor preventive maintenance is the induction of clean air. The air supply for the air compressor is to be filtered air from the air filter for the engine. The minimum filter efficiency is to be 99.6% and must meet ISO5011 test requirements. Clean air is necessary to prevent excessive cylinder and piston ring wear. It is also necessary for proper operation of downstream valves in the air system.

The **air compressor must be naturally aspirated only**. It is compatible for use with turbocharged engines, but the compressor **must not** receive its intake air from a source that is turbocharged (boosted).

To assure no contamination from the engine emissions, compressors will have to be plumbed into the engines air induction system far enough prior to the turbocharger (naturally aspirated) and any other induction connections to avoid any recycled exhaust gasses being supplied to the compressor.

When a compressor is connected to the engine air cleaner by lines and fittings, the compressor inlet depression should not exceed 635 mm (25 inches) of water. Inlet depression should be measured at the base of the inlet fitting to the compressor. The compressor inlet line should be connected as close to the air filter and as far from the turbocharger as possible to help keep the compressor inlet depression as low as possible.

Air inlet line size for a naturally aspirated air induction system should have a minimum Inside Diameter of 25.4 mm (1 inch). Air inlet line length should be a maximum length of 2 m (6.6 ft). Air inlet lines and fittings should be resistant to hydrocarbons (oil) and able to support average operating temperatures of 204°C (400°F). BA921 Compressors will require an expansion chamber and check valve in the inlet line to prevent air from pulsing back into the air line from the air cleaner to the turbo. The pulses could damage turbos and could allow oil to migrate to the turbo. Lines may need to be reinforced to avoid contraction under vacuum and breakage from fatigue. Transitory temperatures of the air delivered to the inlet of the compressor must not exceed 121°C (250°F). The compressor air inlet must not be connected to any part of the engine's air system that contains re-circulated exhaust gas.

Duty Cycle

The duty cycle is the ratio of time the compressor spends building air pressure in the system to the total engine running time. Air compressors are designed to build air pressure (run "loaded") up to 25% of the time. The average charge duration should not exceed 90 seconds to ensure "normal" life of the compressor. Higher duty cycles cause conditions that effect air charging system performance, which may require additional maintenance. Excessive leakage from fittings, connections, lines, chambers or valves, etc. may add to the duty cycle.

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Discharge Line

The air discharge line must transmit high-pressure air from the compressor, to the air dryer and then on to the air reservoir where it becomes available for the air system applications. The discharge line could have an effect on the compressor's life if restrictions exist. Restrictions in the discharge line will cause the compressor to have extremely high peak pressures and overheat.

The Maximum temperature of the air from the compressor discharge port should not exceed 204°C (400°F). The discharge line allows the air, water vapor, and oil-vapor mixture to cool between the compressor and air dryer or reservoir. Air temperature to the dryer inlet should not exceed 71.1°C (160°F). The minimum size of a discharge line should be 15.8 mm (0.625 inch) ID and a minimum length of 3.7 m (12 ft). This assumes a compressor with a normal (less than 25%) duty cycle, operating in a temperate climate. Larger ID and longer discharge lines provide for better cooling of the air and vapors. This may be necessary in some applications to assure that the air temperature to the dryer inlet does not exceed 71.1°C (160°F).

Avoid installing valves (pressure regulating valves, etc.) in the compressor discharge line between the compressor, and reservoir or air dryer. The valves can trap water and lead to discharge line freeze-up during cold temperature conditions. The longer the discharge line length, the greater the potential for a frozen discharge line to occur.

If a copper discharge line is used, a flexible connection to the first reservoir or air dryer should be added to prevent fatigue of the copper line. Wire braided Teflon hose must have a capable operating temperature of 232°C (450°F) and a working pressure of 20.7 bar (300 psig) if connected directly to the compressor discharge fitting. The Minimum bend radii of the discharge line should be no less than 50.8 mm (2 inches).

The discharge line should slope continuously downward from the air compressor discharge port, with no sharp bends, water traps, risers or elbow fittings, to the air dryer or reservoir. If there are any upward or downward deviations, the line can trap water, which during cold weather can freeze causing a blockage. Severe compressor damage can occur as a result of blocked discharge line.

If, instead, ice blockages occur at the air dryer or reservoir inlet, insulation may be added here, or if the inlet fitting is a typical 90° fitting, it may be changed to a straight or 45° fitting. Shorter discharge line lengths or insulation may be required in cold climates.

A discharge line safety valve is installed in the cylinder head or close to the compressor discharge port and protects against over pressurizing the compressor in the event of a discharge line freeze up.

If the discharge line becomes restricted with carbon, the compressor can be damaged. As preventive maintenance, it is recommended that the discharge line be inspected at regular service intervals.

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The application of a downstream device such as an air dryer, discharge line unloader, or turbocharger cut off valve needs to be installed properly to avoid premature compressor durability problems. Refer to the manufacturer's instructions for these products.

The **use of alcohol** in the air system as a means of preventing system freeze-up in cold temperatures **is not acceptable**. Studies indicate that using alcohol and alcohol based products sold for this purpose removes the lubrication from the components of the air system. In addition, the residue that some anti-freeze additives leave behind may adversely impact the materials used for the internal seals of the air system components. Both are detrimental to air system component life expectancy, causing premature wear.

Cooling

Air flowing through the engine compartment from the action of the engine's fan assists in cooling the compressor. Coolant flowing from the engine's cooling system through connecting lines enters the head and passes through internal passages in the cylinder head and is returned to the engine. Proper cooling is important in maintaining discharge air temperatures below the Maximum 204°C (400°F).

The allowable air compressor ambient (under hood or in enclosure) temperature range is -40°C to 121°C (-40°F to 250°F). If any part of the compressor or air line is located within 76.2 mm (3 inches) of an exhaust pipe or turbocharger, a heat shield should be installed to protect the compressor or line from the heat.

Maximum Compressor System Pressure

The Maximum sustained system pressure is 10.3 bar (150 psig).

The maximum transitory system pressure is 13 bar (188 psig).

Governor Installation

The minimum pressure specified for each model air compressor in the Installation Specifications chart at the end of this document must be applied to the compressor unloader port, to insure proper unloader operation. Therefore, the cut-in pressure of the governor used must be at least as high as the value shown in the chart for the compressor being used.

When the governor is mounted directly to the air compressor's cylinder head, if the bolts are 5/16 –18 thread they are to be tightened to a torque of 13 +/- 3 Nm (9.6 +/- 2.2 lbf-ft), If the bolts are M8 x 1.25 thread they are to be tightened to a torque of 15 +/- 3 Nm (11.1+/- 2.2 lbf-ft). The bolt thread is determined by the tapped hole in the compressor cylinder head. The TF550 and TF750 have 5/16 –18 tapped holes. The BA921 and the CAT290 have M8 x 1.25 tapped holes.

When the governor is remote mounted, the following precautions should be taken.

- Keep the unloader line volume, from the tank to the compressor (tank to governor plus governor to compressor), under 0.82 L (50 cubic inches).
- The supply line must have a 6.4 mm (0.25 inch) minimum Inside Diameter from the tank

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to the compressor (tank to governor and/or governor to compressor). When the governor opens, air passes through the governor and fills the unloader line pressurizing the unloaders, cutting out the compressor. If the governor supply line is restricted, a pressure loss at a governor supply may close the governor valve and exhaust the air from the unloader. As soon as pressure builds up again at the governor, it will open once again. This cycle will continue at a high rate. To avoid this "fluttering", use a short line with 6.4 mm (0.25 inch) ID and no restrictions by fittings or sharp bends.

- Governor location above or below the compressor is equally acceptable as long as the connecting line has a continuous slope with no water traps. Refer to the manufacturer's instructions for further installation instructions of the governor.
- "Line Unloaded" systems may be permitted, but require prior approval from the Caterpillar Air System Engineering COE.

Recommended Reservoir Maintenance

The air system reservoirs should be drained at least daily to minimize the amount of moisture in the air system. Excessive liquid in the reservoirs will affect air compressor build-up times. It can also cause damage to the governor and the compressor unloader mechanism.

Auxiliary Mounting Brackets

Fasteners on the compressor are torqued at the factory to insure compressor reliability. Therefore, bolts should not be removed. The removal of compressor bolts to install brackets or accessories is prohibited. Engineering should be consulted regarding the addition of studs to eliminate the need to disturb the original torque setting of a bolt.

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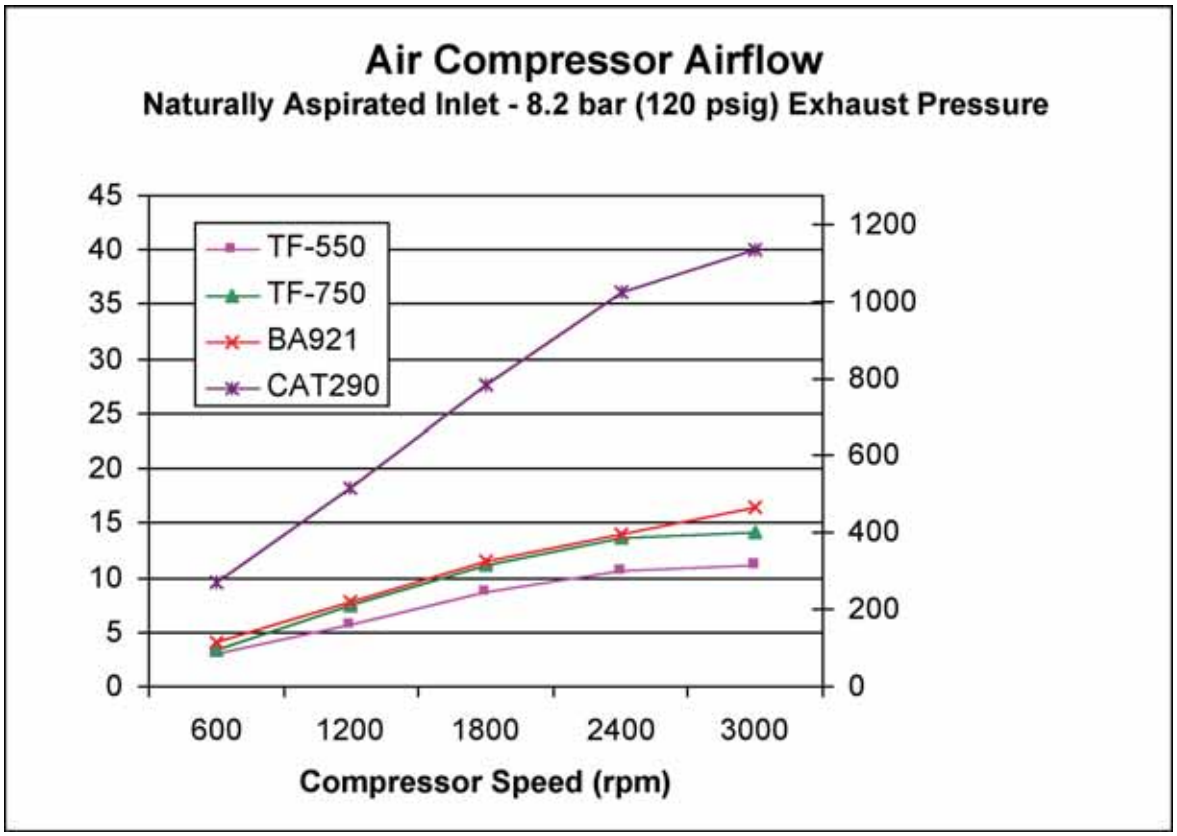

Figure 1

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Installation Specifications				
Air Compressor Model	**TF550**	**TF750**	**BA921**	**CAT290**
Swept Air Displacement - lpm (cfm) @ 1250 rpm (rated*)	373.78 lpm (13.2 scfm)	467.23 lpm (16.5scfm)	447.41 lpm (15.8 scfm)	894.81 lpm (31.6 scfm)
Free Air Delivery (FAD) - lpm (scfm) @ 1800 rpm, 0 bar (0 psig) Inlet, 120 psig Head	243.52 lpm (8.6 scfm)	317.15 lpm (11.2 scfm)	328.48 lpm (11.6 scfm)	656.95 lpm (23.2 scfm)
Max. Compressor Speed - rpm	3000 rpm	3000 rpm	3000 rpm	3000 rpm
Horsepower requirement				
Max. Power Required Loaded - kW (hp) — @ 1800 rpm, 0 psig Inlet, 8.3 bar (120 psig) Head	2.8 kW (3.8 hp)	3.7 KW (4.9 hp)	3.4 KW (4.6 hp)	6.7 KW(9 hp)
Max. Power Required Unloaded - kW (hp) — @ 1800 rpm, 0 psig Inlet, 8.3 bar (120 psig) Head	0.8 kW (1.1 hp)	1 KW (1.4 hp)	1.1KW (1.5 hp)	1.3 KW (1.8 hp)
Air				
Min. Supply Line Size - mm (in)	25.4 mm (1.00 in)	25.4 mm (1.00 in)	25.4 mm (1.00 in)	25.4 mm (1.00 in)
Min. Discharge Line Size ID - mm (in)	15.9 mm (0.62 in)	15.9 mm (0.62 in)	15.9 mm (0.62 in)	15.9 mm(0.62 in)
Max. Inlet Temperature	121°C (250°F)	121°C (250°F)	121°C (250°F)	121°C (250°F)
Max. Discharge Temperature	204°C (400°F)	204°C (400°F)	204°C (400°F)	204°C (400°F)
Inlet Port Location (top, side, front, rear)	side	side	top	top
Inlet Port Thread	Flange Face	Flange Face	1 3/16 - 12 STORP (#14)	2 3/16 - 12 STORP (#14)
Discharge Location (top, side, front, rear)	top	top	rear	top
Outlet Port Thread	1/2 - 14 NPTF	1/2 - 14 NPTF	7/8 - 14 STORP (#10)	7/8 - 14 STORP (#10)
Max. Sustained System Pressure	10.3 bar (150 psig)	10.3 bar (150 psig)	10.3 bar (150 psig)	10.3 bar (150 psig)
Max. Transitory System Pressure	13 bar (188 psig)	13 bar (188 psig)	13 bar (188 psig)	13 bar (188 psig)
Max. Inlet Depression - mm H_2O (inches H_2O)	635 mm H_2O (25 inch H_2O)	635 mm H_2O (25 inch H_2O)	635 mm H_2O (25 inch H_2O)	635 mm H_2O (25 inch H_2O)
Min. Inlet Filtration (Microns)	same as engine	same as engine	same as engine	same as engine
Unloader				
Min. Line size - mm (in)	4.8 ID (0.19 in)	4.8 ID (0.19 in)	4.8 ID (0.19 in)	4.8 ID (0.19 in)
Pressure Required to Unload (psig)	4.8 bar (70 psig)	4.8 bar (70 psig)	6.2 bar (90 psig)	6.2 bar (90 psig)
Port Thread Size	1/8 - 27 NPTF	1/8 - 27 NPTF	1/8 - 27 NPTF	1/8 - 27 NPTF
Drive				
Drive Type (gear, spline, pulley)	Pulley or gear	Gear	Gear	Gear
Retention Bolt/Nut Thread Size	3/4 - 16 SAE Thd	3/4 - 16 SAE Thd	Factory installed only. Not to be serviced.	
Retention Bolt/Nut Torque	370 +/- 50 N·m (273 +/- 37 lbf-ft)	370 +/- 50 N·m (273 +/- 37 lbf-ft)	Factory installed only. Not to be serviced.	
Compressor to engine drive ratio	*C7, C9*	*Gear driven*	*1 : 1*	
	C11, C13	*Gear driven*	*1.14 : 1*	
	C15, C18	*Gear driven*	*1.2 : 1*	
	Belt driven depends on pulley sizes			

Table 1

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