

Compressed Air System Vendor Literature

Section 05-01-09

Komatsu has made every effort to make this manual as accurate as possible based on the information available at the time of publication and printing. Continuous improvement and advancement of product design may cause changes to machines, which may not have been included in this publication. Komatsu reserves the right to make changes and improvements at any time. To ensure the most current information, please contact your service center.

Vendor Literature

- VL 60 - Bendix Tu-Flo 550 Air Compressor
- VL 84 - Bendix Tu-Flo 750 Air Compressor
- VL 85 - Bendix DuraFlo 596 Air Compressor
- VL 90 - Bendix AD-IP Integral Purge Air Dryer
- VL 100 - Bendix R12 & R14 Relay Valves
- VL 103 - Bendix BA-922 Compressor
- VL 116 - Bendix D-2 Governor
- VL 128 – Bendix Troubleshooting Guide

NOTICE

The vendor literature in this section covers a variety of different components. Check your model before using the literature. Some literature shows slightly different components. It is essential to use the Komatsu Parts Manual that was issued for the machine on which work is being performed, to order parts.

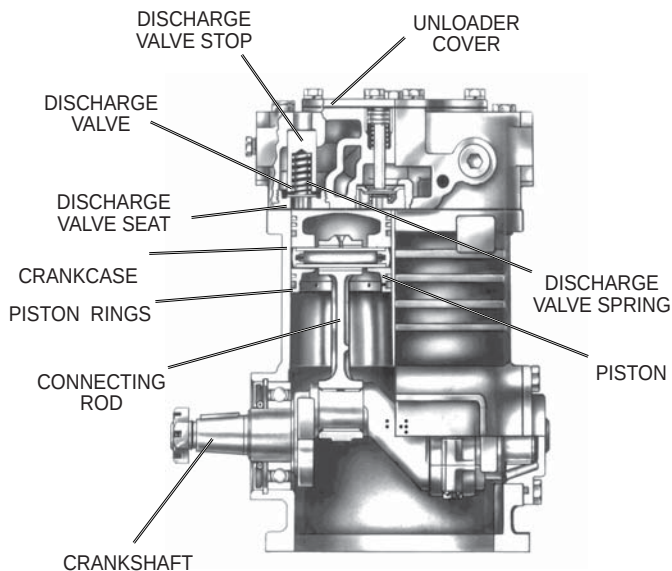
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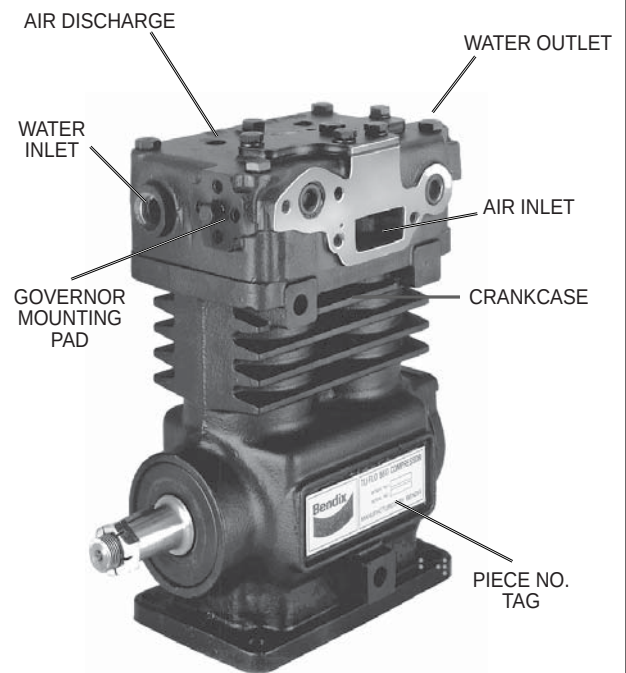
Service Data

SD-01-333

Bendix® Tu-Flo® 550 Air Compressor



BENDIX® TU-FLO® 550 AIR COMPRESSOR
(CROSS SECTION)

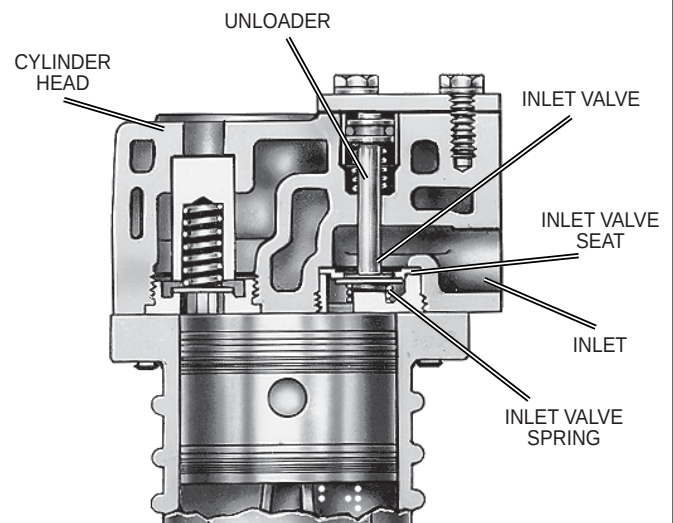


BENDIX® TU-FLO® 550 AIR COMPRESSOR
(EXTERIOR)

DESCRIPTION

The function of the air compressor is to provide and maintain air under pressure to operate devices in the air brake and/or auxiliary air systems. The Bendix® Tu-Flo® 550 compressor is a two cylinder single stage, reciprocating compressor with a rated displacement of 13.2 cubic feet per minute at 1250 RPM.

The compressor assembly consists of two major subassemblies, the cylinder head and the crankcase. The cylinder head is an iron casting which houses the inlet, discharge, and unloader valving. (See Figure 1.) The cylinder head contains the air inlet port and is designed with both top and side air discharge ports. Three water coolant ports provide a choice of coolant line connections. Governor mounting surfaces are provided at both the front and the rear of the cylinder head. The head is mounted on the crankcase and is secured by six cap screws. The Tu-Flo® 550 compressor is designed such that the cylinder head can be installed in one of two positions which are 180 degrees apart. The crankcase houses the cylinder bores, pistons, crankshaft and main bearings, and provides the flange or base mounting surface.



END VIEW OF CYLINDER HEAD

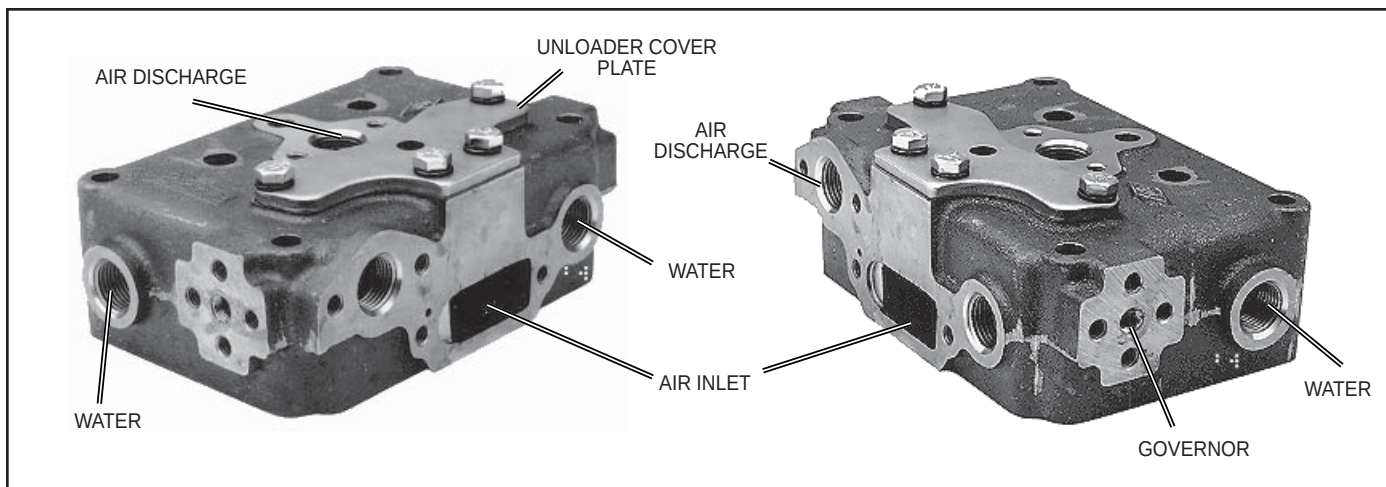


FIGURE 1 - CYLINDER HEAD

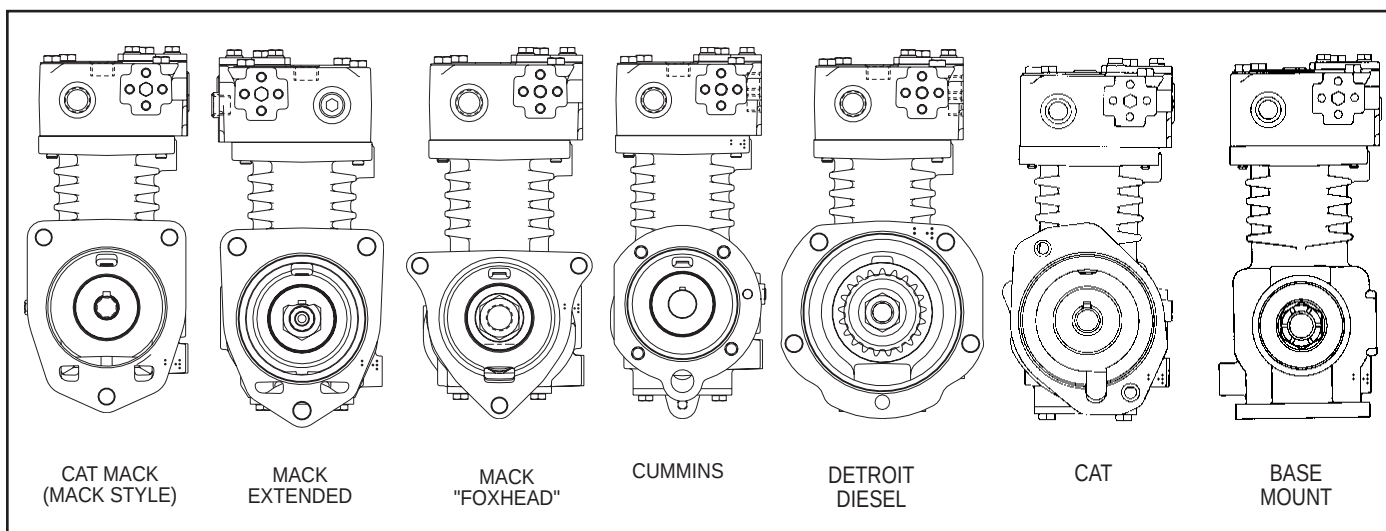


FIGURE 2 - FLANGE CONFIGURATIONS

Various mounting and drive configurations, as shown in Figure 2, are supplied as required by the vehicle engine designs. A nameplate identifying the compressor piece number and serial number is attached to the side of the crankcase. (Reference Figure 3.)



FIGURE 3 - NAMEPLATE

OPERATION

The compressor is driven by the vehicle engine and is operating continuously while the engine is running. Actual compression of air is controlled by the compressor unloading mechanism and the governor. The governor which is generally mounted on the compressor maintains the brake system air pressure to a preset maximum and minimum pressure level.

INTAKE AND COMPRESSION OF AIR (LOADED)

During the down stroke of the piston, a slight vacuum is created between the top of the piston and the cylinder head, causing the inlet valve to move off its seat and open. (Note: The discharge valve remains on its seat.) Atmospheric air is drawn through the air strainer and the open inlet valve into the cylinder (see Figure 4). As the piston begins its upward stroke, the air that was drawn into the cylinder on the down stroke is being compressed. Air pressure on the inlet valve plus the force of the inlet spring, returns the inlet valve to its seat and closes. The piston continues the upward stroke and compressed air pushes the discharge valve off its seat and air flows by the open discharge valve, into the discharge line and to the reservoirs (see Figure 5). As the piston reaches the top of its stroke and starts down, the discharge valve spring and air pressure in the discharge line returns the discharge valve to its seat. This prevents the compressed air in the discharge line from returning to the cylinder bore as the intake and compression cycle is repeated.

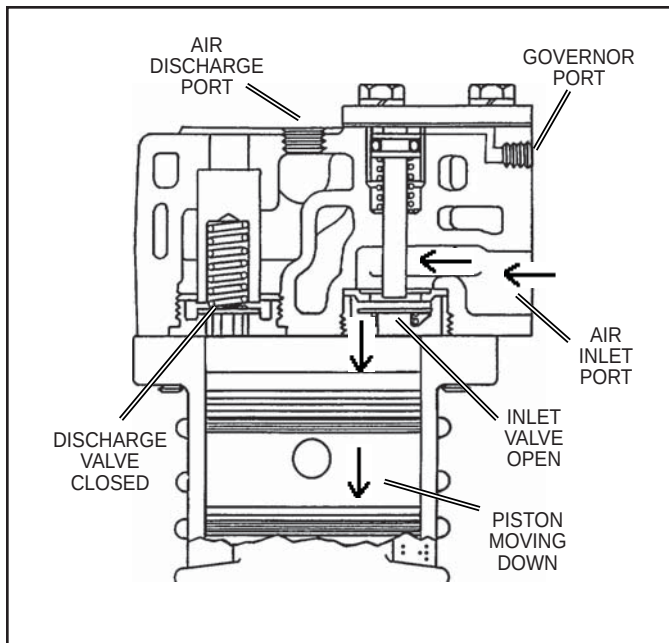


FIGURE 4 - OPERATIONAL-LOADED (INTAKE)

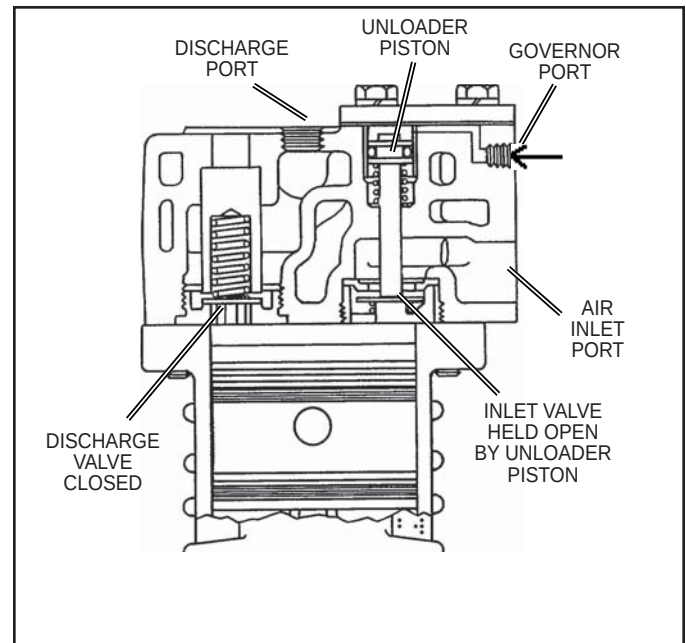


FIGURE 6 - OPERATIONAL-UNLOADED

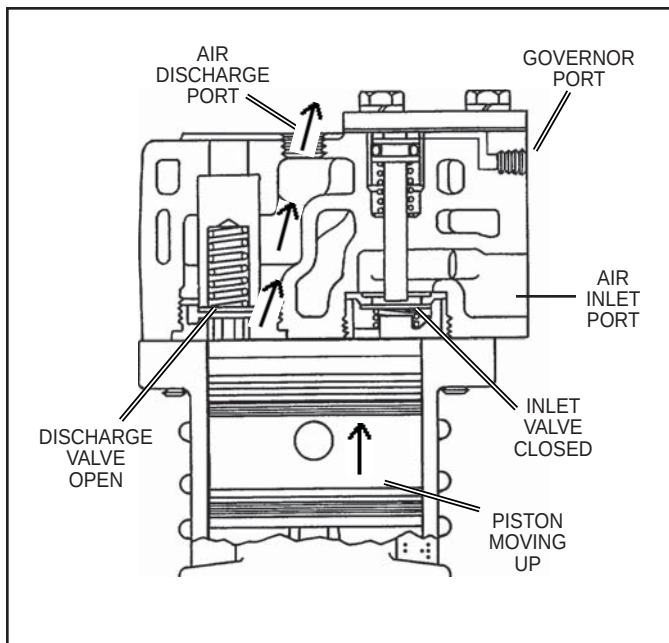


FIGURE 5 - OPERATIONAL-LOADED (COMPRESSION)

NON-COMPRESSON OF AIR (UNLOADED)

When air pressure in the reservoir reaches the cut-out setting of the governor, the governor allows air to pass from the reservoir, through the governor and into the cavity above the unloader pistons. The unloader pistons move down holding the inlet valves off their seats (see Figure 6.)

With the inlet valves held off their seats by the unloader pistons, air is pumped back and forth between the two cylinders, and the discharge valves remain closed. When air pressure from the reservoir drops to the cut-in setting of the governor, the governor closes and exhausts the air from above the unloader pistons. The unloader springs

force the pistons upward and the inlet valves return to their seats. Compression is then resumed.

COMPRESSOR & THE AIR BRAKE SYSTEM

GENERAL

The compressor is part of the total air brake system, more specifically, the charging portion of the air brake system. As a component in the overall system its condition, duty cycle, proper installation and operation will directly affect other components in the system.

Powered by the vehicle engine, the air compressor builds the air pressure for the air brake system. The air compressor is typically cooled by the engine coolant system, lubricated by the engine oil supply and has its inlet connected to the engine induction system.

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 reservoirs. 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.

DUTY CYCLE

The duty cycle is the ratio of time the compressor spends building air to the total engine running time. Air compressors are designed to build air (run "loaded") up to 25% of the time. Higher duty cycles cause conditions that affect air

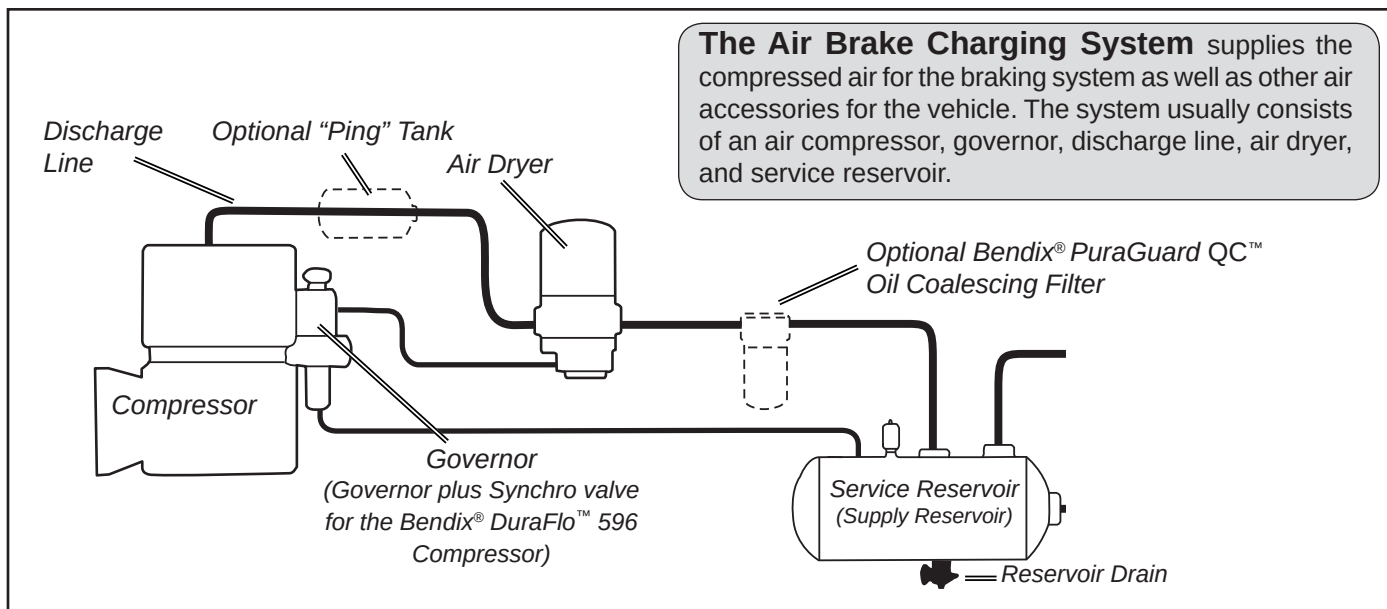


FIGURE 6A - SYSTEM DRAWING

brake charging system performance which may require additional maintenance. Factors that add to the duty cycle are: air suspension, additional air accessories, use of an undersized compressor, frequent stops, excessive leakage from fittings, connections, lines, chambers or valves, etc. Refer to Table A in the Troubleshooting section for a guide to various duty cycles and the consideration that must be given to maintenance of other components.

COMPRESSOR INSTALLATION

While the original compressor installation is usually completed by the vehicle manufacturer, conditions of operation and maintenance may require additional consideration. The following presents base guidelines.

DISCHARGE LINE

The discharge line allows the air, water-vapor and oil-vapor mixture to cool between the compressor and air dryer or reservoir. The typical size of a vehicle's discharge line, (see column 2 of Table A in the Troubleshooting section) assumes a compressor with a normal (less than 25%) duty cycle, operating in a temperate climate. See Bendix and/or other air dryer manufacturer guidelines as needed.

The discharge line must maintain a constant slope down from the compressor to the air dryer inlet fitting or reservoir to avoid low points where ice may form and block the flow. 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 degree fitting, it may be changed to a straight or 45 degree fitting. Shorter discharge line lengths or insulation may be required in cold climates.

While not all compressors and charging systems are equipped with a discharge line safety valve this component is recommended. The discharge line safety valve is

installed in the cylinder head (Tu-Flo® 550/750) or close to the compressor discharge port and protects against over pressurizing the compressor in the event of a discharge line freezeup.

DISCHARGE LINE TEMPERATURE

When the temperature of the compressed air that enters the air dryer is within the normal range, the air dryer can remove most of the charging system oil. If the temperature of the compressed air is above the normal range, oil as oil-vapor is able to pass through the air dryer and into the air system. Larger diameter discharge lines and/or longer discharge line lengths can help reduce the temperature.

The air dryer contains a filter that collects oil droplets, and a desiccant bed that removes almost all of the remaining water vapor. The compressed air is then passed to the air brake service (supply) reservoir. The oil droplets and the water collected are automatically purged when the governor reaches its "cut-out" setting.

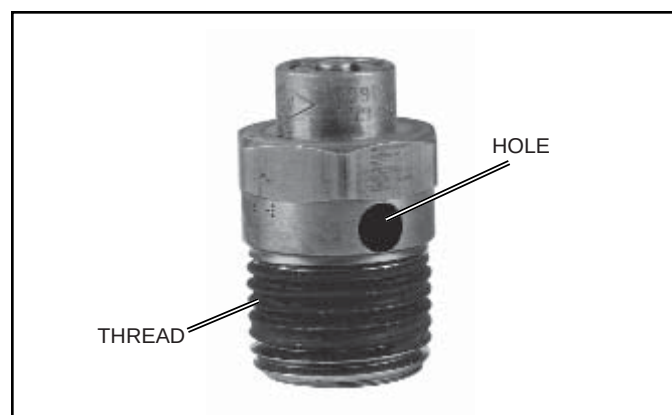


FIGURE 6B - DISCHARGE LINE SAFETY VALVE

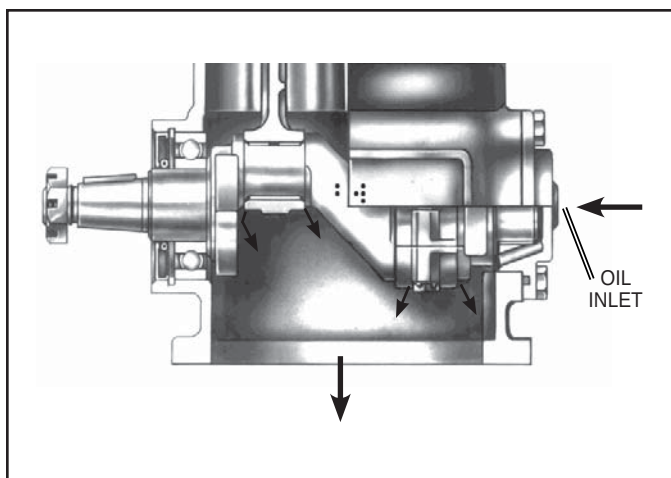


FIGURE 7 - LUBRICATION

For vehicles with accessories that are sensitive to small amounts of oil, we recommend installation of a Bendix® PuraGuard® QC™ oil coalescing filter, designed to minimize the amount of oil present.

LUBRICATION

The vehicle's engine provides a continuous supply of oil to the compressor. Oil is routed from the engine to the compressor oil inlet. An oil passage in the compressor crankshaft allows oil to lubricate the connecting rod crankshaft bearings. Connecting rod wrist pin bushings and crankshaft ball bearings are spray lubricated. An oil return line connected from the compressor drain outlet to the vehicle engine crankcase allows for oil return. On flange mounted models the oil drains back directly to the engine through the mounting flange.

COOLING

Air flowing through the engine compartment from the action of the engine's fan and the movement of the vehicle 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 recommended 400 degrees Fahrenheit.

Figure 8 illustrates the various approved coolant flow connections. See the tabulated technical data in the back of this manual for specific requirements.

AIR INDUCTION

There are three methods of providing clean air to the Tu-Flo® 550 compressor:

1. Naturally aspirated Local Air Strainer - Compressor utilizes its own attached air strainer (polyurethane sponge or pleated paper dry element).

2. Naturally aspirated Engine Air Cleaner - Compressor inlet is connected to the engine air cleaner or the vacuum side (engine air cleaner) of the supercharger or turbocharger.

3. Pressurized induction - Compressor inlet is connected to the pressure side of the supercharger or turbocharger.

See the tabulated technical data on page 14 of this manual for specific requirements for numbers 2 and 3 above.

If a previously unturbocharged compressor is being turbocharged, it is recommended that the inlet cavity screen (238948) be installed with an inlet gasket (291909) on both sides of the screen.

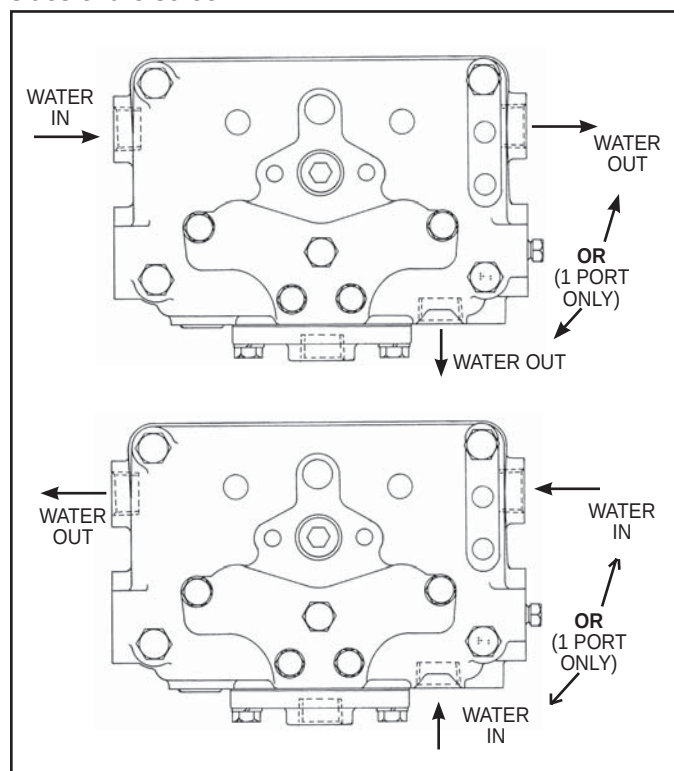


FIGURE 8 - COOLING

COMPRESSOR TURBOCHARGING
PARAMETERS

Air entering the compressor inlet during the loaded cycle must not exceed 250 degrees Fahrenheit (121 degrees Celsius). A metal inlet line is suggested to help meet this parameter.

The following compressor crankshaft rotative speed and inlet pressure relationships may not be exceeded.

Crankshaft R.P.M.	Maximum Compressor Inlet Pressure
2200 RPM	30.0 psi (207 kPa)
2600 RPM	25.0 psi (172.5 kPa)

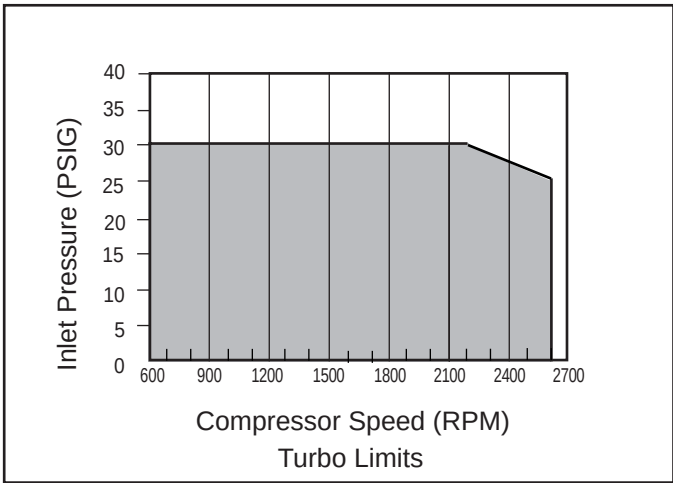


FIGURE 9 - TURBO LIMITS CURVE

PREVENTIVE MAINTENANCE

Regularly scheduled maintenance is the single most important factor in maintaining the air brake charging system. Refer to Table A in the Troubleshooting section for a guide to various considerations that must be given to the maintenance of the compressor and other related charging system components.

Important Note: Review the warranty policy before performing any intrusive maintenance procedures. An extended warranty may be voided if intrusive maintenance is performed during this period.

AIR INDUCTION

One of the single most important aspects of compressor preventive maintenance is the induction of clean air. The type and interval of maintenance required will vary depending upon the air induction system used.

The intervals listed under the headings below pertain to typical highway and street operation. **More frequent maintenance will be required for operation in dusty or dirty environments.**

POLYURETHANE SPONGE STRAINER

Every month, 150 operating hours or 5,000 miles, **whichever occurs first**, remove and wash all of the parts. The strainer element should be cleaned or replaced. If the element is cleaned, it should be washed in a commercial solvent or a detergent and water solution. The element should be saturated in clean engine oil, then squeezed dry before replacing it in the strainer. Be sure to replace the air strainer gasket if the entire strainer is removed from the compressor intake.



FIGURE 10 - STRAINERS

DRY ELEMENT - PLEATED PAPER STRAINER

Every two months, 800 operating hours or 20,000 miles **whichever occurs first**, loosen the spring clip from the unhinged side of the mounting baffle and open the cover. Replace the pleated paper filter and secure the cleaned cover, making sure the filter is in position. Be sure to replace the air strainer gasket if the entire air strainer is removed from the compressor intake.

INTAKE ADAPTER

When the engine air cleaner is replaced: Some compressors are fitted with compressor intake adapters, which allow the compressor intake to be connected to the engine air induction system. In this case, the compressor receives a supply of clean air from the engine air cleaner. When the engine air filter is changed, the compressor intake adapter should be checked. If it is loose, remove the intake adapter, clean the strainer plate, if applicable, and replace the intake adapter gasket, and reinstall the adapter securely. Check line connections both at the compressor intake adapter and at the engine. Inspect the connecting line for ruptures and replace it if necessary.

COMPRESSOR COOLING

Every 6 months, 1800 operating hours or after each 50,000 miles whichever occurs first, inspect the compressor discharge port, inlet cavity and discharge line for evidence of restrictions and carboning. If excessive buildup is noted, thoroughly clean or replace the affected parts and closely inspect the compressor cooling system. Check all compressor coolant lines for kinks and restrictions to flow. **Minimum** coolant line size is 3/8" I.D. Check coolant lines for internal clogging from rust scale. If coolant lines appear suspicious, check the coolant flow and compare to the tabulated technical data present in the back of this manual. Carefully inspect the air induction system for restrictions.

LUBRICATION

Every six months, 1800 operating hours or 50,000 miles whichever occurs first, check external oil supply and return lines, if applicable, for kinks, bends, or restrictions to flow. Supply lines must be a minimum of 3/16" I.D. and return lines must be a minimum of 1/2" I.D. Oil return lines should slope as sharply as possible back to the engine crankcase and should have as few fittings and bends as possible. Refer to the tabulated technical data in the back of this manual for oil pressure minimum values.

Check the exterior of the compressor for the presence of oil seepage and refer to the TROUBLESHOOTING section for appropriate tests and corrective action.

OIL PASSING

All reciprocating compressors currently manufactured will pass a minimal amount of oil. Air dryers will remove the majority of oil prior to entrance into the air brake system. For particularly oil sensitive systems the Bendix® PuraGuard® QC™ oil coalescing filter can be used in conjunction with a Bendix air dryer.

If compressor oil passing is suspected, refer to the TROUBLESHOOTING section and TABLE A for the symptoms and corrective action to be taken. In addition,

Bendix has developed the "Bendix Air System Inspection Cup" or **BASIC** test to help substantiate suspected excessive oil passing. The steps to be followed when using the BASIC test are presented in APPENDIX A at the end of the TROUBLESHOOTING section.

COMPRESSOR DRIVE

Every six months, 1800 operating hours or 50,000 miles, whichever occurs first, check for noisy compressor operation, which could indicate a worn drive gear coupling, a loose pulley or excessive internal wear. Adjust and/or replace as necessary.

If the compressor is belt driven, check for proper belt and pulley alignment and belt tension. Check all compressor mounting bolts and retighten evenly if necessary. Check for leakage and proper unloader mechanism operation. Repair or replace parts as necessary.

Every 24 months, 7200 operating hours, or after each 200,000 miles, perform a thorough inspection, and depending upon the results of this inspection or experience, disassemble the compressor, clean and inspect all parts thoroughly, replace all worn or damaged parts using only genuine Bendix replacements or replace the compressor with a genuine Bendix remanufactured unit.

GENERAL SERVICE CHECKS

OPERATING TESTS

IN SERVICE OPERATING TESTS

Compressor Performance: Build-up Test

This test is performed with the vehicle parked and the engine operating at maximum recommended governed speed. Fully charge the air system to governor cut out (air dryer purges). Pump the service brake pedal to lower the system air pressure below 80 psi using the dash gauges. As the air pressure builds back up, measure the time from when the dash gauge passes 85 psi to the time it passes 100 psi. The time should not exceed 40 seconds. If the vehicle exceeds 40 seconds, test for (and fix) any air leaks, and then re- test the compressor performance. If the vehicle does not pass the test the second time, use the Advanced Troubleshooting Guide for Air Brake Compressors, starting on page A-1 of this document to assist your investigation of the cause(s).

Note: All new vehicles are certified using the FMVSS 121 test (paragraph S5.1.1) by the vehicle manufacturer, however the above test is a useful guide for in-service vehicles.

Optional Comparative Performance Check

It may be useful to also conduct the above test with the engine running at high idle (instead of maximum governed

speed), and record the time taken to raise the system pressure a selected range (for example, from 90 to 120 psi, or from 100 to 120 psi, etc.) and record it in the vehicle's maintenance files. Subsequent build-up times throughout the vehicle's service life can then be compared to the first one recorded. (Note: the 40 second guide in the test above does not apply to this build-up time.) If the performance degrades significantly over time, you may use the Advanced Troubleshooting Guide for Air Brake Compressors, starting on page A-1 of this document, to assist investigation of the cause(s).

Note: When comparing build-up times, be sure to make an allowance for any air system modifications which would cause longer times, such as adding air components or reservoirs. Always check for air system leakage.

AIR LEAKAGE TESTS

Compressor leakage tests need not be performed on a regular basis. These tests should be performed when; it is suspected that discharge valve leakage is substantially affecting compressor build-up performance, or when it is suspected that the compressor is "cycling" between the load and unloaded modes due to unloader piston leakage.

These tests must be performed with the vehicle parked on a level surface, the engine not running, the entire air system completely drained to 0 P.S.I., and the inlet check valve detail parts removed, if applicable.

UNLOADER PISTON LEAKAGE

The unloader pistons can be checked for leakage as follows: with the cylinder head removed from the compressor and the inlet flange securely covered, apply 120 psi of air pressure to the governor port. Listen for an escape of air at the inlet valve area. An audible escape of air should not be detected.

DISCHARGE VALVE LEAKAGE

Unloader piston leakage must be repaired before this test is performed. Leakage past the discharge valves can be detected as follows: Remove the discharge line and apply shop air back through the discharge port. Listen for an escape of air at the compressor inlet cavity. A barely audible escape of air is generally acceptable.

If the compressor does not function as described above or if the leakage is excessive, it is recommended that it be returned to the nearest authorized Bendix distributor for a factory remanufactured compressor. If it is not possible, the compressor can be repaired using a genuine Bendix cylinder head maintenance kit. Retest the cylinder head after installation of the kit.

REMOVAL AND DISASSEMBLY

GENERAL

The following disassembly and assembly procedure is presented for reference purposes and presupposes that a major rebuild of the compressor is being undertaken. Several maintenance kits are available which do not require full disassembly. The instructions provided with these parts and kits should be followed in lieu of the instructions presented here.

REMOVAL

These instructions are general and are intended to be a guide, in some cases additional preparations and precautions are necessary.

1. Block the wheels of the vehicle and drain the air pressure from all the reservoirs in the system.
2. Drain the engine cooling system and the cylinder head of the compressor. Identify and disconnect all air, water and oil lines leading to the compressor.
3. Remove the governor and any supporting bracketry attached to the compressor and note their positions on the compressor to aid in reassembly.
4. Remove the discharge and inlet fittings, if applicable, and note their position on the compressor to aid in reassembly.
5. Remove the flange or base mounting bolts and remove the compressor from the vehicle.
6. Remove the drive gear(s) or pulley from the compressor crankshaft using a gear puller. Inspect the pulley or gear and associated parts for visible wear or damage. Since these parts are precision fitted, they must be replaced if they are worn or damaged.

PREPARATION FOR DISASSEMBLY

Remove road dirt and grease from the exterior of the compressor with a cleaning solvent. Before the compressor is disassembled, the following items should be marked to show their relationship when the compressor is assembled. Mark the rear end cover in relation to the crankcase. Mark the base plate or base adapter in relation to the crankcase.

A convenient method to indicate the above relationships is to use a metal scribe to mark the parts with numbers or lines. Do not use marking methods such as chalk that can be wiped off or obliterated during rebuilding.

CYLINDER HEAD

Remove the six cylinder head cap screws (1) and tap the head with a soft mallet to break the gasket seal. Remove the unloader cover plate cap screws (2), lockwashers (3) and the unloader cover plate (4). Scrape off any gasket

material (5) from the cover plate, cylinder head and crankcase.

1. Remove the unloader pistons (7), o-rings (6) and springs (8).
2. Inspect the unloader piston bushings (9) for nicks, wear, corrosion and scoring. It is recommended that the compressor be replaced if it is determined that the unloader bushing is damaged or worn excessively.

Before disassembling the discharge valve mechanism, measure and record the discharge valve travel (from closed to completely open).

3. If the measured discharge valve travel **exceeds** .046 inches, the compressor should be replaced. If the discharge valve travel does not exceed .046, using a 9/16" Allen wrench, remove the discharge valve seats (18), valves (17) and valve springs (16).
4. Remove the inlet valve stops (14), valves (17), valve seats (11), valve springs (12) and gaskets (10). It is recommended that a tool such as a J-25447-B, produced by Kent Moore Tool Division Roseville, Michigan phone 1-800-328-6657, be used to remove the inlet valve stop.

CRANKCASE BOTTOM COVER OR ADAPTER DISASSEMBLY

1. Remove the cap screws (22) securing the bottom cover or adapter (21). Tap with a soft mallet to break the gasket seal. Scrape off any gasket material (20) from the crankcase and bottom cover or adapter.

CONNECTING ROD DISASSEMBLY

Before removing the connecting rod, mark the connecting rods (37) and their caps (39) to ensure correct reassembly. The connecting rod and cap are a matched set therefore the caps must not be switched or rotated end for end.

1. Remove the connecting rod bolts (40) and bearing caps (39).
2. Push the pistons (26) with the connecting rods (37) attached out the top of the cylinder bore of the crankcase. Replace the bearing caps on the connecting rods.
3. Remove the piston rings (23-25) from the piston. If the piston is to be removed from the connecting rod, remove the wrist pin Teflon plugs (28) and press the wrist pin (27) from the piston and connecting rod.
4. If the piston is removed from the rod, inspect the wrist pin bore in the piston and bronze wrist pin bushing (36) in the connecting rod. If excessive wear is noted or suspected, replace the connecting rod and piston.

COMPRESSOR CRANKCASE DISASSEMBLY

1. Remove the key or keys (30) from the crankshaft (29) and any burrs from the crankshaft where the key or keys were removed. (**Note:** Through drive compressors may have a crankshaft key at both ends.)
2. Remove the four cap screws (35) and lockwashers or nuts and lockwashers that secure the rear end cover (34) to the crankcase.
3. Remove the rear end cover (34), thrust washer (31) and end cover oil seal ring (33), taking care not to damage the bearing if present in the end cover.
4. If the compressor has ball type main bearings, press the crankshaft (29) and ball bearings from the crankcase, then press the ball bearings from the crankshaft.
5. Press the oil seal out of the compressor crankcase, if so equipped.

CLEANING OF PARTS

GENERAL

All parts should be cleaned in a good commercial grade of solvent and dried prior to inspection.

CYLINDER HEAD

Remove carbon deposits from the discharge cavity and rust and scale from the cooling cavities of the cylinder head body. Scrape all foreign matter from the body surfaces and use shop air pressure to blow the dirt particles from the cavities. Clean carbon and dirt from the inlet and unloader passages. Use shop air to blow the carbon and dirt deposits from the unloader passages.

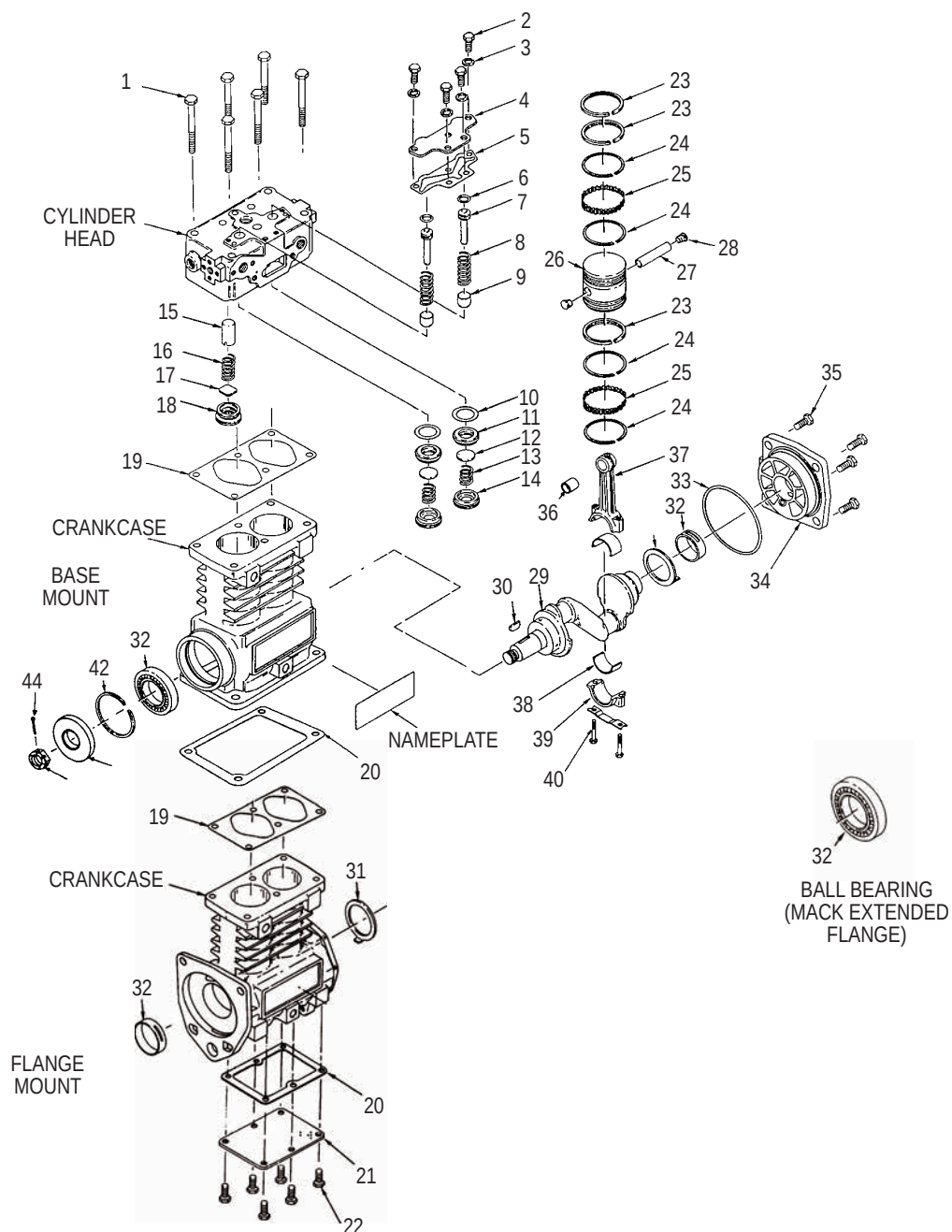
OIL PASSAGES

Thoroughly clean all oil passages through the crankshaft, crankcase, end covers, base plate or base adapter. Inspect the passages with a wire to be sure. Blow the loosened foreign matter out with air pressure.

INSPECTION OF PARTS

CYLINDER HEAD BODY

Inspect the cylinder head for cracks or damage. With the cylinder head and head gasket secured to a flat surface or crankcase, apply shop air pressure to one of the coolant ports with all others plugged, and check for leakage by applying a soap solution to the exterior of the body. If leakage is detected, replace the compressor.



ITEM	QTY	DESCRIPTION	ITEM	QTY	DESCRIPTION	ITEM	QTY	DESCRIPTION
1	6	Cylinder Head Cap Screws	16	2	Discharge Valve Spring	31	2	Thrust Washer
2	4	Unloader Plate Cap Screws	17	2	Discharge Valve	32	2	Sleeve (or Ball) Bearing
3	4	Unloader Plate Lock Washers	18	2	Discharge Valve Stop	33	1	End Cover Seal
4	1	Unloader Plate	19	1	Cylinder Head Gasket	34	1	End Cover
5	1	Unloader Plate Gasket	20	1	Base Gasket	35	4	End Cover Cap Screws
6	2	O-ring	21	1	Base Plate	36	2	Wrist Pin Bushing
7	2	Unloader	22	6	Base Plate Cap Screws	37	2	Connecting Rod
8	2	Spring	23	6	Standard Piston Rings	38	2	Conn. Rod Inserts (Sets)
9	2	Unloader Bushing	24	8	Oil Ring	39	2	Connecting Rod Caps
10	2	Gasket	25	4	Expander Ring	40	4	Connecting Rod Bolts
11	2	Inlet Valve Seat	26	2	Piston	41	1	Ball Bearing
12	2	Inlet Valve	27	2	Wrist Pin	42	1	Retaining Ring
13	2	Inlet Valve Spring	28	4	Wrist Pin Button	43	1	Seal
14	2	Inlet Valve Stop	29	1	Crankshaft	44	1	Cotter Pin
15	2	Discharge Valve Stop	30	1	Crankshaft Key	45	1	Locknut

END COVERS

Check for cracks and external damage. If the crankshaft main bearing (32) is installed in the end cover (34), check for excessive wear and flat spots and replace if necessary.

CRANKCASE

Check all crankcase surfaces for cracks and damage. On compressors where ball bearing main bearings are used the difference between the O.D. of the outer race and the I.D. of the crankcase hole should be .0003 in. tight to .0023 in. loose. This is to maintain the correct fit. The compressor must be replaced if the fit is too loose.

On compressors fitted with precision, sleeve main bearings, the difference between the O.D. of the crankshaft journal and the main bearing I.D. must not exceed .005 in. If the clearance is greater than .005 in. the bearing must be replaced.

The cylinder bores should be checked with inside micrometers or calipers. Cylinder bores which are scored or out of round by more than .0005 in. or tapered more than .0005 in. should be re-bored or honed oversize. Oversized pistons and piston rings are available in .010 in., .020 in. and .030 in. oversizes. Cylinder bores must be smooth, straight and round. Clearance between the cast iron pistons and cylinder bores should be between .002 in. minimum and .004 in. maximum.

PISTON RINGS

Check the pistons for scores, cracks or enlarged ring grooves; replace the pistons if any of these conditions are found. Measure each piston with a micrometer in relation to the cylinder bore diameter to be sure the diametrical clearance is between .002 in. minimum and .004 in. maximum.

Check the fit of the wrist pins to the pistons and connecting rod bushings. The wrist pin should be a light press fit in the piston. If the wrist pin is a loose fit, the piston and pin assembly should be replaced. Check the fit of the wrist pin in the connecting rod bushing by rocking the piston. This clearance should not exceed .0007 in. Replace the connecting rod and cap assembly which includes the wrist pin bushings if excessive clearance is found. Check the fit of the rings in the piston ring grooves. Check the ring gap with the rings installed in the cylinder bores. Refer to Figure 12 for correct gap and groove clearances.

CRANKSHAFT

Check the crankshaft threads, keyways, tapered ends and all machined and ground surfaces for wear, scores, or damage. Standard crankshaft journals are 1.1242 in. - 1.1250 in. in diameter. If the crankshaft journals are excessively scored or worn or out of round and cannot be reground, the compressor must be replaced. Connecting rod bearing inserts are available in .010 in., .020 in. and .030 in. undersizes for compressors with reground crankshafts. Main bearing journals must be maintained so the ball bearings are a snug fit or so that no more than .005 in. clearance exists between the precision sleeve main bearing and the main bearing journals on the crankshaft. Check to be sure the oil passages are open through the crankshaft.

CONNECTING ROD BEARINGS

Used bearing inserts must be replaced. The connecting rod and cap are a matched set and therefore the caps must not be switched or rotated end for end. The solid inserts must be installed in the rod and the slotted inserts into the cap. Make sure the locating tangs on the inserts engage with the locating notches in the rod and cap. Clearance between the connecting rod journal and the connecting rod bearing must not be less than .0003 in. or more than .0021 in. after rebuilding.

REPAIRS

UNLOADER

A new cylinder head maintenance kit should be used when rebuilding. **Note: The entire contents of this kit must be used. Failure to do so may result in compressor failure.** The unloader pistons in the kit are prelubricated

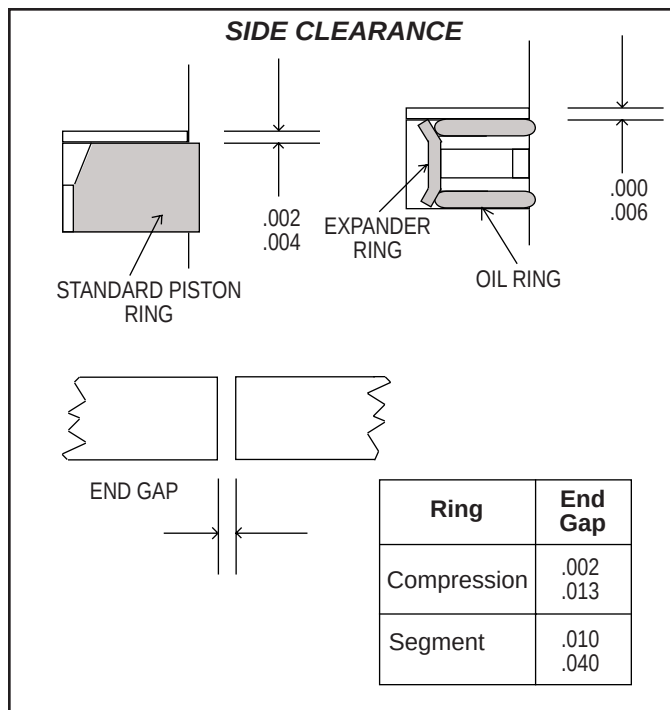


FIGURE 12 - RING CONFIGURATION

with a special lubricant piece number 239379 and need no additional lubrication. Install the springs and unloader pistons in their bores being careful not to cut the o-rings. Install the unloader cover gasket and unloader cover and secure the cover cap screws. Tighten the cap screws to 175-225 in. lbs. in a crossing pattern after first snugging all screws.

DISCHARGE VALVES, VALVE STOPS AND SEATS

If the discharge valve seats merely show signs of slight wear, they can be dressed by using a lapping stone, grinding compound and grinding tool, however, it is recommended that a cylinder head maintenance kit be used. Install new discharge valve springs and valves. Screw in the discharge valve seats, and tighten to 70-90 ft.-lbs. Discharge valve travel should be between .030 in. to .046 in. To test for leakage by the discharge valves, apply 100 psi to the cylinder head discharge port and apply a soap solution to the discharge valve and seats. Leakage in the form of soap bubbles is permissible. If excessive leakage is found, leave the air pressure applied and with the use of a fiber or hardwood dowel and a hammer, tap the discharge valves off their seats several times. This will help the valves to seat and should reduce the leakage. With the air pressure still applied at the discharge port of the cylinder head, check for leakage around the discharge valve stop on the top of the cylinder head casting. No leakage is permitted.

INLET VALVES AND SEATS

Inlet valves and springs should be replaced. However, if the inlet valve seats show signs of slight nicks or scratches, they can be redressed with a fine piece of emery cloth or by lapping with a lapping stone, grinding compound and grinding tool. If the seats are damaged to the extent that they cannot be reclaimed, they must be replaced.

ASSEMBLY

General Note: All torques specified in this manual are assembly torques and typically can be expected to fall off after assembly is accomplished. **Do not retorque** after initial assembly torques fall unless instructed otherwise. A compiled listing of torque specifications is presented on page 13 of this manual.

To convert inch pounds of torque to foot pounds of torque, divide inch pounds by 12.

inch pounds ÷ 12 = foot pounds

To convert foot pounds of torque to inch pounds of torque, multiply foot pounds by 12.

foot pounds x 12 = inch pounds

INSTALLING CRANKSHAFT

Press new sleeve bearings in the end cover and crankcase. Ensure that the slot in the bearings line up with the oil passages in the end cover or crankcase. If you have a model with no oil passage present in the crankcase, press the sleeve bearing into the crankcase with the slot located 90 degrees from vertical.

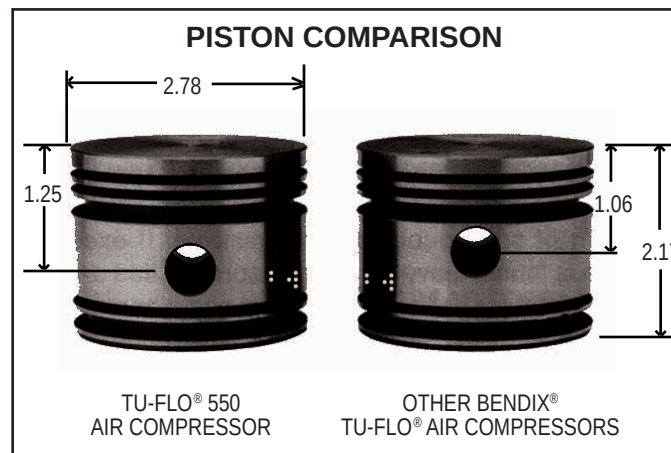


FIGURE 13 - PISTON COMPARISON

Install the front thrust washer with the tang inserted in the slot toward the flange. Insert the crankshaft and the rear thrust washer with the tang toward the rear of the compressor.

Place the oil seal ring on the boss of the rear end cover and install the end cover making sure not to pinch the seal ring. Ensure the tang of the thrust washer is inserted in the slot of the end cover. Fasten the end cover to the crankcase with the four cover cap screws. Torque the cap screws to 175-225 inch pounds in a cross pattern.

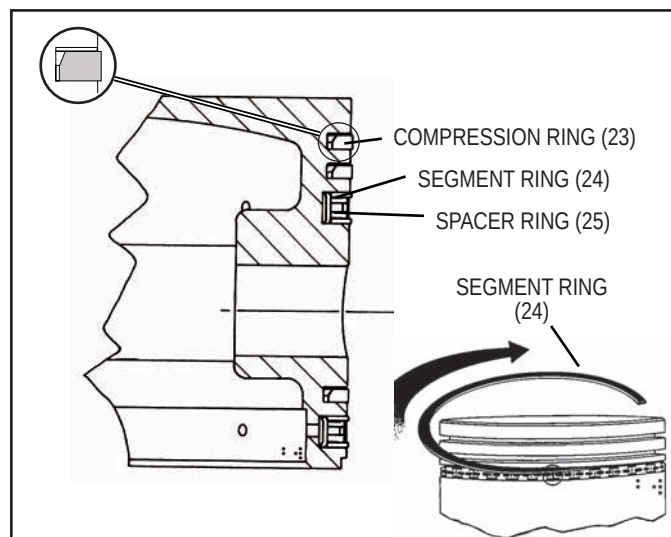


FIGURE 14 - PISTON & RINGS

PISTONS AND CONNECTING RODS

If the pistons are to be replaced ensure that the correct pistons are being installed. Note that the pistons for the Tu-Flo® 550 compressor are similar to those of other Bendix compressor models but may be identified by the piston diameter and the distance to the center of the wrist pin from the top of the piston as shown in Figure 13.

PISTON RINGS

Check each ring end gap in a cylinder bore before installation. Place the ring in the top of the cylinder bore and using the piston, push the ring to the midpoint of the cylinder bore and check the ring gap. If the end gaps are incorrect either the wrong repair size has been purchased or the compressor is worn beyond specification and should be replaced.

Install the rings on the pistons per the following instructions starting at the center of the piston and moving outward.

1. Install the spacer and segment rings as follows. Place the spacer ring (25) in the piston groove, the ends of the spacer must butt and not overlap. Install the top segment (24) by inserting one end above the spacer in the ring groove, 120 degrees from the spacer ends and wind the segment into position. Install the bottom segment in the same manner beneath the spacer making sure the gap is staggered 120 degrees from both the top ring segment and the spacer end gaps. Before using be sure both painted ends of the spacer are visible and butted.
2. Install the compression rings (23) in the proper grooves with the "pip" mark toward the top of the piston. (Refer to Figure 14.)

Check the ring side clearance of each ring in the piston ring groove. (Refer to Figure 14.) If the side clearance is too large, the piston ring groove is worn beyond specifications and the piston must be replaced.

Rotate the piston rings in their respective groove so that each end gap is at least 90 degrees from the previous ring's end gap.

Lubricate the wrist pin (22) and wrist pin bushing in the connecting rod with engine oil. Assemble the upper portion of the connecting rods and the pistons with the wrist pins. Insert the wrist pin buttons (28) in the ends of the wrist pin. Lubricate the pistons and rings with engine oil. Using a ring compression tool return the piston to the cylinder bore.

Turn the crankshaft so that one of its connecting rod journals is in the downward, center position. Install the crankshaft

journal bearing segments (38) on the connecting rod (37) and connecting rod cap (39). Tighten the connecting rod bolts (40) evenly and torque to 150 - 170 inch pounds. Install the other connecting rod and piston in the same manner. It is recommended that new connecting rod cap screws be used.

Before replacing the cylinder head on the crankcase ensure the correct pistons have been used by turning the crankshaft one complete revolution such that each piston moves to its maximum upward stroke. At the maximum upward stroke position each piston should move to the top of the crankcase. If the piston does not approach the top of the crankcase the piston is incorrect and if not replaced could result in compressor damage.

BASE PLATE OR BASE ADAPTER

Position the base plate or base adapter gasket (20) on the crankcase and install the base plate or base adapter (21) as marked before disassembly. Tighten the six cap screws (22), securing the cast iron base adapter evenly to a torque of 175-225 inch pounds for base plate or cover in a crossing pattern after first snugning all 6 screws.

CYLINDER HEAD

Place the cylinder head gasket (19) and cylinder head on the compressor crankcase and install the six cylinder head cap screws. Snug the cylinder head cap screws prior to torquing the cap screws to 300-360 in. lbs. in a cross pattern. Retorque the unloader cover cap screws to 170-225 in. lbs.

FINAL COMPRESSOR ASSEMBLY

Install all crankshaft keys making certain to support the crankshaft to avoid bearing damage. Install the crankshaft nut where applicable. When installing drive couplings or gears, **do not exceed 120 foot pounds torque** on the crankshaft nut.

Use covers, plugs, or masking tape to protect all ports if compressor is not to be installed immediately. Protect the ends of the crankshaft against damage by wrapping with masking tape or friction tape.

TESTING REBUILT COMPRESSOR

In order to properly test a compressor under operating conditions, a test rack for correct mounting, cooling, lubricating, and driving the compressor is necessary. Such tests are not compulsory if the unit has been carefully rebuilt by an experienced person. A compressor efficiency or build up test can be run which is not too difficult. An engine lubricated compressor must be connected to an oil supply line of at least 15 P.S.I. pressure during the test and an oil return line must be installed to keep the crankcase drained.

Connect to the compressor discharge port, a reservoir with a volume of 1500 cubic inches, including the volume of the connecting line. With the compressor operating at 2100 R.P.M., the time required to raise the reservoir(s) pressure from 85 psi to 100 psi should not exceed 7 seconds. During this test, the compressor should be checked for gasket leakage and noisy operation, as well as unloader operation and leakage.

If the compressor functions as indicated reinstall on the vehicle connecting all lines as marked in the disassembly procedure.

TU-FLO® 550 AIR COMPRESSOR SPECIFICATIONS

Average weight	53
Number of cylinders	2
Bore size	2.78 In.
Stroke	1.50 In.
Displacement at 1250 RPM	13.2 CFM
Maximum recommended RPM	3000 RPM
Minimum coolant flow (water cooled) at	
Maximum RPM	2.5 GPM
Minimum RPM	.5 GPM
Approximate horsepower required at	
1250 RPM at 120 PSIG (naturally aspirated)	2.5
Turbocharge limits	
See Compressor Turbocharging Parameters	
Maximum inlet air temperature	250°F
Maximum discharge air temperature	400°F
Minimum pressure required to unload	
(naturally aspirated)	60 PSIG
Minimum oil pressure required at	
engine idling speed	15 PSIG
Minimum oil pressure required at	
maximum governed engine speed	15 PSIG
Minimum discharge-line size	1/2" I.D.
Minimum coolant-line size	3/8" I.D.
Minimum oil-supply line size	3/16" I.D.
Minimum oil-return line size	1/2" I.D.
Minimum air-inlet line size	5/8" I.D.
Minimum unloader-line size	3/16" I.D.

TORQUE SPECIFICATIONS

Bolt, Nut or Screw	Assembly Torque (in. lbs.)
Cylinder Head	440 - 500
Unloader Cover Plate	175 - 225
Discharge Valve Seat	840 - 1080 (70-90 ft. lbs.)
Inlet Valve Stop	840 - 1080 (70-90 ft. lbs.)
End Cover	175 - 225
Connecting Rod	150 - 170
Bottom Cover	175 - 225
Air Strainer	125 - 150
Inlet Fitting	175 - 225
Discharge Fitting	175 - 225
Governor or Governor Adapter	175 - 225
Pipe Plugs	
1/16	35 - 50
1/8	85 - 105
1/4	130 - 170
3/8	160 - 200
1/2	200 - 270
Pipe Bushing	
1/2	175 - 225
Crankshaft Nut:	
Marsden or Castle	1200-1440 (100-120 ft. lbs.)
P/N 298125 (Metric Thread).....	2640-3048 (220-254 ft. lbs.)

DIMENSIONAL DATA

Port Sizes	
Water inlet	1/2 - 14 NPT
Water outlet	1/2 - 14 NPT
Air discharge	1/2 - 14 NPT
Governor	1/8 - 27 NPT
Oil inlet (end cover)	1/8 - 27 NPT
Oil return: Base mount	1/2 - 14 NPT
Piston	
(standard)	2.77825 in.
(.010 oversize)	2.78825 in.
(.020 oversize)	2.79825 in.
(.030 oversize)	2.80825 in.
Cylinder bore	
(standard)	2.7810 in.
(.010 oversize)	2.7910 in.
(.020 oversize)	2.8010 in.
(.030 oversize)	2.8110 in.

MAINTENANCE KITS AND AVAILABLE SERVICE PARTS

Cylinder Maintenance Kit
Piston Ring Kit (standard and oversizes)
Piston and Rod Kit (standard and oversizes)
Crankshaft Bearing Kit
Gasket & Seal Kit

COMPRESSOR TROUBLESHOOTING

IMPORTANT: The troubleshooting contained in this section considers the compressor as an integrated component of the overall air brake charging system and assumes that an air dryer is in use. The troubleshooting presented will cover not only the compressor itself, but also other charging system devices as they relate to the compressor.

WARNING! PLEASE READ AND FOLLOW THESE INSTRUCTIONS TO AVOID PERSONAL INJURY OR DEATH:

When working on or around a vehicle, the following general precautions should be observed at all times.

1. Park the vehicle on a level surface, apply the parking brakes, and always block the wheels. Always wear safety glasses.
2. Stop the engine and remove ignition key when working under or around the vehicle. When working in the engine compartment, the engine should be shut off and the ignition key should be removed. Where circumstances require that the engine be in operation, **EXTREME CAUTION** should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated or electrically charged components.
3. Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.
4. If the work is being performed on the vehicle's air brake system, or any auxiliary pressurized air systems, make certain to drain the air pressure from all reservoirs before beginning **ANY** work on the vehicle. If the vehicle is equipped with an AD-IS® air dryer system or a dryer reservoir module, be sure to drain the purge reservoir.
5. Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.
6. Never exceed manufacturer's recommended pressures.
7. Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.
8. Use only genuine Bendix® replacement parts, components and kits. Replacement hardware, tubing, hose, fittings, etc. must be of equivalent size, type and strength as original equipment and be designed specifically for such applications and systems.
9. Components with stripped threads or damaged parts should be replaced rather than repaired. Do not attempt repairs requiring machining or welding unless specifically stated and approved by the vehicle and component manufacturer.
10. Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.
11. For vehicles with Antilock Traction Control (ATC), the ATC function must be disabled (ATC indicator lamp should be ON) prior to performing any vehicle maintenance where one or more wheels on a drive axle are lifted off the ground and moving.

Appendix A

Advanced Troubleshooting Guide for Air Brake Compressors

The guide consists of an introduction to air brake charging system components, a table showing recommended vehicle maintenance schedules, and a troubleshooting symptom and remedy section with tests to diagnose most charging system problems.

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Maintenance & Usage Guidelines

Maintenance Schedule and
Usage Guidelines (Table A)..... A-3

Introduction to the Air Brake Charging System

Powered by the vehicle engine, the **air compressor** builds the air pressure for the air brake system. The air compressor is typically cooled by the engine coolant system and lubricated by the engine oil supply.

The compressor's unloader mechanism and **governor** (along with a synchro valve for the Bendix® DuraFlo™ 596 air compressor) control the brake system air pressure between a preset maximum and minimum pressure level by monitoring the pressure in the service (or “supply”) reservoir. When the air pressure becomes greater than that of the preset “cut-out”, the governor controls the unloader mechanism of the compressor to stop the compressor from building air and also causes the air dryer to purge. As the service reservoir air pressure drops to the “cut-in” setting of the governor, the governor returns the compressor back to building air and the air dryer to air drying mode.

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.

The **duty cycle** is the ratio of time the compressor spends building air to the total engine running time. Air compressors are designed to build air (run “loaded”) up to 25% of the time. Higher duty cycles cause conditions that affect air brake charging system performance which may require additional maintenance. Factors that add to the duty cycle are: air suspension, additional air accessories, use of an undersized compressor, frequent stops, excessive leakage from fittings, connections, lines, chambers or valves, etc. The **discharge line** allows the air, water-vapor and oil-vapor mixture to cool between the compressor and air dryer. The typical size of a vehicle's discharge line, (see column 2 of Table A on page A-3) assumes a compressor

with a normal (less than 25%) duty cycle, operating in a temperate climate. See Bendix and/or other air dryer manufacturer guidelines as needed.

When the **temperature** of the compressed air that enters the air dryer is within the normal range, the air dryer can remove most of the charging system oil. If the temperature of the compressed air is above the normal range, oil as oil-vapor is able to pass through the air dryer and into the air system. Larger diameter discharge lines and/or longer discharge line lengths can help reduce the temperature.

The discharge line must maintain a **constant slope** down from the compressor to the air dryer inlet fitting to avoid low points where ice may form and block the flow. If, instead, ice blockages occur at the air dryer inlet, insulation may be added here, or if the inlet fitting is a typical 90 degree fitting, it may be changed to a straight or 45 degree fitting. For more information on how to help prevent discharge line freeze-ups, see Bendix Bulletins TCH-08-21 and TCH-08-22 (see pages A-19-21). Shorter discharge line lengths or insulation may be required in cold climates.

The **air dryer** contains a filter that collects oil droplets, and a desiccant bed that removes almost all of the remaining water vapor. The compressed air is then passed to the air brake service (supply) reservoir. The oil droplets and the water collected are automatically purged when the governor reaches its “cut-out” setting.

For vehicles with accessories that are sensitive to small amounts of oil, we recommended installation of a Bendix® PuraGuard® system filter, designed to minimize the amount of oil present.

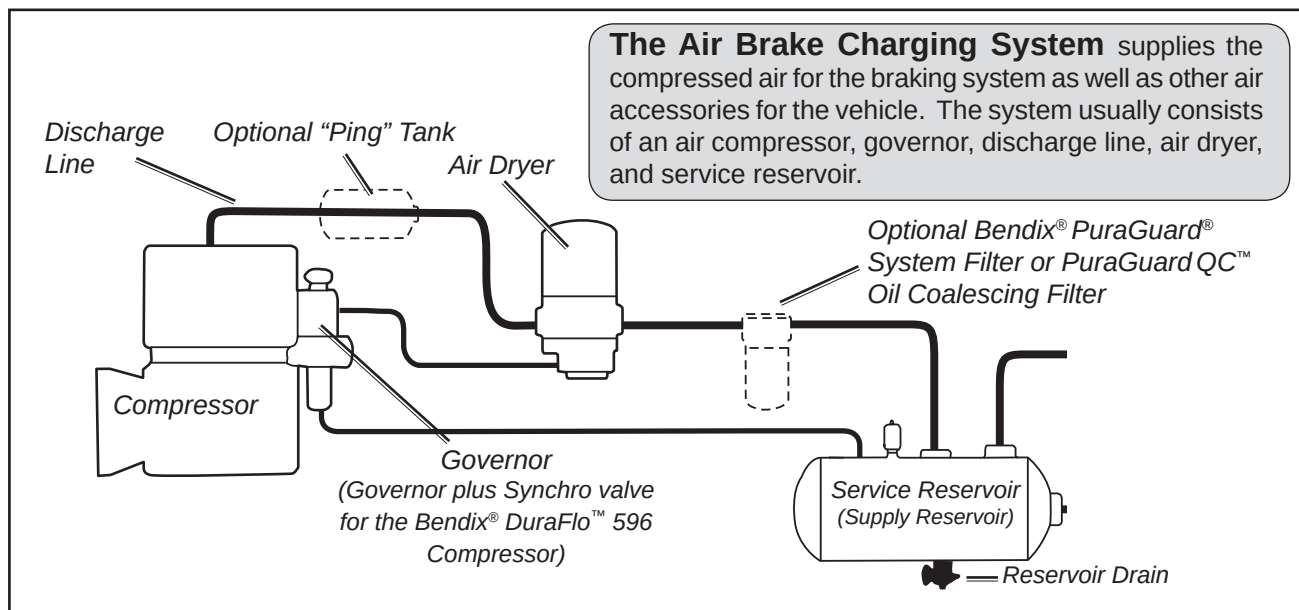


Table A: Maintenance Schedule and Usage Guidelines

Regularly scheduled maintenance is the single most important factor in maintaining the air brake charging system.

Vehicle Used for:	No. of Axles	Column 1	Column 2		Column 3	Column 4	Column 5
		Typical Compressors Spec'd (See footnote 7)	I.D.	Length	Recommended Air Dryer Cartridge Replacement ¹	Recommended Reservoir Drain Schedule ²	Acceptable Reservoir Oil Contents ³ at Regular Drain Interval
Low Air Use		Bendix® BA-921® air compressor Bendix® Tu-Flo® 550 air compressor	1/2 in.	6 ft.	Every 3 Years	Recommended Every Month - Max of every 90 days	BASIC™ test acceptable range: 3 oil units per month. See appendix A.
Compressor with less than 15% duty cycle e.g. Line haul single trailer w/o air suspension, air over hydraulic brakes. 			For oil carry-over control ⁴ suggested upgrades: 5/8 in. 9 ft.				
Compressor with up to 25% duty cycle e.g. Line haul single trailer with air suspension, school bus. 			1/2 in. 9 ft.				
			For oil carry-over control ⁴ suggested upgrades: 5/8 in. 12 ft.				
High Air Use		Bendix® Tu-Flo® 750 air compressor Bendix® BA-921® air compressor Bendix® Tu-Flo® 596 air compressor	1/2 in.	12 ft.	Every 2 Years	Every Month	BASIC™ test acceptable range: 5 oil units per month. See appendix A.
Compressor with up to 25% duty cycle e.g. Double/triple trailer, open highway coach/RV, (most) pick-up & delivery, yard or terminal jockey, off-highway, construction, loggers, concrete mixer, dump truck, fire truck. 			For oil carry-over control ⁴ suggested upgrades: 5/8 in. 15 ft.				
Compressor with up to 25% duty cycle e.g. City transit bus, refuse, bulk unloaders, low boys, urban region coach, central tire inflation. 			3/4 in. 12 ft.				

For the BASIC™ Test Kit: Order Bendix P/N 5013711

Footnotes:

1. With increased air demand the air dryer cartridge needs to be replaced more often.
2. Use the drain valves to slowly drain all reservoirs to zero psi.
3. Allow the oil/water mixture to fully settle before measuring oil quantity.
4. To counter above normal temperatures at the air dryer inlet, (and resultant oil-vapor passing upstream in the air system) replace the discharge line with one of a larger diameter and/or longer length. This helps reduce the air's temperature. If sufficient cooling occurs, the oil-vapor condenses and can be removed by the air dryer. Discharge line upgrades are not covered under warranty. Note: To help prevent discharge line freeze-ups, shorter discharge line lengths or insulation may be required in cold climates. (See Bendix

Bulletins TCH-08-21 and TCH-08-22, included in Appendix B, for more information.)

5. For certain vehicles/applications, where turbo-charged inlet air is used, a smaller size compressor may be permissible.
6. Note: Compressor and/or air dryer upgrades are recommended in cases where duty cycle is greater than the normal range (for the examples above).
7. For correct compressor upgrades consult Bendix - Please note that because a compressor is listed in the same area of the chart does not necessarily mean that it would be a suitable candidate for upgrade purposes.

For Bendix® Tu-Flo® 550 and 750 compressors, unloader service is recommended every 250,000 miles.

Air Brake Charging System Troubleshooting

How to use this guide:

Find the **symptom(s)** that you see, then move to the right to find the possible causes ("**What it may indicate**") and remedies ("**What you should do**").

Review the warranty policy before performing any intrusive compressor maintenance. Unloader or cylinder head gasket replacement and resealing of the bottom cover plate are usually permitted under warranty. Follow all standard safety procedures when performing any maintenance.

Look for:

 **Normal**

Normal - Charging system is working within normal range.

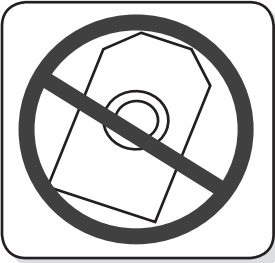
 **Check**

Check - Charging system needs further investigation.

WARNING! Please READ and follow these instructions to avoid personal injury or death:

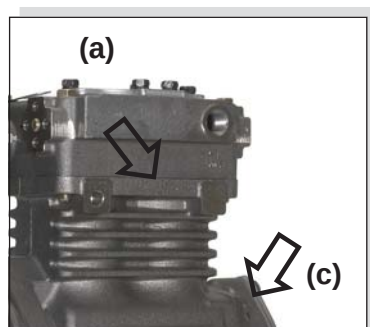
When working on or around a vehicle, the following general precautions should be observed at all times.

1. Park the vehicle on a level surface, apply the parking brakes, and always block the wheels. Always wear safety glasses.
2. Stop the engine and remove ignition key when working under or around the vehicle. When working in the engine compartment, the engine should be shut off and the ignition key should be removed. Where circumstances require that the engine be in operation, EXTREME CAUTION should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated or electrically charged components.
3. Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.
4. If the work is being performed on the vehicle's air brake system, or any auxiliary pressurized air systems, make certain to drain the air pressure from all reservoirs before beginning ANY work on the vehicle. If the vehicle is equipped with an AD-IS® air dryer system or a dryer reservoir module, be sure to drain the purge reservoir.
5. Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.
6. Never exceed manufacturer's recommended pressures.
7. Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.
8. Use only genuine Bendix® replacement parts, components and kits. Replacement hardware, tubing, hose, fittings, etc. must be of equivalent size, type and strength as original equipment and be designed specifically for such applications and systems.
9. Components with stripped threads or damaged parts should be replaced rather than repaired. Do not attempt repairs requiring machining or welding unless specifically stated and approved by the vehicle and component manufacturer.
10. Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.
11. For vehicles with Antilock Traction Control (ATC), the ATC function must be disabled (ATC indicator lamp should be ON) prior to performing any vehicle maintenance where one or more wheels on a drive axle are lifted off the ground and moving.

Symptom:	What it may indicate:	What you should do:
1.0 Oil Test Card Results 	Not a valid test.	Discontinue using this test. Do not use this card test to diagnose compressor "oil passing" issues. They are subjective and error prone. Use only the Bendix® Air System Inspection Cup (BASIC™) test and the methods described in this guide for advanced troubleshooting. The Bendix® BASIC™ test should be the definitive method for judging excessive oil fouling/oil passing. (See Appendix A, on page A-16 for a flowchart and expanded explanation of the checklist used when conducting the BASIC™ test.)
		

Symptom:	What it may indicate:	What you should do:
2.0 Oil on the Outside of the Compressor	Engine and/or other accessories leaking onto compressor.	Find the source and repair. Return the vehicle to service.
2.1 Oil leaking at compressor / engine connections:	(a) Leak at the front or rear (fuel pump, etc.) mounting flange.	⇒ Repair or replace as necessary. If the mounting bolt torques are low, replace the gasket.
	(b) Leak at air inlet fitting.	⇒ Replace the fitting gasket. Inspect inlet hose and replace as necessary.
	(c) Leak at air discharge fitting.	⇒ Replace gasket or fitting as necessary to ensure good seal.
	(d) Loose/broken oil line fittings.	⇒ Inspect and repair as necessary.
2.2 Oil leaking from compressor:	(a) Excessive leak at head gasket.	⇒ Go to Test 1 on page A-14.
	(b) Leak at bottom cover plate.	⇒ Reseal bottom cover plate using RTV silicone sealant.
	(c) Leak at internal rear flange gasket.	⇒ Replace compressor.
	(d) Leak through crankcase.	⇒ Replace compressor.
	(e) (If unable to tell source of leak.)	⇒ Clean compressor and check periodically.

? Check



Head gaskets and rear flange gasket locations.

3.0 Oil at air dryer purge/exhaust or surrounding area	Air brake charging system functioning normally.	⇒ Air dryers remove water and oil from the air brake charging system. Check that regular maintenance is being performed. Return the vehicle to service. An optional kit (Bendix piece number 5011327 for the Bendix® AD-IS® or AD-IP™ air dryers, or 5003838 for the Bendix® AD-9™ air dryer) is available to redirect the air dryer exhaust.
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✓ Normal

Symptom:**What it may indicate:****What you should do:****4.0 Oil in Supply or Service Reservoir (air dryer installed)**

(If a maintained Bendix® PuraGuard® system filter or Bendix® PuraGuard QC™ oil coalescing filter is installed, call 1-800-AIR-BRAKE (1-800-247-2725) and speak to a Tech Team member.)



See Table A, on page A-3, for maintenance schedule information.

Maintenance

- (a) **If** air brake charging system maintenance **has not been performed**. That is, reservoir(s) **have not** been drained per the schedule in Table A on page **A-3**, Column 4 **and/or** the air dryer maintenance **has not** been performed as in Column 3.
- (b) **If** the vehicle maintenance **has been performed** as recommended in Table A on page **A-3**, some oil in the reservoirs is normal.



Drain all air tanks (reservoirs) into the Bendix® BASIC™ test cup. (Bendix kit P/N 5013711).

- ⇒ Drain all air tanks and check vehicle at next service interval using the Bendix® BASIC™ test. See Table A on page **A-3**, column 3 and 4, for recommended service schedule.

? Check

- ⇒ Drain all air tanks into Bendix® BASIC™ test cup (Bendix Air System Inspection Cup). If less than one unit of reservoir contents is found, the vehicle can be returned to service. **Note: If more than one oil unit of water (or a cloudy emulsion mixture) is present, change the vehicle's air dryer, check for air system leakage (Test 2, on page A-14), stop inspection and check again at the next service interval.**

See the BASIC™ test kit for full details.

If less than one "oil unit" of water (or water/cloudy emulsion mixture) is present, use the BASIC™ cup chart on the label of the cup to determine if the amount of oil found is within the acceptable level.

⇒ If within the normal range, return the vehicle to service. For vehicles with accessories that are sensitive to small amounts of oil, consider a Bendix® PuraGuard QC™ oil coalescing filter.

⇒ If outside the normal range go to Symptom 4.0(c).

Also see the Table A on page A-3, column 3 for recommended air dryer cartridge replacement schedule.

Duty cycle too high

- (c) Air brake system leakage.
- (d) Compressor may be undersized for the application.

- ⇒ Go to Test 2 on page **A-14**.

- ⇒ See Table A, column 1, on page **A-3** for recommended compressor sizes.

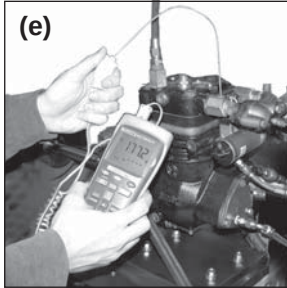
⇒ If the compressor is "too small" for the vehicle's role (for example, where a vehicle's use has changed or service conditions exceed the original vehicle or engine OE spec's) then upgrade the compressor. Note: The costs incurred (e.g. installing a larger capacity compressor, etc.) are not covered under original compressor warranty.

⇒ If the compressor is correct for the vehicle, go to Symptom 4.0 (e).

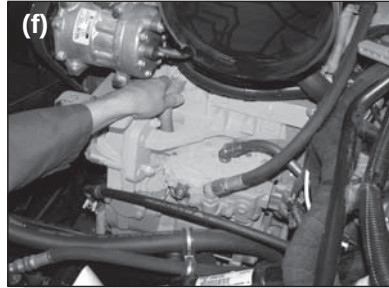
The **duty cycle** is the ratio of time the compressor spends building air to total engine running time. Air compressors are designed to build air (to "run loaded") up to 25% of the time. Higher duty cycles cause conditions that affect air brake charging system performance which may require additional maintenance. Factors that add to the duty cycle are: air suspension, additional air accessories, use of an undersized compressor, frequent stops, excessive leakage from fittings, connections, lines, chambers or valves, etc.

Symptom:**What it may indicate:****What you should do:****4.0 Oil in Supply
or Service
Reservoir*
(air dryer installed)
(continued)****Temperature**

(e) Air compressor discharge and/or air dryer inlet temperature too high.



Testing the temperature at the discharge fitting.



Inspecting the coolant hoses.

(f) Insufficient coolant flow.

(g) Restricted discharge line.



Kinked discharge line shown.

⇒ Check temperature as outlined in Test 3 on page A-14. If temperatures are normal go to 4.0(h).

⇒ Inspect coolant line. Replace as necessary (I.D. is 1/2").

⇒ Inspect the coolant lines for kinks and restrictions and fittings for restrictions. Replace as necessary.

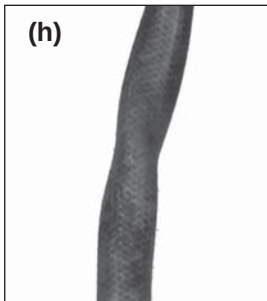
⇒ Verify coolant lines go from engine block to compressor and back to the water pump. Repair as necessary.

⇒ If discharge line is restricted or more than 1/16" carbon build-up is found, replace the discharge line. See Table A, column 2, on page A-3 for recommended size. Replace as necessary.

⇒ The discharge line must maintain a **constant slope** down from the compressor to the air dryer inlet fitting to avoid low points where ice may form and block the flow. If, instead, ice blockages occur at the air dryer inlet, insulation may be added here, or if the inlet fitting is a typical 90 degree fitting, it may be changed to a straight or 45 degree fitting. For more information on how to help prevent discharge line freeze-ups, see Bendix Bulletins TCH-08-21 and TCH-08-22 (Appendix B). Shorter discharge line lengths or insulation may be required in cold climates.

Other

(h) Restricted air inlet (not enough air to compressor).



Partly collapsed inlet line shown.

⇒ Check compressor air inlet line for restrictions, brittleness, soft or sagging hose conditions etc. Repair as necessary. Inlet line size is 3/4 ID. Maximum restriction requirement for compressors is 25 inches of water.

⇒ Check the engine air filter and service if necessary (if possible, check the air filter usage indicator).

? Check

*If a maintained Bendix® PuraGuard® system filter or Bendix® PuraGuard QC™ oil coalescing filter is installed, call 1-800-AIR-BRAKE (1-800-247-2725) and speak to a Tech Team member.

Symptom:	What it may indicate:	What you should do:
----------	-----------------------	---------------------

4.0 Oil in Supply or Service Reservoir* (air dryer installed) (continued)

Other (cont.)

- (i) Poorly filtered inlet air (poor air quality to compressor).



Inspect the engine air cleaner.

- ⇒ Check for leaking, damaged or defective compressor air inlet components (e.g. induction line, fittings, gaskets, filter bodies, etc.). Repair inlet components as needed. Note: Dirt ingestion will damage compressor and is not covered under warranty.

? Check

- (j) Governor malfunction or setting.

- ⇒ Go to Test 4 on page A-15.

- (k) Compressor malfunction.

- ⇒ If you found excessive oil present in the service reservoir in step 4.0 (b) above and you did not find any issues in steps 4.0 (c) through 4.0 (j) above, the compressor may be passing oil.

Replace compressor. If still under warranty, follow normal warranty process. Note: After replacing a compressor, residual oil may take a considerable period of time to be flushed from the air brake system.

Crankcase Flooding

Consider installing a compressor bottom drain kit (where available) in cases of chronic oil passing where all other operating conditions have been investigated. Bendix compressors are designed to have a 'dry' sump and the presence of excess oil in the crankcase can lead to oil carryover.

*If a maintained Bendix® PuraGuard® system filter or Bendix® PuraGuard QC™ oil coalescing filter is installed, call 1-800-AIR-BRAKE (1-800-247-2725) and speak to a Tech Team member.

5.0 Oil present at valves (e.g. at exhaust, or seen during servicing).

Air brake system valves are required to tolerate a light coating of oil.

✓ Normal

- ⇒ A small amount of oil does not affect SAE J2024** compliant valves.

- ⇒ Check that regular maintenance is being performed and that the amount of oil in the air tanks (reservoirs) is within the acceptable range shown on the Bendix® BASIC™ test cup (see also column 5 of Table A on page A-3). Return the vehicle to service.

For oil-sensitive systems, see page 16.



Genuine Bendix valves are all SAE J2024 compliant.

** SAE J2024 outlines tests all air brake system pneumatic components need to be able to pass, including minimum levels of tolerance to contamination.

Symptom:	What it may indicate:	What you should do:
6.0 Excessive oil consumption in engine.	A problem with engine or other engine accessory.  The engine service manual has more information.	⇒ See engine service manual. ? Check
7.0 Oil present at air dryer cartridge during maintenance.	Air brake charging system is functioning normally.  Oil shown leaking from an air dryer cartridge. ✓ Normal	⇒ Air dryers remove water and oil from the air brake charging system. A small amount of oil is normal. Check that regular maintenance is being performed and that the amount of oil in the air tanks (reservoirs) is within the acceptable range shown by the BASIC™ test (see also column 5 of Table A on page A-3). Replace the air dryer cartridge as needed and return the vehicle to service.
8.0 Oil in ping tank or compressor discharge aftercooler.	Air brake charging system is functioning normally. ✓ Normal	⇒ Follow vehicle O.E. maintenance recommendation for these components.
9.0 Air brake charging system seems slow to build pressure.	(a) Air brake charging system functioning normally. ✓ Normal (b) Air brake system leakage. (c) Compressor may be undersized for the application. (d) Compressor unloader mechanism malfunction. (e) Damaged compressor head gasket.	⇒ Using dash gauges, verify that the compressor builds air system pressure from 85-100 psi in 40 seconds or less with engine at full governed rpm. Return the vehicle to service. ⇒ Go to Test 2 on page A-14. ⇒ See Table A, column 1, on page A-3 for some typical compressor applications. If the compressor is "too small" for the vehicle's role, for example, where a vehicle's use has changed, then upgrade the compressor. Note: The costs incurred (e.g. installing a larger capacity compressor, etc.) are not covered under original compressor warranty. ⇒ Go to Test 6 on page A-15. ⇒ An air leak at the head gasket may indicate a downstream restriction such as a freeze-up or carbon blockage and/or could indicate a defective or missing safety valve. Find blockage (go to 9.0(f) for details) and then replace the compressor. Do not re-use the safety valve without testing. See Symptom 12.0(a).

Symptom:**What it may indicate:****What you should do:**

9.0 Air brake charging system seems slow to build pressure. (continued)



Dash gauges.

(f) Restricted discharge line.

? Check



Kinked discharge line shown.

Engine Oil Quality

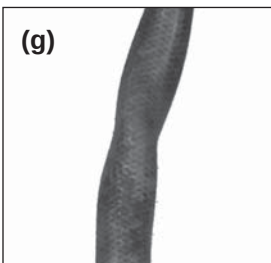
Inadequate oil change intervals, the formulation of the oil and/or the quality of oil filter used can all lead to poor oil quality. These can increase the rate at which carbon builds up in the discharge line. Bendix recommends oil soot (solids) be maintained at less than 3%.

⇒ If discharge line is restricted:

⇒ By more than 1/16" carbon build-up, replace the discharge line (see Table A, column 2, on page A-3 for recommended size) and go to Test 3 on page A-14.

⇒ By other restrictions (e.g. kinks). Replace the discharge line. See Table A, column 2, on page A-3 for recommended size. Re test for air build. Return vehicle to service or, if problem persists, go to 9.0(a).

⇒ The discharge line must maintain a **constant slope** down from the compressor to the air dryer inlet fitting to avoid low points where ice may form and block the flow. If, instead, ice blockages occur at the air dryer inlet, insulation may be added here, or if the inlet fitting is a typical 90 degree fitting, it may be changed to a straight or 45 degree fitting. For more information on how to help prevent discharge line freeze-ups, see Bendix Bulletins TCH-08-21 and TCH-08-22 (Appendix B). Shorter discharge line lengths or insulation may be required in cold climates.



Partly collapsed inlet line shown.

(g) Restricted air inlet (not enough air to compressor).

? Check

⇒ Check compressor air inlet line for restrictions, brittleness, soft or sagging hose conditions etc. Repair as necessary. Refer to vehicle manufacturer's guidelines for inlet line size.

⇒ Check the engine air filter and service if necessary (if possible, check the air filter usage indicator).

(h) Poorly filtered inlet air (poor air quality to compressor).

? Check

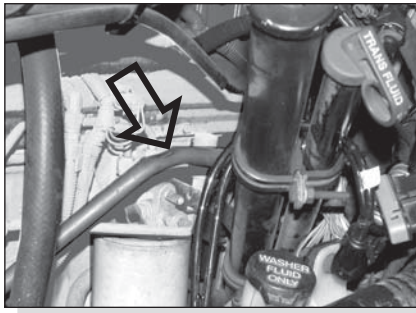
⇒ Check for leaking, damaged or defective compressor air inlet components (e.g. induction line, fittings, gaskets, filter bodies, etc.). Repair inlet components as needed. Note: Dirt ingestion will damage compressor and is not covered under warranty.

(i) Compressor malfunction.

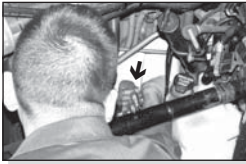
? Check

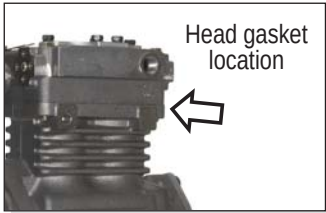
⇒ Replace the compressor only after making certain that none of the preceding conditions, 9.0 (a) through 9.0 (h), exist.

Symptom:	What it may indicate:	What you should do:
10.0 Air charging system doesn't build air.	(a) Governor malfunction*.	⇒ Go to Test 4 on page A-15.
	(b) Restricted discharge line.	⇒ See 9.0(f).
	(c) Air dryer heater malfunction: exhaust port frozen open.	⇒ Replace air dryer heater.
	(d) Compressor malfunction.	⇒ Replace the compressor only after making certain the preceding conditions do not exist.
* Note: For the Bendix® DuraFlo™ 596 air compressor, not only the governor, but also the SV-1™ synchro valve used would need to be tested. See Bulletin TCH-001-048.		
11.0 Compressor safety valve releases air (Compressor builds too much air).	(a) Restricted discharge line.	⇒ If discharge line is restricted:
	? Check	⇒ By more than 1/16" carbon build-up, replace the discharge line (see Table A, column 2, on page A-3 for recommended size) and go to Test 3 on page A-14. ⇒ By other restrictions (e.g. kinks). Replace the discharge line. See Table A, column 2, on page A-3 for recommended size.
		⇒ The discharge line must maintain a constant slope down from the compressor to the air dryer inlet fitting to avoid low points where ice may form and block the flow. If, instead, ice blockages occur at the air dryer inlet, insulation may be added here, or if the inlet fitting is a typical 90 degree fitting, it may be changed to a straight or 45 degree fitting. For more information on how to help prevent discharge line freeze-ups, see Bendix Bulletins TCH-08-21 and TCH-08-22 (Appendix B). Shorter discharge line lengths or insulation may be required in cold climates.
	(b) Downstream air brake system check valves or lines may be blocked or damaged.	⇒ Inspect air lines and verify check valves are operating properly.
	(c) Air dryer lines incorrectly installed.	⇒ Ensure discharge line is installed into the inlet of the air dryer and delivery is routed to the service reservoir.
	(d) Compressor safety valve malfunction.	⇒ Verify relief pressure is 250 psi. Replace if defective.
	(e) Compressor unloader mechanism malfunction.	⇒ Go to Test 6 on page A-15.
	(f) Governor malfunction.	⇒ Go to Test 4 on page A-15.



Damaged discharge line shown.

Symptom:	What it may indicate:	What you should do:
12.0 Air dryer safety valve releases air.   Technician removes governor.	(a) Restriction between air dryer and reservoir. (b) Air dryer safety valve malfunction. (c) Air dryer maintenance not performed. (d) Air dryer malfunction. (e) Improper governor control line installation to the reservoir. (f) Governor malfunction.	⇒ Inspect delivery lines to reservoir for restrictions and repair as needed. ⇒ Verify relief pressure is at vehicle or component manufacturer specifications. Replace if defective. ⇒ See Maintenance Schedule and Usage Guidelines (Table A, column 3, on page A-3). ⇒ Verify operation of air dryer. Follow vehicle O.E. maintenance recommendations and component Service Data information. ⇒ Go to Test 5 on page A-15. ⇒ Go to Test 4 on page A-15.
13.0 Reservoir safety valve releases air	(a) Reservoir safety valve malfunction. (b) Governor malfunction. (c) Compressor unloader mechanism malfunction.	⇒ Verify relief pressure is at vehicle or component manufacturer's specifications (typically 150 psi). Replace if defective. ⇒ Go to Test 4 on page A-15. ⇒ Go to Test 6 on page A-15.
14.0 Air dryer doesn't purge. (Never hear exhaust from air dryer.)	(a) Air dryer malfunction. (b) Governor malfunction. (c) Air brake system leakage. (d) Improper governor control line installation to the reservoir.	⇒ Verify operation of air dryer. Follow vehicle O.E. maintenance recommendations. ⇒ Go to Test 4 on page A-15. ⇒ Go to Test 2 on page A-14. ⇒ Go to Test 5 on page A-15.
15.0 Compressor constantly cycles (compressor remains unloaded for a very short time.)	(a) Air brake charging system maintenance not performed.  Check (b) Compressor unloader mechanism malfunction. (c) Air dryer purge valve or delivery check valve malfunction. (d) Air brake system leakage.	⇒ Available reservoir capacity may be reduced by build-up of water etc. Drain and perform routine maintenance per Table A, columns 3 & 4, on page A-3. ⇒ Go to Test 6 on page A-15. ⇒ Verify operation of air dryer. Follow vehicle O.E. maintenance recommendations and component Service Data information. ⇒ Go to Test 2 on page A-14.

Symptom:	What it may indicate:	What you should do:
16.0 Compressor leaks air  Testing for leaks with soap solution.	(a) Compressor leaks air at connections or ports. (b) Compressor unloader mechanism malfunction. (c) Damaged compressor head gasket(s).	⇒ Check for leaking, damaged or defective compressor fittings, gaskets, etc. Repair or replace as necessary. ⇒ Go to Test 6 on page A-15. ⇒ An air leak at the head gasket(s) may indicate a downstream restriction such as a freeze-up or carbon blockage and/or could indicate a defective or missing safety valve. Find blockage (go to 9.0(f) for details) and then replace the compressor. Do not re-use the safety valve without testing. See Symptom 12.0(a).
		
17.0 Compressor leaks coolant	(a) Improperly installed plugs or coolant line fittings. (b) Damaged compressor head gasket. (c) Porous compressor head casting.	⇒ Inspect for loose or over-torqued fittings. Reseal and tighten loose fittings and plugs as necessary. If overtightened fittings and plugs have cracked ports in the head, replace the compressor. ⇒ An air leak at the head gasket may indicate a downstream restriction such as a freeze-up or carbon blockage and/or could indicate a defective or missing safety valve. Find blockage (go to 9.0(f) for details) and then replace the compressor. Do not re-use the safety valve without testing. See Symptom 12.0(a). ⇒ If casting porosity is detected, replace the compressor.
18.0 Noisy compressor (Multi-cylinder compressors only)	(a) Damaged compressor.	⇒ Replace the compressor.

Other Miscellaneous Areas to Consider

This guide attempts to cover most compressor system problems. Here are some rare sources of problems not covered in this guide:

- Turbocharger leakage. Lubricating oil from leaking turbocharger seals can enter the air compressor intake and give misleading symptoms.

- Where a compressor does not have a safety valve installed, if a partial or complete discharge line blockage has occurred, damage can occur to the connecting rod bearings. Damage of this kind may not be detected and could lead to compressor problems at a later date.

Tests

Test 1: Excessive Oil Leakage at the Head Gasket

Exterior leaks at the head gasket are not a sign that oil is being passed into the air charging system. Oil weepage at the head gasket does not prevent the compressor from building air.

Observe the amount of weepage from the head gasket.

If the oil is only around the cylinder head area, it is acceptable (return the vehicle to service), but, if the oil weepage extends down to the nameplate area of the compressor, the gasket can be replaced.



Test 2: Air Brake System and Accessory Leakage

Inspect for air leaks when working on a vehicle and repair them promptly.

Park the vehicle on level ground and chock wheels. Build system pressure to governor cut-out and allow the pressure to stabilize for one minute.

Step 1: Observe the dash gauges for two additional minutes without the service brakes applied.

Step 2: Apply the service brakes and allow the pressure to stabilize. Continue holding for two minutes (you may use a block of wood to hold the

pedal in position.) Observe the dash gauges.

If you see **any noticeable decrease** of the dash air gauge readings (i.e. more than 4 psi, plus two psi for each additional trailer) during either two minute test, **repair the leaks** and repeat this test to confirm that they have been repaired.

Air leaks can also be found in the charging system, parking brakes, and/or other components - inspect and repair as necessary.

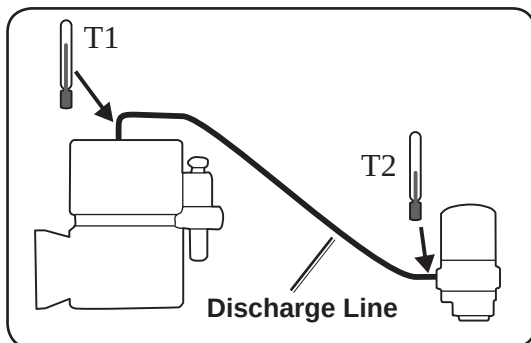
Test 3: Air Compressor Discharge Temperature and Air Dryer Inlet Temperature*

Caution: The temperatures used in this test are not normal vehicle conditions.

Above normal temperatures can cause oil (as vapor) to pass through the air dryer into the air brake system.

This test is run with the engine at normal operating temperature, with engine at max. rpm. If available, a dyno may be used.

1. Allow the compressor to build the air system pressure to governor cut-in.
2. Pump the brakes to bring the dash gauge pressure to 90 psi.
3. Allow the compressor to build pressure from 95 to 105 psi gauge pressure and maintain this pressure range by cycling the brakes for **five (5) minutes**.



(* Note that only vehicles that have passed Test 2 would be candidates for this test.)

4. Then, while maintaining max rpm and pressure range, measure and **record the surface temperature** of the fittings:

⇒ at the compressor discharge port. (T1).

⇒ at the air dryer inlet fitting. (T2).

Use a touch probe thermocouple for measuring the temperature.

5. See table below.

6. Re test before returning the vehicle to service.

T1 Compressor Discharge Fitting	T2 Air Dryer Inlet Fitting	Action
under 360°F	under 200°F	Temperatures are within normal range for this test, check other symptoms. Go to 4.0 (h).
under 360°F	over 200°F	This could indicate a discharge line problem (e.g. restriction). Call 1-800-AIR-BRAKE (1-800-247-2725) and speak with our Tech Team.
over 360°F	—	Compressor is running hot. Check coolant 4(f) and/or discharge line 4(g).

Tests (continued)

Test 4: Governor Malfunction

1. Inspect control lines to and from the governor for restrictions (e.g. collapsed or kinked). Repair as necessary.
2. Using a calibrated external gauge in the supply reservoir, service reservoir, or reservoir port of the D-2™ governor, verify cut-in and cut-out pressures are within vehicle OEM specification.
3. If the governor is malfunctioning, replace it.

Test 5: Governor Control Line

1. Ensure that the governor control line from the reservoir is located at or near the top of the reservoir. (This line, if located near the bottom of the reservoir, can become blocked or restricted by the reservoir contents e.g. water or ice.)
2. Perform proper reservoir drain intervals and air dryer cartridge maintenance per Maintenance Schedule and Usage Guidelines (Table A on page A-3).
3. Return the vehicle to service.

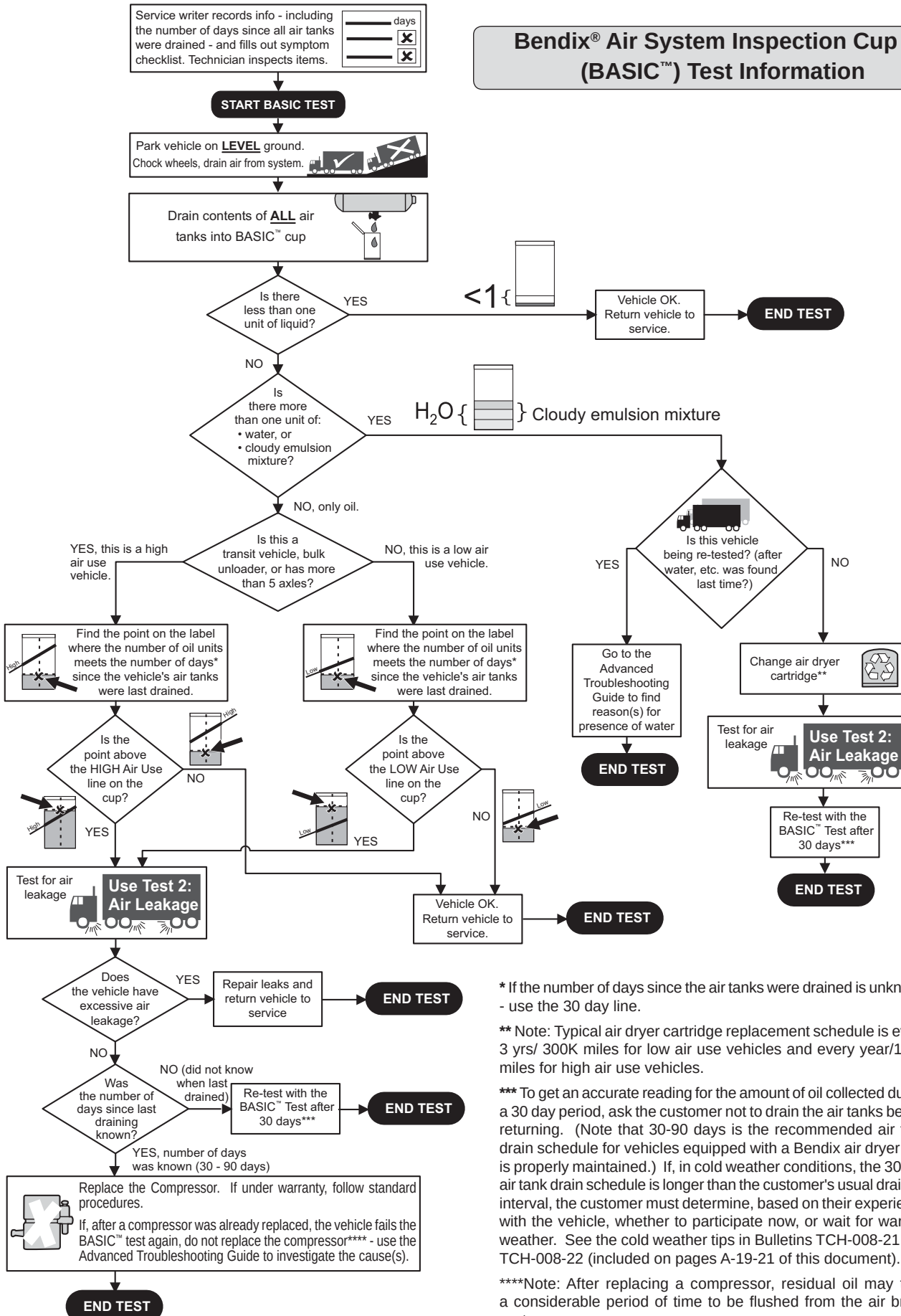
Test 6: Compressor Unloader Leakage

Bendix® Compressors: Park vehicle, chock wheels, and follow all standard safety procedures. Remove the governor and install a fitting to the unloader port. Add a section of air hose (min 1 ft long for a 1/2" diameter line) and a gauge to the fitting followed by a shut-off valve and an air source (shop air or small air tank). Open the

shut-off and charge the unloader port by allowing air pressure to enter the hose and unload the compressor. Shut off the air supply and observe the gauge. A steady reading indicates no leakage at the unloader port, but a falling reading shows that the unloader mechanism is leaking and needs to be serviced.

Appendix B: Information about the BASIC™ Test Kit (Bendix P/N 5013711)

Bendix® Air System Inspection Cup (BASIC™) Test Information



* If the number of days since the air tanks were drained is unknown - use the 30 day line.

** Note: Typical air dryer cartridge replacement schedule is every 3 yrs/ 300K miles for low air use vehicles and every year/100K miles for high air use vehicles.

*** To get an accurate reading for the amount of oil collected during a 30 day period, ask the customer not to drain the air tanks before returning. (Note that 30-90 days is the recommended air tank drain schedule for vehicles equipped with a Bendix air dryer that is properly maintained.) If, in cold weather conditions, the 30 day air tank drain schedule is longer than the customer's usual draining interval, the customer must determine, based on their experience with the vehicle, whether to participate now, or wait for warmer weather. See the cold weather tips in Bulletins TCH-008-21 and TCH-008-22 (included on pages A-19-21 of this document).

****Note: After replacing a compressor, residual oil may take a considerable period of time to be flushed from the air brake system.

Appendix B continued: Information about the BASIC™ Test Kit (Bendix P/N 5013711)

Filling in the Checklist for the Bendix® Air System Inspection Cup (BASIC™) Test

Note: Follow all standard safety precautions. For vehicles using a desiccant air dryer.

The Service Writer fills out these fields with information gained from the customer

Number of Days Since Air Tanks Were Last Drained: _____	Date: _____	Vehicle #: _____
Engine SN _____	Vehicle Used for: _____	Typical Load: _____ (lbs.)
No. of Axles: ____ (tractor) ____ (trailer)	No. of Lift Axles: ____	Technician's Name: _____

The Service Writer also checks off any complaints that the customer makes to help the Technician in investigating.

Customer's complaint? (Please check all that apply)	Checklist for Technician Have you confirmed
"Relay valve ☐ leaks oil / ☐ malfunctions"	☐ no ☐ yes*
"Dash valve ☐ leaks oil / ☐ malfunctions"	☐ no ☐ yes*
☐ "Air dryer leaks oil"	☐ no ☐ yes*
☐ "Governor malfunction"	☐ no ☐ yes*
☐ "Oil in gladhands"	☐ no ☐ yes*
how much oil did you find? _____	
☐ "Oil on ground or vehicle exterior"	☐ no ☐ yes*
amount described: _____	
☐ "Short air dryer cartridge life"	
replaces every: _____ ☐ miles, ☐ kms, or ☐ months	
☐ "Oil in air tanks" amount described: _____	
We will measure amount currently found when we get to step B of the test.	
☐ "Excessive engine oil loss" amount described: _____	
Is the engine leaking oil?	☐ no ☐ yes*
Is the compressor leaking oil?	☐ no ☐ yes*
☐ Other complaint: _____	
☐ No customer complaint.	

The Technician checks boxes for any of the complaints that can be confirmed.

* Note: A confirmed complaint above does NOT mean that the compressor must be replaced. The full BASIC™ test below will investigate the facts.

BASIC™ test starts here:

STEP A - Select one:

- ☐ This is a low air use vehicle: Line haul (single trailer) with 5 or less axles, or
- ☐ This is a high air use vehicle: Garbage truck, transit bus, bulk unloader, or line haul with more than 5 axles.

Then go to Step B.

The Technician selects the air use category for the vehicle. This decides which of the two acceptance lines on the cup will be used for the test below.

STEP B - Measure the Charging System Contents

1. Park and chock vehicle on level ground. Drain the air system by pumping the service brakes.
2. Completely drain ALL the air tanks into a single BASIC™ cup.
3. If there is less than one unit of contents total, end the test now and return the vehicle to service. Vehicle passes.
4. **If** more than one oil unit of water (or a cloudy emulsion mixture) is found:
 - (a) Change the vehicle's air dryer cartridge - see Footnote 1,
 - (b) Conduct the 4 minute leakage test (Step D),
 - (c) STOP the inspection, and check the vehicle again after 30 days - see Footnote 2.

STOP
+ CK.



For an accurate test, the contents of all the air tanks on the vehicle should be used.

Note for returning vehicles that are being re tested after a water/cloudy emulsion mixture was found last time and the air dryer cartridge replaced: If more than one oil unit of water or a cloudy emulsion mixture is found again, stop the BASIC™ test and consult the air dryer's Service Data sheet troubleshooting section.

Otherwise, go to Step C.

Footnote 1: Note: Typical air dryer cartridge replacement schedule is every 3 yrs/ 300K miles for low air use vehicles and every year/100K miles for high air use vehicles.

Footnote 2: To get an accurate reading for the amount of oil collected during a 30 day period, ask the customer not to drain the air tanks before returning. (Note that 30-90 days is the recommended air tank drain schedule for vehicles equipped with a Bendix air dryer that are properly maintained.) If, in cold weather conditions, the 30 day air tank drain schedule is longer than the customer's usual draining interval, the customer must determine, based on its experience with the vehicle, whether to participate now, or wait for warmer weather. See the cold weather tips in Bulletins TCH-008-21 and TCH-008-22 (included in Appendix B of the advanced troubleshooting guide).

Appendix B continued: Information about the BASIC™ Test Kit (Bendix P/N 5013711)

Filling in the Checklist for the Bendix® Air System Inspection Cup (BASIC™) Test

Note: Follow all standard safety precautions. For vehicles using a desiccant air dryer.

STEP C - How to Use the BASIC™ Test

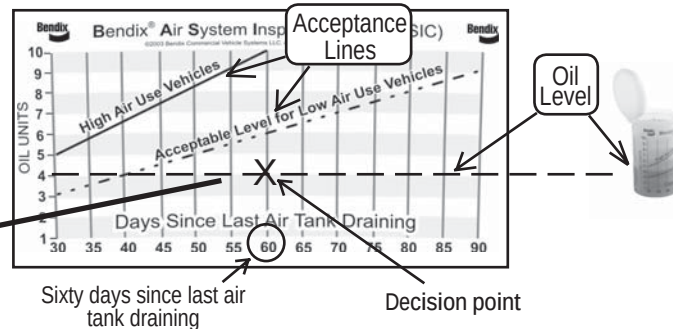
The Technician uses the chart (label) on the BASIC™ test cup to help decide the action to take, based on the amount of oil found. Use the lower acceptance line for low air use vehicles, and upper line for high air use vehicles (from Step A).

1. Record days since air tanks were last drained. _____ days	2. Record amount of oil found: _____ units	3. Action to take
If number of days is: 30-60 days (high air use) or 30-90 days (low air use) →	if oil level is at or below acceptance line for number of days →	System OK. Return to service. STOP TEST
	if oil level is above acceptance line for number of days →	Go to Step D
Otherwise . . . → (if the number of days is unknown, or outside the limits above)	if oil level is at or below 30-day acceptance line →	System OK. Return to service. STOP TEST
	if oil level is above 30-day acceptance line →	Stop inspection. Test again after 30 days. See Footnote 2. STOP + CK.

BASIC™ Test Example

An oil level of 4 units in a sixty-day period is within the acceptance area (at or below the line) for both low and high air use vehicles. Return the vehicle to service.

The Technician looks for the point where the number of days since the air tanks were drained meets the oil level. If it is at or below the (low or high use) acceptance line, the vehicle has passed the test. If the point is above the line then go to the leakage test.



STEP D - Air Brake System Leakage Test

Park the vehicle on level ground and chock wheels. Build system pressure to governor cut-out and allow the pressure to stabilize for one minute.

- 1: Observe the dash gauges for two additional minutes without the service brakes applied.
- 2: Apply service brakes for two minutes (allow pressure to stabilize) and observe the dash gauges.

If you see any noticeable decrease of the dash air gauge readings, repair leaks. Repeat this test to confirm that air leaks have been repaired and return vehicle to service. Please repeat BASIC™ test at next service interval. Note: Air leaks can also be found in the charging system, parking brakes, and/or other components - inspect and repair as necessary.

Air leakage is the number one cause of compressors having to pump excessive amounts of air, in turn run too hot and pass oil vapor along into the system. Here the Technician conducts a four-minute test to see if leakage is a problem with the vehicle being tested.

If no air leakage was detected, and if you are conducting this test after completing Step C, go to Step E.

STEP E - If no air leakage was detected in Step D

Replace the compressor.

Note: If the compressor is within warranty period, please follow standard warranty procedures. Attach the completed checklist to warranty claim.

The Technician only reaches Step E if the amount of oil found, or the amount of time since the air tanks were last drained exceeds the acceptance level, AND the vehicle passes the four-minute leakage test (no noticeable leakage was detected).

Technical Bulletin



Bulletin No.: TCH-008-021
Page: 1 of 2

Effective Date: 11/1/92

Subject: Air Brake System - Cold Weather Operation Tips

As the cold weather approaches, operators and fleets alike begin to look to their vehicles with an eye toward "winterization", and particularly what can be done to guard against air system freeze-up. Here are some BASIC™ "Tips" for operation in the cold weather.

Engine Idling

Avoid idling the engine for long periods of time! In addition to the fact that most engine manufacturers warn that long idle times are detrimental to engine life, winter idling is a big factor in compressor discharge line freeze-up. Discharge line freeze-ups account for a significant number of compressor failures each year. The discharge line recommendations under "Discharge Lines" are important for all vehicles but are especially so when some periods of extended engine idling can not be avoided.

Discharge Lines

The discharge line should slope downward from the compressor discharge port without forming water traps, kinks, or restrictions. Cross-overs from one side of the frame rail to the other, if required, should occur as close as possible to the compressor. Fitting extensions must be avoided. Recommended discharge line lengths and inside diameters are dependent on the vehicle application and are as follows.

Typical P&D, School Bus and Line Haul

The maximum discharge line length is 16 feet.

<u>Length</u>	<u>I.D. Min.</u>	<u>Other Requirements</u>
6.0-9.5 ft.	½ in.	None
9.5-12 ft. ½ in.		Last 3 feet, including fitting at the end of the discharge line, must be insulated with ½ inch thick closed cell polyethylene pipe insulation.
12-16 ft.	5/8 in.	Last 3 feet, including fitting at the end of the discharge line, must be insulated with ½ inch thick closed cell polyethylene pipe insulation.

If the discharge line length must be less than 6 feet or greater than 16 feet, contact your local Bendix representative.

Appendix C: Continued

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Page: 2 of 2

High Duty Cycle Vehicles (City Transit Coaches, Refuse Haulers, Etc.)

The maximum discharge line length is 16 feet.

<u>Length</u>	<u>I.D. min.</u>	<u>Other Requirements</u>
10-16 ft. ½ in.		None

If the discharge line length must be less than 10 feet or greater than 16 feet, contact your local Bendix representative.

System Leakage

Check the air brake system for excessive air leakage using the Bendix "Dual System Air Brake Test and Check List" (BW1279). Excessive system leakage causes the compressor to "pump" more air and also more moisture into the brake system.

Reservoir Draining (System Without Air Dryer)

Routine reservoir draining is the most BASIC™ step (although not completely effective) in reducing the possibility of freeze-up. **All reservoirs** in a brake system can accumulate water and other contamination and must be drained! The best practice is to drain all reservoirs daily. When draining reservoirs; turn the ENGINE OFF and drain ALL AIR from the reservoir, better still, open the drain cocks on all reservoirs and leave them open over night to assure all contamination is drained (reference Service Data Sheet SD-04-400 for Bendix Reservoirs). If automatic drain valves are installed, check their operation **before** the weather turns cold (reference Service Data Sheet SD-03-2501 for Bendix® DV-2™ Automatic Drain Valves). It should be noted that, while the need for daily reservoir draining is eliminated through the use of an automatic drain valve, periodic manual draining is still required.

Alcohol Evaporator or Injector Systems

Check for proper operation of these systems by monitoring alcohol consumption for a few days (Reference Service Data Sheet SD-08-2301 for the Bendix Alcohol Evaporator). Too little means the system is not receiving adequate protection and too much simply wastes alcohol. As a general guide, these systems should consume approximately 1 to 2 ounces of alcohol per hour of compressor loaded time (compressing air). City pick-up and delivery vehicles will operate with the compressors loaded (compressing air) more while compressors on highway vehicles will be loaded less. These figures are approximate and assume that air system leakage is within the limits of the Bendix "Dual System Air Brake Test and Check List" (BW1279). Last but not least, begin using alcohol several weeks prior to freezing weather to ensure that the system is completely protected. Use only methanol alcohol, such as Bendix "Air Guard", in evaporators or injectors.

Air Dryers

Make certain air brake system leakage is within the limits stated in BW1279. Check the operation and function of the air dryer using the appropriate Service Data Sheet for the air dryer.

AD-9™ Air Dryer	Service Data Sheet SD-08-2412
AD-4™ Air Dryer	Service Data Sheet SD-08-2407
AD-2™ Air Dryer	Service Data Sheet SD-08-2403
AD-IP™ Air Dryer	Service Data Sheet SD-08-2414
AD-SP™ Air Dryer	Service Data Sheet SD-08-2415
Trailer System-Guard® Air Dryer	Service Data Sheet SD-08-2416
Bendix® PuraGuard QC™ Oil Coalescing Filter	Service Data Sheet SD-08-187B



Technical Bulletin

Bulletin No.: TCH-008-022
Page: 1 of 1

Effective Date: 1/1/1994

Subject: **Additional Cold Weather Operation Tips for the Air Brake System**

Last year we published Bulletin PRO-08-21 which provided some guidelines for “winterizing” a vehicle air brake system. Here are some additional suggestions for making cold weather vehicle operation just a little more bearable.

Thawing Frozen Air Lines

The old saying; “Prevention is the best medicine” truly applies here! Each year this activity accounts for an untold amount of unnecessary labor and component replacement. Here are some Do’s and Don’ts for prevention and thawing.

Do’s

1. Do maintain freeze prevention devices to prevent road calls. Don’t let evaporators or injectors run out of methanol alcohol or protection will be degraded. Check the air dryer for proper operation and change the desiccant when needed.
2. Do thaw out frozen air lines and valves by placing the vehicle in a warmed building. This is the only method for thawing that will not cause damage to the air system or its components.
3. Do use dummy hose couplings on the tractor and trailer.
4. Do check for sections of air line that could form water traps. Look for “drooping” lines.

Don’ts

1. Do not apply an open flame to air lines and valves. Beyond causing damage to the internal nonmetallic parts of valves and melting or burning non-metallic air lines. **WARNING: THIS PRACTICE IS UNSAFE AND CAN RESULT IN VEHICLE FIRE!**
2. Do not introduce (pour) fluids into air brake lines or hose couplings (“glad hands”). Some fluids used can cause immediate and severe damage to rubber components. Even methanol alcohol, which is used in Alcohol Evaporators and Injectors, should not be poured into air lines. Fluids poured into the system wash lubricants out of valves, collect in brake chambers and valves and can cause malfunction. Loss of lubricant can affect valve operating characteristics, accelerate wear and cause premature replacement.
3. Do not park a vehicle outside after thawing its air system indoors. Condensation will form in the system and freeze again. Place the vehicle in operation when it is removed to the outdoors.

Supporting Air and Electrical Lines

Make certain tie wraps are replaced and support brackets are re-assembled if removed during routine maintenance. These items prevent the weight of ice and snow accumulations from breaking or disconnecting air lines and wires.

Automatic Drain Valves (System without Air Dryer)

As we stated last year, routine reservoir draining is the most BASIC™ step (although not completely effective) in reducing the possibility of freeze-up. While automatic drain valves relieve the operator of draining reservoirs on a daily basis, these valves **MUST** be routinely checked for proper operation. Don’t overlook them until they fail and a road call is required.

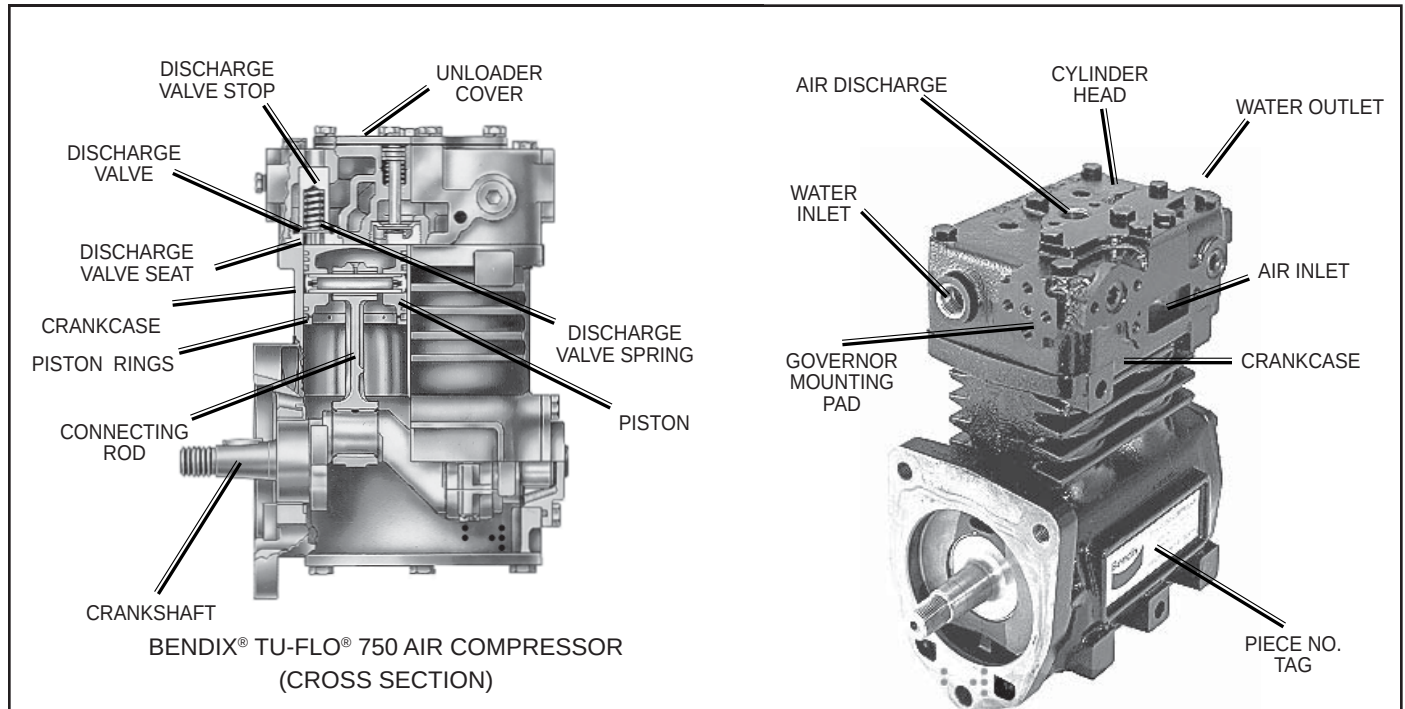




Service Data

SD-01-344

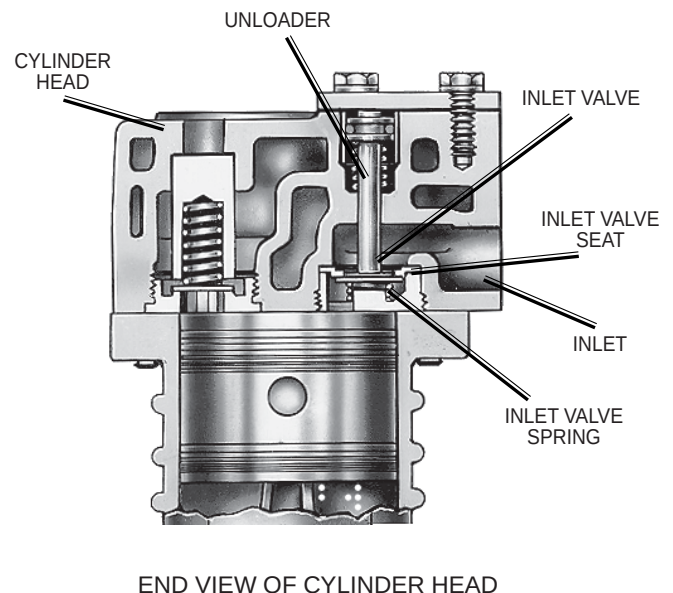
Bendix® Tu-Flo® 750 Air Compressor



DESCRIPTION

The function of the air compressor is to provide and maintain air under pressure to operate devices in the air brake and/or auxiliary air systems. The Tu-Flo® 750 compressor is a two cylinder single stage, reciprocating compressor with a rated displacement of 16.5 cubic feet per minute at 1,250 RPM.

The compressor assembly consists of two major subassemblies, the cylinder head and the crankcase. The cylinder head is an iron casting which houses the inlet, discharge, and unloader valving. (See Figure 1.) The cylinder head contains the air inlet port and is designed with both top and side air discharge ports. Three water coolant ports provide a choice of coolant line connections. Governor mounting surfaces are provided at both the front and the rear of the cylinder head. The head is mounted on the crankcase and is secured by six cap screws. The Tu-Flo® 750 compressor is designed such that the cylinder head can be installed in one of two positions which are 180 degrees apart. The crankcase houses the cylinder bores, pistons, crankshaft and main bearings, and provides the flange or base mounting surface.



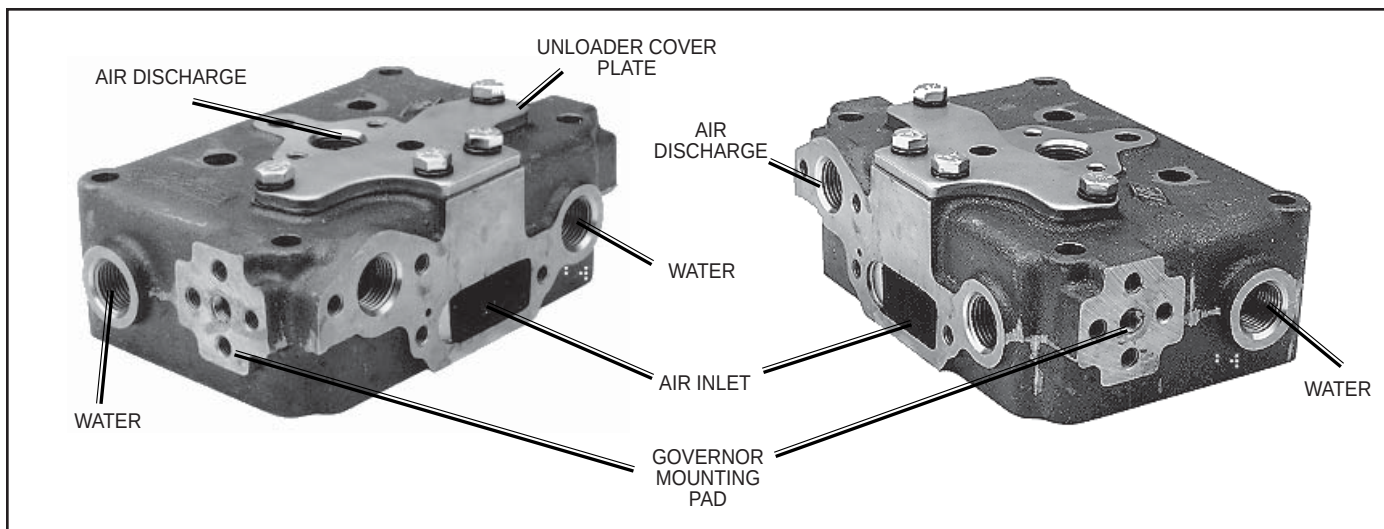


FIGURE 1 - CYLINDER HEAD

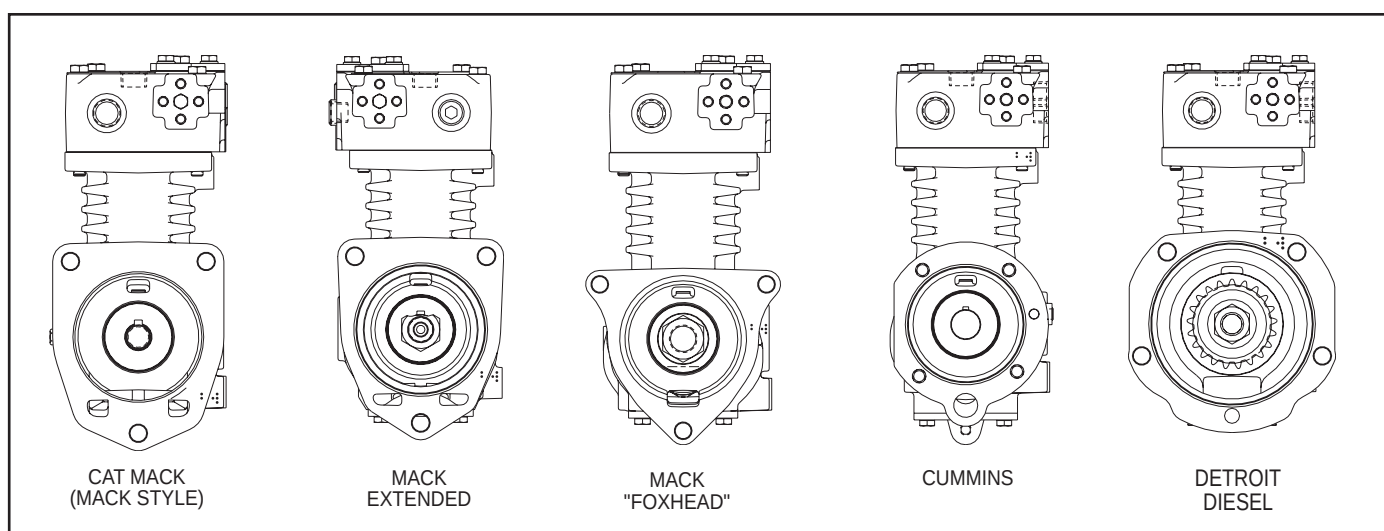


FIGURE 2 - MOUNTING CONFIGURATIONS

Various mounting and drive configurations, as shown in Figure 2, are supplied as required by the vehicle engine designs. A nameplate identifying the compressor piece number and serial number is attached to the side of the crankcase. (Reference Figure 3.)

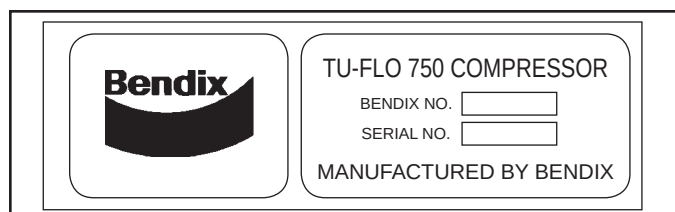


FIGURE 3 - NAMEPLATE

OPERATION

The compressor is driven by the vehicle engine and is operating continuously while the engine is running. Actual compression of air is controlled by the compressor unloading mechanism and the governor. The governor, which is generally mounted on the compressor, maintains the brake

system air pressure to a preset maximum and minimum pressure level.

INTAKE AND COMPRESSION OF AIR (LOADED)

During the down stroke of the piston, a slight vacuum is created between the top of the piston and the cylinder head, causing the inlet valve to move off its seat and open. (Note: The discharge valve remains on its seat.) Atmospheric air is drawn through the air strainer and the open inlet valve into the cylinder (see Figure 4). As the piston begins its upward stroke, the air that was drawn into the cylinder on the down stroke is being compressed. Air pressure on the inlet valve plus the force of the inlet spring, returns the inlet valve to its seat and closes. The piston continues the upward stroke and compressed air pushes the discharge valve off its seat and air flows by the open discharge valve, into the discharge line and to the reservoirs (see Figure 5). As the piston reaches the top of its stroke and starts down, the discharge valve spring and air pressure in the discharge line returns the discharge valve to its seat. This prevents the compressed air in the discharge

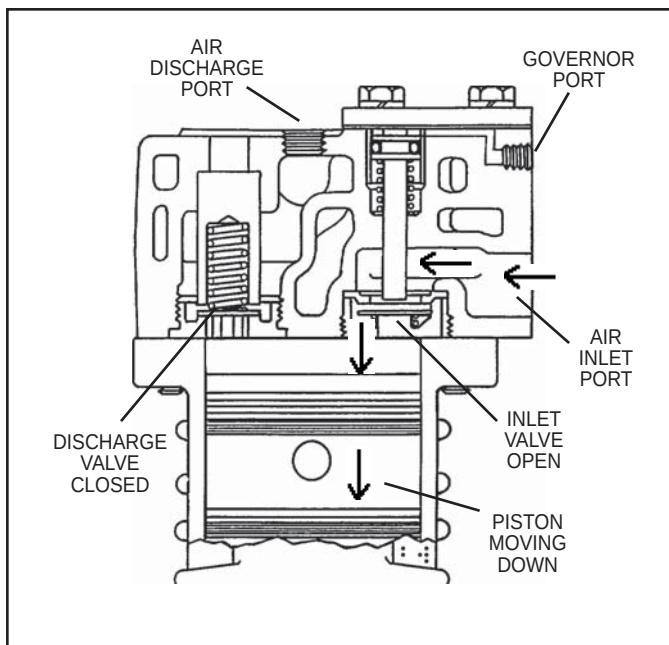


FIGURE 4 - OPERATIONAL-LOADED (INTAKE)

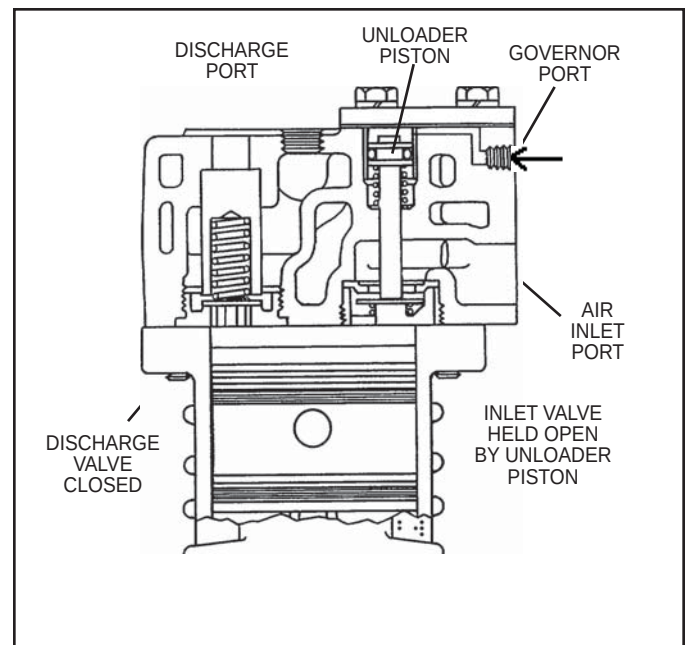


FIGURE 6 - OPERATIONAL-UNLOADED

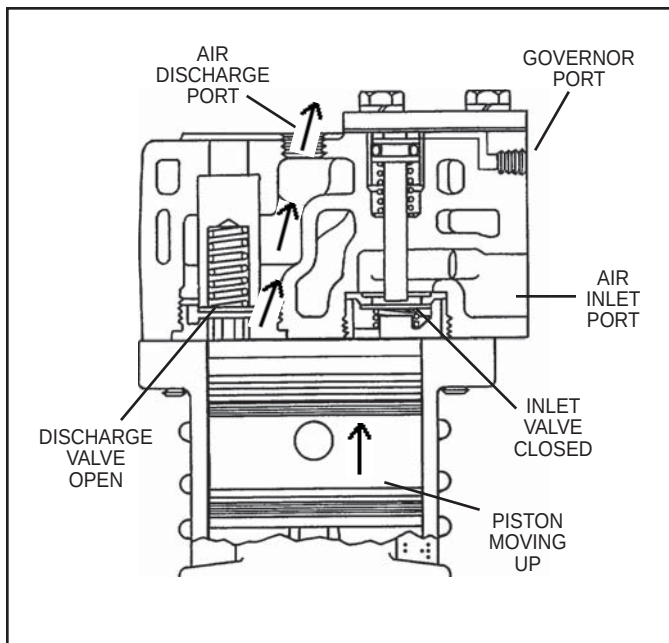


FIGURE 5 - OPERATIONAL-LOADED (COMPRESSION)

line from returning to the cylinder bore as the intake and compression cycle is repeated.

NON-COMPRESSION OF AIR (UNLOADED)

When air pressure in the reservoir reaches the cut-out setting of the governor, the governor allows air to pass from the reservoir, through the governor and into the cavity above the unloader pistons. The unloader pistons move down holding the inlet valves off their seats (see Figure 6.) With the inlet valves held off their seats by the unloader pistons, air is pumped back and forth between the two cylinders, and the discharge valves remain closed. When air pressure from the reservoir drops to the cut-in setting of the governor, the

governor closes and exhausts the air from above the unloader pistons. The unloader springs force the pistons upward and the inlet valves return to their seats. Compression is then resumed.

COMPRESSOR & THE AIR BRAKE SYSTEM

GENERAL

The compressor is part of the total air brake system, more specifically, the charging portion of the air brake system. As a component in the overall system its condition, duty cycle, proper installation and operation will directly affect other components in the system.

Powered by the vehicle engine, the air compressor builds the air pressure for the air brake system. The air compressor is typically cooled by the engine coolant system, lubricated by the engine oil supply and has its inlet connected to the engine induction system.

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 reservoirs. 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.

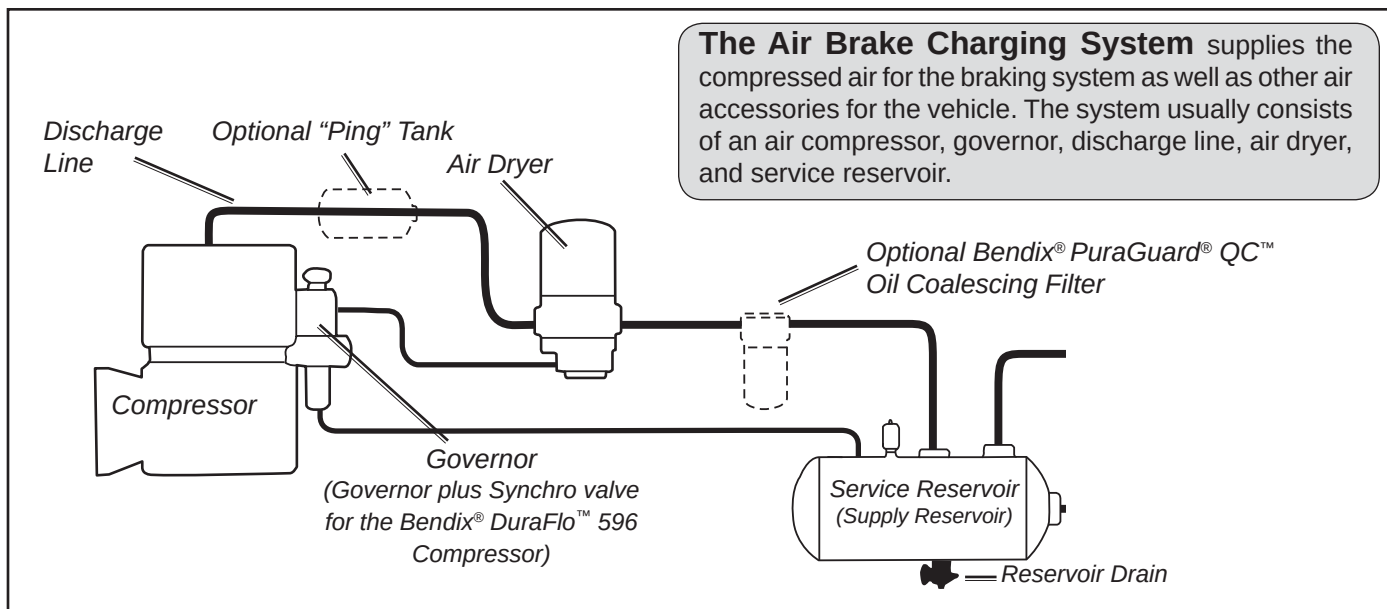


FIGURE 6A - SYSTEM DRAWING

DUTY CYCLE

The duty cycle is the ratio of time the compressor spends building air to the total engine running time. Air compressors are designed to build air (run "loaded") up to 25% of the time. Higher duty cycles cause conditions that affect air brake charging system performance which may require additional maintenance. Factors that add to the duty cycle are: air suspension, additional air accessories, use of an undersized compressor, frequent stops, excessive leakage from fittings, connections, lines, chambers or valves, etc. Refer to Table A in the Troubleshooting section for a guide to various duty cycles and the consideration that must be given to maintenance of other components.

COMPRESSOR INSTALLATION

While the original compressor installation is usually completed by the vehicle manufacturer, conditions of operation and maintenance may require additional consideration. The following presents base guidelines.

DISCHARGE LINE

The discharge line allows the air, water-vapor and oil-vapor mixture to cool between the compressor and air dryer or reservoir. The typical size of a vehicle's discharge line, (see column 2 of Table A in the Troubleshooting section) assumes a compressor with a normal (less than 25%) duty cycle, operating in a temperate climate. See Bendix and/or other air dryer manufacturer guidelines as needed.

The discharge line must maintain a constant slope down from the compressor to the air dryer inlet fitting or reservoir to avoid low points where ice may form and block the flow. 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 degree fitting, it may be changed to a straight or 45 degree fitting. Shorter discharge line lengths or insulation may be required in cold climates.

While not all compressors and charging systems are equipped with a discharge line safety valve this component is recommended. The discharge line safety valve is installed in the cylinder head (Tu-Flo® 550/750) or close to the compressor discharge port and protects against over pressurizing the compressor in the event of a discharge line freezeup.

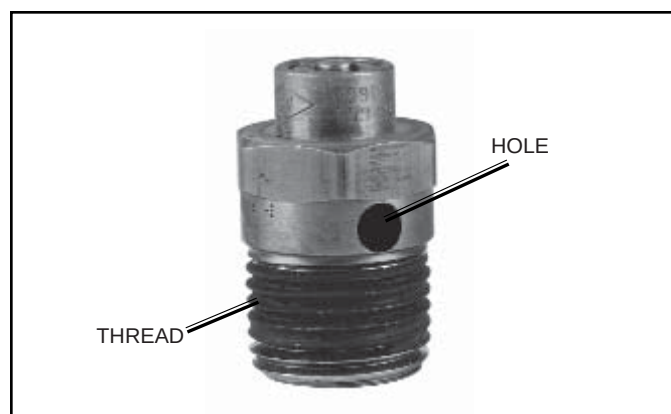


FIGURE 6B - DISCHARGE LINE SAFETY VALVE

DISCHARGE LINE TEMPERATURE

When the temperature of the compressed air that enters the air dryer is within the normal range, the air dryer can remove most of the charging system oil. If the temperature of the compressed air is above the normal range, oil as oil-vapor is able to pass through the air dryer and into the air system. Larger diameter discharge lines and/or longer discharge line lengths can help reduce the temperature.

The air dryer contains a filter that collects oil droplets, and a desiccant bed that removes almost all of the remaining water vapor. The compressed air is then passed to the air brake service (supply) reservoir. The oil droplets and the water collected are automatically purged when the governor reaches its "cut-out" setting.

For vehicles with accessories that are sensitive to small amounts of oil, we recommend installation of a Bendix® PuraGuard® QC™ oil coalescing filter, designed to minimize the amount of oil present.

LUBRICATION

The vehicle's engine provides a continuous supply of oil to the compressor. Oil is routed from the engine to the compressor oil inlet. An oil passage in the compressor crankshaft allows oil to lubricate the connecting rod crankshaft bearings. Connecting rod wrist pin bushings and crankshaft ball bearings are spray lubricated. An oil return line connected from the compressor drain outlet to the vehicle engine crankcase allows for oil return. On flange mounted models, the oil drains back directly to the engine through the mounting flange.

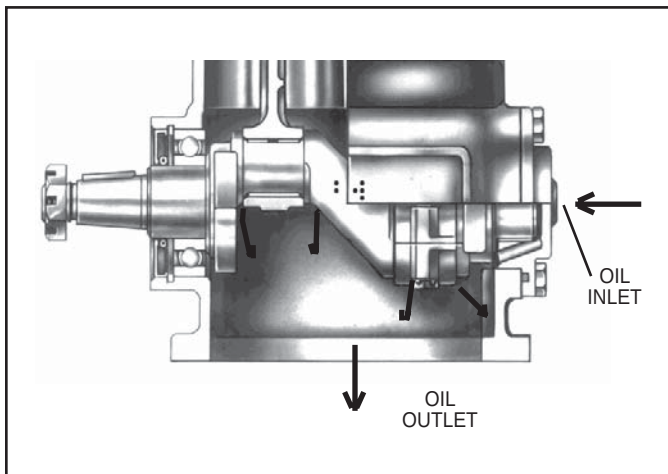


FIGURE 7 - LUBRICATION (BASE MOUNT MODEL SHOWN)

COOLING

Air flowing through the engine compartment from the action of the engine's fan and the movement of the vehicle 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 recommended 400 degrees Fahrenheit.

Figure 8 illustrates the various approved coolant flow connections. See the tabulated technical data in the back of this manual for specific requirements.

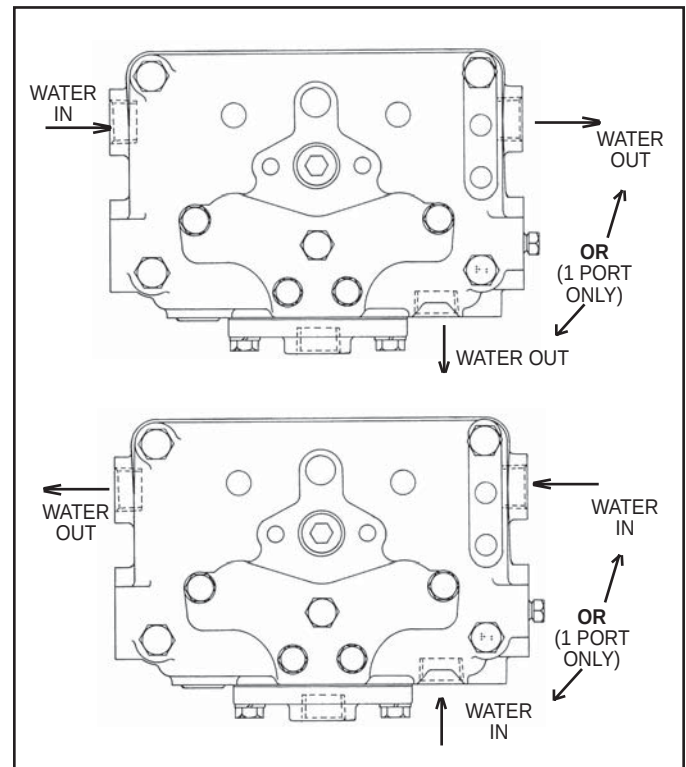


FIGURE 8 - COOLING

AIR INDUCTION

There are three methods of providing clean air to the Tu-Flo® 750 compressor:

1. Naturally aspirated Local Air Strainer - Compressor utilizes its own attached air strainer (polyurethane sponge or pleated paper dry element).
2. Naturally aspirated Engine Air Cleaner - Compressor inlet is connected to the engine air cleaner or the vacuum side (engine air cleaner) of the supercharger or turbocharger.
3. Pressurized induction - Compressor inlet is connected to the pressure side of the supercharger or turbocharger.

See the tabulated technical data in the back of this manual for specific requirements for numbers 2 and 3 above.

If a previously unturbocharged compressor is being turbocharged, it is recommended that the inlet cavity screen (238948) be installed with an inlet gasket (291909) on both sides of the screen.

COMPRESSOR TURBOCHARGING PARAMETERS

Air entering the compressor inlet during the loaded cycle must not exceed 250 degrees Fahrenheit (121 degrees Celsius). A metal inlet line is suggested to help meet this parameter.

The following compressor crankshaft rotative speed and inlet pressure relationships may not be exceeded.

Crankshaft R.P.M.	Maximum Compressor Inlet Pressure
1900 RPM	30.0 psi (207 kPa)
2000 RPM	27.5 psi (190 kPa)
2100 RPM	24.0 psi (165 kPa)
2200 RPM	21.0 psi (145 kPa)
2300 RPM	19.0 psi (131 kPa)
2400 RPM	16.0 psi (110 kPa)

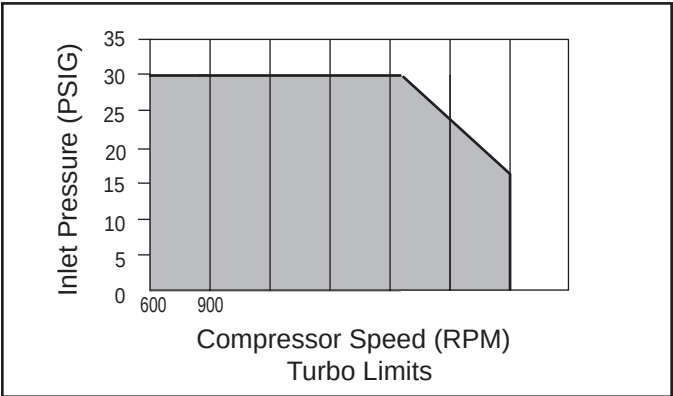


FIGURE 9 - TURBO LIMITS CURVE

PREVENTATIVE MAINTENANCE

Regularly scheduled maintenance is the single most important factor in maintaining the air brake charging system. Refer to Table A in the Troubleshooting section for a guide to various considerations that must be given to the maintenance of the compressor and other related charging system components.

Important Note: Review the warranty policy before performing any intrusive maintenance procedures. An extended warranty may be voided if intrusive maintenance is performed during this period.

AIR INDUCTION

One of the single most important aspects of compressor preventive maintenance is the induction of clean air. The type and interval of maintenance required will vary depending upon the air induction system used.

The intervals listed under the headings below pertain to typical highway and street operation. More frequent maintenance will be required for operation in dusty or dirty environments.



FIGURE 10 - STRAINERS

POLYURETHANE SPONGE STRAINER

Every month, 150 operating hours or 5,000 miles, whichever occurs first, remove and wash all of the parts. The strainer element should be cleaned or replaced. If the element is cleaned, it should be washed in a commercial solvent or a detergent and water solution. The element should be saturated in clean engine oil, then squeezed dry before replacing it in the strainer. Be sure to replace the air strainer gasket if the entire strainer is removed from the compressor intake.

DRY ELEMENT - PLEATED PAPER STRAINER

Every two months, 800 operating hours or 20,000 miles whichever occurs first, loosen the spring clip from the unhinged side of the mounting baffle and open the cover. Replace the pleated paper filter and secure the cleaned cover, making sure the filter is in position. Be sure to replace the air strainer gasket if the entire air strainer is removed from the compressor intake.

INTAKE ADAPTER

When the engine air cleaner is replaced: Some compressors are fitted with compressor intake adapters, which allow the compressor intake to be connected to the engine air induction system. In this case, the compressor receives a supply of clean air from the engine air cleaner. When the engine air filter is changed, the compressor intake adapter should be checked. If it is loose, remove the intake adapter, clean the strainer plate, if applicable, and replace the intake adapter gasket, and reinstall the adapter securely. Check line connections both at the compressor intake adapter and at the engine. Inspect the connecting line for ruptures and replace it if necessary.

COMPRESSOR COOLING

Every 6 months, 1,800 operating hours or after each 50,000 miles whichever occurs first, inspect the compressor discharge port, inlet cavity and discharge line for evidence of restrictions and carboning. If excessive buildup is noted, thoroughly clean or replace the affected parts and closely inspect the compressor cooling system. Check all compressor coolant lines for kinks and restrictions to flow. **Minimum** coolant line size is 3/8" I.D. Check coolant lines for internal clogging from rust scale. If coolant lines appear suspicious, check the coolant flow and compare to the tabulated technical data present in the back of this manual. Carefully inspect the air induction system for restrictions.

LUBRICATION

Every six months, 1,800 operating hours or 50,000 miles whichever occurs first, check external oil supply and return lines, if applicable, for kinks, bends, or restrictions to flow. Supply lines must be a minimum of 3/16" I.D. and return lines must be a minimum of 1/2" I.D. Oil return lines should slope as sharply as possible back to the engine crankcase and should have as few fittings and bends as possible. Refer to the tabulated technical data in the back of this manual for oil pressure minimum values.

Check the exterior of the compressor for the presence of oil seepage and refer to the TROUBLESHOOTING section for appropriate tests and corrective action.

OIL PASSING

All reciprocating compressors currently manufactured will pass a minimal amount of oil. Air dryers will remove the majority of oil prior to entrance into the air brake system. For particularly oil sensitive systems the Bendix® PuraGuard® QC™ oil coalescing filter can be used in conjunction with a Bendix air dryer.

If compressor oil passing is suspected, refer to the TROUBLESHOOTING section and TABLE A for the symptoms and corrective action to be taken. In addition, Bendix has developed the "Bendix Air System Inspection Cup" or **BASIC** test to help substantiate suspected excessive oil passing. The steps to be followed when using the BASIC test are presented in APPENDIX A at the end of the TROUBLESHOOTING section.

COMPRESSOR DRIVE

Every six months, 1,800 operating hours or 50,000 miles, whichever occurs first, check for noisy compressor operation, which could indicate a worn drive gear coupling, a loose pulley or excessive internal wear. Adjust and/or replace as necessary.

If the compressor is belt driven, check for proper belt and pulley alignment and belt tension. Check all compressor mounting bolts and retighten evenly if necessary. Check for leakage and proper unloader mechanism operation. Repair or replace parts as necessary.

Every 24 months, 7,200 operating hours, or after each 200,000 miles, perform a thorough inspection, and depending upon the results of this inspection or experience, disassemble the compressor, clean and inspect all parts thoroughly, replace all worn or damaged parts using only genuine Bendix replacements or replace the compressor with a genuine Bendix remanufactured unit.

GENERAL SERVICE CHECKS

OPERATING TESTS

Vehicles manufactured after the effective date of FMVSS 121, with the minimum required reservoir volume, must have a compressor capable of raising air system pressure from 85-100 psi in 25 seconds or less. This test is performed with the engine operating at maximum recommended governed speed. The vehicle manufacturer must certify this performance on new vehicles with appropriate allowances for air systems with greater than the minimum required reservoir volume.

AIR LEAKAGE TESTS

Compressor leakage tests need not be performed on a regular basis. These tests should be performed when; it is suspected that discharge valve leakage is substantially affecting compressor build-up performance, or when it is suspected that the compressor is "cycling" between the load and unloaded modes due to unloader piston leakage.

These tests must be performed with the vehicle parked on a level surface, the engine not running, the entire air system completely drained to 0 P.S.I., and the inlet check valve detail parts removed, if applicable.

UNLOADER PISTON LEAKAGE

The unloader pistons can be checked for leakage as follows: with the cylinder head removed from the compressor and the inlet flange securely covered, apply 120 psi of air pressure to the governor port. Listen for an escape of air at the inlet valve area. An audible escape of air should not be detected.

DISCHARGE VALVE LEAKAGE

Unloader piston leakage must be repaired before this test is performed. Leakage past the discharge valves can be detected as follows: Remove the discharge line and apply shop air back through the discharge port. Listen for an escape of air at the compressor inlet cavity. A barely audible escape of air is generally acceptable.

If the compressor does not function as described above or if the leakage is excessive, it is recommended that it be returned to the nearest authorized Bendix distributor for a factory remanufactured compressor. If it is not possible, the compressor can be repaired using a genuine Bendix cylinder head maintenance kit. Retest the cylinder head after installation of the kit.

REMOVAL AND DISASSEMBLY

GENERAL

The following disassembly and assembly procedure is presented for reference purposes and presupposes that a major rebuild of the compressor is being undertaken. Several maintenance kits are available which do not require full disassembly. The instructions provided with these parts and kits should be followed in lieu of the instructions presented here.

REMOVAL

These instructions are general and are intended to be a guide, in some cases additional preparations and precautions are necessary.

1. Block the wheels of the vehicle and drain the air pressure from all the reservoirs in the system.

2. Drain the engine cooling system and the cylinder head of the compressor. Identify and disconnect all air, water and oil lines leading to the compressor.
3. Remove the governor and any supporting bracketry attached to the compressor and note their positions on the compressor to aid in reassembly.
4. Remove the discharge and inlet fittings, if applicable, and note their position on the compressor to aid in reassembly.
5. Remove the flange or base mounting bolts and remove the compressor from the vehicle.
6. Remove the drive gear(s) or pulley from the compressor crankshaft using a gear puller. Inspect the pulley or gear and associated parts for visible wear or damage. Since these parts are precision fitted, they must be replaced if they are worn or damaged.

PREPARATION FOR DISASSEMBLY

Remove road dirt and grease from the exterior of the compressor with a cleaning solvent. Before the compressor is disassembled, the following items should be marked to show their relationship when the compressor is assembled. Mark the rear end cover in relation to the crankcase. Mark the base plate or base adapter in relation to the crankcase.

A convenient method to indicate the above relationships is to use a metal scribe to mark the parts with numbers or lines. Do not use marking methods such as chalk that can be wiped off or obliterated during rebuilding.

CYLINDER HEAD

Remove the six cylinder head cap screws (1) and tap the head with a soft mallet to break the gasket seal. Remove the unloader cover plate cap screws (2), lockwashers (3) and the unloader cover plate (4). Scrape off any gasket material (5) from the cover plate, cylinder head and crankcase.

1. Remove the unloader pistons (7), o-rings (6) and springs (8).
2. Inspect the unloader piston bushings (9) for nicks, wear, corrosion and scoring. It is recommended that the compressor be replaced if it is determined that the unloader bushing is damaged or worn excessively.

Before disassembling the discharge valve mechanism, measure and record the discharge valve travel (from closed to completely open).

3. If the measured discharge valve travel **exceeds** .046 inches, the compressor should be replaced. If the discharge valve travel does not exceed .046, using a 9/16" Allen wrench, remove the discharge valve seats (18), valves (17) and valve springs (16).

4. Remove the inlet valve stops (14), valves (17), valve seats (11), valve springs (12) and gaskets (10). It is recommended that a tool such as a J-25447-B, produced by Kent Moore Tool Division Roseville, Michigan phone 1-800-328-6657, be used to remove the inlet valve stop.

CRANKCASE BOTTOM COVER OR ADAPTER DISASSEMBLY

1. Remove the cap screws (22) securing the bottom cover or adapter (21). Tap with a soft mallet to break the gasket seal. Scrape off any gasket material (20) from the crankcase and bottom cover or adapter.

CONNECTING ROD DISASSEMBLY

Before removing the connecting rod, mark the connecting rods (37) and their caps (39) to ensure correct reassembly. The connecting rod and cap are a matched set therefore the caps must not be switched or rotated end for end.

1. Remove the connecting rod bolts (40) and bearing caps (39).
2. Push the pistons (26) with the connecting rods (37) attached out the top of the cylinder bore of the crankcase. Replace the bearing caps on the connecting rods.
3. Remove the piston rings (23-25) from the piston. If the piston is to be removed from the connecting rod, remove the wrist pin teflon plugs (28) and press the wrist pin (27) from the piston and connecting rod.
4. If the piston is removed from the rod, inspect the wrist pin bore in the piston and bronze wrist pin bushing (36) in the connecting rod. If excessive wear is noted or suspected, replace the connecting rod and piston.

COMPRESSOR CRANKCASE DISASSEMBLY

1. Remove the key or keys (30) from the crankshaft (29) and any burrs from the crankshaft where the key or keys were removed. (**Note:** Through drive compressors may have a crankshaft key at both ends.)
2. Remove the four cap screws (35) and lockwashers or nuts and lockwashers that secure the rear end cover (34) to the crankcase.
3. Remove the rear end cover (34), thrust washer (31) and end cover oil seal ring (33), taking care not to damage the bearing if present in the end cover.
4. If the compressor has ball type main bearings, press the crankshaft (29) and ball bearings from the crankcase, then press the ball bearings from the crankshaft.
5. Press the oil seal out of the compressor crankcase, if so equipped.

CLEANING OF PARTS GENERAL

All parts should be cleaned in a good commercial grade of solvent and dried prior to inspection.

CYLINDER HEAD

Remove carbon deposits from the discharge cavity and rust and scale from the cooling cavities of the cylinder head body. Scrape all foreign matter from the body surfaces and use shop air pressure to blow the dirt particles from the cavities. Clean carbon and dirt from the inlet and unloader passages. Use shop air to blow the carbon and dirt deposits from the unloader passages.

OIL PASSAGES

Thoroughly clean all oil passages through the crankshaft, crankcase, end covers, base plate or base adapter. Inspect the passages with a wire to be sure. Blow the loosened foreign matter out with air pressure.

INSPECTION OF PARTS

CYLINDER HEAD BODY

Inspect the cylinder head for cracks or damage. With the cylinder head and head gasket secured to a flat surface or crankcase, apply shop air pressure to one of the coolant ports with all others plugged, and check for leakage by applying a soap solution to the exterior of the body. If leakage is detected, replace the compressor.

END COVERS

Check for cracks and external damage. If the crankshaft main bearing (32) is installed in the end cover (34), check for excessive wear and flat spots and replace if necessary.

CRANKCASE

Check all crankcase surfaces for cracks and damage. On compressors where ball bearing main bearings are used the difference between the O.D. of the outer race and the I.D. of the crankcase hole should be .0003 in. tight to .0023 in. loose. This is to maintain the correct fit. The compressor must be replaced if the fit is too loose.

On compressors fitted with precision, sleeve main bearings, the difference between the O.D. of the crankshaft journal and the main bearing I.D. must not exceed .005 in. If the clearance is greater than .005 in. the bearing must be replaced.

The cylinder bores should be checked with inside micrometers or calipers. Cylinder bores which are scored or out of round by more than .0005 in. or tapered more than .0005

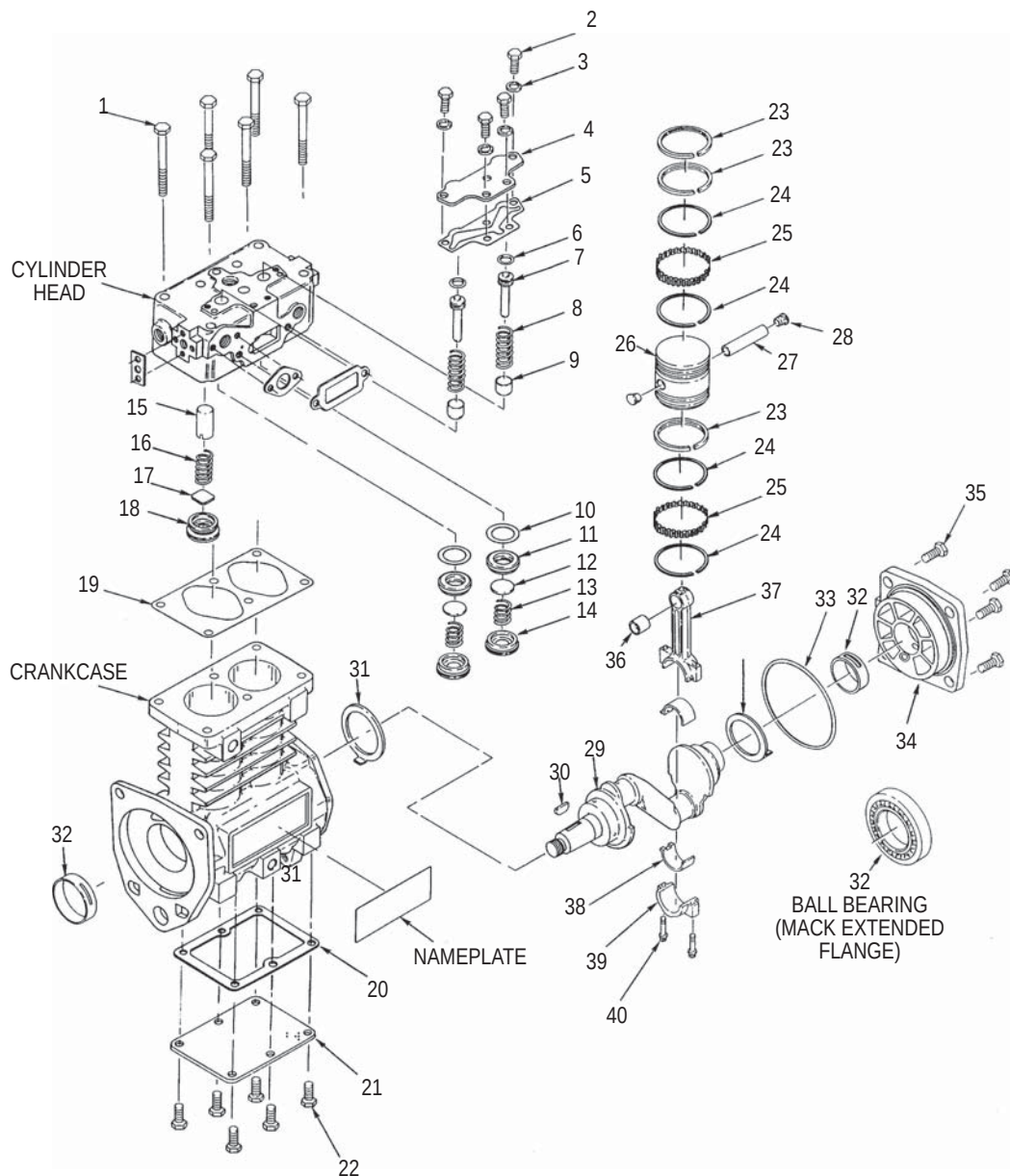


FIGURE 11 - EXPLODED VIEW

ITEM	QTY	DESCRIPTION	ITEM	QTY	DESCRIPTION	ITEM	QTY	DESCRIPTION
1	6	Cylinder Head Cap Screws	15	2	Discharge Valve Stop	29	1	Crankshaft
2	4	Unloader Plate Cap Screws	16	2	Discharge Valve Spring	30	1	Crankshaft Key
3	4	Unloader Plate Lock Washers	17	2	Discharge Valve	31	2	Thrust Washer
4	1	Unloader Plate	18	2	Discharge Valve Stop	32	2	Sleeve (or Ball) Bearing
5	1	Unloader Plate Gasket	19	1	Cylinder Head Gasket	33	1	End Cover Seal
6	2	O-ring	20	1	Base Gasket	34	1	End Cover
7	2	Unloader	21	1	Base Plate	35	4	End Cover Cap Screws
8	2	Spring	22	6	Base Plate Cap Screws	36	2	Wrist Pin Bushing
9	2	Unloader Bushing	23	6	Standard Piston Rings	37	2	Connecting Rod
10	2	Gasket	24	8	Oil Ring	38	2	Conn. Rod Inserts (Sets)
11	2	Inlet Valve Seat	25	4	Expander Ring	39	2	Connecting Rod Caps
12	2	Inlet Valve	26	2	Piston	40	4	Connecting Rod Bolts
13	2	Inlet Valve Spring	27	2	Wrist Pin			
14	2	Inlet Valve Stop	28	4	Wrist Pin Button			

in. should be rebored or honed oversize. Oversized pistons and piston rings are available in .010 in., .020 in. and .030 in. oversizes. Cylinder bores must be smooth, straight and round. Clearance between the cast iron pistons and cylinder bores should be between .002 in. minimum and .004 in. maximum.

PISTON RINGS

Check the pistons for scores, cracks or enlarged ring grooves; replace the pistons if any of these conditions are found. Measure each piston with a micrometer in relation to the cylinder bore diameter to be sure the diametrical clearance is between .002 in. minimum and .004 in. maximum.

Check the fit of the wrist pins to the pistons and connecting rod bushings. The wrist pin should be a light press fit in the piston. If the wrist pin is a loose fit, the piston and pin assembly should be replaced. Check the fit of the wrist pin in the connecting rod bushing by rocking the piston. This clearance should not exceed .0007 in. Replace the connecting rod and cap assembly which includes the wrist pin bushings if excessive clearance is found. Check the fit of the rings in the piston ring grooves. Check the ring gap with the rings installed in the cylinder bores. Refer to Figure 12 for correct gap and groove clearances.

CRANKSHAFT

Check the crankshaft threads, keyways, tapered ends and all machined and ground surfaces for wear, scores, or damage. Standard crankshaft journals are 1.1242 in. - 1.1250 in. in diameter. If the crankshaft journals are excessively

scored or worn or out of round and cannot be reground, the compressor must be replaced. Connecting rod bearing inserts are available in .010 in., .020 in. and .030 in. undersizes for compressors with reground crankshafts. Main bearing journals must be maintained so the ball bearings are a snug fit or so that no more than .005 in. clearance exists between the precision sleeve main bearing and the main bearing journals on the crankshaft. Check to be sure the oil passages are open through the crankshaft.

CONNECTING ROD BEARINGS

Used bearing inserts must be replaced. The connecting rod and cap are a matched set and therefore the caps must not be switched or rotated end for end. Make sure the locating tangs on the inserts engage with the locating notches in the rod and cap. Clearance between the connecting rod journal and the connecting rod bearing must not be less than .0003 in. or more than .0021 in. after rebuilding.

REPAIRS

UNLOADER

A new cylinder head maintenance kit should be used when rebuilding. **Note: The entire contents of this kit must be used. Failure to do so may result in compressor failure.** The unloader pistons in the kit are prelubricated with a special lubricant piece number 239379 and need no additional lubrication. Install the springs and unloader pistons in their bores being careful not to cut the o-rings. Install the unloader cover gasket and unloader cover and secure the cover cap screws. Tighten the cap screws to 175-225 in. lbs. in a crossing pattern after first snugging all screws.

DISCHARGE VALVES, VALVE STOPS AND SEATS

If the discharge valve seats merely show signs of slight wear, they can be dressed by using a lapping stone, grinding compound and grinding tool however it is recommended that a cylinder head maintenance kit be used. Install new discharge valve springs and valves. Screw in the discharge valve seats, and tighten to 70-90 ft.-lbs. Discharge valve travel should be between .030 in. to .046 in. To test for leakage by the discharge valves, apply 100 psi to the cylinder head discharge port and apply a soap solution to the discharge valve and seats. Leakage in the form of soap bubbles is permissible. If excessive leakage is found, leave the air pressure applied and with the use of a fiber or hardwood dowel and a hammer, tap the discharge valves off their seats several times. This will help the valves to seat and should reduce the leakage. With the air pressure still applied at the discharge port of the cylinder head, check for leakage around the discharge valve stop on the top of the cylinder head casting. No leakage is permitted.

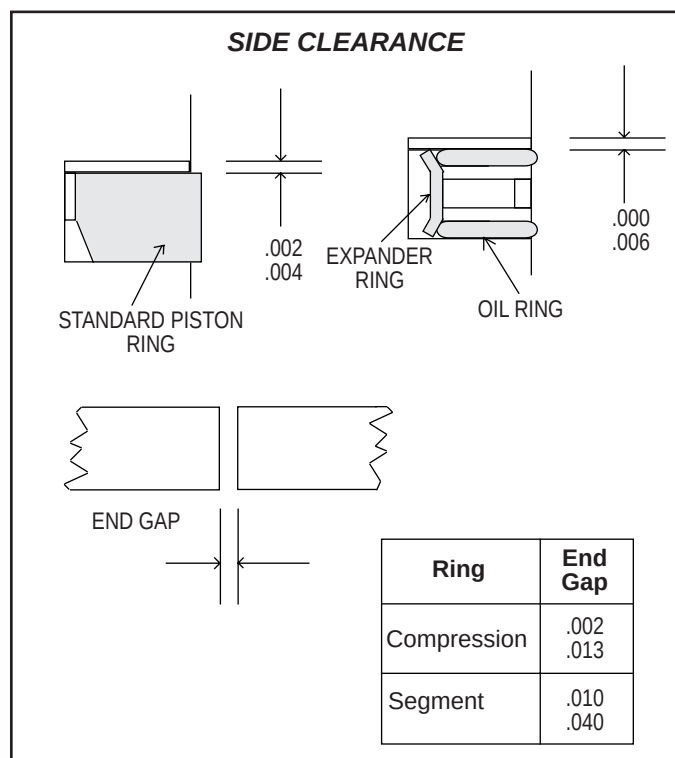


FIGURE 12 - RING CONFIGURATION

INLET VALVES AND SEATS

Inlet valves and springs should be replaced. However, if the inlet valve seats show signs of slight nicks or scratches, they can be redressed with a fine piece of emery cloth or by lapping with a lapping stone, grinding compound and grinding tool. If the seats are damaged to the extent that they cannot be reclaimed, they must be replaced.

ASSEMBLY

General Note: All torques specified in this manual are assembly torques and typically can be expected to fall off after assembly is accomplished. **Do not retorque** after initial assembly torques fall unless instructed otherwise. A compiled listing of torque specifications is presented at the end of this manual.

To convert inch pounds of torque to foot pounds of torque, divide inch pounds by 12.

inch pounds ÷ 12 = foot pounds

To convert foot pounds of torque to inch pounds of torque, multiply foot pounds by 12.

foot pounds x 12 = inch pounds

INSTALLING CRANKSHAFT

Press new sleeve bearings in the end cover and crankcase. Ensure that the slot in the bearings line up with the oil passages in the end cover or crankcase. If you have a model with no oil passage present in the crankcase, press the sleeve bearing into the crankcase with the slot located 90 degrees from vertical.

Install the front thrust washer with the tang inserted in the slot toward the flange. Insert the crankshaft and the rear thrust washer with the tang toward the rear of the compressor.

Place the oil seal ring on the boss of the rear end cover and install the end cover making sure not to pinch the seal ring. Ensure the tang of the thrust washer is inserted in the slot of the end cover. Fasten the end cover to the crankcase with the four cover cap screws. Torque the cap screws to 175-225 inch pounds in a cross pattern.

PISTONS AND CONNECTING RODS

If the pistons are to be replaced ensure that the correct pistons are being installed. Note that the pistons for the Tu-Flo® 750 compressor are similar to those of other Bendix compressor models but may be identified by the piston diameter and the distance to the center of the wrist pin from the top of the piston as shown in Figure 13.

PISTON RINGS

Check each ring end gap in a cylinder bore before installation. Place the ring in the top of the cylinder bore and using the piston, push the ring to the midpoint of the cylinder bore and check the ring gap. If the end gaps are incorrect either the wrong repair size has been purchased or the compressor is worn beyond specification and should be replaced.

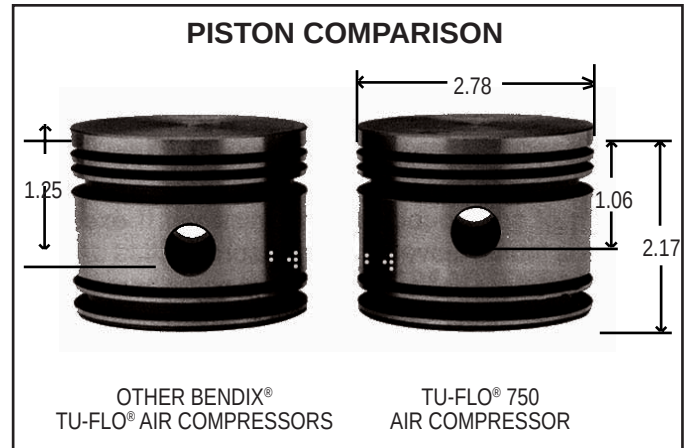


FIGURE 13 - PISTON COMPARISON

Install the rings on the pistons per the following instructions starting at the center of the piston and moving outward.

1. Install the spacer and segment rings as follows. Place the spacer ring (25) in the piston groove, the ends of the spacer must butt and not overlap. Install the top segment (24) by inserting one end above the spacer in the ring groove, 120 degrees from the spacer ends and wind the segment into position. Install the bottom segment in the same manner beneath the spacer, making sure the gap is staggered 120 degrees from both the top ring segment and the spacer end gaps. Before using be sure both painted ends of the spacer are visible and butted. (Refer to Figure 14.)

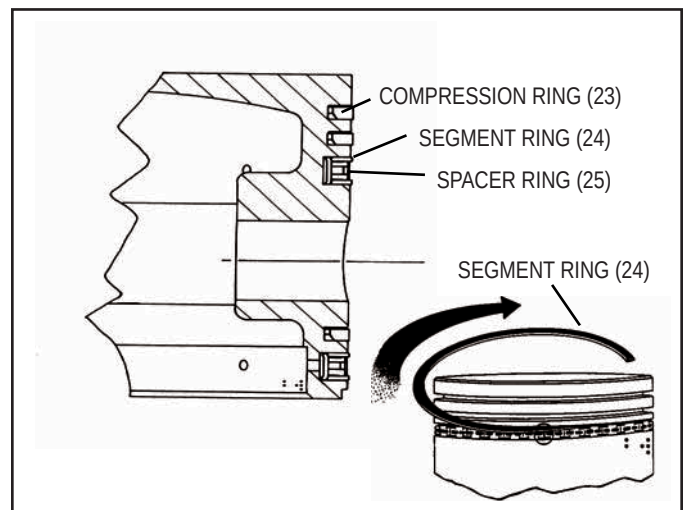


FIGURE 14 - PISTON & RINGS

2. Install the compression rings (23) in the proper grooves with the "pip" mark toward the top of the piston. (Refer to Figure 14.)

Check the ring side clearance of each ring in the piston ring groove. (Refer to Figure 12.) If the side clearance is too large, the piston ring groove is worn beyond specifications and the piston must be replaced.

Rotate the piston rings in their respective groove so that each end gap is at least 90 degrees from the previous ring's end gap.

Lubricate the wrist pin (22) and wrist pin bushing in the connecting rod with engine oil. Assemble the upper portion of the connecting rods and the pistons with the wrist pins. Insert the wrist pin buttons (28) in the ends of the wrist pin. Lubricate the pistons and rings with engine oil. Using a ring compression tool return the piston to the cylinder bore.

Turn the crankshaft so that one of its connecting rod journals is in the downward, center position. Install the crankshaft journal bearing segments (38) on the connecting rod (37) and connecting rod cap (39). Tighten the connecting rod bolts (40) evenly and torque to 150 - 170 inch pounds. Install the other connecting rod and piston in the same manner. It is recommended that new connecting rod cap screws be used.

Before replacing the cylinder head on the crankcase ensure the correct pistons have been used by turning the crankshaft one complete revolution such that each piston moves to its maximum upward stroke. At the maximum upward stroke position each piston should move to the top of the crankcase. If the piston does not approach the top of the crankcase the piston is incorrect, and if not replaced, could result in compressor damage.

BASE PLATE OR BASE ADAPTER

Position the base plate or base adapter gasket (20) on the crankcase and install the base plate or base adapter (21) as marked before disassembly. Tighten the six cap screws (22), securing the cast iron base adapter evenly to a torque of 175-225 inch pounds for base plate or cover in a crossing pattern after first snugging all 6 screws.

CYLINDER HEAD

Place the cylinder head gasket (19) and cylinder head on the compressor crankcase and install the six cylinder head cap screws. Snug the cylinder head cap screws prior to torquing the cap screws to 300-360 in. lbs. in a cross pattern. Retorque the unloader cover cap screws to 170-225 in. lbs.

FINAL COMPRESSOR ASSEMBLY

Install all crankshaft keys making certain to support the crankshaft to avoid bearing damage. Install the crankshaft nut where applicable. When installing drive couplings or gears, **do not exceed 120 foot pounds torque** on the crankshaft nut.

Use covers, plugs, or masking tape to protect all ports if compressor is not to be installed immediately. Protect the ends of the crankshaft against damage by wrapping with masking tape or friction tape.

TESTING REBUILT COMPRESSOR

In order to properly test a compressor under operating conditions, a test rack for correct mounting, cooling, lubricating, and driving the compressor is necessary. Such tests are not compulsory if the unit has been carefully rebuilt by an experienced person. A compressor efficiency or build up test can be run which is not too difficult. An engine lubricated compressor must be connected to an oil supply line of at least 15 P.S.I. pressure during the test and an oil return line must be installed to keep the crankcase drained.

Connect to the compressor discharge port, a reservoir with a volume of 1,500 cubic inches, including the volume of the connecting line. With the compressor operating at 2,100 R.P.M., the time required to raise the reservoir(s) pressure from 85 psi to 100 psi should not exceed 5 seconds. During this test, the compressor should be checked for gasket leakage and noisy operation, as well as unloader operation and leakage.

If the compressor functions as indicated reinstall on the vehicle connecting all lines as marked in the disassembly procedure.

TU-FLO® 750 AIR COMPRESSOR SPECIFICATIONS

Average weight	53
Number of cylinders	2
Bore size	2.78 In.
Stroke	1.87 In.
Displacement at 1250 RPM	16.5 CFM
CFM Maximum recommended RPM	2,400 RPM
Minimum coolant flow (water cooled) at	
Maximum RPM	2.5 GPM
Minimum RPM	5 GPM
Approximate horsepower required at	
1250 RPM at 120 PSIG (naturally aspirated)	3.2
Turbocharge limits	
See Compressor Turbocharging Parameters	
Maximum inlet air temperature	250°F
Maximum discharge air temperature	400°F
Minimum pressure required to unload	
(naturally aspirated)	60 PSIG

Minimum oil pressure required at engine idling speed	15 PSIG
Minimum oil pressure required at maximum governed engine speed	15 PSIG
Minimum discharge-line size	1/2" I.D.
Minimum coolant-line size	3/8" I.D.
Minimum oil-supply line size	3/16" I.D.
Minimum oil-return line size	1/2" I.D.
Minimum air-inlet line size	5/8" I.D.
Minimum unloader-line size	3/16" I.D.

TORQUE SPECIFICATIONS

Bolt, Nut or Screw	Assembly Torque (in. lbs.)
Cylinder Head	300 - 360
Unloader Cover Plate	175 - 225
Discharge Valve Seat	840 - 1,080 (70-90 ft. lbs.)
Inlet Valve Stop	840 - 1,080 (70-90 ft. lbs.)
End Cover	175 - 225
Connecting Rod	150 - 170
Bottom Cover	175 - 225
Air Strainer	125 - 150
Inlet Fitting	175 - 225
Discharge Fitting	175 - 225
Governor or Governor Adapter	175 - 225
Pipe Plugs	
1/16	35 - 50
1/8	85 - 105
1/4	130 - 170
3/8	160 - 200
1/2	200 - 270
Pipe Bushing	
1/2	175 - 225
Crankshaft Nut:	
Marsden or Castle	1,200 - 1,400 (100-120 ft. lbs.)
P/N 298125	
(Metric Thread)	2,640 - 3,048 (220-254 ft. lbs.)

DIMENSIONAL DATA

Port Sizes	
Water inlet	1/2 - 14 NPT
Water outlet	1/2 - 14 NPT
Air discharge	1/2 - 14 NPT
Governor	1/8 - 27 NPT
Oil inlet (end cover)	1/8 - 27 NPT
Piston	
(standard)	2.77825 in.
(.010 oversize)	2.78825 in.
(.020 oversize)	2.79825 in.
(.030 oversize)	2.80825 in.
Cylinder bore	
(standard)	2.7810 in.
(.010 oversize)	2.7910 in.
(.020 oversize)	2.8010 in.
(.030 oversize)	2.8110 in.

MAINTENANCE KITS AND AVAILABLE SERVICE PARTS

Cylinder Maintenance Kit.

Piston Ring Kit (standard and oversizes.)

Piston and Rod Kit (standard and oversizes.)

Crankshaft Bearing Kit.

Gasket & Seal Kit.

COMPRESSOR TROUBLESHOOTING

IMPORTANT: The troubleshooting contained in this section considers the compressor as an integrated component of the overall air brake charging system and assumes that an air dryer is in use. The troubleshooting presented will cover not only the compressor itself, but also other charging system devices as they relate to the compressor.

WARNING! PLEASE READ AND FOLLOW THESE INSTRUCTIONS TO AVOID PERSONAL INJURY OR DEATH:

When working on or around a vehicle, the following general precautions should be observed at all times.

1. Park the vehicle on a level surface, apply the parking brakes, and always block the wheels. Always wear safety glasses.
2. Stop the engine and remove ignition key when working under or around the vehicle. When working in the engine compartment, the engine should be shut off and the ignition key should be removed. Where circumstances require that the engine be in operation, **EXTREME CAUTION** should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated or electrically charged components.
3. Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.
4. If the work is being performed on the vehicle's air brake system, or any auxiliary pressurized air systems, make certain to drain the air pressure from all reservoirs before beginning **ANY** work on the vehicle. If the vehicle is equipped with an AD-IS® air dryer system or a dryer reservoir module, be sure to drain the purge reservoir.
5. Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.
6. Never exceed manufacturer's recommended pressures.

7. Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.
8. Use only genuine Bendix® replacement parts, components and kits. Replacement hardware, tubing, hose, fittings, etc. must be of equivalent size, type and strength as original equipment and be designed specifically for such applications and systems.
9. Components with stripped threads or damaged parts should be replaced rather than repaired. Do not attempt repairs requiring machining or welding unless specifically stated and approved by the vehicle and component manufacturer.
10. Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.
11. For vehicles with Antilock Traction Control (ATC), the ATC function must be disabled (ATC indicator lamp should be ON) prior to performing any vehicle maintenance where one or more wheels on a drive axle are lifted off the ground and moving.

Advanced Troubleshooting Guide for Air Brake Compressors*

The guide consists of an introduction to air brake charging system components, a table showing recommended vehicle maintenance schedules, and a troubleshooting symptom and remedy section with tests to diagnose most charging system problems.

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- (5) Governor Control Line 30
- (6) Compressor Unloader 30
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Maintenance & Usage Guidelines

- Maintenance Schedule and
Usage Guidelines (Table A) . . . 18



*This guide is only for vehicles that use desiccant air dryers.

Introduction to the Air Brake Charging System

Powered by the vehicle engine, the **air compressor** builds the air pressure for the air brake system. The air compressor is typically cooled by the engine coolant system and lubricated by the engine oil supply.

The compressor's unloader mechanism and **governor** (along with a synchro valve for the Bendix® DuraFlo™ 596 air compressor) control the brake system air pressure between a preset maximum and minimum pressure level by monitoring the pressure in the service (or “supply”) reservoir. When the air pressure becomes greater than that of the preset “cut-out”, the governor controls the unloader mechanism of the compressor to stop the compressor from building air and also causes the air dryer to purge. As the service reservoir air pressure drops to the “cut-in” setting of the governor, the governor returns the compressor back to building air and the air dryer to air drying mode.

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.

The **duty cycle** is the ratio of time the compressor spends building air to the total engine running time. Air compressors are designed to build air (run “loaded”) up to 25% of the time. Higher duty cycles cause conditions that affect air brake charging system performance which may require additional maintenance. Factors that add to the duty cycle are: air suspension, additional air accessories, use of an undersized compressor, frequent stops, excessive leakage from fittings, connections, lines, chambers or valves, etc.

The **discharge line** allows the air, water-vapor and oil-vapor mixture to cool between the compressor and air dryer. The typical size of a vehicle's discharge

line, (see column 2 of Table A on page 18) assumes a compressor with a normal (less than 25%) duty cycle, operating in a temperate climate. See Bendix and/or other air dryer manufacturer guidelines as needed.

When the **temperature** of the compressed air that enters the air dryer is within the normal range, the air dryer can remove most of the charging system oil. If the temperature of the compressed air is above the normal range, oil as oil-vapor is able to pass through the air dryer and into the air system. Larger diameter discharge lines and/or longer discharge line lengths can help reduce the temperature.

The discharge line must maintain a **constant slope** down from the compressor to the air dryer inlet fitting to avoid low points where ice may form and block the flow. If, instead, ice blockages occur at the air dryer inlet, insulation may be added here, or if the inlet fitting is a typical 90 degree fitting, it may be changed to a straight or 45 degree fitting. For more information on how to help prevent discharge line freeze-ups, see Bendix Bulletins TCH-08-21 and TCH-08-22 (see pages 35-37). Shorter discharge line lengths or insulation may be required in cold climates.

The **air dryer** contains a filter that collects oil droplets, and a desiccant bed that removes almost all of the remaining water vapor. The compressed air is then passed to the air brake service (supply) reservoir. The oil droplets and the water collected are automatically purged when the governor reaches its “cut-out” setting.

For vehicles with accessories that are sensitive to small amounts of oil, we recommended installation of a Bendix® PuraGuard® system filter, designed to minimize the amount of oil present.

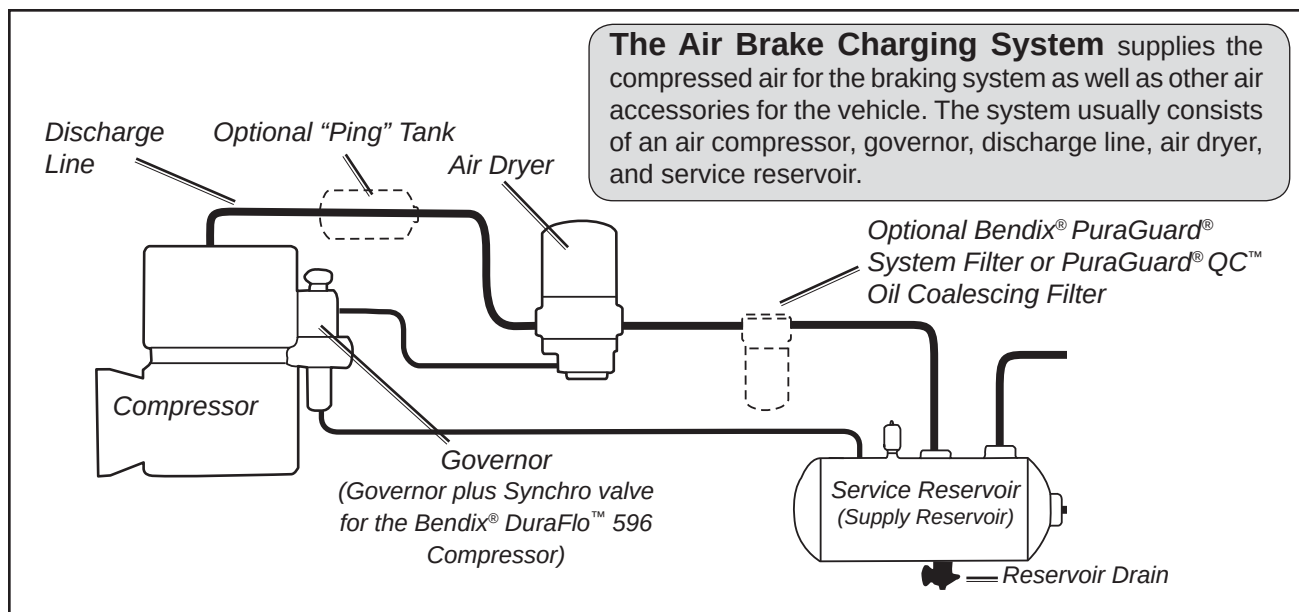


Table A: Maintenance Schedule and Usage Guidelines

Regularly scheduled maintenance is the single most important factor in maintaining the air brake charging system.

Vehicle Used for:	No. of Axles	Column 1	Column 2		Column 3	Column 4	Column 5
		Typical Compressors Spec'd	Discharge Line		Recommended Air Dryer Cartridge Replacement ¹	Recommended Reservoir Drain Schedule ²	Acceptable Reservoir Oil Contents ³ at Regular Drain Interval
			I.D.	Length			
Low Air Use		Bendix® BA-921® air compressor Bendix® Tu-Flo® 550 air compressor	1/2 in.	6 ft.	Every 3 Years	Recom- mended Every Month - Max of ev- ery 90 days	BASIC test acceptable range: 3 oil units per month. See appendix A.
Compressor with less than 15% duty cycle e.g. Line haul single trailer w/o air suspension, air over hydraulic brakes. 	5 or less		For oil carry-over control ⁴ suggested upgrades: 5/8 in. 9 ft.				
Compressor with up to 25% duty cycle e.g. Line haul single trailer with air suspension, school bus. 	5 or less		1/2 in.	9 ft.			
			For oil carry-over control ⁴ suggested upgrades: 5/8 in. 12 ft.				
High Air Use		Bendix® Tu-Flo® 750 air compressor Bendix® BA-922® or DuraFlo™ 596 air compressor	1/2 in.	12 ft.	Every 2 Years	Every Month	BASIC test acceptable range: 5 oil units per month. See appendix A.
Compressor with up to 25% duty cycle e.g. Double/triple trailer, open highway coach/RV, (most) pick-up & delivery, yard or terminal jockey, off-highway, construction, loggers, concrete mixer, dump truck, fire truck.          	8 or less		For oil carry-over control ⁴ suggested upgrades: 5/8 in. 15 ft.				
Compressor with up to 25% duty cycle e.g. City transit bus, refuse, bulk unloaders, low boys, urban region coach, central tire inflation.      	12 or less		5/8 in.	12 ft.			
			For oil carry-over control ⁴ suggested upgrades: 3/4 in. 15 ft.				

Footnotes:

- 1 With increased air demand the air dryer cartridge needs to be replaced more often.
- 2 Use the drain valves to slowly drain all reservoirs to zero psi.
- 3 Allow the oil/water mixture to fully settle before measuring oil quantity.
- 4 To counter above normal temperatures at the air dryer inlet, (and resultant oil-vapor passing upstream in the air system) replace the discharge line with one of a larger diameter and/or longer length. This helps reduce the air's temperature. If sufficient cooling occurs, the oil-vapor condenses and can be removed by the air dryer. Discharge line upgrades are not covered under warranty. Note: To help prevent discharge line freeze-ups, shorter discharge line lengths or insulation may be required in cold climates. (See Bendix Bulletins TCH-08-21 and TCH-08-22, included in Appendix B, for more information.)
- 5 For certain vehicles/applications, where turbo-charged inlet air is used, a smaller size compressor may be permissible.

Note: Compressor and/or air dryer upgrades are recommended in cases where duty cycle is greater than the normal range (for the examples above).

For Bendix® Tu-Flo® 550 and 750 compressors, unloader service is recommended every 250,000 miles.

Air Brake Charging System Troubleshooting

How to use this guide:

Find the **symptom(s)** that you see, then move to the right to find the possible causes ("**What it may indicate**") and remedies ("**What you should do**").

Review the warranty policy before performing any intrusive compressor maintenance. Unloader or cylinder head gasket replacement and resealing of the bottom cover plate are usually permitted under warranty. Follow all standard safety procedures when performing any maintenance.

Look for:

 **Normal**

Normal - Charging system is working within normal range.

 **Check**

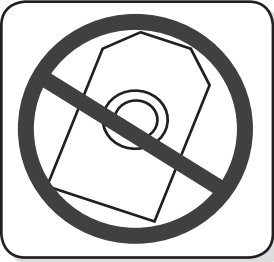
Check - Charging system needs further investigation.

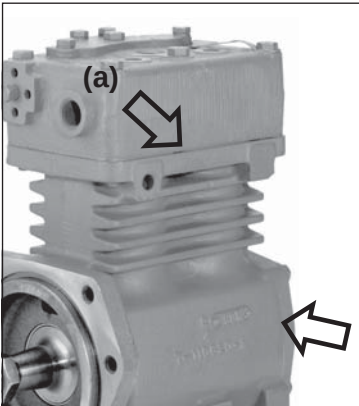
WARNING! Please READ and follow these instructions to avoid personal injury or death:

When working on or around a vehicle, the following general precautions should be observed at all times.

1. Park the vehicle on a level surface, apply the parking brakes, and always block the wheels. Always wear safety glasses.
2. Stop the engine and remove ignition key when working under or around the vehicle. When working in the engine compartment, the engine should be shut off and the ignition key should be removed. Where circumstances require that the engine be in operation, EXTREME CAUTION should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated or electrically charged components.
3. Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.
4. If the work is being performed on the vehicle's air brake system, or any auxiliary pressurized air systems, make certain to drain the air pressure from all reservoirs before beginning ANY work on the vehicle. If the vehicle is equipped with an AD-IS® air dryer system or a dryer reservoir module, be sure to drain the purge reservoir.

5. Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.
6. Never exceed manufacturer's recommended pressures.
7. Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.
8. Use only genuine Bendix® replacement parts, components and kits. Replacement hardware, tubing, hose, fittings, etc. must be of equivalent size, type and strength as original equipment and be designed specifically for such applications and systems.
9. Components with stripped threads or damaged parts should be replaced rather than repaired. Do not attempt repairs requiring machining or welding unless specifically stated and approved by the vehicle and component manufacturer.
10. Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.
11. For vehicles with Antilock Traction Control (ATC), the ATC function must be disabled (ATC indicator lamp should be ON) prior to performing any vehicle maintenance where one or more wheels on a drive axle are lifted off the ground and moving.

Symptom:	What it may indicate:	What you should do:
1.0 Oil Test Card Results 	Not a valid test. 	Discontinue using this test. Do not use this card test to diagnose compressor "oil passing" issues. They are subjective and error prone. Use only the Bendix Air System Inspection Cup (BASIC) test and the methods described in this guide for advanced troubleshooting. The Bendix® BASIC test should be the definitive method for judging excessive oil fouling/oil passing. (See Appendix A, on page 32 for a flowchart and expanded explanation of the checklist used when conducting the BASIC test.)

Symptom:	What it may indicate:	What you should do:
2.0 Oil on the Outside of the Compressor	Engine and/or other accessories leaking onto compressor.	Find the source and repair. Return the vehicle to service.
2.1 Oil leaking at compressor / engine connections:	(a) Leak at the front or rear (fuel pump, etc.) mounting flange. (b) Leak at air inlet fitting. (c) Leak at air discharge fitting. (d) Loose/broken oil line fittings.	⇒ Repair or replace as necessary. If the mounting bolt torques are low, replace the gasket. ⇒ Replace the fitting gasket. Inspect inlet hose and replace as necessary. ⇒ Replace gasket or fitting as necessary to ensure good seal. ⇒ Inspect and repair as necessary.
2.2 Oil leaking from compressor:	(a) Excessive leak at head gasket. (b) Leak at bottom cover plate. (c) Leak at internal rear flange gasket. (d) Leak through crankcase. (e) (If unable to tell source of leak.)	⇒ Go to Test 1 on page 29. ⇒ Reseal bottom cover plate using RTV silicone sealant. ⇒ Replace compressor. ⇒ Replace compressor. ⇒ Clean compressor and check periodically.
 Head gasket and rear flange gasket locations.		

? Check

3.0 Oil at air dryer purge/exhaust or surrounding area	Air brake charging system functioning normally.	⇒ Air dryers remove water and oil from the air brake charging system. Check that regular maintenance is being performed. Return the vehicle to service. An optional kit (Bendix piece number 5011327 for the Bendix® AD-IS® or AD-IP® air dryers, or 5003838 for the Bendix® AD-9® air dryer) is available to redirect the air dryer exhaust.
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✓ Normal

Symptom:	What it may indicate:	What you should do:
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4.0 Oil in Supply or Service Reservoir (air dryer installed)

(If a maintained Bendix® PuraGuard® system filter or Bendix® PuraGuard® QC™ oil coalescing filter is installed, call 1-800-AIR-BRAKE (1-800-247-2725) and speak to a Tech Team member.)



See Table A, on page 18, for maintenance schedule information.

Maintenance

- (a) If air brake charging system maintenance **has not been performed**.

That is, reservoir(s) **have not** been drained per the schedule in Table A on page 18, Column 4 **and/or** the air dryer maintenance **has not** been performed as in Column 3.

- (b) If the vehicle maintenance **has been performed** as recommended in Table A on page 18, some oil in the reservoirs is normal.



Drain all air tanks (reservoirs) into the Bendix® BASIC test cup. (Bendix kit P/N 5013711).

- ⇒ Drain all air tanks and check vehicle at next service interval using the Bendix® BASIC test. See Table A on page 18, column 3 and 4, for recommended service schedule.

? Check

- ⇒ Drain all air tanks into Bendix® BASIC test cup (Bendix Air System Inspection Cup). If less than one unit of reservoir contents is found, the vehicle can be returned to service. **Note: If more than one oil unit of water (or a cloudy emulsion mixture) is present, change the vehicle's air dryer, check for air system leakage (Test 2, on page 29), stop inspection and check again at the next service interval.**

See the BASIC test kit for full details.

If less than one "oil unit" of water (or water/cloudy emulsion mixture) is present, use the BASIC cup chart on the label of the cup to determine if the amount of oil found is within the acceptable level.

⇒ If within the normal range, return the vehicle to service. For vehicles with accessories that are sensitive to small amounts of oil, consider a Bendix® PuraGuard® QC™ oil coalescing filter.

⇒ If outside the normal range go to Symptom 4.0(c).

Also see the Table A on page 18, column 3 for recommended air dryer cartridge replacement schedule.

Duty cycle too high

- (c) Air brake system leakage.
- (d) Compressor may be undersized for the application.

- ⇒ Go to Test 2 on page 29.

- ⇒ See Table A, column 1, on page 18 for recommended compressor sizes.

⇒ If the compressor is "too small" for the vehicle's role (for example, where a vehicle's use has changed or service conditions exceed the original vehicle or engine OE spec's) then upgrade the compressor. Note: The costs incurred (e.g. installing a larger capacity compressor, etc.) are not covered under original compressor warranty.

⇒ If the compressor is correct for the vehicle, go to Symptom 4.0 (e).

The **duty cycle** is the ratio of time the compressor spends building air to total engine running time. Air compressors are designed to build air (to "run loaded") up to 25% of the time. Higher duty cycles cause conditions that affect air brake charging system performance which may require additional maintenance. Factors that add to the duty cycle are: air suspension, additional air accessories, use of an undersized compressor, frequent stops, excessive leakage from fittings, connections, lines, chambers or valves, etc.

Symptom:	What it may indicate:	What you should do:
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4.0 Oil in Supply or Service Reservoir* (air dryer installed) (continued)

Temperature

(e) Air compressor discharge and/or air dryer inlet temperature too high.

⇒ Check temperature as outlined in Test 3 on page 29. If temperatures are normal go to 4.0(h).

(f) Insufficient coolant flow.

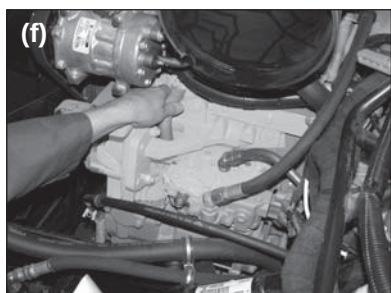
⇒ Inspect coolant line. Replace as necessary (I.D. is 1/2").

⇒ Inspect the coolant lines for kinks and restrictions and fittings for restrictions. Replace as necessary.

⇒ Verify coolant lines go from engine block to compressor and back to the water pump. Repair as necessary.



Testing the temperature at the discharge fitting.



Inspecting the coolant hoses.

(g) Restricted discharge line.

⇒ If discharge line is restricted or more than 1/16" carbon build up is found, replace the discharge line. See Table A, column 2, on page 18 for recommended size. Replace as necessary.

⇒ The discharge line must maintain a **constant slope** down from the compressor to the air dryer inlet fitting to avoid low points where ice may form and block the flow. If, instead, ice blockages occur at the air dryer inlet, insulation may be added here, or if the inlet fitting is a typical 90 degree fitting, it may be changed to a straight or 45 degree fitting. For more information on how to help prevent discharge line freeze-ups, see Bendix Bulletins TCH-08-21 and TCH-08-22 (Appendix B). Shorter discharge line lengths or insulation may be required in cold climates.



Kinked discharge line shown.

Other

(h) Restricted air inlet (not enough air to compressor).

⇒ Check compressor air inlet line for restrictions, brittleness, soft or sagging hose conditions etc. Repair as necessary. Inlet line size is 3/4 ID. Maximum restriction requirement for compressors is 25 inches of water.

⇒ Check the engine air filter and service if necessary (if possible, check the air filter usage indicator).



Partly collapsed inlet line shown.

? Check

*If a maintained Bendix® PuraGuard® system filter or Bendix® PuraGuard® QC™ oil coalescing filter is installed, call 1-800-AIR-BRAKE (1-800-247-2725) and speak to a Tech Team member.

Symptom:**What it may indicate:****What you should do:****4.0 Oil in Supply or Service Reservoir* (air dryer installed) (continued)****Other (cont.)**

- (i) Poorly filtered inlet air (poor air quality to compressor).



Inspect the engine air cleaner.

- (j) Governor malfunction or setting.

- (k) Compressor malfunction.

Crankcase Flooding

Consider installing a compressor bottom drain kit (where available) in cases of chronic oil passing where all other operating conditions have been investigated. Bendix compressors are designed to have a 'dry' sump and the presence of excess oil in the crankcase can lead to oil carryover.

- ⇒ Check for leaking, damaged or defective compressor air inlet components (e.g. induction line, fittings, gaskets, filter bodies, etc.). Repair inlet components as needed. Note: Dirt ingestion will damage compressor and is not covered under warranty.

? Check

- ⇒ Go to Test 4 on page 30.

- ⇒ If you found excessive oil present in the service reservoir in step 4.0 (b) above and you did not find any issues in steps 4.0 (c) through 4.0 (j) above, the compressor may be passing oil.

Replace compressor. If still under warranty, follow normal warranty process. Note: After replacing a compressor, residual oil may take a considerable period of time to be flushed from the air brake system.

*If a maintained Bendix® PuraGuard® system filter or Bendix® PuraGuard® QC™ oil coalescing filter is installed, call 1-800-AIR-BRAKE (1-800-247-2725) and speak to a Tech Team member.

5.0 Oil present at valves (e.g. at exhaust, or seen during servicing).

Air brake system valves are required to tolerate a light coating of oil.

✓ Normal

- ⇒ A small amount of oil does not affect SAE J2024** compliant valves.

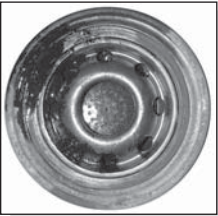
- ⇒ Check that regular maintenance is being performed and that the amount of oil in the air tanks (reservoirs) is within the acceptable range shown on the Bendix® BASIC test cup (see also column 5 of Table A on page 18). Return the vehicle to service.

For oil-sensitive systems, see page 17.



Genuine Bendix valves are all SAE J2024 compliant.

** SAE J2024 outlines tests all air brake system pneumatic components need to be able to pass, including minimum levels of tolerance to contamination.

Symptom:	What it may indicate:	What you should do:
6.0 Excessive oil consumption in engine.	A problem with engine or other engine accessory.  The engine service manual has more information.	⇒ See engine service manual. ? Check
7.0 Oil present at air dryer cartridge during maintenance.	Air brake charging system is functioning normally.  Oil shown leaking from an air dryer cartridge. ✓ Normal	⇒ Air dryers remove water and oil from the air brake charging system. A small amount of oil is normal. Check that regular maintenance is being performed and that the amount of oil in the air tanks (reservoirs) is within the acceptable range shown by the BASIC Test (see also column 5 of Table A on page 18). Replace the air dryer cartridge as needed and return the vehicle to service.
8.0 Oil in ping tank or compressor discharge aftercooler.	Air brake charging system is functioning normally. ✓ Normal	⇒ Follow vehicle O.E. maintenance recommendation for these components.
9.0 Air brake charging system seems slow to build pressure.	(a) Air brake charging system functioning normally. ✓ Normal (b) Air brake system leakage. (c) Compressor may be undersized for the application. (d) Compressor unloader mechanism malfunction. (e) Damaged compressor head gasket.	⇒ Using dash gauges, verify that the compressor builds air system pressure from 85-100 psi in 40 seconds or less with engine at full governed rpm. Return the vehicle to service. ⇒ Go to Test 2 on page 29. ⇒ See Table A, column 1, on page 18 for some typical compressor applications. If the compressor is "too small" for the vehicle's role, for example, where a vehicle's use has changed, then upgrade the compressor. Note: The costs incurred (e.g. installing a larger capacity compressor, etc.) are not covered under original compressor warranty. ⇒ Go to Test 6 on page 30. ⇒ An air leak at the head gasket may indicate a downstream restriction such as a freeze-up or carbon blockage and/or could indicate a defective or missing safety valve. Find blockage (go to 9.0(f) for details.) and then replace the compressor. Do not re-use the safety valve without testing. See Symptom 12.0(a).

Symptom:**What it may indicate:****What you should do:**

9.0 Air brake charging system seems slow to build pressure. (continued)



Dash gauges.

(f) Restricted discharge line.

? Check



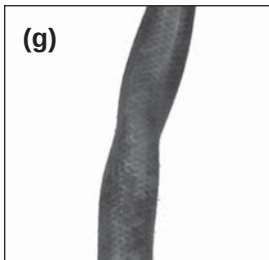
Kinked discharge line shown.

⇒ If discharge line is restricted:

⇒ By more than 1/16" carbon build up, replace the discharge line (see Table A, column 2, on page 18 for recommended size) and go to Test 3 on page 29.

⇒ By other restrictions (e.g. kinks). Replace the discharge line. See Table A, column 2, on page 18 for recommended size. Retest for air build. Return vehicle to service or, if problem persists, go to 9.0(a).

⇒ The discharge line must maintain a **constant slope** down from the compressor to the air dryer inlet fitting to avoid low points where ice may form and block the flow. If, instead, ice blockages occur at the air dryer inlet, insulation may be added here, or if the inlet fitting is a typical 90 degree fitting, it may be changed to a straight or 45 degree fitting. For more information on how to help prevent discharge line freeze-ups, see Bendix Bulletins TCH-08-21 and TCH-08-22 (Appendix B). Shorter discharge line lengths or insulation may be required in cold climates.



Partly collapsed inlet line shown.

(g) Restricted air inlet (not enough air to compressor).

? Check

⇒ Check compressor air inlet line for restrictions, brittleness, soft or sagging hose conditions etc. Repair as necessary. Refer to vehicle manufacturer's guidelines for inlet line size.

⇒ Check the engine air filter and service if necessary (if possible, check the air filter usage indicator).

(h) Poorly filtered inlet air (poor air quality to compressor).

? Check

⇒ Check for leaking, damaged or defective compressor air inlet components (e.g. induction line, fittings, gaskets, filter bodies, etc.). Repair inlet components as needed. Note: Dirt ingestion will damage compressor and is not covered under warranty.

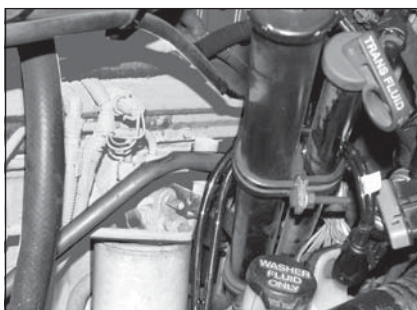
(i) Compressor malfunction.

? Check

⇒ Replace the compressor only after making certain that none of the preceding conditions, 9.0 (a) through 9.0 (h), exist.

Symptom:	What it may indicate:	What you should do:
10.0 Air charging system doesn't build air.	(a) Governor malfunction*.	⇒ Go to Test 4 on page 30.
	(b) Restricted discharge line.	⇒ See 9.0(f).
	(c) Air dryer heater malfunction: exhaust port frozen open.	⇒ Replace air dryer heater.
	(d) Compressor malfunction.	⇒ Replace the compressor only after making certain the preceding conditions do not exist.
* Note: For the Bendix® DuraFlo™ 596 air compressor, not only the governor, but also the SV-1™ synchro valve used would need to be tested. See Bulletin TCH-001-048.		

11.0 Compressor safety valve releases air (Compressor builds too much air).



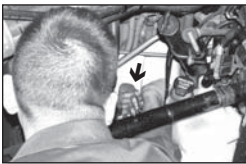
Damaged discharge line shown.

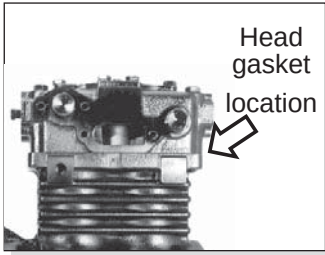
? Check

- (a) Restricted discharge line.

- ⇒ If discharge line is restricted:
- ⇒ By more than 1/16" carbon build up, replace the discharge line (see Table A, column 2, on page 18 for recommended size) and go to Test 3 on page 29.
 - ⇒ By other restrictions (e.g. kinks). Replace the discharge line. See Table A, column 2, on page 18 for recommended size.
- ⇒ The discharge line must maintain a **constant slope** down from the compressor to the air dryer inlet fitting to avoid low points where ice may form and block the flow. If, instead, ice blockages occur at the air dryer inlet, insulation may be added here, or if the inlet fitting is a typical 90 degree fitting, it may be changed to a straight or 45 degree fitting. For more information on how to help prevent discharge line freeze-ups, see Bendix Bulletins TCH-08-21 and TCH-08-22 (Appendix B). Shorter discharge line lengths or insulation may be required in cold climates.

- (b) Downstream air brake system check valves or lines may be blocked or damaged. ⇒ Inspect air lines and verify check valves are operating properly.
- (c) Air dryer lines incorrectly installed. ⇒ Ensure discharge line is installed into the inlet of the air dryer and delivery is routed to the service reservoir.
- (d) Compressor safety valve malfunction. ⇒ Verify relief pressure is 250 psi. Replace if defective.
- (e) Compressor unloader mechanism malfunction. ⇒ Go to Test 6 on page 30.
- (f) Governor malfunction. ⇒ Go to Test 4 on page 30.

Symptom:	What it may indicate:	What you should do:
12.0 Air dryer safety valve releases air.   Technician removes governor.	(a) Restriction between air dryer and reservoir. (b) Air dryer safety valve malfunction. (c) Air dryer maintenance not performed. (d) Air dryer malfunction. (e) Improper governor control line installation to the reservoir. (f) Governor malfunction.	⇒ Inspect delivery lines to reservoir for restrictions and repair as needed. ⇒ Verify relief pressure is at vehicle or component manufacturer specifications. Replace if defective. ⇒ See Maintenance Schedule and Usage Guidelines (Table A, column 3, on page 18). ⇒ Verify operation of air dryer. Follow vehicle O.E. maintenance recommendations and component Service Data information. ⇒ Go to Test 5 on page 30. ⇒ Go to Test 4 on page 30.
13.0 Reservoir safety valve releases air	(a) Reservoir safety valve malfunction. (b) Governor malfunction. (c) Compressor unloader mechanism malfunction.	⇒ Verify relief pressure is at vehicle or component manufacturer's specifications (typically 150 psi). Replace if defective. ⇒ Go to Test 4 on page 30. ⇒ Go to Test 6 on page 30.
14.0 Air dryer doesn't purge. (Never hear exhaust from air dryer.)	(a) Air dryer malfunction. (b) Governor malfunction. (c) Air brake system leakage. (d) Improper governor control line installation to the reservoir.	⇒ Verify operation of air dryer. Follow vehicle O.E. maintenance recommendations. ⇒ Go to Test 4 on page 30. ⇒ Go to Test 2 on page 29. ⇒ Go to Test 5 on page 30.
15.0 Compressor constantly cycles (compressor remains unloaded for a very short time.)	(a) Air brake charging system maintenance not performed.  Check (b) Compressor unloader mechanism malfunction. (c) Air dryer purge valve or delivery check valve malfunction. (d) Air brake system leakage.	⇒ Available reservoir capacity may be reduced by build up of water etc. Drain and perform routine maintenance per Table A, columns 3 & 4, on page 18. ⇒ Go to Test 6 on page 30. ⇒ Verify operation of air dryer. Follow vehicle O.E. maintenance recommendations and component Service Data information. ⇒ Go to Test 2 on page 29.

Symptom:	What it may indicate:	What you should do:
16.0 Compressor leaks air  Testing for leaks with soap solution.	(a) Compressor leaks air at connections or ports. (b) Compressor unloader mechanism malfunction. (c) Damaged compressor head gasket. 	⇒ Check for leaking, damaged or defective compressor fittings, gaskets, etc. Repair or replace as necessary. ⇒ Go to Test 6 on page 30. ⇒ An air leak at the head gasket may indicate a downstream restriction such as a freeze-up or carbon blockage and/or could indicate a defective or missing safety valve. Find blockage (go to 9.0(f) for details.) and then replace the compressor. Do not re-use the safety valve without testing. See Symptom 12.0(a).
17.0 Compressor leaks coolant	(a) Improperly installed plugs or coolant line fittings. (b) Damaged compressor head gasket. (c) Porous compressor head casting.	⇒ Inspect for loose or over-torqued fittings. Reseal and tighten loose fittings and plugs as necessary. If overtightened fittings and plugs have cracked ports in the head, replace the compressor. ⇒ An air leak at the head gasket may indicate a downstream restriction such as a freeze-up or carbon blockage and/or could indicate a defective or missing safety valve. Find blockage (go to 9.0(f) for details.) and then replace the compressor. Do not re-use the safety valve without testing. See Symptom 12.0(a). ⇒ If casting porosity is detected, replace the compressor.
18.0 Noisy compressor (Multi-cylinder compressors only)	(a) Damaged compressor.	⇒ Replace the compressor.

Other Miscellaneous Areas to Consider

This guide attempts to cover most compressor system problems. Here are some rare sources of problems not covered in this guide:

- Turbocharger leakage. Lubricating oil from leaking turbocharger seals can enter the air compressor intake and give misleading symptoms.

- Where a compressor does not have a safety valve installed, if a partial or complete discharge line blockage has occurred, damage can occur to the connecting rod bearings. Damage of this kind may not be detected and could lead to compressor problems at a later date.

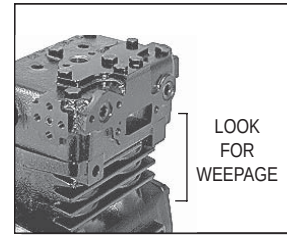
Tests

Test 1: Excessive Oil Leakage at the Head Gasket

Exterior leaks at the head gasket are not a sign that oil is being passed into the air charging system. Oil weepage at the head gasket does not prevent the compressor from building air.

Observe the amount of weepage from the head gasket.

If the oil is only around the cylinder head area, it is acceptable (return the vehicle to service), but, if the oil weepage extends down to the nameplate area of the compressor, the gasket can be replaced.



Test 2: Air Brake System and Accessory Leakage

Inspect for air leaks when working on a vehicle and repair them promptly.

Park the vehicle on level ground and chock wheels. Build system pressure to governor cut-out and allow the pressure to stabilize for one minute.

Step 1: Observe the dash gauges for two additional minutes without the service brakes applied.

Step 2: Apply the service brakes and allow the pressure to stabilize. Continue holding for two minutes (you may use a block of wood to hold the

pedal in position.) Observe the dash gauges.

If you see **any noticeable decrease** of the dash air gauge readings (i.e. more than 4 psi, plus two psi for each additional trailer) during either two minute test, **repair the leaks** and repeat this test to confirm that they have been repaired.

Air leaks can also be found in the charging system, parking brakes, and/or other components - inspect and repair as necessary.

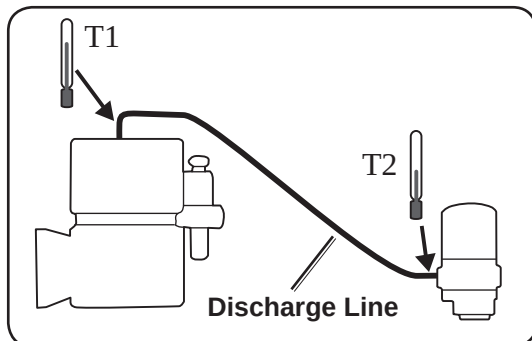
Test 3: Air Compressor Discharge Temperature and Air Dryer Inlet Temperature*

Caution: The temperatures used in this test are not normal vehicle conditions.

Above normal temperatures can cause oil (as vapor) to pass through the air dryer into the air brake system.

This test is run with the engine at normal operating temperature, with engine at max. rpm. If available, a dyno may be used.

1. Allow the compressor to build the air system pressure to governor cut-in.
2. Pump the brakes to bring the dash gauge pressure to 90 psi.
3. Allow the compressor to build pressure from 95 to 105 psi gauge pressure and maintain this pressure range by cycling the brakes **for five (5) minutes.**



(* Note that only vehicles that have passed Test 2 would be candidates for this test.)

4. Then, while maintaining max rpm and pressure range, measure and **record the surface temperature** of the **ittings**:
 - ⇒ at the compressor discharge port. (T1).
 - ⇒ at the air dryer inlet fitting. (T2).
 Use a touch probe thermocouple for measuring the temperature.
5. See table below.
6. Retest before returning the vehicle to service.

T1 Compressor Discharge Fitting	T2 Air Dryer Inlet Fitting	Action
under 360°F	under 200°F	Temperatures are within normal range for this test, check other symptoms. Go to 4.0 (h).
under 360°F	over 200°F	This could indicate a discharge line problem (e.g. restriction). Call 1-800-AIR-BRAKE (1-800-247-2725) and speak with our Tech Team.
over 360°F	—	Compressor is running hot. Check coolant 4(f) and/or discharge line 4(g).

Tests (continued)

Test 4: Governor Malfunction

1. Inspect control lines to and from the governor for restrictions (e.g. collapsed or kinked). Repair as necessary.
2. Using a calibrated external gauge in the supply reservoir, service reservoir, or reservoir port of the D-2[®] governor, verify cut-in and cut-out pressures are within vehicle OEM specification.
3. If the governor is malfunctioning, replace it.

Test 5: Governor Control Line

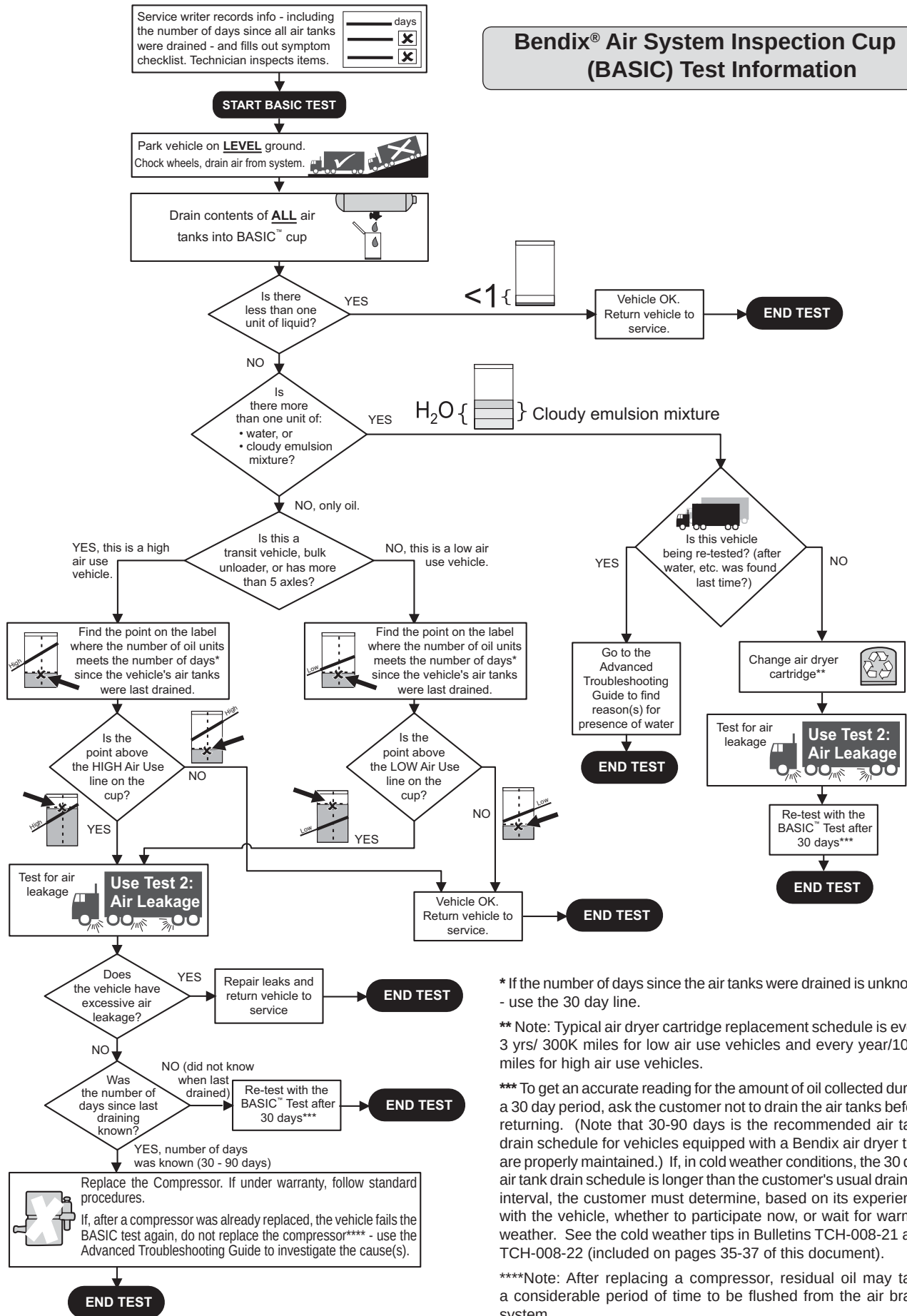
1. Ensure that the governor control line from the reservoir is located at or near the top of the reservoir. (This line, if located near the bottom of the reservoir, can become blocked or restricted by the reservoir contents e.g. water or ice.)
2. Perform proper reservoir drain intervals and air dryer cartridge maintenance per Maintenance Schedule and Usage Guidelines (Table A on page 18).
3. Return the vehicle to service.

Test 6: Compressor Unloader Leakage

Bendix[®] Compressors: Park vehicle, chock wheels, and follow all standard safety procedures. Remove the governor and install a fitting to the unloader port. Add a section of air hose (min 1ft long for a 1/2" diameter line) and a gauge to the fitting followed by a shut-off valve and an air source (shop air or small air tank). Open the shut

off and charge the unloader port by allowing air pressure to enter the hose and unload the compressor. Shut off the air supply and observe the gauge. A steady reading indicates no leakage at the unloader port, but a falling reading shows that the unloader mechanism is leaking and needs to be serviced.

Appendix A: Information about the BASIC Test Kit (Bendix P/N 5013711)



* If the number of days since the air tanks were drained is unknown - use the 30 day line.

** Note: Typical air dryer cartridge replacement schedule is every 3 yrs/ 300K miles for low air use vehicles and every year/100K miles for high air use vehicles.

*** To get an accurate reading for the amount of oil collected during a 30 day period, ask the customer not to drain the air tanks before returning. (Note that 30-90 days is the recommended air tank drain schedule for vehicles equipped with a Bendix air dryer that are properly maintained.) If, in cold weather conditions, the 30 day air tank drain schedule is longer than the customer's usual draining interval, the customer must determine, based on its experience with the vehicle, whether to participate now, or wait for warmer weather. See the cold weather tips in Bulletins TCH-008-21 and TCH-008-22 (included on pages 35-37 of this document).

****Note: After replacing a compressor, residual oil may take a considerable period of time to be flushed from the air brake system.

Appendix A continued: Information about the BASIC Test Kit (Bendix P/N 5013711)

Filling in the Checklist for the Bendix® Air System Inspection Cup (BASIC) Test

Note: Follow all standard safety precautions. For vehicles using a desiccant air dryer.

The Service Writer fills out these fields with information gained from the customer

Number of Days Since Air Tanks Were Last Drained: _____	Date: _____	Vehicle #: _____
Engine SN _____	Vehicle Used for: _____	Typical Load: _____ (lbs.)
No. of Axles: ____ (tractor) ____ (trailer)	No. of Lift Axles: ____	Technician's Name: _____

The Service Writer also checks off any complaints that the customer makes to help the Technician in investigating.

Customer's Complaint (Please check all that apply)	Checklist for Technician Have you confirmed complaint?
☐ "Relay valve leaks oil / malfunctions"	☐ no ☐ yes*
☐ "Dash valve leaks oil / malfunctions"	☐ no ☐ yes*
☐ "Air dryer leaks oil"	☐ no ☐ yes*
☐ "Governor malfunction"	☐ no ☐ yes*
☐ "Oil in gladhands"	☐ no ☐ yes*
how much oil did you find? _____	
☐ "Oil on ground or vehicle exterior"	☐ no ☐ yes*
amount described: _____	
☐ "Short air dryer cartridge life"	
replaces every: _____ ☐ miles, ☐ kms, or ☐ months	
☐ "Oil in air tanks" amount described: _____	
We will measure amount currently found when we get to step B of the test.	
☐ "Excessive engine oil loss" amount described: _____	
Is the engine leaking oil?	☐ no ☐ yes*
Is the compressor leaking oil?	☐ no ☐ yes*
☐ Other complaint: _____	
☐ No customer complaint.	

The Technician checks boxes for any of the complaints that can be confirmed.

* Note: A confirmed complaint above does NOT mean that the compressor must be replaced. The full BASIC test below will investigate the facts.

BASIC test starts here:

STEP A - Select one:

- ☐ This is a low air use vehicle: Line haul (single trailer) with 5 or less axles, or
 - ☐ This is a high air use vehicle: Garbage truck, transit bus, bulk unloader, or line haul with 6 or more axles.
- Then go to Step B.

The Technician selects the air use category for the vehicle. This decided which of the two acceptance lines on the cup will be used for the test below.

STEP B - Measure the Charging System Contents

1. Park and chock vehicle on level ground. Drain the air system by pumping the service brakes.
2. Completely drain ALL the air tanks into a single BASIC cup.
3. If there is less than one unit of contents total, end the test now and return the vehicle to service. Vehicle passes.
4. **If** more than one oil unit of water (or a cloudy emulsion mixture) is found:
 - (a) Change the vehicle's air dryer cartridge - see Footnote 1,
 - (b) Conduct the 4 minute leakage test (Step D),
 - (c) STOP the inspection, and check the vehicle again after 30 days - see Footnote 2.



STOP
+ CK

Otherwise, go to Step C.

For an accurate test, the contents of all the air tanks on the vehicle should be used.

Note for returning vehicles that are being retested after a water/cloudy emulsion mixture was found last time and the air dryer cartridge replaced: If more than one oil unit of water or a cloudy emulsion mixture is found again, stop the BASIC test and consult the air dryer's Service Data sheet troubleshooting section.

Footnote 1: Note: Typical air dryer cartridge replacement schedule is every 3 yrs/ 300K miles for low air use vehicles and every year/100K miles for high air use vehicles.

Footnote 2: To get an accurate reading for the amount of oil collected during a 30 day period, ask the customer not to drain the air tanks before returning. (Note that 30-90 days is the recommended air tank drain schedule for vehicles equipped with a Bendix air dryer that are properly maintained.) If, in cold weather conditions, the 30 day air tank drain schedule is longer than the customer's usual draining interval, the customer must determine, based on its experience with the vehicle, whether to participate now, or wait for warmer weather. See the cold weather tips in Bulletins TCH-008-21 and TCH-008-22 (included in Appendix B of the advanced troubleshooting guide).

Appendix A continued: Information about the BASIC Test Kit (Bendix P/N 5013711)

Filling in the Checklist for the Bendix® Air System Inspection Cup (BASIC) Test

Note: Follow all standard safety precautions. For vehicles using a desiccant air dryer.

STEP C - How to Use the BASIC Test

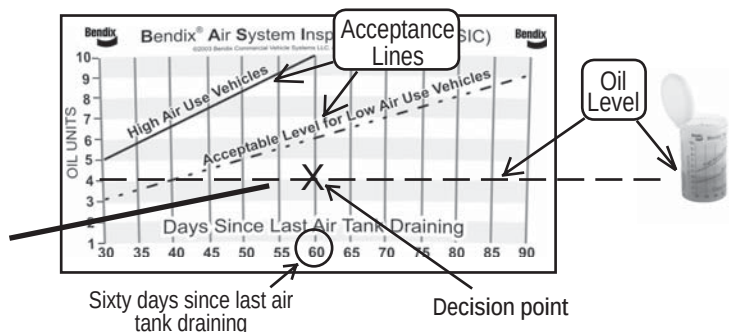
The Technician uses the chart (label) on the BASIC test cup to help decide the action to take, based on the amount of oil found. Use the lower acceptance line for low air use vehicles, and upper line for high air use vehicles (from Step A).

1. Record days since air tanks were last drained.	2. Record amount of oil found:	3. Action to take
days	units	
If number of days is: 30-60 days (high air use) or 30-90 days (low air use) →	if oil level is at or below acceptance line for number of days → if oil level is above acceptance line for number of days →	System OK. Return to service. STOP TEST Go to Step D
Otherwise . . . → (if the number of days is unknown, or outside the limits above)	if oil level is at or below 30-day acceptance line → if oil level is above 30-day acceptance line →	System OK. Return to service. STOP TEST Stop inspection. Test again after 30 days. See Footnote 2. STOP + CK

BASIC Test Example

An oil level of 4 units in a sixty-day period is within the acceptance area (at or below the line) for both low and high air use vehicles. Return the vehicle to service.

The Technician looks for the point where the number of days since the air tanks were drained meets the oil level. If it is at or below the (low or high use) acceptance line, the vehicle has passed the test. If the point is above the line we go to the leakage test.



STEP D - Air Brake System Leakage Test

Park the vehicle on level ground and chock wheels. Build system pressure to governor cut-out and allow the pressure to stabilize for one minute.

- 1: Observe the dash gauges for two additional minutes without the service brakes applied.
- 2: Apply service brakes for two minutes (allow pressure to stabilize) and observe the dash gauges.

If you see any noticeable decrease of the dash air gauge readings repair leaks. Repeat this test to confirm that air leaks have been repaired and return vehicle to service. Please repeat BASIC test at next service interval. Note: Air leaks can also be found in the charging system, parking brakes, and/or other components - inspect and repair as necessary.

Air leakage is the number one cause of compressors having to pump excessive amounts of air, in turn run too hot and pass oil vapor along into the system. Here the Technician conducts a four-minute test to see if leakage is a problem with the vehicle being tested.

If no air leakage was detected, and if you are conducting this test after completing Step C, go to Step E.

STEP E - If no air leakage was detected in Step D

Replace the compressor.

Note: If the compressor is within warranty period, please follow standard warranty procedures. Attach the completed checklist to warranty claim.

The Technician only reaches Step E if the amount of oil found, for the amount of time since the air tanks were last drained exceeds the acceptance level, AND the vehicle passes the four-minute leakage test (no noticeable leakage was detected).

Technical Bulletin



Bulletin No.: TCH-008-021

Effective Date: 11/1/92

Page: 1 of 2

Subject: **Air Brake System - Cold Weather Operation Tips**

As the cold weather approaches, operators and fleets alike begin to look to their vehicles with an eye toward "winterization", and particularly what can be done to guard against air system freeze-up. Here are some basic "Tips" for operation in the cold weather.

Engine Idling

Avoid idling the engine for long periods of time! In addition to the fact that most engine manufacturers warn that long idle times are detrimental to engine life, winter idling is a big factor in compressor discharge line freeze-up. Discharge line freeze-ups account for a significant number of compressor failures each year. The discharge line recommendations under "Discharge Lines" are important for all vehicles but are especially so when some periods of extended engine idling can not be avoided.

Discharge Lines

The discharge line should slope downward from the compressor discharge port without forming water traps, kinks, or restrictions. Cross-overs from one side of the frame rail to the other, if required, should occur as close as possible to the compressor. Fitting extensions must be avoided. Recommended discharge line lengths and inside diameters are dependent on the vehicle application and are as follows.

Typical P&D, School Bus and Line Haul

The maximum discharge line length is 16 feet.

<u>Length</u>	<u>I.D. Min.</u>	<u>Other Requirements</u>
6.0-9.5 ft.	½ in.	None
9.5-12 ft.	½ in.	Last 3 feet, including fitting at the end of the discharge line, must be insulated with ½ inch thick closed cell polyethylene pipe insulation.
12-16 ft.	5/8 in.	Last 3 feet, including fitting at the end of the discharge line, must be insulated with ½ inch thick closed cell polyethylene pipe insulation.

If the discharge line length must be less than 6 feet or greater than 16 feet, contact your local Bendix representative.

High Duty Cycle Vehicles (City Transit Coaches, Refuse Haulers, Etc.)

The maximum discharge line length is 16 feet.

<u>Length</u>	<u>I.D. min.</u>	<u>Other Requirements</u>
10-16 ft.	½ in.	None

If the discharge line length must be less than 10 feet or greater than 16 feet, contact your local Bendix representative.

System Leakage

Check the air brake system for excessive air leakage using the Bendix "Dual System Air Brake Test and Check List" (BW1279). Excessive system leakage causes the compressor to "pump" more air and also more moisture into the brake system.

Reservoir Draining (System Without Air Dryer)

Routine reservoir draining is the most basic step (although not completely effective) in reducing the possibility of freeze-up. **All reservoirs** in a brake system can accumulate water and other contamination and must be drained! The best practice is to drain all reservoirs daily. When draining reservoirs; turn the ENGINE OFF and drain ALL AIR from the reservoir, better still, open the drain cocks on all reservoirs and leave them open over night to assure all contamination is drained (reference Service Data Sheet SD-04-400 for Bendix Reservoirs). If automatic drain valves are installed, check their operation **before** the weather turns cold (reference Service Data Sheet SD-03-2501 for Bendix® DV-2™ Automatic Drain Valves). It should be noted that, while the need for daily reservoir draining is eliminated through the use of an automatic drain valve, periodic manual draining is still required.

Alcohol Evaporator or Injector Systems

Check for proper operation of these systems by monitoring alcohol consumption for a few days (Reference Service Data Sheet SD-08-2301 for the Bendix Alcohol Evaporator). Too little means the system is not receiving adequate protection and too much simply wastes alcohol. As a general guide, these systems should consume approximately 1 to 2 ounces of alcohol per hour of compressor loaded time (compressing air). City pick-up and delivery vehicles will operate with the compressors loaded (compressing air) more while compressors on highway vehicles will be loaded less. These figures are approximate and assume that air system leakage is within the limits of the Bendix "Dual System Air Brake Test and Check List" (BW1279). Last but not least, begin using alcohol several weeks prior to freezing weather to ensure that the system is completely protected. Use only methanol alcohol, such as Bendix "Air Guard", in evaporators or injectors.

Air Dryers

Make certain air brake system leakage is within the limits stated in BW1279. Check the operation and function of the air dryer using the appropriate Service Data Sheet for the air dryer.

AD-9® Air Dryer	Service Data Sheet SD-08-2412
AD-4® Air Dryer	Service Data Sheet SD-08-2407
AD-2® Air Dryer	Service Data Sheet SD-08-2403
AD-IP® Air Dryer	Service Data Sheet SD-08-2414
AD-SP® Air Dryer	Service Data Sheet SD-08-2415
Trailer System-Guard® Air Dryer	Service Data Sheet SD-08-2416

Technical Bulletin



Bulletin No.: TCH-008-022

Effective Date: 1/1/1994

Page: 1 of 1

Subject: **Additional Cold Weather Operation Tips for the Air Brake System**

Last year we published Bulletin PRO-08-21 which provided some guidelines for "winterizing" a vehicle air brake system. Here are some additional suggestions for making cold weather vehicle operation just a little more bearable.

Thawing Frozen Air Lines

The old saying; "Prevention is the best medicine" truly applies here! Each year this activity accounts for an untold amount of unnecessary labor and component replacement. Here are some Do's and Don'ts for prevention and thawing.

Do's

1. Do maintain freeze prevention devices to prevent road calls. Don't let evaporators or injectors run out of methanol alcohol or protection will be degraded. Check the air dryer for proper operation and change the desiccant when needed.
2. Do thaw out frozen air lines and valves by placing the vehicle in a warmed building. This is the only method for thawing that will not cause damage to the air system or its components.
3. Do use dummy hose couplings on the tractor and trailer.
4. Do check for sections of air line that could form water traps. Look for "drooping" lines.

Don'ts

1. Do not apply an open flame to air lines and valves. Beyond causing damage to the internal nonmetallic parts of valves and melting or burning non-metallic air lines. **WARNING: THIS PRACTICE IS UNSAFE AND CAN RESULT IN VEHICLE FIRE!**
2. Do not introduce (pour) fluids into air brake lines or hose couplings ("glad hands"). Some fluids used can cause immediate and severe damage to rubber components. Even methanol alcohol, which is used in Alcohol Evaporators and Injectors, should not be poured into air lines. Fluids poured into the system wash lubricants out of valves, collect in brake chambers and valves and can cause malfunction. Loss of lubricant can affect valve operating characteristics, accelerate wear and cause premature replacement.
3. Do not park a vehicle outside after thawing its air system indoors. Condensation will form in the system and freeze again. Place the vehicle in operation when it is removed to the outdoors.

Supporting Air and Electrical Lines

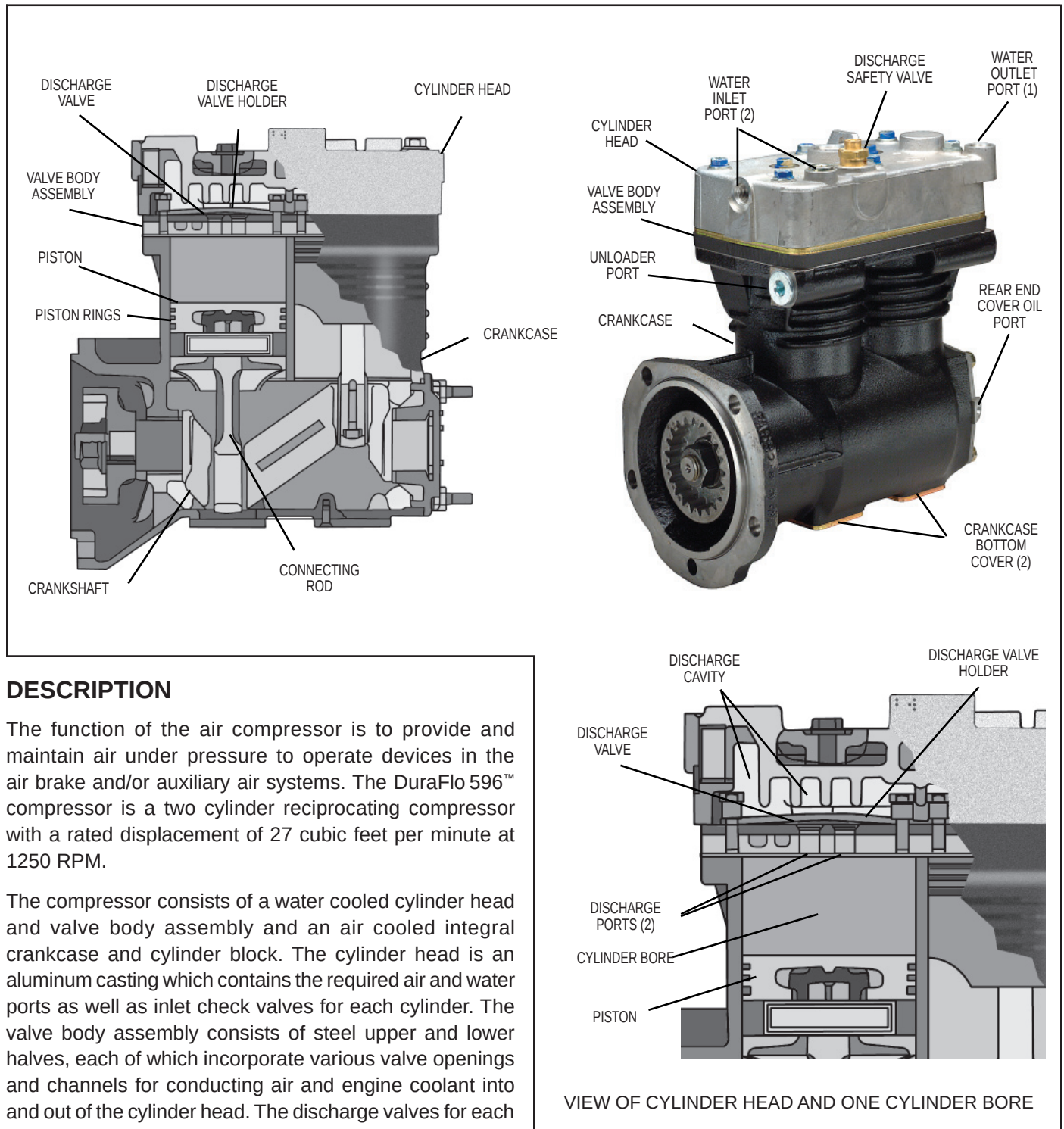
Make certain tie wraps are replaced and support brackets are re-assembled if removed during routine maintenance. These items prevent the weight of ice and snow accumulations from breaking or disconnecting air lines and wires.

Automatic Drain Valves (System without Air Dryer)

As we stated last year, routine reservoir draining is the most basic step (although not completely effective) in reducing the possibility of freeze-up. While automatic drain valves relieve the operator of draining reservoirs on a daily basis, these valves **MUST** be routinely checked for proper operation. Don't overlook them until they fail and a road call is required.



Bendix® DuraFlo 596™ Air Compressor

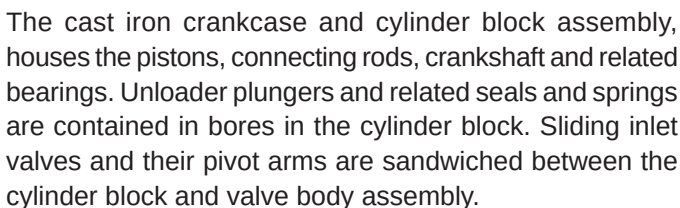
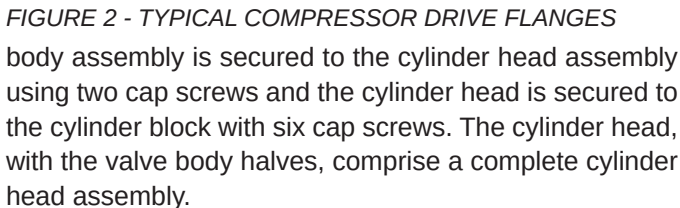


DESCRIPTION

The function of the air compressor is to provide and maintain air under pressure to operate devices in the air brake and/or auxiliary air systems. The DuraFlo 596™ compressor is a two cylinder reciprocating compressor with a rated displacement of 27 cubic feet per minute at 1250 RPM.

The compressor consists of a water cooled cylinder head and valve body assembly and an air cooled integral crankcase and cylinder block. The cylinder head is an aluminum casting which contains the required air and water ports as well as inlet check valves for each cylinder. The valve body assembly consists of steel upper and lower halves, each of which incorporate various valve openings and channels for conducting air and engine coolant into and out of the cylinder head. The discharge valves for each cylinder are part of the valve body assembly. The valve

FIGURE 1 - DURAFLO 596™ AIR COMPRESSOR



The DuraFlo 596™ compressor incorporates an unloader system that features an energy saving system or ESS which reduces compressor power consumption by approximately 80% in the unloaded mode. The ESS also reduces compressor oil consumption (oil passing) when the compressor is in the unloaded mode.

A nameplate identifying the compressor piece number and serial number is attached to the end of the cylinder block opposite the drive end.

The compressor is driven by the vehicle engine and functions continuously while the engine is in operation. Actual compression of air is controlled by the compressor unloading mechanism operating in conjunction with a remote mounted governor and synchro valve. Unlike the Tu-Flo® compressor series, the DuraFlo 596™ compressor requires the addition of a synchro valve to assure proper operation and service life. The governor and synchro valve combination maintains brake system air pressure between a preset maximum and minimum pressure level. Refer to Figure 3.

The compressor has a built in unloading and ESS or Energy Saving System.

The piston strokes are 180 degrees opposed. As one piston is on an up stroke the opposing piston is on a down stroke. During the piston down stroke, a vacuum is created in the cylinder and ESS chamber within the cylinder head. The vacuum causes the inlet check valve and sliding inlet valve to flex open. Atmospheric air flows through the open inlet check valve into and through the ESS chamber to the sliding inlet valve. Air flowing past the sliding inlet valve fills the cylinder above the piston. See Figures 4 & 7.



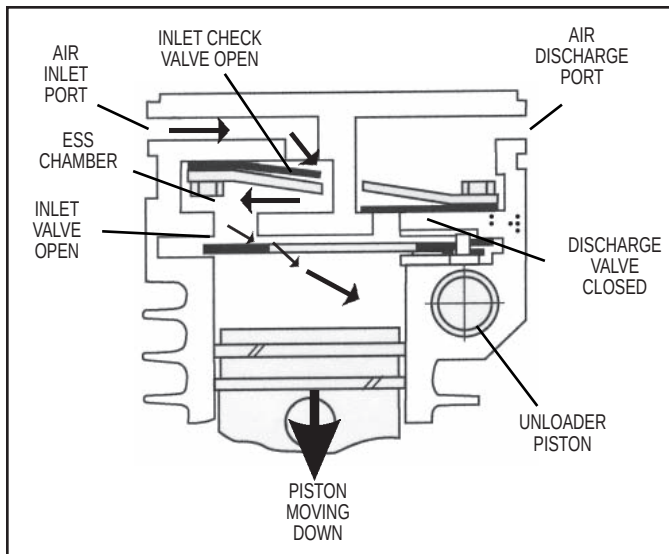


FIGURE 4 - OPERATIONAL-LOADED (INTAKE)

AIR COMPRESSION (LOADED)

When the piston reaches approximately bottom dead center (BDC) the inlet check valve and sliding inlet valve close. Air above the piston is trapped by the closed inlet valve and is compressed as the piston begins to move toward top dead center (TDC). When air in the cylinder bore reaches a pressure greater than that of the system pressure the discharge valves open and air flows into the discharge line and air brake system.

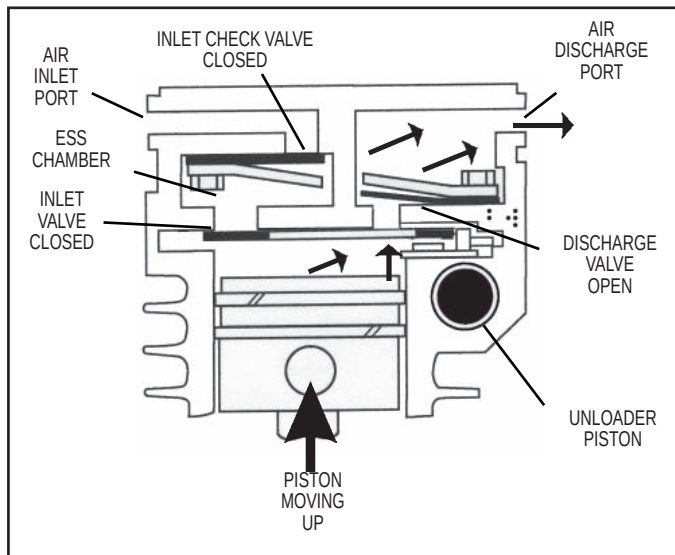


FIGURE 5 - OPERATIONAL-LOADED (COMPRESSION)

NON-COMPRESSION OF AIR (UNLOADED)

When air pressure in the supply reservoir reaches the cut-out setting of the governor, the governor delivers system air to the control port of the synchro valve. The synchro valve opens in response to control pressure from the governor and delivers system pressure to either of the two compressor unloader ports. Air entering the

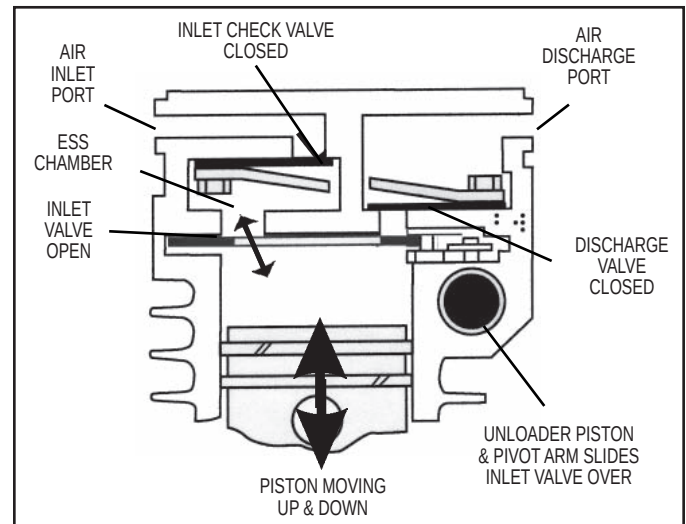


FIGURE 6 - OPERATIONAL-UNLOADED

unloader port acts on one unloader plunger directly and is simultaneously conducted through a passage in the valve body assembly to the other unloader plunger.

The unloader plungers move horizontally in their bores in response to control pressure from the governor and synchro valve. A guide pin in the unloader plunger rotates the pivot arm which causes the inlet valve to slide. As the inlet valve slides from the loaded to the unloaded position it blocks the two discharge ports and opens the six inlet ports connecting the cylinder bore to the ESS chamber. When the piston travels upward, air in the cylinder is trapped between the top of the piston and the closed inlet check valve and is compressed. The intake check valves prevent the intake air from escaping through the air intake port when the compressor is in the unloaded ESS mode. See Figures 5 & 7.

The added volume of the ESS chamber lowers the amount of compression. Air that is compressed during the upward movement of the piston provides a driving force for the piston during its downward movement. As one piston is moving downward the opposing piston is moving up. With the exception of losses in the form of heat, which is formed during compression, the energy used to compress the air will be reused as the driving force for the downward stroke of the piston. This results in the compressor using very little power in its unloading position. See Figures 6 & 7.

DuraFlo 596™ compressors can also be discharge line unloaded which would eliminate the need for the synchro valve, however, the power savings associated with the ESS system would not be realized.

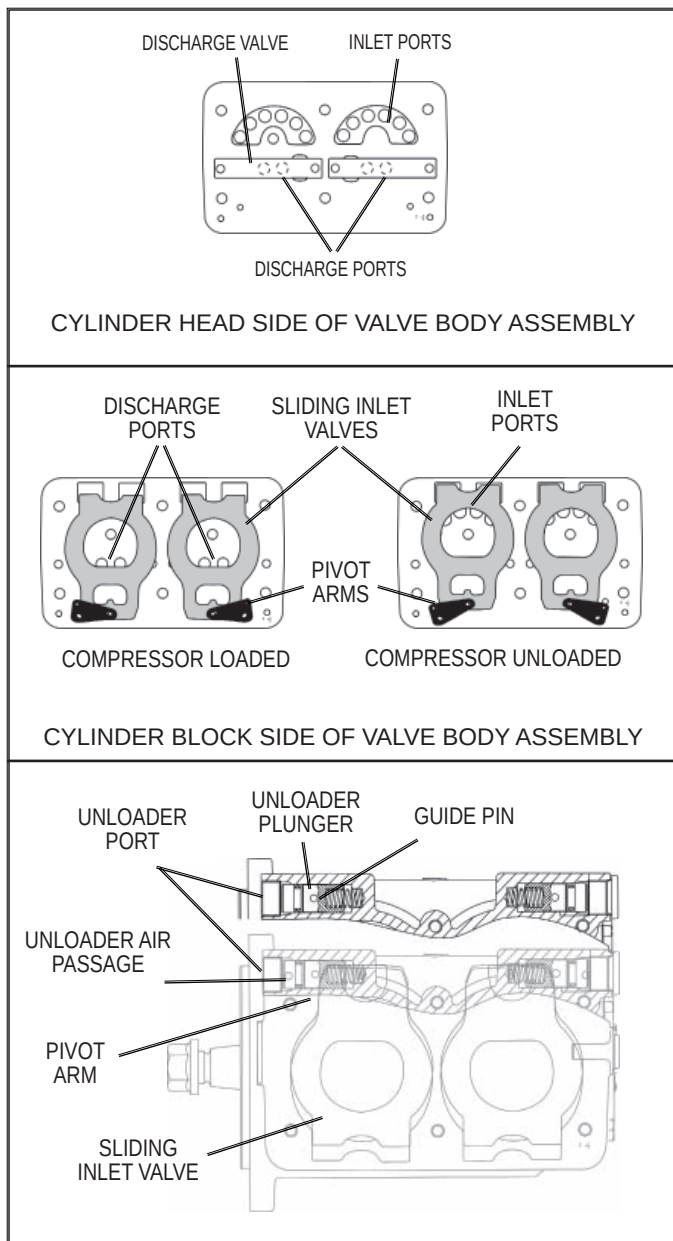


FIGURE 7 - UNLOADER MECHANISM

COMPRESSOR & THE AIR BRAKE SYSTEM

GENERAL

The compressor is part of the total air brake system, more specifically, the charging portion of the air brake system. As a component in the overall system its condition, duty cycle, proper installation and operation will directly affect other components in the system.

Powered by the vehicle engine, the air compressor builds the air pressure for the air brake system. The air compressor is typically cooled by the engine coolant system, lubricated by the engine oil supply and has its inlet connected to the engine induction system.

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 reservoirs. 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.

DUTY CYCLE

The duty cycle is the ratio of time the compressor spends building air to the total engine running time. Air compressors are designed to build air (run "loaded") up to 25% of the time. Higher duty cycles cause conditions that affect air brake charging system performance which may require additional maintenance. Factors that add to the duty cycle are: air suspension, additional air accessories, use of an undersized compressor, frequent stops, excessive leakage from fittings, connections, lines, chambers or valves, etc. Refer to Table A in the Troubleshooting section for a guide to various duty cycles and the consideration that must be given to maintenance of other components.

COMPRESSOR INSTALLATION

While the original compressor installation is usually completed by the vehicle manufacturer, conditions of operation and maintenance may require additional consideration. The following presents base guidelines.

DISCHARGE LINE

The discharge line allows the air, water-vapor and oil-vapor mixture to cool between the compressor and air dryer or reservoir. The typical size of a vehicle's discharge line, (see column 2 of Table A in the Troubleshooting section) assumes a compressor with a normal (less than 25%) duty cycle, operating in a temperate climate. See Bendix and/or other air dryer manufacturer guidelines as needed.

The discharge line must maintain a constant slope down from the compressor to the air dryer inlet fitting or reservoir to avoid low points where ice may form and block the flow. 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 degree fitting, it may be changed to a straight or 45 degree fitting. Shorter discharge line lengths or insulation may be required in cold climates.

While not all compressors and charging systems are equipped with a discharge line safety valve, this component is recommended. The 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.

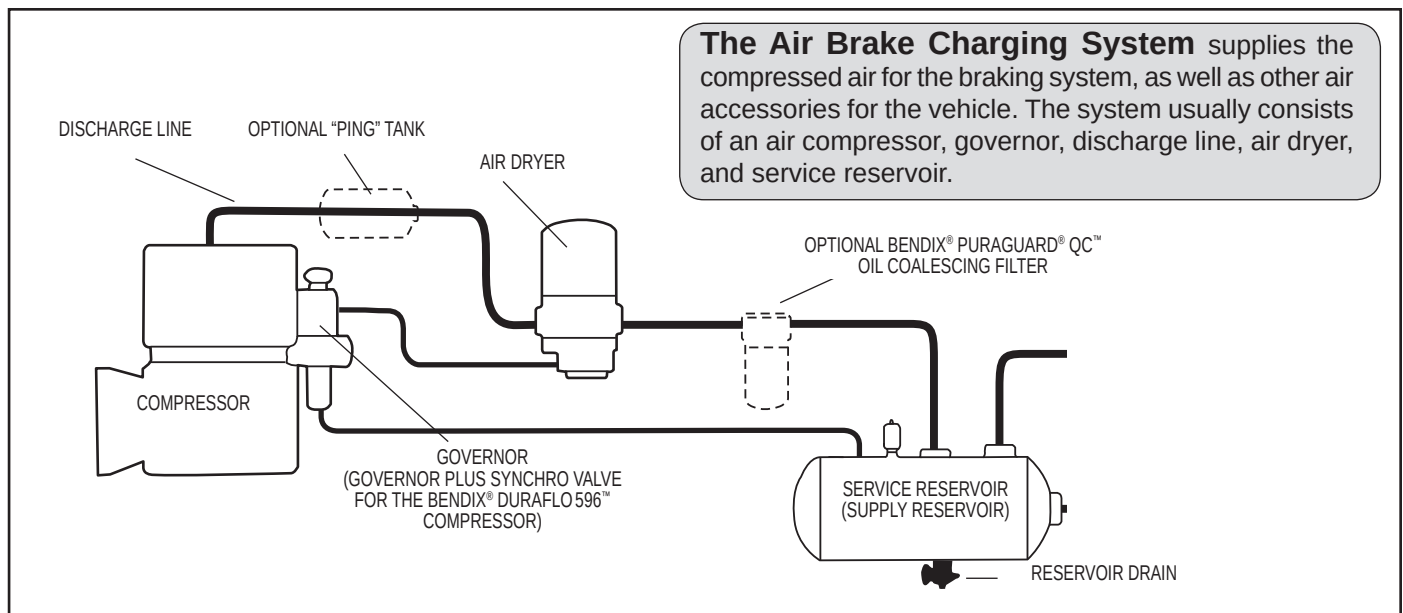


FIGURE 8A - SYSTEM DRAWING

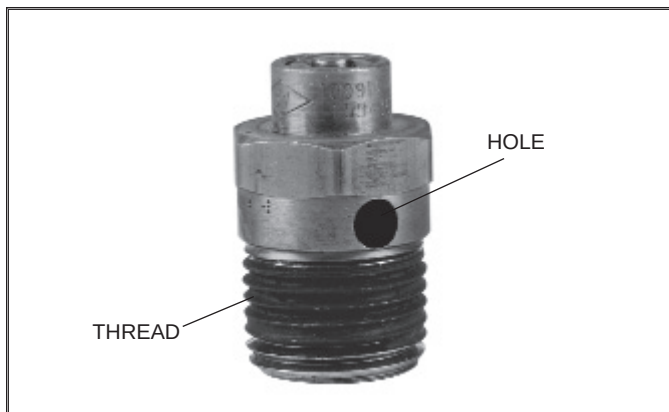


FIGURE 8B - DISCHARGE LINE SAFETY VALVE

DISCHARGE LINE TEMPERATURE

When the temperature of the compressed air that enters the air dryer is within the normal range, the air dryer can remove most of the charging system oil. If the temperature of the compressed air is above the normal range, oil as oil-vapor is able to pass through the air dryer and into the air system. Larger diameter discharge lines and/or longer discharge line lengths can help reduce the temperature.

The air dryer contains a filter that collects oil droplets, and a desiccant bed that removes almost all of the remaining water vapor. The compressed air is then passed to the air brake service (supply) reservoir. The oil droplets and the water collected are automatically purged when the governor reaches its "cut-out" setting.

For vehicles with accessories that are sensitive to small amounts of oil, we recommend installation of a Bendix® PuraGuard® QC oil coalescing filter, designed to minimize the amount of oil present.

LUBRICATION

The vehicle's engine provides a continuous supply of oil to the compressor. Oil is routed from the engine to the compressor oil inlet. An oil passage in the crankshaft conducts pressurized oil to precision sleeve main bearings and to the connecting rod bearings. Spray lubrication of the cylinder bores, connecting rod wrist pin bushings, and ball type main bearings is obtained as oil is forced out around the crankshaft journals by engine oil pressure. Oil then falls to the bottom of the compressor crankcase and is returned to the engine through drain holes in the compressor mounting flange.

COOLING

Air flowing through the engine compartment from the action of the engine fan and the movement of the vehicle assists in cooling the compressor. Cooling fins are part of the crankcase/cylinder block casting. Coolant flowing from the engine 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 recommended 400 degrees Fahrenheit. Figure 9 illustrates the various approved coolant flow connections. See the tabulated technical data in the back of this manual for specific requirements.

AIR INDUCTION

The DuraFlo 596™ compressor is approved for natural aspiration only. The compressor inlet is connected to the vacuum side of the engine air induction system. See the tabulated technical data in the back of this manual for specific requirements.

PREVENTATIVE MAINTENANCE

Regularly scheduled maintenance is the single most important factor in maintaining the air brake charging system. Refer to Table A in the Troubleshooting section for a guide to various considerations that must be given to the maintenance of the compressor and other related charging system components.

Important Note: Review the warranty policy before performing any intrusive maintenance procedures. An extended warranty may be voided if intrusive maintenance is performed during this period.

AIR INDUCTION

One of the single most important aspects of compressor preventive maintenance is the induction of clean air. Since the DuraFlo 596™ is connected to the engine air cleaner, proper periodic maintenance of the engine air filter eliminates the need for separate filter maintenance.

Inspect the compressor intake adapter, and the connecting hoses each time engine air cleaner maintenance is performed.

1. Inspect the intake hose adapters for physical damage. Make certain to check the adapters at both ends of the intake hose or tubing.
2. Inspect the intake hose clamps and tighten them if needed.
3. Inspect the intake hose or line for signs of drying, cracking, chafing and ruptures and replace it if necessary.

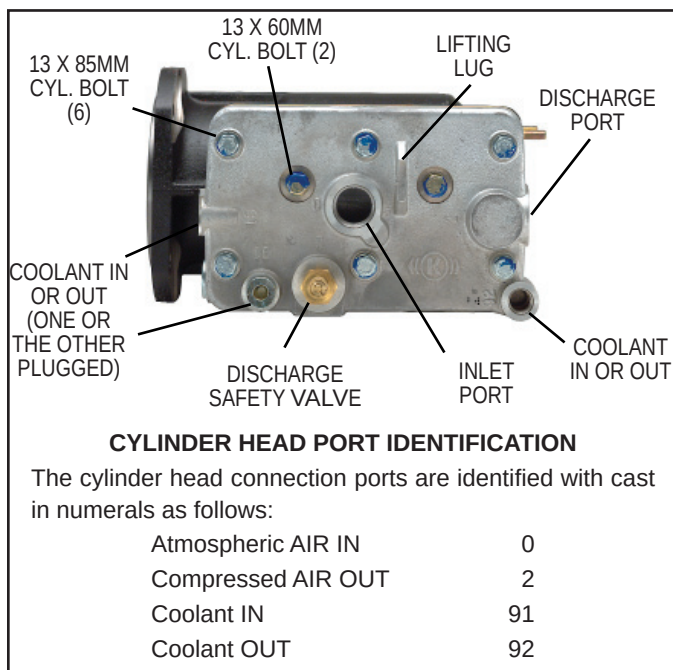


FIGURE 9 - TYPICAL DURAFL0 596™ AIR COMPRESSOR CYLINDER HEAD

EVERY 6 MONTHS, 1800 OPERATING HOURS OR AFTER EACH 50,000 MILES WHICHEVER OCCURS FIRST PERFORM THE FOLLOWING INSPECTIONS AND TESTS.

COMPRESSOR COOLING

Inspect the compressor discharge port, inlet cavity and discharge line for evidence of restrictions and carboning. If excessive buildup is noted, thoroughly clean or replace the affected parts. Since carbon buildup generally indicates inadequate cooling, closely inspect the compressor cooling system. Check all compressor coolant lines for kinks and restrictions to flow. **Minimum** coolant line size is 3/8" I.D. Check coolant lines for internal clogging from rust scale. If coolant lines appear suspicious, check the coolant flow and compare to the tabulated technical data present in the back of this manual. Carefully inspect the air induction system for restrictions.

LUBRICATION

Check the external oil supply line for kinks, bends, or restrictions to flow. Supply lines must be a minimum of 3/16" I.D. Refer to the tabulated technical data in the back of this manual for oil pressure minimum values.

Check the exterior of the compressor for the presence of oil seepage and refer to the TROUBLESHOOTING section for appropriate tests and corrective action.

OIL PASSING

All reciprocating compressors currently manufactured will pass a minimal amount of oil. Air dryers will remove the majority of oil prior to entrance into the air brake system. For particularly oil sensitive systems the Bendix® PuraGuard® QC oil coalescing filter can be used in conjunction with a Bendix air dryer.

If compressor oil passing is suspected, refer to the TROUBLESHOOTING section and TABLE A for the symptoms and corrective actions to be taken. In addition, Bendix has developed the "Bendix Air System Inspection Cup" or BASIC™ test to help substantiate suspected excessive oil passing. The steps to be followed when using the BASIC™ test are presented in APPENDIX A at the end of the TROUBLESHOOTING section.

COMPRESSOR DRIVE

Check for noisy compressor operation, which could indicate excessive drive component wear. Adjust and/or replace as necessary. Check all compressor mounting bolts and retighten evenly if necessary. Check for leakage and proper unloader mechanism operation. Repair or replace parts as necessary.

COMPRESSOR & GOVERNOR UNLOADER SYSTEM

Test and inspect the compressor and governor unloader system for proper operation and pressure setting.

1. Make certain the unloader system contains both the governor and synchro valve as illustrated in Figure 3.
2. Cycle the compressor through the loaded and unloaded cycle several times. Make certain that the governor cuts out at 130 psi (cut-in should be approximately 110 psi). Adjust or replace the governor as required.
3. Note that the DuraFlo 596™ compressor cycles to the loaded and unloaded conditions promptly. This can be definitely confirmed by installing a test gauge in the unused unloader port on the compressor and observing the reaction during transition from the loaded and unloaded condition. Air pressure should be applied and exhausted with a distinct “snap action” with no appreciable lag for buildup or release of pressure. If prompt action is not noted, repair or replace the synchro valve.

SERVICE TESTS

GENERAL

The following compressor operating and leakage tests need not be performed on a regular basis. These tests should be performed when; it is suspected that leakage is substantially affecting compressor buildup performance, or when it is suspected that the compressor is “cycling” between the load and unloaded modes due to unloader plunger leakage.

OPERATING TESTS

Compressor Performance

Vehicles manufactured after the effective date of FMVSS 121 must have a compressor capable of raising air system pressure from 85-100 psi in 25 seconds or less, with the minimum required reservoir volume for the vehicle. This test is performed with the engine operating at maximum recommended governed speed. The vehicle manufacturer must certify this performance on new vehicles with appropriate allowances for air systems with greater than the minimum required reservoir volume. As a less severe alternative to running a high RPM test, a new compressor's buildup time can be measured and recorded at high idle. Subsequent testing throughout the compressor's service life can be compared to the base line new compressor performance. Compressor buildup times should be recorded and kept with the vehicle maintenance files for reference. When testing compressor buildup times it is essential that air system leakage be kept below the allowed maximum for the vehicle type being tested. Before running buildup tests, check the service and supply systems for excessive leakage and repair as necessary.

Note: Supply system leakage is not displayed on the vehicle dash gauges and must be tested separately. Supply system components such as the governor, synchro valve, air dryer, reservoir drain cocks, safety valve and check valves can leak without indication on the dash gauges. These components must be checked for leakage separately and individually. Refer to the various maintenance manuals for individual component leakage tests and the Bendix “Test and Checklist” published in the Air Brake System Handbook (BW5057) for air system leakage testing.

LEAKAGE TESTS

Cylinder Head

Check for cylinder head gasket air leakage.

1. With the engine running, lower air system pressure to 60 psi and apply a soap solution around the cylinder head. Check the gasket between the cylinder head and valve body assembly and the gasket between the valve body assembly and cylinder block for air leakage.
2. No leakage is permitted. If leakage is detected, replace the compressor or repair the cylinder head using a genuine Bendix maintenance kit available from authorized Bendix parts outlets.

Inlet, Discharge & Unloader

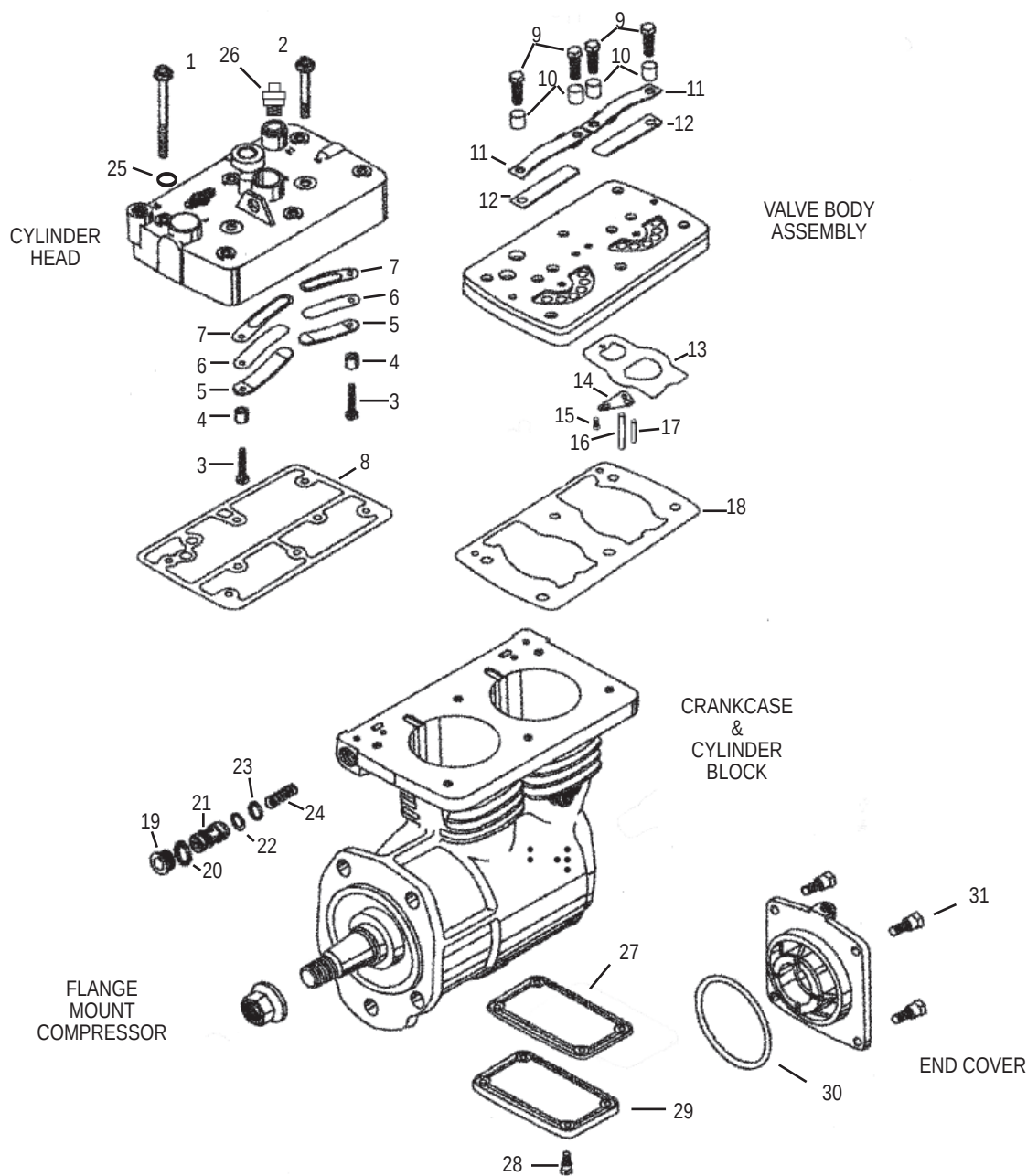
While it is possible to test for inlet, discharge, and unloader plunger leakage it requires disassembly of the cylinder head to accomplish. For this reason it is not recommended.

Inlet and discharge valve leakage can generally be detected by longer compressor buildup and recovery times. Compare current compressor buildup times with the last several recorded times. Make certain to test for Air system leakage, as described under Operating Tests, before making a determination that performance has been lost.

1. With the engine running, lower air system pressure to 90 psi and raise engine RPM to 1800. Measure and record the time required to raise system pressure from 100 psi to 130 psi. Run this test three times and use the average time.

Note: This test should be run with the engine and air system at normal operating temperature (i.e. not cold).

2. Compare the average time recorded in step 1 with previously recorded build up times to evaluate compressor performance.



Item	Qty.	Description	Item	Qty.	Description	Item	Qty	Description
1	6	13mm x 85mm Bolt	12	2	Discharge Valve	23	2	Backup Ring
2	2	13mm x 60mm Bolt	13	2	Sliding Inlet Valve	24	2	Spring
3	2	10mm x 25mm Bolt	14	2	Pivot Arm	25	6	13mm Washer
4	2	Spacer Sleeve	15	2	Stud	26	1	Discharge Safety Valve
5	2	Holder	16	2	Guide Pin	27	2	Base Plate Gasket
6	2	Inlet Check Valve	17	2	Guide Pin	28	8	Base Plate Cap Screw
7	2	Seat	18	1	Vlv. Asm. to Block Gskt.	29	2	Base Plate
8	1	Head to Valve Asm. Gskt.	19	1	Plug	30	1	End Cover O-Ring
9	4	10mm x 25mm Bolt	20	1	Sealing Washer	31	4	13mm x 20mm Bolt
10	4	Spacer Sleeve	21	2	Unloader Plunger			
11	2	Holder	22	2	O-Ring			

FIGURE 10 - DURAFL0 596™ AIR COMPRESSOR EXPLODED VIEW OF SERVICEABLE PARTS

Unloader leakage is exhibited by excessive compressor cycling between the loaded and unloaded condition.

1. With service and supply system leakage below the maximum allowable limits and the vehicle parked, bring system pressure to governor cut-out and allow the engine to idle.
2. The compressor should remain unloaded for a minimum of 5-10 minutes. If compressor cycling occurs more frequently and service and supply system leakage is within tolerance, replace the compressor or repair the compressor unloader system using a genuine Bendix maintenance kit available from authorized Bendix parts outlets.

COMPRESSOR REMOVAL & DISASSEMBLY

GENERAL

The following disassembly and assembly procedure is presented for reference purposes and presupposes that a rebuild or repair of the compressor is being undertaken. Several maintenance kits are available and the instructions provided with these parts and kits should be followed in lieu of the instructions presented here.

MAINTENANCE KITS & SERVICE PARTS

Cylinder Head Maintenance Kit.

Unloader Maintenance Kit.

All components shown in Figure 10 with a key number are available in kits and/or as individual service parts.

COMPRESSOR TROUBLESHOOTING

IMPORTANT: The troubleshooting contained in this section considers the compressor as an integrated component of the overall air brake charging system and assumes that an air dryer is in use. The troubleshooting presented will cover not only the compressor itself, but also other charging system devices as they relate to the compressor.

GENERAL SAFETY GUIDELINES

WARNING! PLEASE READ AND FOLLOW THESE INSTRUCTIONS TO AVOID PERSONAL INJURY OR DEATH:

When working on or around a vehicle, the following general precautions should be observed at all times.

1. Park the vehicle on a level surface, apply the parking brakes, and always block the wheels. Always wear safety glasses.
2. Stop the engine and remove ignition key when working under or around the vehicle. When working in the engine compartment, the engine should be shut

off and the ignition key should be removed. Where circumstances require that the engine be in operation, **EXTREME CAUTION** should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated or electrically charged components.

3. Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.
4. If the work is being performed on the vehicle's air brake system, or any auxiliary pressurized air systems, make certain to drain the air pressure from all reservoirs before beginning ANY work on the vehicle. If the vehicle is equipped with an AD-IS® air dryer system or a dryer reservoir module, be sure to drain the purge reservoir.
5. Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.
6. Never exceed manufacturer's recommended pressures.
7. Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.
8. Use only genuine Bendix® replacement parts, components and kits. Replacement hardware, tubing, hose, fittings, etc. must be of equivalent size, type and strength as original equipment and be designed specifically for such applications and systems.
9. Components with stripped threads or damaged parts should be replaced rather than repaired. Do not attempt repairs requiring machining or welding unless specifically stated and approved by the vehicle and component manufacturer.
10. Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.
11. For vehicles with Automatic Traction Control (ATC), the ATC function must be disabled (ATC indicator lamp should be ON) prior to performing any vehicle maintenance where one or more wheels on a drive axle are lifted off the ground and moving.

REMOVAL

These instructions are general and are intended to be a guide. In some cases additional preparations and precautions are necessary. In all cases follow the instructions contained in the vehicle maintenance manual in lieu of the instructions, precautions and procedures presented in this manual.

1. Block the wheels of the vehicle and drain the air pressure from all the reservoirs in the system.
2. Drain the engine cooling system and the cylinder head of the compressor. Identify and disconnect all air, water and oil lines leading to the compressor.
3. Remove as much road dirt and grease from the exterior of the compressor as possible.
4. Remove the discharge and inlet fittings, if applicable, and note their position on the compressor to aid in reassembly.

Note: If a cylinder head or unloader maintenance kit is being installed, stop here and proceed to PREPARATION FOR DISASSEMBLY. If replacing the compressor continue.

5. Remove any supporting bracketing attached to the compressor and note their positions on the compressor to aid in reassembly.
6. Remove the flange mounting bolts and remove the compressor from the vehicle.
7. Inspect gear and associated drive parts for visible wear or damage. Since these parts are precision fitted, they must be replaced if they are worn or damaged. If replacing the compressor or replacing the drive gear, remove the drive gear from the compressor crankshaft using a gear puller.
8. If the compressor is being replaced stop here and proceed to "Installing The Compressor" at the end of the assembly procedure.

PREPARATION FOR DISASSEMBLY

Remove the balance of road dirt and grease from the exterior of the compressor with a cleaning solvent. Before the compressor is disassembled, the following items should be marked to show their relationship when the compressor is assembled. Mark the rear end cover or end cover adapter in relation to the crankcase. Mark the relationship of the cylinder head to the valve body assembly and crankcase and cylinder block assembly.

A convenient method to indicate the above relationships is to use a metal scribe to mark the parts with numbers or lines. Do not use marking methods such as chalk that can be wiped off or obliterated during rebuilding.

Prior to disassembly make certain that the appropriate kits and or replacement parts are available. Refer to Figure 10 during the entire disassembly and assembly procedure.

UNLOADER & INLET VALVE

1. Remove the discharge safety valve (26) from the cylinder head.
2. Remove the unloader port plug and sealing washer (19 & 20).
3. Loosen but do not remove the two 13mm x 60mm bolts (2).
4. Remove the six 13mm x 85mm cylinder head bolts and washers (1 & 25) and tap the head with a soft mallet to break the gasket seal. Lift the cylinder head and valve body assembly off the cylinder block.

IMPORTANT NOTE: Do not attempt to separate the two halves of the valve body assembly. Service replacements and gaskets are not available.

5. Remove the metal gasket (18).
 6. Remove both sliding inlet valves (13).
 7. Remove both pivot arms (14) and pivot arm studs (15).
 8. To remove spring tension from the unloader plunger guide pin (16), insert a 1/4" brass dowel into one of the unloader plunger bore and depress the plunger (21) slightly. While holding the plunger (21) depressed, remove the plunger guide pin (16). Slowly extract the dowel rod from the unloader bore until spring tension is relieved.
- Note:** As an alternative, to this procedure an appropriately sized nut or dowel rod can be placed in the unloader bore and the plug (19) installed then removed after the guide pin is removed.
9. Remove the unloader plunger (21), with its o-ring (22) and backup ring (23) from the bore. Remove the unloader spring (24).
 10. Repeat steps 7 and 8 for the other unloader plunger.
 11. Remove both pivot arm guide pins (17) from the cylinder block.

DISCHARGE & INLET CHECK VALVES

1. Remove the two 13mm x 60mm cylinder head bolts (2) and gently tap the head and valve body assembly with a soft mallet to break the gasket seal. Separate the cylinder head and valve body assembly.

IMPORTANT NOTE: Do not attempt to separate the two halves of the valve body assembly. Service replacements and gaskets are not available.

2. Remove the gasket (8).
3. Turn the cylinder head over to expose the inlet check valves and remove the 10mm x 25mm inlet check valve bolt (3) that secures the inlet check valve components. Remove the spacer sleeve (4), holder (5), check valve (6) and check valve seat (7).

4. Repeat step 3 for the second inlet check valve assembly.
5. Remove the two 10mm x 25mm discharge valve bolts (9) that secure the discharge check valve components. Remove the spacer sleeve (10), holder (11) and discharge valve (12).
6. Repeat step 5 for the second discharge valve assembly.

CRANKCASE COVER

1. Remove the four cap screws (28) securing the crankcase cover (29). Using a soft mallet, gently tap the crankcase cover (29) to break the gasket seal. Scrape off any gasket material (27) from the crankcase and bottom cover or adapter.
2. Repeat step 1 for the second crankcase cover.

END COVER OR END COVER ADAPTER

1. Remove the cap screws (31) that secure the rear end cover or end cover adapter to the crankcase.
Note: Some compressor models use four cap screws while others use a combination of cap screws and studs.
2. Remove the rear end cover or end cover adapter from the crankcase. Remove the o-ring seal (30) from the end cover if so equipped.

CLEANING OF PARTS

GENERAL

All parts should be cleaned in a good commercial grade of solvent and dried prior to inspection.

CYLINDER HEAD

1. Carefully remove all gasket material adhering to the cylinder head, valve body assembly and cylinder block. Make certain not to deeply scratch or mar the gasket surfaces. Pay particular attention to the gasket surfaces of the aluminum head.
2. Remove carbon deposits from the discharge and inlet cavities of the cylinder head and valve body assembly. Make certain the inlet and discharge ports of the valve body assembly are open and clear.
3. Remove rust and scale from the cooling cavities and passages in the head and valve body assembly and use shop air to clear debris from the passages.
4. Make certain the unloader air passages and coolant passages through the valve body are open and clear of contamination.
5. Check the threads in all cylinder head ports for galling. Minor chasing is permitted.

OIL PASSAGES

Thoroughly clean all oil passages through the end cover or end cover adapter. Inspect the passages with a wire to be sure. Blow the loosened foreign matter out with air pressure.

CYLINDER BLOCK UNLOADER BORES

Thoroughly clean the unloader bore on both sides of the compressor cylinder block. Make certain not to scratch or gouge the air pressure sealing surfaces of the bores during the cleaning process.

INSPECTION OF PARTS

CYLINDER HEAD & VALVE BODY

1. Carefully inspect the cylinder head gasket surfaces for deep gouges and nicks. If detected, the compressor must be replaced.
2. Carefully inspect the valve body gasket surfaces for deep gouges and nicks. Pay particular attention to the metal gasket surface. A metal gasket (18) is used between the valve body assembly and cylinder block. This surface must be smooth and free of all but the most minor scratching. If excessive marring or gouging is detected, the compressor must be replaced.
3. Inspect the cylinder head for cracks or damage. With the cylinder head and head gasket secured to the valve body, apply shop air pressure to one of the coolant ports with all others plugged, and check for leakage by applying a soap solution to the exterior of the head. If leakage is detected in the cylinder head casting, replace the compressor.

END COVER OR END COVER ADAPTER

Check for cracks and external damage. Check the crankshaft main bearing surface in the end cover or end cover adapter, check for excessive wear and flat spots and replace the end cover if necessary. Check for galling of the oil port threads and replace the end cover or end cover adapter if necessary. Minor thread chasing is permitted but do not "recut" the threads if they are badly damaged.

CYLINDER BLOCK

1. Check the cylinder head gasket surface on the cylinder block for nicks, gouges, and marring. A metal gasket is used to seal the cylinder head to the cylinder block. This surface must be smooth and free of all but the most minor scratching. If excessive marring or gouging is detected, the compressor must be replaced.

ASSEMBLY

General Note: All torques specified in this manual are assembly torques and typically can be expected to fall off after assembly is accomplished. **Do not re-torque** after initial assembly torques fall unless instructed otherwise. A compiled listing of torque specifications is presented at the end of this manual.

INCH POUNDS TO FOOT POUNDS

To convert inch pounds to foot pounds of torque, divide inch pounds by 12.

Example: $\frac{12 \text{ Inch Pounds}}{12} = 1 \text{ Foot Pound}$

FOOT POUNDS TO INCH POUNDS

To convert foot pounds to inch pounds of torque, multiply foot pounds by 12.

Example: $1 \text{ Foot Pound} \times 12 = 12 \text{ Inch Pounds}$

CRANKCASE COVER

1. Position one of the two crankcase cover gaskets (27) on either the crankcase or crankcase cover and install the crankcase cover (29) using the position marks made prior to disassembly. Tighten the four cap screws (28), securing the crankcase cover to a torque of 101-111 inch pounds for crankcase cover or cover in a crossing pattern after first snugging all 4 screws.
2. Repeat this assembly for the second crankcase cover (29).

CRANKCASE END COVER OR END COVER ADAPTER

1. Install the end cover o-ring (30) on the crankcase end cover.
2. Orient the crankcase end cover or end cover adapter to the crankcase using the reference marks made during disassembly. Carefully install the end cover or end cover adapter in the crankcase making certain not to damage the crankshaft bearing surface in it.
3. Install the four 13mm x 20mm end cover or end cover adapter bolts or studs (31) and tighten to 195 to 212 inch pounds.

CYLINDER HEAD INLET CHECK VALVES

1. Locate one of the two inlet check valve seats (7) and note that one side is flat while the other has three protruding tabs around the bolt hole. Position one of the two inlet check valves (6) on the inlet check valve seat (7) so that the three positioning and locating tabs interlock with the corresponding tabs on the seat. When properly fitted together, the valve (6) should lay flat against the seat (7) and cover the slotted opening of the seat.

2. Locate one of the two inlet check valve holders (5). Place the holder (5) on the inlet check valve (6) making certain that the three indentations around the bolt hole, on the holder, interlock with the tabs on the inlet check valve (5). When properly assembled the seat (7), valve (6) and holder (5) should be parallel and interlocked.
3. Place the three components over one of the two slotted inlet openings in the cylinder head making certain that the bolt holes in the components and head correspond.
4. Insert one of the two 10mm x 25mm bolts (3) through a spacer sleeve (4). Using the bolt and sleeve, secure the assembled seat (7), valve (6) and holder (5) in the cylinder head. Tighten the bolt finger tight and check that the seat (7), valve (6) and holder (5) are still interlocked. This can be done by attempting to rotate the holder (5) and noting that the valve and seat follow and are locked together.
5. Torque the 10mm bolt to 101 to 111 inch pounds.
6. Repeat steps one through five for the other inlet check valve assembly.

DISCHARGE VALVES

1. Locate and place one of the two discharge valves (12) on the valve body assembly with its bolt hole corresponding with the threaded hole on the outside edge of the valve body assembly. When correctly placed, the discharge valve (12) will cover the two discharge holes in the valve body assembly. Refer to Figure 11.

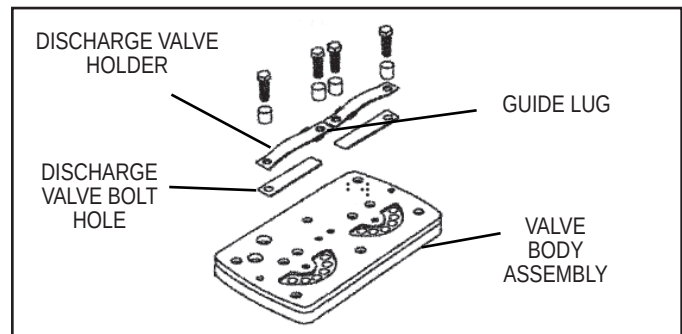


FIGURE 11 - DISCHARGE VALVE INSTALLATION

2. Locate one of the two discharge valve holders (11) and install it over the discharge valve (12) so that the free end of the discharge valve (12) is contained between the two guide lugs on the sides of the holder. Refer to Figure 11.
3. Insert one of the four 10mm x 25mm bolts (9) through a spacer sleeve (10). Using the bolt and sleeve, loosely secure one end of the discharge valve (12) and holder (11) to the valve body assembly. Insert a second 10mm x 25mm bolt (9) through a spacer sleeve (10) and loosely secure the other end of the discharge valve (12) and holder (11) to the valve body assembly.

Before attempting to tighten the two 10mm bolts make certain the free tip of the discharge valve (12) is not pinched between the holder (11) and the valve body assembly. The valve must be free to flex.

4. Torque the 10mm bolts to 101 to 111 inch pounds.
5. Repeat steps one through four for the other discharge valve assembly.

UNLOADER PLUNGERS

1. Install the metal sealing washer (20) on the plug (19) and set aside.
2. Install one o-ring (22) and backup ring (23) in the groove of the unloader plunger (21). The backup ring (23) should be installed in the groove so that it is closest to the center of the plunger.
3. Install the unloader plunger return spring (24) in the bore in the end of the unloader plunger (21).
4. Insert the assembled plunger (21) and spring (24) into one of the unloader bores in the cylinder block. When inserting the plunger orient it so that its guide pin hole will be visible through the slotted opening in the cylinder block.
5. Insert a 1/4" brass dowel into the unloader plunger bore and depress the plunger (21) slightly. While holding the plunger (21) depressed, insert the plunger guide pin (16) into the slotted opening in the cylinder block and into the unloader plunger until it is fully seated and extends above the top surface of the cylinder block approximately 1/8". Slowly extract the dowel rod from the unloader bore until spring tension is relieved and the guide pin retains the plunger.

Note: The unloader plunger guide pin (16) is larger in diameter and longer than the pivot arm guide pin (17).

6. Repeat steps one through five for the other unloader plunger assembly.

INLET VALVES & PIVOT ARMS

1. Install both pivot arm guide pins (17) in the cylinder block.
2. Place the pivot arm studs (15) in their slots in the cylinder block. The head (large diameter) of the stud should be in the slot with the small diameter facing away from the cylinder block.
3. Install both pivot arms (14) over the cylinder block guide pin (17) and unloader plunger guide pin (16) as well as the stud (15). When installed correctly the stud (15) and unloader plunger guide pin (16) will be in the slotted openings of the pivot arm (14).

Note: It may be necessary to slightly depress each unloader plunger to allow easy installation of the pivot arms over the guide pins.

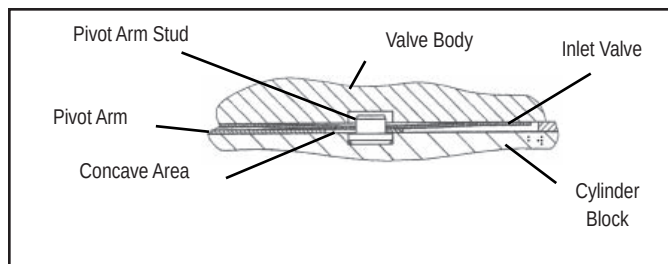


FIGURE 12 - SLIDING INLET VALVE INSTALLATION

4. Locate one of the sliding inlet valves (13) and place it on a flat surface. Note that there is a concave and convex side in the surface where the small pivot arm stud hole is located. Refer to Figure 11.
5. Place the metal gasket (18) on the cylinder block, **red side toward the cylinder block**, while aligning the cylinder head bolt holes.
6. Install the sliding inlet valves (13) on the pivot arm stud, concave side toward the cylinder block. Make certain to center the inlet valves within their openings in the metal gasket (18).

Note: The inlet valves must not be pinched between the metal gasket and the cylinder block. They must be free to slide within their openings in the metal gasket.

VALVE BODY & CYLINDER HEAD

1. Orient and carefully install the valve body assembly on the cylinder block. The cylinder block guide pins (17) will locate and guide the installation of the valve body.

Note: Try not to disturb the location of the metal gasket (18) during the installation of the valve body because the sliding inlet valves may be pinched.

2. Orient and install the cylinder head gasket (8) on the valve body.
3. Orient and carefully install the cylinder head on the valve body assembly. The cylinder block guide pins (17) will locate and guide the installation of the valve body.
4. Insert the six 13mm x 85mm head bolts into the head and tighten each finger tight.
5. Insert the two 13mm x 60mm head bolts into the head and tighten each finger tight.
6. Insert a 1/4" brass dowel into one of the unloader

plunger bore and depress the plunger (21) several times. The plunger (21) should move freely with only spring tension resistance noted. If greater resistance is noted the sliding inlet valve (13) is pinched and the cylinder head and valve body must be removed and the sliding inlet valve (13) must be repositioned within the opening of the meatal gasket (18). Repeat this procedure for the other unloader plunger and sliding inlet valve.

- 7. Torque the two 13mm x 60mm head bolts to 265 - 292 inch pounds.
- 8. Beginning with one of the center bolts, torque the six 13mm x 85mm head bolts to 265 - 292 inch pounds using a figure eight pattern.
- 9. Apply a thread sealant to the assembled plug and sealing washer (19 & 20) and install it in the cylinder block unloader bore that was marked during disassembly. Tighten sufficiently to seal air pressure.

INSTALLING THE COMPRESSOR

- 1. If the compressor was removed for replacement, install the drive components. Torque the crankshaft nut to 120 foot pounds.
- 2. Install any supporting bracketing on the compressor in the same position noted and marked during removal.
- 3. Install the gasket on the drive flange of the compressor. Make certain oil supply or return holes in the gasket are properly aligned with the compressor and engine. Gasket sealants are not recommended. Secure the compressor on the engine and tighten the mounting bolts.
- 4. Install the discharge and inlet fittings, if applicable, in the same position on the compressor noted and marked during disassembly. Make certain the threads are clean and the fittings are free of corrosion. Replace as necessary.
- 5. Inspect all air, oil, and coolant lines and fittings before reconnecting them to the compressor. Make certain o-ring seals are in good or new condition. Tighten all hose clamps.
- 6. Clean oil supply line. Before connecting this line to the compressor. Run the engine briefly to be sure oil is flowing freely through the supply line.
- 7. Before returning the vehicle to service, perform the Operation and Leakage Tests specified in this manual. Pay particular attention to all lines reconnected during installation and check for air, oil, and coolant leaks at compressor connections. Also check for noisy operation.

TESTING REBUILT COMPRESSOR

In order to properly test a compressor under operating conditions, a test rack for correct mounting, cooling,

lubricating, and driving the compressor is necessary. Such tests are not compulsory if the unit has been carefully rebuilt by an experienced person. A compressor efficiency or build up test can be run which is not too difficult. An engine lubricated compressor must be connected to an oil supply line of at least 15 psi. pressure during the test and an oil return line must be installed to keep the crankcase drained. Connect to the compressor discharge port, a reservoir with a volume of 1500 cubic inches, including the volume of the connecting line. With the compressor operating at 2100 RPM., the time required to raise the reservoir(s) pressure from 85 psi to 100 psi should not exceed 5 seconds. During this test, the compressor should be checked for gasket leakage and noisy operation, as well as unloader operation and leakage. If the compressor functions as indicated reinstall on the vehicle connecting all lines as marked in the disassembly procedure.

DURAFLO 596™ COMPRESSOR SPECIFICATIONS

Typical weight	50 lbs.
Number of cylinders	2
Bore size	3.465 in. (88 mm)
Stroke	1.968 in. (50 mm)
Calculated displacement at 1250 RPM	27 CFM
Flow Capacity @ 2100 RPM & 120 PSI	23 CFM
Maximum recommended RPM	3000 RPM
Minimum coolant flow maximum RPM	2.5 Gals./Min.
Approximate horsepower required:	
Loaded 1800 RPM at 120 PSIG	7.5 HP
Unloaded 1800 RPM	0.9 HP
Maximum inlet air temperature	250°F
Maximum discharge air temperature	400°F
Minimum oil pressure required at	
engine idling speed	15 PSI
Minimum oil pressure required at	
maximum governed engine speed	15 PSI
Minimum oil-supply line size	3/16" I.D.
Minimum unloader-line size	3/16" I.D.
Minimum Governor Cutout Pressure	130 PSI

TORQUE SPECIFICATIONS

Assembly torques in inch pounds (in. lbs.)

13mm Cylinder head bolts.....	265 - 292
10mm Valve bolts	101 -111
Rear end cover or adapter bolts/studs	195 - 212
Bottom cover	97 - 115
Crankshaft nut	1200 - 1440

Metric (Detroit Diesel)

M12 x 1.5	222
M16 x 1.5.....	386
M22 x 1.5.....	531
M27 x 2.....	792

U.S. (Caterpillar)

1/2"-20 UNF.....	222
3/4"-16 UNF.....	398
7/8"-14 UNF.....	531
1 1/16"-12 UNF.....	792

DIMENSIONAL DATA

Port Sizes

Metric (Detroit Diesel)

Water inlet	M16 x 1.5
Water outlet	M16 x 1.5
Discharge safety valve	M16 x 1.5
Air discharge	M27 x 2
Unloader port.....	M22 x 1.5
Oil inlet (end cover or adapter)	M12 x 1.5

U.S. (Caterpillar)

Water inlet	3/4"-16 UNF
Water outlet	3/4"-16 UNF
Discharge safety valve	3/4"-16 UNF
Air discharge	1 1/16"-12 UNF
Unloader port.....	7/8"-14 UNF
Oil inlet (end cover or adapter)	1/2"-20 UNF

Advanced Troubleshooting Guide for Air Brake Compressors*

The guide consists of an introduction to air brake charging system components, a table showing recommended vehicle maintenance schedules, and a troubleshooting symptom and remedy section with tests to diagnose most charging system problems.

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*This guide is only for vehicles that use desiccant air dryers.

Introduction to the Air Brake Charging System

Powered by the vehicle engine, the **air compressor** builds the air pressure for the air brake system. The air compressor is typically cooled by the engine coolant system and lubricated by the engine oil supply.

The compressor's unloader mechanism and **governor** (along with a synchro valve for the Bendix® DuraFlo 596™ air compressor) control the brake system air pressure between a preset maximum and minimum pressure level by monitoring the pressure in the service (or “supply”) reservoir. When the air pressure becomes greater than that of the preset “cut-out”, the governor controls the unloader mechanism of the compressor to stop the compressor from building air and also causes the air dryer to purge. As the service reservoir air pressure drops to the “cut-in” setting of the governor, the governor returns the compressor back to building air and the air dryer to air drying mode.

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.

The **duty cycle** is the ratio of time the compressor spends building air to the total engine running time. Air compressors are designed to build air (run “loaded”) up to 25% of the time. Higher duty cycles cause conditions that affect air brake charging system performance which may require additional maintenance. Factors that add to the duty cycle are: air suspension, additional air accessories, use of an undersized compressor, frequent stops, excessive leakage from fittings, connections, lines, chambers or valves, etc.

The **discharge line** allows the air, water-vapor and oil-vapor mixture to cool between the compressor

and air dryer. The typical size of a vehicle's discharge line, (see column 2 of Table A on page 18) assumes a compressor with a normal (less than 25%) duty cycle, operating in a temperate climate. See Bendix and/or other air dryer manufacturer guidelines as needed.

When the **temperature** of the compressed air that enters the air dryer is within the normal range, the air dryer can remove most of the charging system oil. If the temperature of the compressed air is above the normal range, oil as oil-vapor is able to pass through the air dryer and into the air system. Larger diameter discharge lines and/or longer discharge line lengths can help reduce the temperature.

The discharge line must maintain a **constant slope** down from the compressor to the air dryer inlet fitting to avoid low points where ice may form and block the flow. If, instead, ice blockages occur at the air dryer inlet, insulation may be added here, or if the inlet fitting is a typical 90 degree fitting, it may be changed to a straight or 45 degree fitting. For more information on how to help prevent discharge line freeze-ups, see Bendix Bulletins TCH-008-021 and TCH-008-022 (see pages 35-37). Shorter discharge line lengths or insulation may be required in cold climates.

The **air dryer** contains a filter that collects oil droplets, and a desiccant bed that removes almost all of the remaining water vapor. The compressed air is then passed to the air brake service (supply) reservoir. The oil droplets and the water collected are automatically purged when the governor reaches its “cut-out” setting. For vehicles with accessories that are sensitive to small amounts of oil, we recommended installation of a Bendix® PuraGuard® system filter, designed to minimize the amount of oil present.

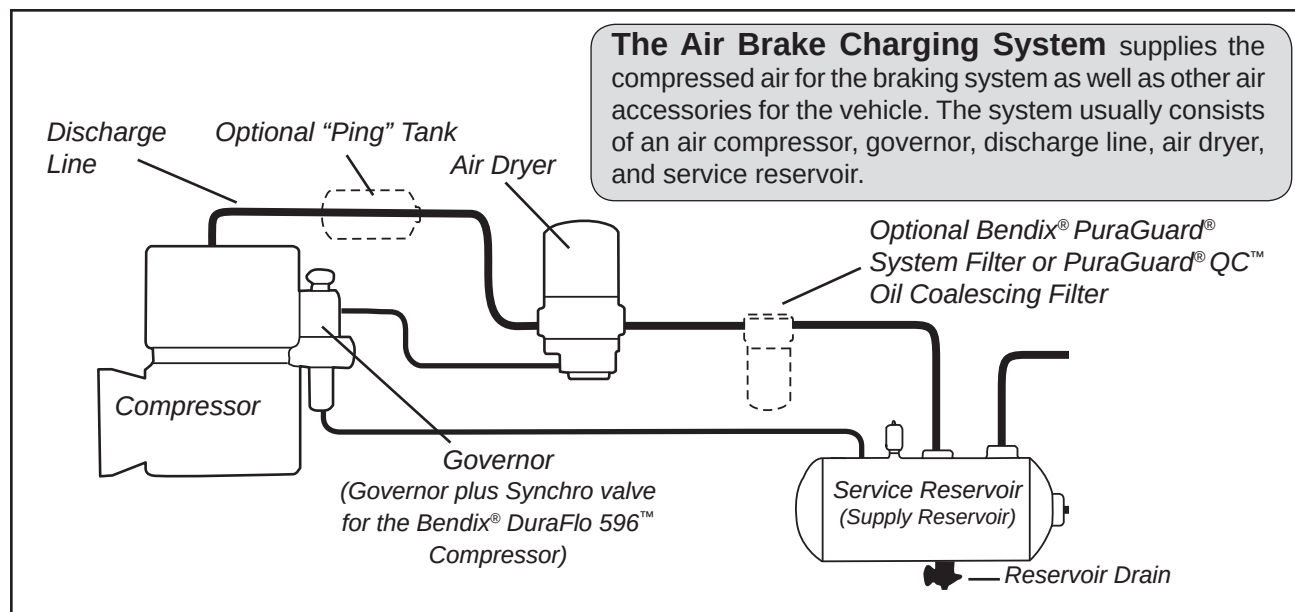


Table A: Maintenance Schedule and Usage Guidelines

Regularly scheduled maintenance is the single most important factor in maintaining the air brake charging system.

Vehicle Used for:	No. of Axles	Column 1	Column 2		Column 3	Column 4	Column 5
		Typical Compressors Spec'd	Discharge Line		Recommended Air Dryer Cartridge Replacement ¹	Recommended Reservoir Drain Schedule ²	Acceptable Reservoir Oil Contents ³ at Regular Drain Interval
			I.D.	Length			
Low Air Use							
Compressor with less than 15% duty cycle e.g. Line haul single trailer w/o air suspension, air over hydraulic brakes. 	5 or less	Bendix® BA-921® air compressor Bendix® Tu-Flo® 550 air compressor	1/2 in.	6 ft.	Every 3 Years	Recommended Every Month - Max of every 90 days	BASIC™ test acceptable range: 3 oil units per month. See appendix A.
Compressor with up to 25% duty cycle e.g. Line haul single trailer with air suspension, RV, school bus. 	5 or less		1/2 in.	9 ft.			
High Air Use							
Compressor with up to 25% duty cycle e.g. Double/triple trailer, open highway coach, (most) pick-up & delivery, yard or terminal jockey, off-highway, construction, loggers, concrete mixer, dump truck, fire truck. 	8 or less	Bendix® Tu-Flo® 750 air compressor Bendix® BA-921® air compressor Bendix® Tu-Flo® 550 air compressor	1/2 in.	12 ft.	Every 2 Years	Every Month	BASIC™ test acceptable range: 5 oil units per month. See appendix A.
Compressor with up to 25% duty cycle e.g. City transit bus, refuse, bulk unloaders, low boys, urban region coach, central tire inflation. 	12 or less		5/8 in.	12 ft.			

Footnotes:

- 1 With increased air demand the air dryer cartridge needs to be replaced more often.
- 2 Use the drain valves to slowly drain all reservoirs to zero psi.
- 3 Allow the oil/water mixture to fully settle before measuring oil quantity.
- 4 To counter above normal temperatures at the air dryer inlet, (and resultant oil-vapor passing upstream in the air system) replace the discharge line with one of a larger diameter and/or longer length. This helps reduce the air's temperature. If sufficient cooling occurs, the oil-vapor condenses and can be removed by the air dryer. Discharge line upgrades are not covered under warranty. Note: To help prevent discharge line freeze-ups, shorter discharge line lengths or insulation may be required in cold climates. (See Bendix Bulletins TCH-008-021 and TCH-008-022, included in Appendix B, for more information.)
- 5 For certain vehicles/applications, where turbo-charged inlet air is used, a smaller size compressor may be permissible.

Note: Compressor and/or air dryer upgrades are recommended in cases where duty cycle is greater than the normal range (for the examples above).

For Bendix® Tu-Flo® 550 and 750 compressors, unloader service is recommended every 250,000 miles.

Air Brake Charging System Troubleshooting

How to use this guide:

Find the **symptom(s)** that you see, then move to the right to find the possible causes ("**What it may indicate**") and remedies ("**What you should do**").

Review the warranty policy before performing any intrusive compressor maintenance. Unloader or cylinder head gasket replacement and resealing of the bottom cover plate are usually permitted under warranty. Follow all standard safety procedures when performing any maintenance.

Look for:

 **Normal**

Normal - Charging system is working within normal range.

 **Check**

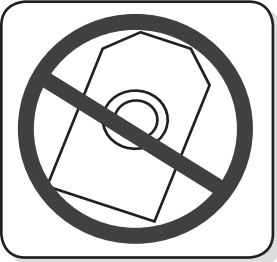
Check - Charging system needs further investigation.

GENERAL SAFETY GUIDELINES

WARNING! Please read and follow these instructions to avoid personal injury or death:

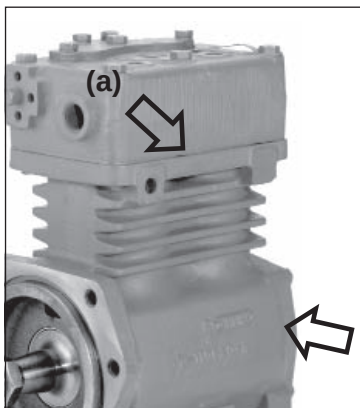
When working on or around a vehicle, the following general precautions should be observed at all times.

1. Park the vehicle on a level surface, apply the parking brakes, and always block the wheels. Always wear safety glasses.
2. Stop the engine and remove ignition key when working under or around the vehicle. When working in the engine compartment, the engine should be shut off and the ignition key should be removed. Where circumstances require that the engine be in operation, EXTREME CAUTION should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated or electrically charged components.
3. Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.
4. If the work is being performed on the vehicle's air brake system, or any auxiliary pressurized air systems, make certain to drain the air pressure from all reservoirs before beginning ANY work on the vehicle. If the vehicle is equipped with an AD-IS® air dryer system or a dryer reservoir module, be sure to drain the purge reservoir.
5. Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.
6. Never exceed manufacturer's recommended pressures.
7. Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.
8. Use only genuine Bendix® replacement parts, components and kits. Replacement hardware, tubing, hose, fittings, etc. must be of equivalent size, type and strength as original equipment and be designed specifically for such applications and systems.
9. Components with stripped threads or damaged parts should be replaced rather than repaired. Do not attempt repairs requiring machining or welding unless specifically stated and approved by the vehicle and component manufacturer.
10. Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.
11. For vehicles with Automatic Traction Control (ATC), the ATC function must be disabled (ATC indicator lamp should be ON) prior to performing any vehicle maintenance where one or more wheels on a drive axle are lifted off the ground and moving.

Symptom:	What it may indicate:	What you should do:
1.0 Oil Test Card Results	Not a valid test.	Discontinue using this test. Do not use this card test to diagnose compressor "oil passing" issues. They are subjective and error prone. Use only the Bendix Air System Inspection Cup (BASIC) test and the methods described in this guide for advanced troubleshooting. The Bendix® BASIC™ test should be the definitive method for judging excessive oil fouling/oil passing. (See Appendix A, on page 32 for a flowchart and expanded explanation of the checklist used when conducting the BASIC™ test.)
		
		Bendix® BASIC™ Test 

Symptom:	What it may indicate:	What you should do:
2.0 Oil on the Outside of the Compressor	Engine and/or other accessories leaking onto compressor.	Find the source and repair. Return the vehicle to service.
2.1 Oil leaking at compressor / engine connections:	(a) Leak at the front or rear (fuel pump, etc.) mounting flange. (b) Leak at air inlet fitting. (c) Leak at air discharge fitting. (d) Loose/broken oil line fittings.	⇒ Repair or replace as necessary. If the mounting bolt torques are low, replace the gasket. ⇒ Replace the fitting gasket. Inspect inlet hose and replace as necessary. ⇒ Replace gasket or fitting as necessary to ensure good seal. ⇒ Inspect and repair as necessary.
2.2 Oil leaking from compressor:	(a) Excessive leak at head gasket. (b) Leak at bottom cover plate. (c) Leak at internal rear flange gasket. (d) Leak through crankcase. (e) (If unable to tell source of leak.)	⇒ Go to Test 1 on page 29. ⇒ Reseal bottom cover plate using RTV silicone sealant. ⇒ Replace compressor. ⇒ Replace compressor. ⇒ Clean compressor and check periodically.

? Check



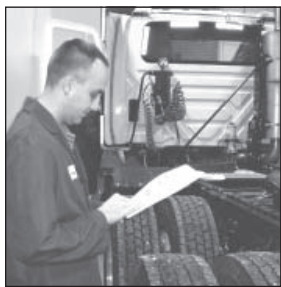
Head
gasket
and rear
flange
gasket
locations.

3.0 Oil at air dryer purge/exhaust or surrounding area	Air brake charging system functioning normally.	⇒ Air dryers remove water and oil from the air brake charging system. Check that regular maintenance is being performed. Return the vehicle to service. An optional kit (Bendix piece number 5011327 for the Bendix® AD-IS® or AD-IP® air dryers, or 5003838 for the Bendix® AD-9® air dryer) is available to redirect the air dryer exhaust.
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✓ Normal

Symptom:**What it may indicate:****What you should do:****4.0 Oil in Supply or Service Reservoir (air dryer installed)**

(If a maintained Bendix® PuraGuard® system filter or Bendix® PuraGuard® QC oil coalescing filter is installed, call 1-800-AIR-BRAKE (1-800-247-2725) and speak to a Tech Team member.)



See Table A, on page 18, for maintenance schedule information.

Maintenance

- (a) **If** air brake charging system maintenance **has not been performed**. That is, reservoir(s) **have not** been drained per the schedule in Table A on page 18, Column 4 **and/or** the air dryer maintenance **has not** been performed as in Column 3.
- (b) **If** the vehicle maintenance **has been performed** as recommended in Table A on page 18, some oil in the reservoirs is normal.



Drain **all** air tanks (reservoirs) into the Bendix® BASIC™ test cup. (Bendix kit P/N 5013711).

- ⇒ Drain all air tanks and check vehicle at next service interval using the Bendix® BASIC™ test. See Table A on page 18, column 3 and 4, for recommended service schedule.

? Check

- ⇒ Drain all air tanks into Bendix® BASIC™ test cup (Bendix Air System Inspection Cup). If less than one unit of reservoir contents is found, the vehicle can be returned to service. **Note: If more than one oil unit of water (or a cloudy emulsion mixture) is present, change the vehicle's air dryer, check for air system leakage (Test 2, on page 29), stop inspection and check again at the next service interval. See the BASIC™ test kit for full details.** If less than one "oil unit" of water (or water/cloudy emulsion mixture) is present, use the BASIC™ test cup chart on the label of the cup to determine if the amount of oil found is within the acceptable level.
- ⇒ If within the normal range, return the vehicle to service. For vehicles with accessories that are sensitive to small amounts of oil, consider a Bendix® PuraGuard® QC oil coalescing filter.
- ⇒ If outside the normal range go to Symptom 4.0(c).
- Also see the Table A on page 18, column 3 for recommended air dryer cartridge replacement schedule.

Duty cycle too high

- (c) Air brake system leakage.
- (d) Compressor may be undersized for the application.

- ⇒ Go to Test 2 on page 29.
- ⇒ See Table A, column 1, on page 18 for recommended compressor sizes.
- ⇒ If the compressor is "too small" for the vehicle's role (for example, where a vehicle's use has changed or service conditions exceed the original vehicle or engine OE spec's) then upgrade the compressor. Note: The costs incurred (e.g. installing a larger capacity compressor, etc.) are not covered under original compressor warranty.
- ⇒ If the compressor is correct for the vehicle, go to Symptom 4.0 (e).

The **duty cycle** is the ratio of time the compressor spends building air to total engine running time. Air compressors are designed to build air (to "run loaded") up to 25% of the time. Higher duty cycles cause conditions that affect air brake charging system performance which may require additional maintenance. Factors that add to the duty cycle are: air suspension, additional air accessories, use of an undersized compressor, frequent stops, excessive leakage from fittings, connections, lines, chambers or valves, etc.

Symptom:	What it may indicate:	What you should do:
----------	-----------------------	---------------------

4.0 Oil in Supply or Service Reservoir* (air dryer installed) (continued)

Temperature

(e) Air compressor discharge and/or air dryer inlet temperature too high.

⇒ Check temperature as outlined in Test 3 on page 29. If temperatures are normal go to 4.0(h).

(f) Insufficient coolant flow.

⇒ Inspect coolant line. Replace as necessary (I.D. is 1/2").

⇒ Inspect the coolant lines for kinks and restrictions and fittings for restrictions. Replace as necessary.

⇒ Verify coolant lines go from engine block to compressor and back to the water pump. Repair as necessary.



Testing the temperature at the discharge fitting.



Inspecting the coolant hoses.

(g) Restricted discharge line.

⇒ If discharge line is restricted or more than 1/16" carbon build up is found, replace the discharge line. See Table A, column 2, on page 18 for recommended size. Replace as necessary.

⇒ The discharge line must maintain a **constant slope** down from the compressor to the air dryer inlet fitting to avoid low points where ice may form and block the flow. If, instead, ice blockages occur at the air dryer inlet, insulation may be added here, or if the inlet fitting is a typical 90 degree fitting, it may be changed to a straight or 45 degree fitting. For more information on how to help prevent discharge line freeze-ups, see Bendix Bulletins TCH-008-021 and TCH-008-022 (Appendix B). Shorter discharge line lengths or insulation may be required in cold climates.



Kinked discharge line shown.

Other

(h) Restricted air inlet (not enough air to compressor).

⇒ Check compressor air inlet line for restrictions, brittleness, soft or sagging hose conditions, etc. Repair as necessary. Inlet line size is 3/4 ID. Maximum restriction requirement for compressors is 25 inches of water.

⇒ Check the engine air filter and service if necessary (if possible, check the air filter usage indicator).



Partly collapsed inlet line shown.

? Check

*If a maintained Bendix® PuraGuard® system filter or Bendix® PuraGuard® QC oil coalescing filter is installed, call 1-800-AIR-BRAKE (1-800-247-2725) and speak to a Tech Team member.

Symptom:**What it may indicate:****What you should do:****4.0 Oil in Supply or Service Reservoir* (air dryer installed) (continued)****Other (cont.)**

- (i) Poorly filtered inlet air (poor air quality to compressor).



Inspect the engine air cleaner.

- ⇒ Check for leaking, damaged or defective compressor air inlet components (e.g. induction line, fittings, gaskets, filter bodies, etc.). Repair inlet components as needed. Note: Dirt ingestion will damage compressor and is not covered under warranty.

? Check

- (j) Governor malfunction or setting.

- ⇒ Go to Test 4 on page 30.

- (k) Compressor malfunction.

- ⇒ If you found excessive oil present in the service reservoir in step 4.0 (b) above and you did not find any issues in steps 4.0 (c) through 4.0 (j) above, the compressor may be passing oil.

Replace compressor. If still under warranty, follow normal warranty process. Note: After replacing a compressor, residual oil may take a considerable period of time to be flushed from the air brake system.

Crankcase Flooding

Consider installing a compressor bottom drain kit (where available) in cases of chronic oil passing where all other operating conditions have been investigated. Bendix compressors are designed to have a 'dry' sump and the presence of excess oil in the crankcase can lead to oil carryover.

*If a maintained Bendix® PuraGuard® system filter or Bendix® PuraGuard® QC oil coalescing filter is installed, call 1-800-AIR-BRAKE (1-800-247-2725) and speak to a Tech Team member.

5.0 Oil present at valves (e.g. at exhaust, or seen during servicing).

Air brake system valves are required to tolerate a light coating of oil.

✓ Normal

- ⇒ A small amount of oil does not affect SAE J2024** compliant valves.

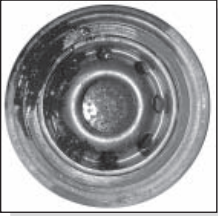
- ⇒ Check that regular maintenance is being performed and that the amount of oil in the air tanks (reservoirs) is within the acceptable range shown on the Bendix® BASIC™ test cup (see also column 5 of Table A on page 18). Return the vehicle to service.

For oil-sensitive systems, see page 17.



Genuine Bendix valves are all SAE J2024 compliant.

** SAE J2024 outlines tests all air brake system pneumatic components need to be able to pass, including minimum levels of tolerance to contamination.

Symptom:	What it may indicate:	What you should do:
6.0 Excessive oil consumption in engine.	A problem with engine or other engine accessory.  The engine service manual has more information.	⇒ See engine service manual. ? Check
7.0 Oil present at air dryer cartridge during maintenance.	Air brake charging system is functioning normally.  Oil shown leaking from an air dryer cartridge. ✓ Normal	⇒ Air dryers remove water and oil from the air brake charging system. A small amount of oil is normal. Check that regular maintenance is being performed and that the amount of oil in the air tanks (reservoirs) is within the acceptable range shown by the BASIC™ Test (see also column 5 of Table A on page 18). Replace the air dryer cartridge as needed and return the vehicle to service.
8.0 Oil in ping tank or compressor discharge aftercooler.	Air brake charging system is functioning normally. ✓ Normal	⇒ Follow vehicle O.E. maintenance recommendation for these components.
9.0 Air brake charging system seems slow to build pressure.	(a) Air brake charging system functioning normally. ✓ Normal (b) Air brake system leakage. (c) Compressor may be undersized for the application. (d) Compressor unloader mechanism malfunction. (e) Damaged compressor head gasket.	⇒ Using dash gauges, verify that the compressor builds air system pressure from 85-100 psi in 40 seconds or less with engine at full governed rpm. Return the vehicle to service. ⇒ Go to Test 2 on page 29. ⇒ See Table A, column 1, on page 18 for some typical compressor applications. If the compressor is "too small" for the vehicle's role, for example, where a vehicle's use has changed, then upgrade the compressor. Note: The costs incurred (e.g. installing a larger capacity compressor, etc.) are not covered under original compressor warranty. ⇒ Go to Test 6 on page 30. ⇒ An air leak at the head gasket may indicate a downstream restriction such as a freeze-up or carbon blockage and/or could indicate a defective or missing safety valve. Find blockage (go to 9.0(f) for details.) and then replace the compressor. Do not re-use the safety valve without testing. See Symptom 12.0(a).

Symptom:**What it may indicate:****What you should do:**

9.0 Air brake charging system seems slow to build pressure. (continued)



Dash gauges.

(f) Restricted discharge line.

? Check



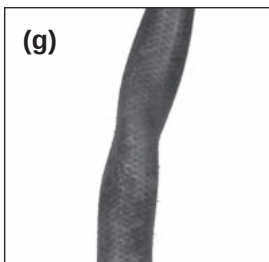
Kinked discharge line shown.

⇒ If discharge line is restricted:

⇒ By more than 1/16" carbon build up, replace the discharge line (see Table A, column 2, on page 18 for recommended size) and go to Test 3 on page 29.

⇒ By other restrictions (e.g. kinks). Replace the discharge line. See Table A, column 2, on page 18 for recommended size. Retest for air build. Return vehicle to service or, if problem persists, go to 9.0(a).

⇒ The discharge line must maintain a **constant slope** down from the compressor to the air dryer inlet fitting to avoid low points where ice may form and block the flow. If, instead, ice blockages occur at the air dryer inlet, insulation may be added here, or if the inlet fitting is a typical 90 degree fitting, it may be changed to a straight or 45 degree fitting. For more information on how to help prevent discharge line freeze-ups, see Bendix Bulletins TCH-008-021 and TCH-008-022 (Appendix B). Shorter discharge line lengths or insulation may be required in cold climates.



Partly collapsed inlet line shown.

(g) Restricted air inlet (not enough air to compressor).

? Check

⇒ Check compressor air inlet line for restrictions, brittleness, soft or sagging hose conditions, etc. Repair as necessary. Refer to vehicle manufacturer's guidelines for inlet line size.

⇒ Check the engine air filter and service if necessary (if possible, check the air filter usage indicator).

(h) Poorly filtered inlet air (poor air quality to compressor).

? Check

⇒ Check for leaking, damaged or defective compressor air inlet components (e.g. induction line, fittings, gaskets, filter bodies, etc.). Repair inlet components as needed. Note: Dirt ingestion will damage compressor and is not covered under warranty.

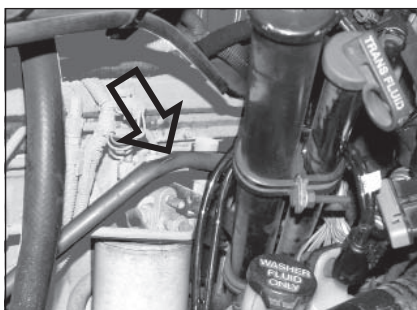
(i) Compressor malfunction.

? Check

⇒ Replace the compressor only after making certain that none of the preceding conditions, 9.0 (a) through 9.0 (h), exist.

Symptom:	What it may indicate:	What you should do:
10.0 Air charging system doesn't build air.	(a) Governor malfunction*.	⇒ Go to Test 4 on page 30.
	(b) Restricted discharge line.	⇒ See 9.0(f).
	(c) Air dryer heater malfunction: exhaust port frozen open.	⇒ Replace air dryer heater.
	(d) Compressor malfunction.	⇒ Replace the compressor only after making certain the preceding conditions do not exist.
* Note: For the Bendix® DuraFlo 596™ air compressor, not only the governor, but also the SV-1™ synchro valve used would need to be tested. See Bulletin TCH-001-048.		

11.0 Compressor safety valve releases air (Compressor builds too much air).

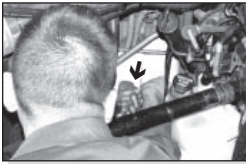


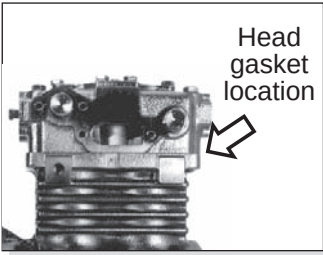
Damaged discharge line shown.

(a) Restricted discharge line.

? Check

- ⇒ If discharge line is restricted:
 - ⇒ By more than 1/16" carbon build up, replace the discharge line (see Table A, column 2, on page 18 for recommended size) and go to Test 3 on page 29.
 - ⇒ By other restrictions (e.g. kinks). Replace the discharge line. See Table A, column 2, on page 18 for recommended size.
- ⇒ The discharge line must maintain a **constant slope** down from the compressor to the air dryer inlet fitting to avoid low points where ice may form and block the flow. If, instead, ice blockages occur at the air dryer inlet, insulation may be added here, or if the inlet fitting is a typical 90 degree fitting, it may be changed to a straight or 45 degree fitting. For more information on how to help prevent discharge line freeze-ups, see Bendix Bulletins TCH-008-021 and TCH-008-022 (Appendix B). Shorter discharge line lengths or insulation may be required in cold climates.
- (b) Downstream air brake system check valves or lines may be blocked or damaged. ⇒ Inspect air lines and verify check valves are operating properly.
- (c) Air dryer lines incorrectly installed. ⇒ Ensure discharge line is installed into the inlet of the air dryer and delivery is routed to the service reservoir.
- (d) Compressor safety valve malfunction. ⇒ Verify relief pressure is 250 psi. Replace if defective.
- (e) Compressor unloader mechanism malfunction. ⇒ Go to Test 6 on page 30.
- (f) Governor malfunction. ⇒ Go to Test 4 on page 30.

Symptom:	What it may indicate:	What you should do:
12.0 Air dryer safety valve releases air.   Technician removes governor.	(a) Restriction between air dryer and reservoir. (b) Air dryer safety valve malfunction. (c) Air dryer maintenance not performed. (d) Air dryer malfunction. (e) Improper governor control line installation to the reservoir. (f) Governor malfunction.	⇒ Inspect delivery lines to reservoir for restrictions and repair as needed. ⇒ Verify relief pressure is at vehicle or component manufacturer specifications. Replace if defective. ⇒ See Maintenance Schedule and Usage Guidelines (Table A, column 3, on page 18). ⇒ Verify operation of air dryer. Follow vehicle O.E. maintenance recommendations and component Service Data information. ⇒ Go to Test 5 on page 30. ⇒ Go to Test 4 on page 30.
13.0 Reservoir safety valve releases air	(a) Reservoir safety valve malfunction. (b) Governor malfunction. (c) Compressor unloader mechanism malfunction.	⇒ Verify relief pressure is at vehicle or component manufacturer's specifications (typically 150 psi). Replace if defective. ⇒ Go to Test 4 on page 30. ⇒ Go to Test 6 on page 30.
14.0 Air dryer doesn't purge. (Never hear exhaust from air dryer.)	(a) Air dryer malfunction. (b) Governor malfunction. (c) Air brake system leakage. (d) Improper governor control line installation to the reservoir.	⇒ Verify operation of air dryer. Follow vehicle O.E. maintenance recommendations. ⇒ Go to Test 4 on page 30. ⇒ Go to Test 2 on page 29. ⇒ Go to Test 5 on page 30.
15.0 Compressor constantly cycles (compressor remains unloaded for a very short time.)	(a) Air brake charging system maintenance not performed.  Check (b) Compressor unloader mechanism malfunction. (c) Air dryer purge valve or delivery check valve malfunction. (d) Air brake system leakage.	⇒ Available reservoir capacity may be reduced by build up of water, etc. Drain and perform routine maintenance per Table A, columns 3 & 4, on page 18. ⇒ Go to Test 6 on page 30. ⇒ Verify operation of air dryer. Follow vehicle O.E. maintenance recommendations and component Service Data information. ⇒ Go to Test 2 on page 29.

Symptom:	What it may indicate:	What you should do:
16.0 Compressor leaks air  Testing for leaks with soap solution.	(a) Compressor leaks air at connections or ports. (b) Compressor unloader mechanism malfunction. (c) Damaged compressor head gasket. 	⇒ Check for leaking, damaged or defective compressor fittings, gaskets, etc. Repair or replace as necessary. ⇒ Go to Test 6 on page 30. ⇒ An air leak at the head gasket may indicate a downstream restriction such as a freeze-up or carbon blockage and/or could indicate a defective or missing safety valve. Find blockage (go to 9.0(f) for details.) and then replace the compressor. Do not re-use the safety valve without testing. See Symptom 12.0(a).
17.0 Compressor leaks coolant	(a) Improperly installed plugs or coolant line fittings. (b) Damaged compressor head gasket. (c) Porous compressor head casting.	⇒ Inspect for loose or over-torqued fittings. Reseal and tighten loose fittings and plugs as necessary. If overtightened fittings and plugs have cracked ports in the head, replace the compressor. ⇒ An air leak at the head gasket may indicate a downstream restriction such as a freeze-up or carbon blockage and/or could indicate a defective or missing safety valve. Find blockage (go to 9.0(f) for details.) and then replace the compressor. Do not re-use the safety valve without testing. See Symptom 12.0(a). ⇒ If casting porosity is detected, replace the compressor.
18.0 Noisy compressor (Multi-cylinder compressors only)	(a) Damaged compressor.	⇒ Replace the compressor.

Other Miscellaneous Areas to Consider

This guide attempts to cover most compressor system problems. Here are some rare sources of problems not covered in this guide:

- Turbocharger leakage. Lubricating oil from leaking turbocharger seals can enter the air compressor intake and give misleading symptoms.

- Where a compressor does not have a safety valve installed, if a partial or complete discharge line blockage has occurred, damage can occur to the connecting rod bearings. Damage of this kind may not be detected and could lead to compressor problems at a later date.

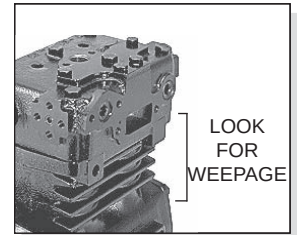
Tests

Test 1: Excessive Oil Leakage at the Head Gasket

Exterior leaks at the head gasket are not a sign that oil is being passed into the air charging system. Oil weepage at the head gasket does not prevent the compressor from building air.

Observe the amount of weepage from the head gasket.

If the oil is only around the cylinder head area, it is acceptable (return the vehicle to service), but, if the oil weepage extends down to the nameplate area of the compressor, the gasket can be replaced.



Test 2: Air Brake System and Accessory Leakage

Inspect for air leaks when working on a vehicle and repair them promptly.

Park the vehicle on level ground and chock wheels. Build system pressure to governor cut-out and allow the pressure to stabilize for one minute.

Step 1: Observe the dash gauges for two additional minutes without the service brakes applied.

Step 2: Apply the service brakes and allow the pressure to stabilize. Continue holding for two minutes (you may use a block of wood to hold the

pedal in position.) Observe the dash gauges.

If you see **any noticeable decrease** of the dash air gauge readings (i.e. more than 4 psi, plus two psi for each additional trailer) during either two minute test, **repair the leaks** and repeat this test to confirm that they have been repaired.

Air leaks can also be found in the charging system, parking brakes, and/or other components - inspect and repair as necessary.

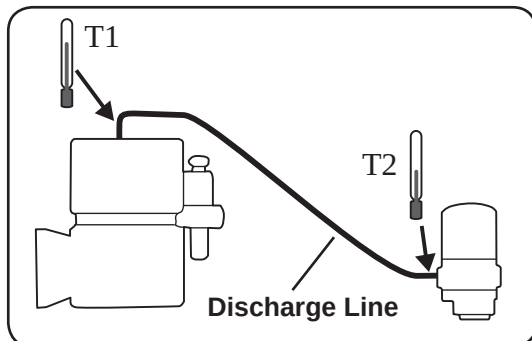
Test 3: Air Compressor Discharge Temperature and Air Dryer Inlet Temperature*

Caution: The temperatures used in this test are not normal vehicle conditions.

Above normal temperatures can cause oil (as vapor) to pass through the air dryer into the air brake system.

This test is run with the engine at normal operating temperature, with engine at max. rpm. If available, a dyno may be used.

1. Allow the compressor to build the air system pressure to governor cut-in.
2. Pump the brakes to bring the dash gauge pressure to 90 psi.
3. Allow the compressor to build pressure from 95 to 105 psi gauge pressure and maintain this pressure range by cycling the brakes **for five (5) minutes.**



(* Note that only vehicles that have passed Test 2 would be candidates for this test.)

4. Then, while maintaining max rpm and pressure range, measure and **record the surface temperature** of the **ittings**:
 - ⇒ at the compressor discharge port. (T1).
 - ⇒ at the air dryer inlet fitting. (T2).
 Use a touch probe thermocouple for measuring the temperature.
5. See table below.
6. Retest before returning the vehicle to service.

T1 Compressor Discharge Fitting	T2 Air Dryer Inlet Fitting	Action
under 360°F	under 200°F	Temperatures are within normal range for this test, check other symptoms. Go to 4.0 (h).
under 360°F	over 200°F	This could indicate a discharge line problem (e.g. restriction). Call 1-800-AIR-BRAKE (1-800-247-2725) and speak with our Tech Team.
over 360°F	—	Compressor is running hot. Check coolant 4(f) and/or discharge line 4(g).

Tests (continued)

Test 4: Governor Malfunction

1. Inspect control lines to and from the governor for restrictions (e.g. collapsed or kinked). Repair as necessary.
2. Using a calibrated external gauge in the supply reservoir, service reservoir, or reservoir port of the D-2[®] governor, verify cut-in and cut-out pressures are within vehicle OEM specification.
3. If the governor is malfunctioning, replace it.

Test 5: Governor Control Line

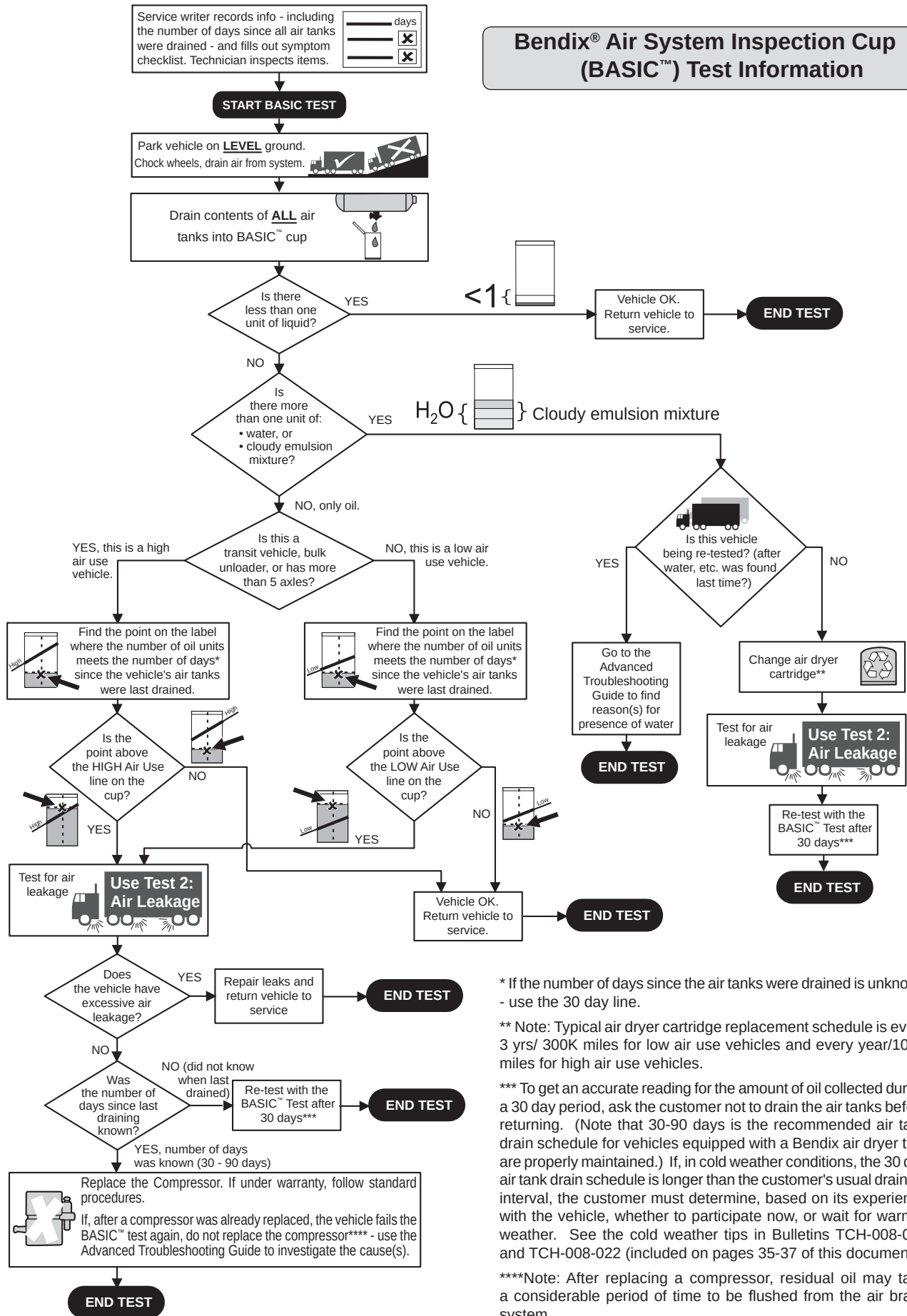
1. Ensure that the governor control line from the reservoir is located at or near the top of the reservoir. (This line, if located near the bottom of the reservoir, can become blocked or restricted by the reservoir contents e.g. water or ice.)
2. Perform proper reservoir drain intervals and air dryer cartridge maintenance per Maintenance Schedule and Usage Guidelines (Table A on page 18).
3. Return the vehicle to service.

Test 6: Compressor Unloader Leakage

Bendix[®] Compressors: Park vehicle, chock wheels, and follow all standard safety procedures. Remove the governor and install a fitting to the unloader port. Add a section of air hose (min 1ft long for a 1/2" diameter line) and a gauge to the fitting followed by a shut-off valve and an air source (shop air or small air tank). Open the shut off and

charge the unloader port by allowing air pressure to enter the hose and unload the compressor. Shut off the air supply and observe the gauge. A steady reading indicates no leakage at the unloader port, but a falling reading shows that the unloader mechanism is leaking and needs to be serviced.

Appendix A: Information about the BASIC™ Test Kit (Bendix P/N 5013711)



* If the number of days since the air tanks were drained is unknown - use the 30 day line.

** Note: Typical air dryer cartridge replacement schedule is every 3 yrs/ 300K miles for low air use vehicles and every year/100K miles for high air use vehicles.

*** To get an accurate reading for the amount of oil collected during a 30 day period, ask the customer not to drain the air tanks before returning. (Note that 30-90 days is the recommended air tank drain schedule for vehicles equipped with a Bendix air dryer that are properly maintained.) If, in cold weather conditions, the 30 day air tank drain schedule is longer than the customer's usual draining interval, the customer must determine, based on its experience with the vehicle, whether to participate now, or wait for warmer weather. See the cold weather tips in Bulletins TCH-008-021 and TCH-008-022 (included on pages 35-37 of this document).

****Note: After replacing a compressor, residual oil may take a considerable period of time to be flushed from the air brake system.

Appendix A continued: Information about the BASIC™ Test Kit (Bendix P/N 5013711)

Filling in the Checklist for the Bendix® Air System Inspection Cup (BASIC™) Test

Note: Follow all standard safety precautions. For vehicles using a desiccant air dryer.

The Service Writer fills out these fields with information gained from the customer

Number of Days Since Air Tanks Were Last Drained: _____ Date: _____ Vehicle #: _____
Engine SN _____ Vehicle Used for: _____ Typical Load: _____ (lbs.)
No. of Axles: ____ (tractor) ____ (trailer) No. of Lift Axles: ____ Technician's Name: _____

The Service Writer also checks off any complaints that the customer makes to help the Technician in investigating.

Customer's Complaint (Please check all that apply)	Checklist for Technician Have you confirmed complaint?
"Relay valve ☐ leaks oil / ☐ malfunctions"	☐ no ☐ yes*
"Dash valve ☐ leaks oil / ☐ malfunctions"	☐ no ☐ yes*
☐ "Air dryer leaks oil"	☐ no ☐ yes*
☐ "Governor malfunction"	☐ no ☐ yes*
☐ "Oil in gladhands"	☐ no ☐ yes*
how much oil did you find? _____	
☐ "Oil on ground or vehicle exterior"	☐ no ☐ yes*
amount described: _____	
☐ "Short air dryer cartridge life"	
replaces every: _____ ☐ miles, ☐ kms, or ☐ months	
☐ "Oil in air tanks" amount described: _____	
We will measure amount currently found when we get to step B of the test.	
☐ "Excessive engine oil loss" amount described: _____	
Is the engine leaking oil?	☐ no ☐ yes*
Is the compressor leaking oil?	☐ no ☐ yes*
☐ Other complaint: _____	
☐ No customer complaint.	

The Technician checks boxes for any of the complaints that can be confirmed.

* Note: A confirmed complaint above **does NOT** mean that the compressor must be replaced. The full BASIC™ test below will investigate the facts.

BASIC™ test starts here:

STEP A - Select one:

- ☐ This is a low air use vehicle: Line haul (single trailer) with 5 or less axles, **or**
 - ☐ This is a high air use vehicle: Garbage truck, transit bus, bulk unloader, or line haul with 6 or more axles.
- Then go to Step B.**

The Technician selects the air use category for the vehicle. This decided which of the two acceptance lines on the cup will be used for the test below.

STEP B - Measure the Charging System Contents

1. Park and chock vehicle on level ground. Drain the air system by pumping the service brakes.
2. Completely drain **ALL** the air tanks into a single BASIC™ cup.
3. If there is less than one unit of contents total, end the test now and return the vehicle to service. Vehicle passes.
4. **If more than one oil unit of water (or a cloudy emulsion mixture) is found:**
 - (a) Change the vehicle's air dryer cartridge - see Footnote 1,
 - (b) Conduct the 4 minute leakage test (Step D),
 - (c) **STOP the inspection, and check the vehicle again after 30 days** - see Footnote 2.



For an accurate test, the contents of all the air tanks on the vehicle should be used.

Note for returning vehicles that are being retested after a water/cloudy emulsion mixture was found last time and the air dryer cartridge replaced: If more than one oil unit of water or a cloudy emulsion mixture is found **again**, stop the BASIC™ test and consult the air dryer's Service Data sheet troubleshooting section.

Otherwise, go to Step C.

Footnote 1: Note: Typical air dryer cartridge replacement schedule is every 3 yrs/300K miles for low air use vehicles and every year/100K miles for high air use vehicles.

Footnote 2: To get an accurate reading for the amount of oil collected during a 30 day period, ask the customer not to drain the air tanks before returning. (Note that 30-90 days is the recommended air tank drain schedule for vehicles equipped with a Bendix air dryer that are properly maintained.) If, in cold weather conditions, the 30 day air tank drain schedule is longer than the customer's usual draining interval, the customer must determine, based on its experience with the vehicle, whether to participate now, or wait for warmer weather. See the cold weather tips in Bulletins TCH-008-021 and TCH-008-022 (included in Appendix B of the advanced troubleshooting guide).

Appendix A continued: Information about the BASIC™ Test Kit (Bendix P/N 5013711)

Filling in the Checklist for the Bendix® Air System Inspection Cup (BASIC™) Test

Note: Follow all standard safety precautions. For vehicles using a desiccant air dryer.

STEP C - How to Use the BASIC™ Test

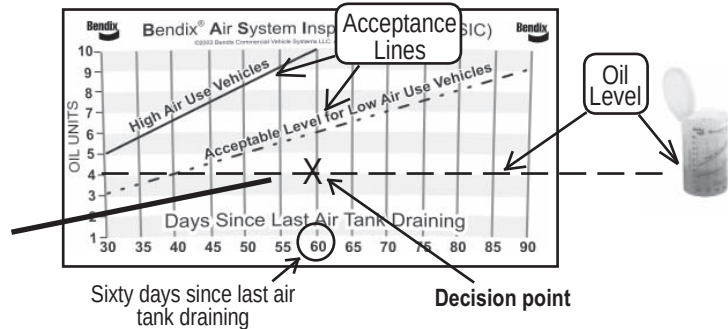
The Technician uses the chart (label) on the BASIC™ test cup to help decide the action to take, based on the amount of oil found. Use the lower acceptance line for low air use vehicles, and upper line for high air use vehicles (from Step A).

1. Record days since air tanks were last drained. _____ days	2. Record amount of oil found: _____ units	3. Action to take
If number of days is: 30-60 days (high air use) or 30-90 days (low air use) →	if oil level is at or below acceptance line for number of days →	System OK. Return to service. STOP TEST
	if oil level is above acceptance line for number of days →	Go to Step D
Otherwise . . . → (if the number of days is unknown, or outside the limits above)	if oil level is at or below 30-day acceptance line →	System OK. Return to service. STOP TEST
	if oil level is above 30-day acceptance line →	Stop inspection. Test again after 30 days. See Footnote 2. STOP + CK

BASIC™ Test Example

An oil level of 4 units in a sixty-day period is within the acceptance area (at or below the line) for both low and high air use vehicles. Return the vehicle to service.

The Technician looks for the point where the number of days since the air tanks were drained meets the oil level. If it is at or below the (low or high use) acceptance line, the vehicle has passed the test. If the point is above the line we go to the leakage test.



STEP D - Air Brake System Leakage Test

Park the vehicle on level ground and chock wheels. Build system pressure to governor cut-out and allow the pressure to stabilize for one minute.

- 1: Observe the dash gauges for two additional minutes without the service brakes applied.
- 2: Apply service brakes for two minutes (allow pressure to stabilize) and observe the dash gauges.

If you see any noticeable decrease of the dash air gauge readings repair leaks. Repeat this test to confirm that air leaks have been repaired and return vehicle to service. Please repeat BASIC™ test at next service interval. Note: Air leaks can also be found in the charging system, parking brakes, and/or other components - inspect and repair as necessary.

Air leakage is the number one cause of compressors having to pump excessive amounts of air, in turn run too hot and pass oil vapor along into the system. Here the Technician conducts a four-minute test to see if leakage is a problem with the vehicle being tested.

If no air leakage was detected, and if you are conducting this test after completing Step C, go to Step E.

STEP E - If no air leakage was detected in Step D

Replace the compressor.

Note: If the compressor is within warranty period, please follow standard warranty procedures. Attach the completed checklist to warranty claim.

The Technician only reaches Step E if the amount of oil found, for the amount of time since the air tanks were last drained exceeds the acceptance level, AND the vehicle passes the four-minute leakage test (no noticeable leakage was detected).

Technical Bulletin

Bulletin No: **TCH-008-021**Effective Date: **3-5-2010**Cancels: **PRO-08-21 dated 2-6-2008**

Page: 1 of 2

Subject: **Air Brake System - Cold Weather Operation Tips**

As the cold weather approaches, operators and fleets alike begin to look to their vehicles with an eye toward "winterization", and particularly what can be done to guard against air system freeze-up. Here are some basic "Tips" for operation in the cold weather.

Engine Idling

Avoid idling the engine for long periods of time! In addition to the fact that most engine manufacturers warn that long idle times are detrimental to engine life, winter idling is a big factor in compressor discharge line freeze-up. Discharge line freeze-ups account for a significant number of compressor failures each year. The discharge line recommendations under "Discharge Lines" are important for all vehicles, but are especially so when some periods of extended engine idling can not be avoided.

Discharge Lines

The discharge line should slope downward from the compressor discharge port without forming water traps, kinks, or restrictions. Cross-overs from one side of the frame rail to the other, if required, should occur as close as possible to the compressor.

Dryer Inlet Temperature

The dryer inlet air temperature should typically be within the range of no more than 160°F and no less than 45°F above low ambient (surrounding) temperature to prevent freeze-ups. (For example, if low ambient is minus 40°F, the dryer inlet must be above 5°F.) Lower dryer inlet temperatures should be avoided to minimize the risk of freeze-up upstream of the air dryer. Higher temperatures should also be avoided to minimize the risk of heat damage to the air dryer seals and to avoid a loss of drying performance.

Compressor Line Size

The line size and length is established by the vehicle manufacturer and should not be altered without the vehicle manufacturers approval. As a reference, the line length from the compressor to the air dryer should be less than 16 feet and the minimum line sizes should be as follows:

Minimum Length	Minimum I.D.	Application
6 ft.	1/2 in.	Low Compressor Duty Cycle Applications (0-20%)
10 ft.	5/8 in.	High Compressor Duty Cycle Applications (20-40%)

Line Insulation

To guard against freez-ups in Low Duty Cycle applications, the discharge line can be insulated if it is greater than 9 feet in length. The line can only be insulated back to 9 feet and a maximum of 3 feet. For example, if the line is 10 feet, insulate the fitting and the last one foot of the line. If the line is 15 feet, insulate the fitting and the last 3 feet of the line.

System Leakage

Check the air brake system for excessive air leakage using the Bendix “Dual System Air Brake Test and Check List” (BW1279). Excessive system leakage causes the compressor to “pump” more air and also reduce the life of the air dryer desiccant cartridge.

Reservoir Draining (System without an Air Dryer)

Routine reservoir draining is the most basic step in reducing the possibility of freeze-up. All reservoirs in a brake system can accumulate water and other contamination and must be drained! The best practice is to drain all reservoirs daily if the air brake system does not include an air dryer. When draining reservoirs; turn the ENGINE OFF and drain ALL AIR from the reservoir, better still, open the drain cocks on all reservoirs and leave them open over night to assure all contamination is drained (reference Service Data Sheet SD-04-400 for Bendix Reservoirs). If automatic drain valves are installed, check their operation before the weather turns cold (reference Service Data Sheet SD-03-2501 for Bendix® DV-2™ Automatic Drain Valves). It should be noted that, while the need for daily reservoir draining is eliminated through the use of an automatic drain valve, periodic manual draining is still required.

Reservoir Draining (System with an Air Dryer)

Daily reservoir draining should not be performed on systems with an air dryer. This practice will cause the dryer to do excessive work (i.e. build pressure from 0 -130 psi instead of the normal 110-130 psi).

Alcohol Evaporator or Injector Systems

Bendix Commercial Vehicle Systems LLC discourages the use of alcohol in the air brake system as a means of preventing system freeze-up in cold temperatures. Studies indicate that using alcohol and alcohol based products sold for this purpose removes the lubrication from the components of the air braking system. In addition, the materials used for the internal seals of the air system components may be adversely impacted by the residue that some anti-freeze additives leave behind. Both are detrimental to air system component life expectancy, causing premature wear. Because of this, Bendix® air system components warranty will be void if analysis shows that alcohol was added to the air brake system.

Alcohol is not an acceptable substitute for having adequate air drying capacity. If the air dryer is maintained in accordance with the manufacturer's recommended practices and moisture is found to be present in the system reservoirs, more drying capacity is required. Bendix has several viable options including extended purge air dryers, extended purge tandem dryers in parallel with common control, and air dryers arranged to provide continuous flow as with the Bendix® EverFlow® continuous flow air dryer module. To address concerns with contaminants in trailer air brake systems, the Bendix® Cyclone DuraDrain™ water separator and the Bendix® System-Guard® trailer air dryer are available. Refer to Bendix Technical Bulletin TCH-008-042 “Alcohol in the Air Brake System” for additional information.

Air Dryers

Make certain air brake system leakage is within the limits stated in BW1279. Check the operation and function of the air dryer using the appropriate Service Data Sheet for the air dryer.

Air Dryer	Service Data Sheet
AD-2® air dryer	SD-08-2403
AD-4® air dryer	SD-08-2407
AD-9® air dryer	SD-08-2412
AD-IP® air dryer	SD-08-2414
AD-IS® air dryer	SD-08-2418
AD-IS® EverFlow® air dryer	SD-08-2417
AD-SP® air dryer	SD-08-2415
Cyclone DuraDrain™ water separator	SD-08-2402
PuraGuard® QC system filter	SD-08-187B
Trailer System-Guard® air dryer	SD-08-2416

Bendix literature is
available to order or
download on Bendix.com



Technical Bulletin



Bulletin No.: TCH-008-022

Effective Date: 1/1/1994

Page: 1 of 1

Subject: **Additional Cold Weather Operation Tips for the Air Brake System**

Last year we published Bulletin TCH-008-021 which provided some guidelines for "winterizing" a vehicle air brake system. Here are some additional suggestions for making cold weather vehicle operation just a little more bearable.

Thawing Frozen Air Lines

The old saying; "Prevention is the best medicine" truly applies here! Each year this activity accounts for an untold amount of unnecessary labor and component replacement. Here are some Do's and Don'ts for prevention and thawing.

Do's

1. Do maintain freeze prevention devices to prevent road calls. Don't let evaporators or injectors run out of methanol alcohol or protection will be degraded. Check the air dryer for proper operation and change the desiccant when needed.
2. Do thaw out frozen air lines and valves by placing the vehicle in a warmed building. This is the only method for thawing that will not cause damage to the air system or its components.
3. Do use dummy hose couplings on the tractor and trailer.
4. Do check for sections of air line that could form water traps. Look for "drooping" lines.

Don'ts

1. Do not apply an open flame to air lines and valves. Beyond causing damage to the internal nonmetallic parts of valves and melting or burning non-metallic air lines. **WARNING: THIS PRACTICE IS UNSAFE AND CAN RESULT IN VEHICLE FIRE!**
2. Do not introduce (pour) fluids into air brake lines or hose couplings ("glad hands"). Some fluids used can cause immediate and severe damage to rubber components. Even methanol alcohol, which is used in Alcohol Evaporators and Injectors, should not be poured into air lines. Fluids poured into the system wash lubricants out of valves, collect in brake chambers and valves and can cause malfunction. Loss of lubricant can affect valve operating characteristics, accelerate wear and cause premature replacement.
3. Do not park a vehicle outside after thawing its air system indoors. Condensation will form in the system and freeze again. Place the vehicle in operation when it is removed to the outdoors.

Supporting Air and Electrical Lines

Make certain tie wraps are replaced and support brackets are re-assembled if removed during routine maintenance. These items prevent the weight of ice and snow accumulations from breaking or disconnecting air lines and wires.

Automatic Drain Valves (System without Air Dryer)

As we stated last year, routine reservoir draining is the most basic step (although not completely effective) in reducing the possibility of freeze-ups. While automatic drain valves relieve the operator of draining reservoirs on a daily basis, these valves **MUST** be routinely checked for proper operation. Don't overlook them until they fail and a road call is required.



Bendix® AD-IP™ Integral Purge Air Dryer

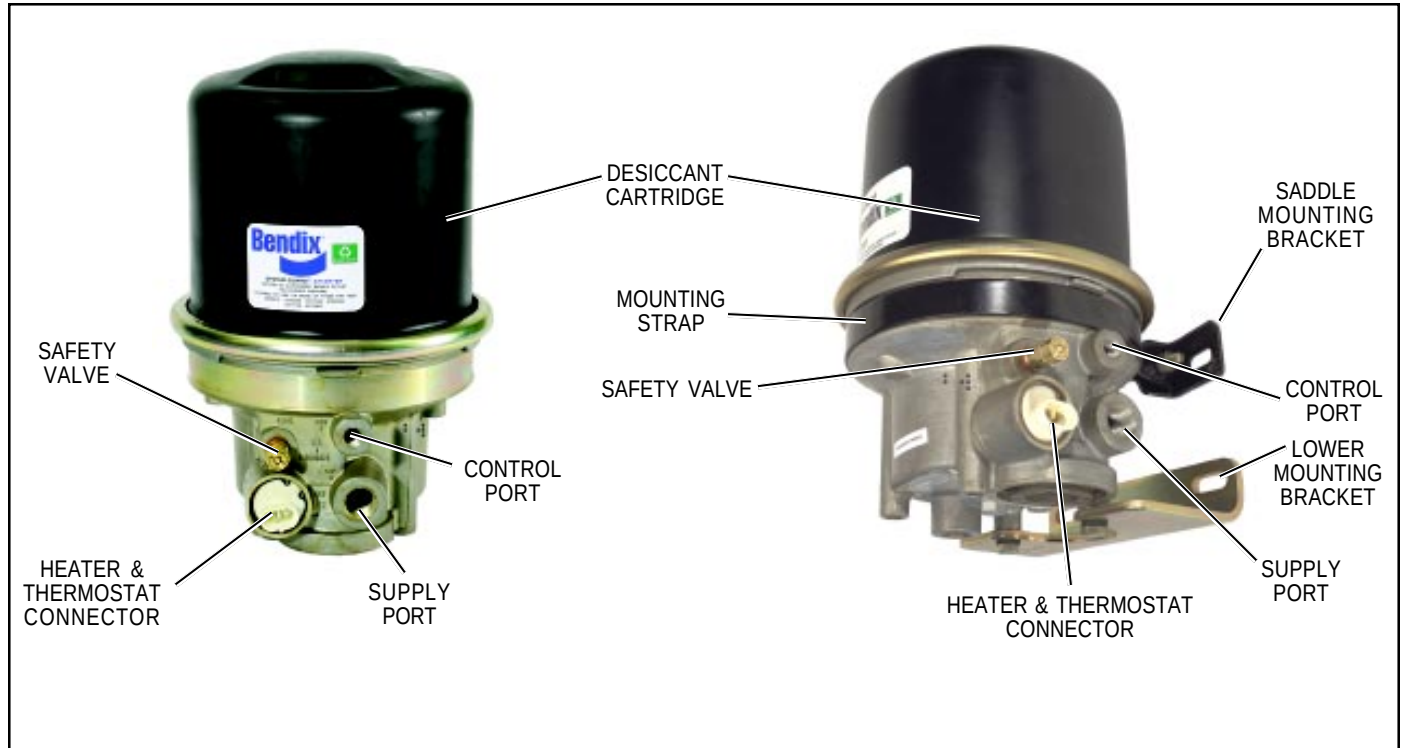


FIGURE 1 - AD-IP™ INTEGRAL PURGE AIR DRYER

DESCRIPTION

The function of the Bendix® AD-IP™ integral purge air dryer is to collect and remove air system contaminants in solid, liquid and vapor form before they enter the brake system. It provides clean, dry air to the components of the brake system which increases the life of the system and reduces maintenance costs. Daily manual draining of the reservoirs is eliminated.

The AD-IP™ air dryer consists of a desiccant cartridge secured to a die cast aluminum end cover with a single, central bolt. The end cover contains a check valve assembly, safety valve, heater and thermostat assembly, three pipe thread air connections and the purge valve assembly. The removable purge valve assembly incorporates the purge valve mechanism and a turbo charger cutoff feature that is designed to prevent loss of engine “turbo” boost pressure during the purge cycle of the AD-IP™ air dryer. For ease of serviceability, all replaceable assemblies can be replaced without removal of the air dryer from its mounting on the vehicle.

The AD-IP™ air dryer has three female pipe thread air connections identified as follows:

Air Connection Port ID	Function/Connection
CON 4	Control Port (purge valve control & turbo cutoff).
SUP 11	Supply Port (air in).
DEL 2	Delivery Port (air out).

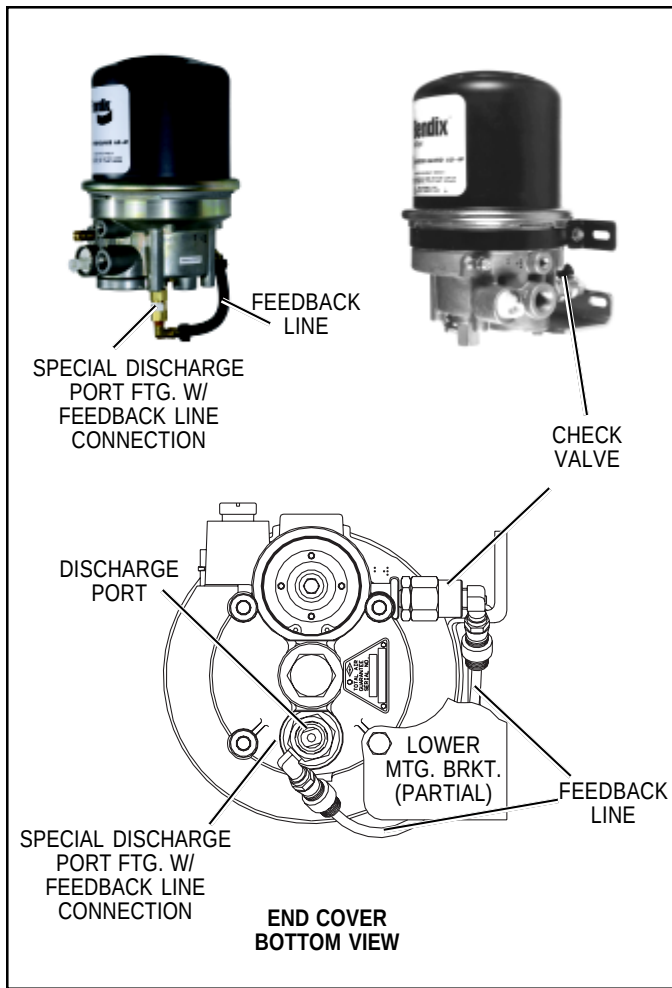


FIGURE 2 - AD-IP™ DI DROP IN AIR DRYER FOR HOLSET COMPRESSORS

AD-IP™ DI “DROP IN” AIR DRYER MODEL

In addition to the standard AD-IP™ air dryer, the Bendix® AD-IP™ DI (Drop In) air dryer is also offered. It is a specialized version designed especially for air systems that use either the Holset (Cummins) Type E or QE air compressor. These Holset compressors utilize an unusual unloading system that requires that air pressure remain in the discharge line during the entire unloaded cycle of the compressor. To accomplish this, Holset compressors rely on air “feedback” from the supply reservoir as shown in Figure 3B. When an air dryer is installed the direct “feedback” from the supply reservoir is interrupted and an alternate source for “feedback” pressure must be provided. A standard AD-IP™ air dryer can be installed, however a separate “feedback” line with a single check must be installed as shown in Figure 3C.

The AD-IP™ DI drop in air dryer model incorporates the feedback line and single check as an integral part of the dryer and eliminates the need for these components as shown in Figures 2 & 3C.

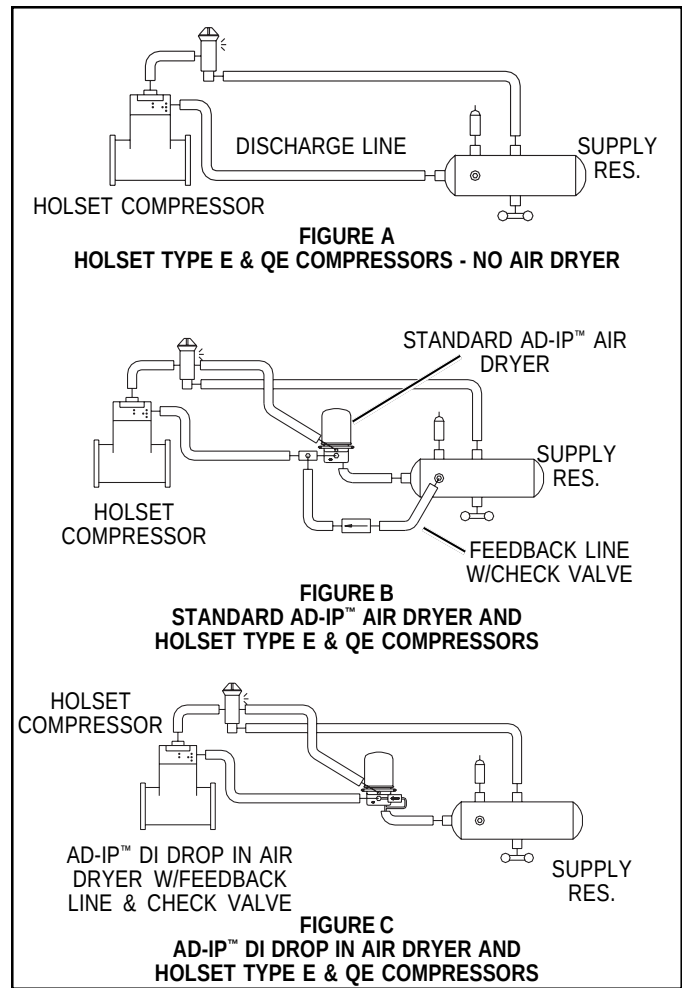


FIGURE 3 - AD-IP™ AIR DRYER AND HOLSET TYPE E & QE COMPRESSORS

OPERATION

GENERAL

The AD-IP™ air dryer alternates between two operational modes or “cycles” during operation: the Charge Cycle and the Purge Cycle. The following description of operation is separated into these “cycles” of operation.

CHARGE CYCLE (refer to Figure 4)

When the compressor is loaded (compressing air) compressed air, along with oil, oil vapor, water and water vapor flows through the compressor discharge line to the supply port of the air dryer body.

As air travels through the end cover assembly, its direction of flow changes several times, reducing the temperature, causing contaminants to condense and drop to the bottom or sump of the air dryer end cover.

After exiting the end cover, the air flows into the desiccant cartridge. Once in the desiccant cartridge air first flows through an oil separator located between the outer and inner shells of the cartridge. The separator removes water in liquid form as well as liquid oil and solid contaminants.

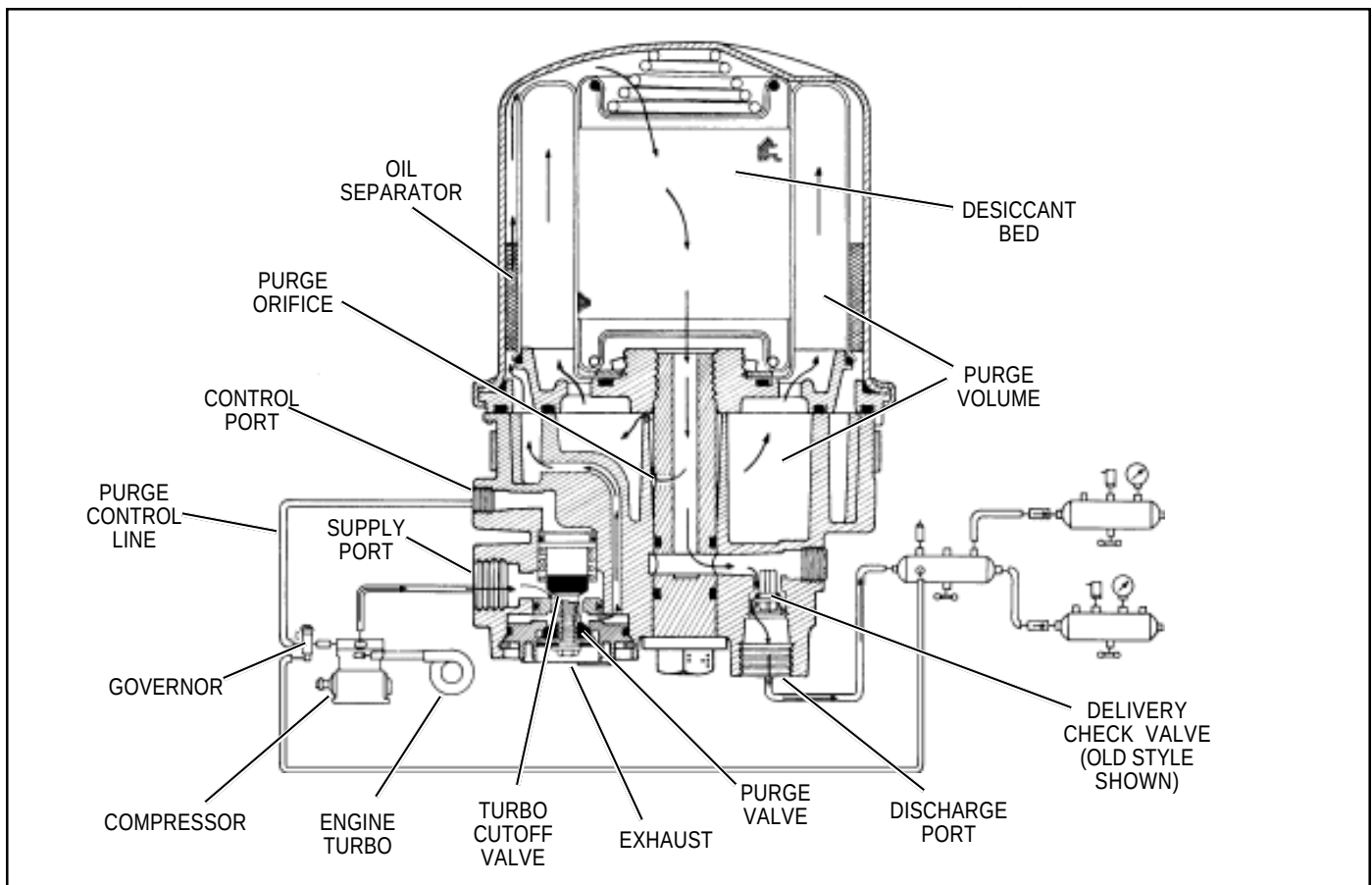


FIGURE 4 - AD-IP™ INTEGRAL PURGE AIR DRYER CHARGE CYCLE

Air, along with the remaining water vapor, is further cooled as it exits the oil separator and continues to flow upward between the outer and inner shells. Upon reaching the top of the cartridge the air reverses its direction of flow and enters the desiccant drying bed. Air flowing down through the column of desiccant becomes progressively drier as water vapor adheres to the desiccant material in a process known as “ADSORPTION.” The desiccant cartridge using the adsorption process typically removes most of the water vapor from the pressurized air.

Dry air exits the bottom of the desiccant cartridge and flows through the center of the bolt used to secure the cartridge to the end cover. Air flows down the center of the desiccant cartridge bolt, through a cross drilled passage and exits the air dryer delivery port through the delivery check valve. Note: the early end cover designs incorporated a vertical delivery check valve while the newer versions have a horizontal check valve. Both have the same function, but the components are not interchangeable. See Figure 7.

Dry air flowing through the center of the desiccant cartridge bolt also flows out the cross drilled purge orifice and into the purge volume.

The air dryer will remain in the charge cycle until the air brake system pressure builds to the governor cutout setting.

PURGE CYCLE (refer to Figure 5)

As air brake system pressure reaches the cutout setting of the governor, the governor unloads the compressor (air compression is stopped) and the purge cycle of the air dryer begins. When the governor unloads the compressor, it pressurizes the compressor unloader mechanism and the line connecting the governor unloader port to the AD-IP™ air dryer end cover control port. The purge piston moves in response to air pressure causing the purge valve to open to the atmosphere and the turbo cutoff valve to close off the supply of air from the compressor (this will be further discussed in the *Turbo Cutoff Feature* section). Water and contaminants in the end cover sump are expelled immediately when the purge valve opens. Also, air which was flowing through the desiccant cartridge changes direction and begins to flow toward the open purge valve. Liquid oil and solid contaminants collected by the oil separator are removed by air flowing from the purge volume through the desiccant drying bed to the open purge valve.

The initial purge and desiccant cartridge decompression lasts only a few seconds and is evidenced by an audible burst of air at the AD-IP™ air dryer exhaust. No purging of air should occur after 30 seconds.

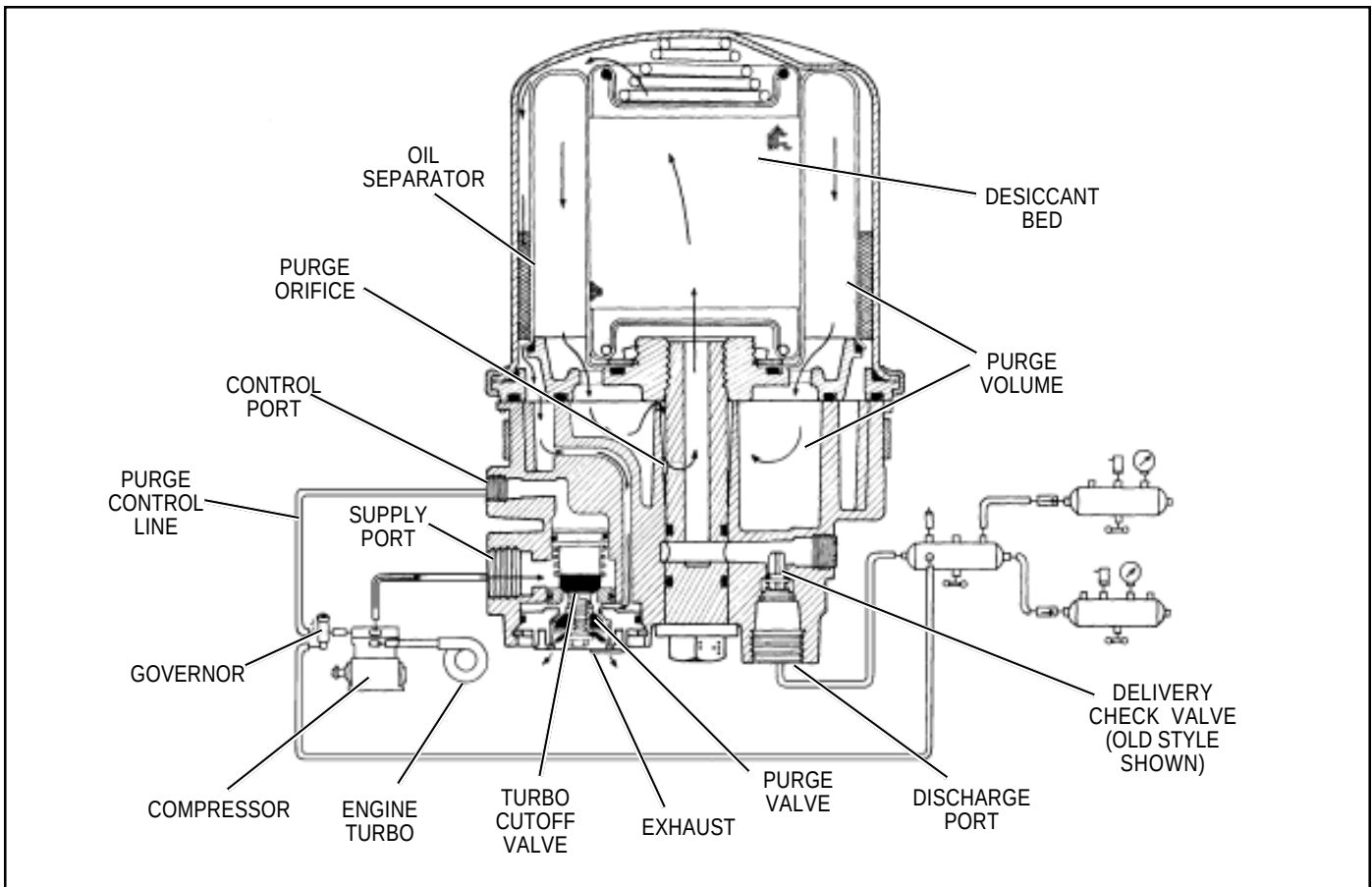


FIGURE 5 - AD-IP™ INTEGRAL PURGE AIR DRYER PURGE CYCLE

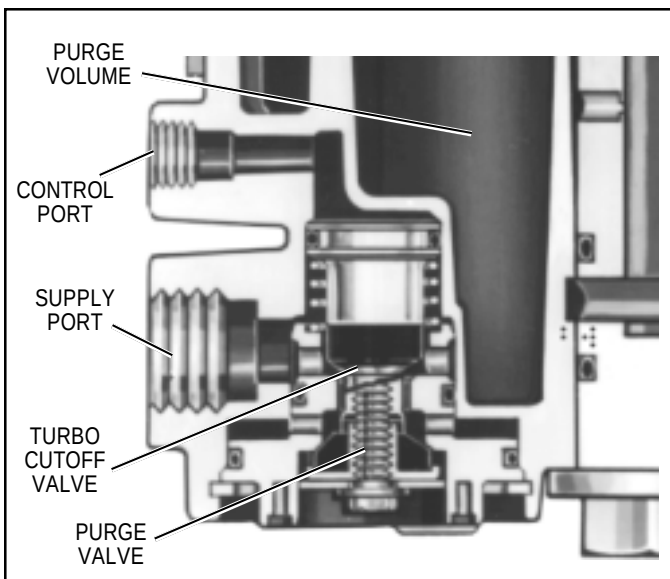


FIGURE 6 - AD-IP™ INTEGRAL PURGE AIR DRYER TURBO CUTOFF

The actual reactivation of the desiccant drying bed begins as dry air flows from the purge volume through the purge orifice in the desiccant cartridge bolt, then through the center of the bolt and into the desiccant bed. Pressurized air from the purge volume expands after passing through the purge orifice; its pressure is lowered and its volume increased. The flow of dry air through the drying bed reactivates the desiccant material by removing the water vapor adhering to it. Generally 30 seconds are required for the entire purge volume of a standard AD-IP™ air dryer to flow through the desiccant drying bed.

The delivery check valve assembly prevents air pressure in the brake system from returning to the air dryer during the purge cycle. After the 30 second purge cycle is complete the desiccant has been reactivated or dried. The air dryer is ready for the next charge cycle to begin. However the purge valve will remain open and will not close until air brake system pressure is reduced and the governor signals the compressor to charge the system.

TURBO CUTOFF FEATURE (Refer to Figure 6)

The primary function of the turbo cutoff valve is to prevent loss of engine turbocharger air pressure through the AD-IP™ air dryer in systems where the compressor intake is

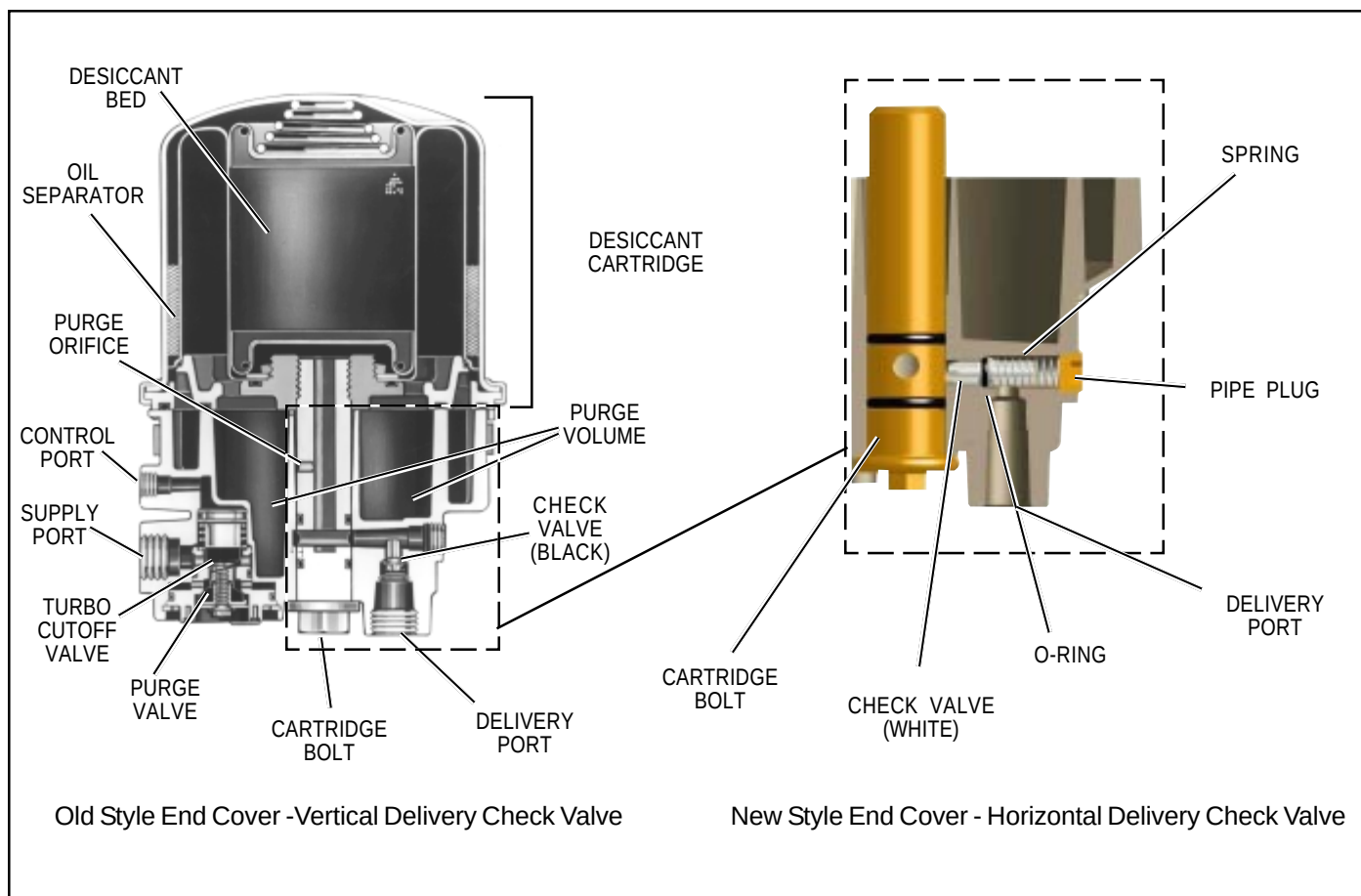


FIGURE 7 - AD-IP™ AIR DRYER SECTIONAL VIEW

connected to the engine turbocharger. The turbo cutoff valve also removes the “puffing” of air out the open purge exhaust when a naturally aspirated, single cylinder compressor, equipped with an inlet check valve, is in use.

At the onset of the purge cycle, the downward travel of the purge piston is stopped when the turbo cutoff valve (tapered portion of purge piston) contacts its mating metal seat in the purge valve housing. With the turbo cutoff valve seated (closed position), air in the compressor discharge line and AD-IP™ air dryer inlet port cannot enter the air dryer. In this manner the turbo cutoff effectively maintains turbocharger boost pressure to the engine.

PREVENTIVE MAINTENANCE

Important: Review the warranty policy before performing any intrusive maintenance procedures. An extended warranty may be voided if intrusive maintenance is performed during this period. Note: It is acceptable for the purge valve to be maintained as necessary, i.e., the installation of a purge valve maintenance kit, without voiding the warranty.

Because no two vehicles operate under identical conditions, maintenance and maintenance intervals will vary. Experience is a valuable guide in determining the best maintenance interval for any one particular operation.

Every 900 operating hours, or 25,000 miles or three (3) months:

1. Check for moisture in the air brake system by opening reservoirs, drain cocks, or drain valves and checking for presence of water. If moisture is present, the desiccant cartridge may require replacement; however, the following conditions can also cause water accumulation and should be considered before replacing the desiccant:
 - A. An outside air source has been used to charge the system. This air does not pass through the drying bed.
 - B. Air usage is exceptionally high and not normal for a highway vehicle.
This may be due to accessory air demands or some unusual air requirement that does not allow the compressor to load and unload (compressing and non-compressing cycle) in a normal fashion. Check for high air system leakage. If the vehicle vocation has changed it may be necessary to upgrade the compressor size. Refer to Appendix A, Table A and the column entitled Vehicle Vocation.
 - C. The air dryer has been installed in a system that has been previously used without an air dryer. The system will be saturated with moisture and several weeks of operation may be required to dry it out.

Note: A small amount of oil in the system is normal and should not be considered as a reason to replace the desiccant cartridge; oil stained desiccant can function adequately.

2. Visually check for physical damage to the AD-IP™ air dryer such as chaffed or broken air and electrical lines and broken or missing parts.
3. Check mounting bolts for tightness. Re-torque to 270- 385 in.lbs.
4. Perform the *Operation & Leakage Tests* listed in this publication.

WARNING!

This air dryer is intended to remove moisture and other contaminants normally found in the air brake system. Do not inject alcohol, anti-freeze, or other de-icing substances into or upstream of the air dryer. Alcohol is removed by the dryer, but reduces the effectiveness of the device to dry air. Use of other substances can damage the air dryer and may void the warranty.

- D. Location of the air dryer is too close to the air compressor. Refer to “*Locating AD-IP™ Air Dryer On Vehicle*” section and Appendix A, Table A, column 2 for discharge line length.
- E. In areas where more than a 30 degree range of temperature occurs in one day, small amounts of water can temporarily accumulate in the air brake system due to condensation. Under these conditions, the presence of small amounts of moisture is normal and should not be considered as an indication that the dryer is not performing properly.

OPERATION & LEAKAGE TESTS

1. Install a pressure gauge in the #1 reservoir. Check all lines and fittings leading to and from the air dryer for leakage and integrity. Test the delivery port check valve assembly by building the air system to governor cutout and observing a test air gauge installed in the #1 reservoir. Note the pressure on the air gauge after governor cutout pressure is reached, a rapid loss of pressure could indicate a failed delivery port check valve. This can be confirmed by shutting the engine off, draining system pressure to a point below governor cutin (usually not less than 95 psi), draining residual air pressure in the compressor discharge line. Remove the discharge line at the supply port of the dryer, and use soapy water to determine if air is flowing out of the supply port. Make sure there is no air pressure at the control port, by removing the line from the control port to the governor UNL port. The reservoir needs to have a least 50 PSIG for this test. If a 1” bubble forms within one second, the delivery check valve should be repaired. Remove the test gauge before returning the vehicle to service.

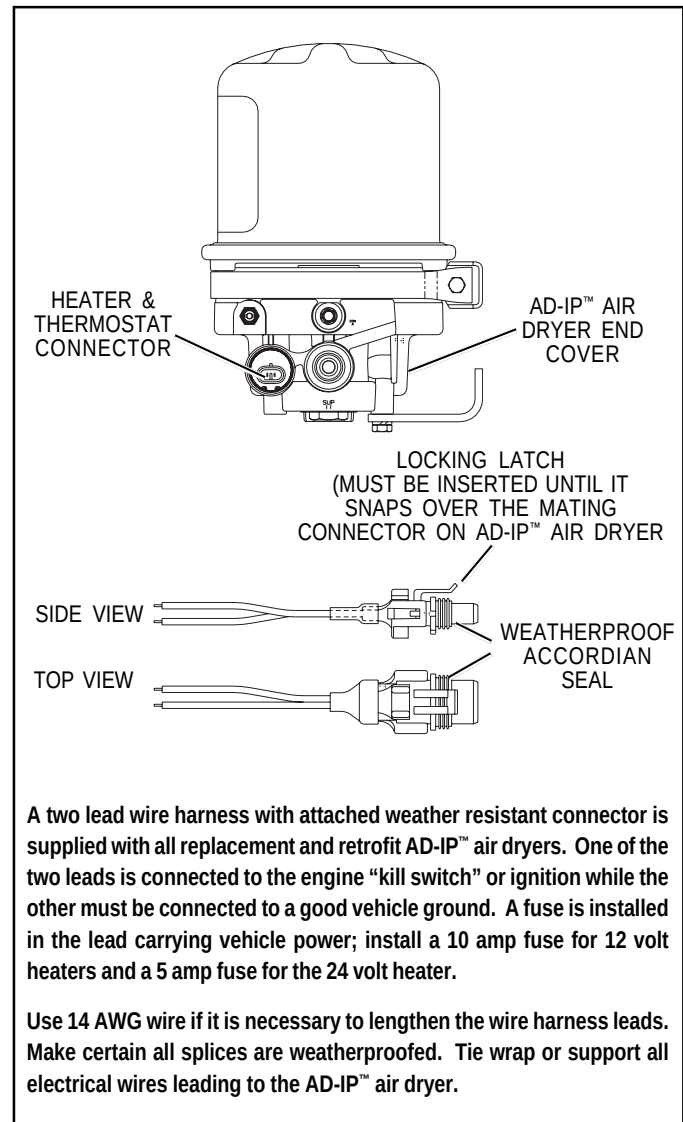


FIGURE 8 - AD-IP™ AIR DRYER HEATER AND THERMOSTAT CONNECTOR

2. Check for excessive leakage around the purge valve. With the compressor in loaded mode (compressing air), apply a soap solution to the purge valve exhaust port and observe that leakage does not exceed a 1” bubble in 1 second. If the leakage exceeds the maximum specified, repair the purge valve assembly.
3. Close all reservoir drain cocks. Build up system pressure to governor cutout and note that AD-IP™ air dryer purges with an audible escape of air. “Fan” the service brakes to reduce system air pressure to governor cut-in. Note that the system once again builds to full pressure and is followed by an AD-IP™ air dryer purge.
4. Check the operation of the end cover heater and thermostat assembly during cold weather operation as follows:

A. Electric Power to the Dryer

With the ignition or engine kill switch in the ON position, check for voltage to the heater and thermostat assembly using a voltmeter or test light. Unplug the electrical connector at the air dryer and place the test leads on each of the pins of the connector with the locking latch. If there is no voltage, look for a blown fuse, broken wires, or corrosion in the vehicle wiring harness. Check to see if a good ground path exists.

B. Thermostat and Heater Operation

Note: These tests are not required except in cold weather operation.

Turn off the ignition switch and cool the thermostat and heater assembly to below 35 degrees Fahrenheit. Using an ohmmeter, check the resistance between the electrical pins in the air dryer connector half. The resistance should be 1.5 to 3.0 ohms for the 12 volt heater assembly and 6.0 to 9.0 ohms for the 24 volt heater assembly.

Warm the thermostat and heater assembly to over 90 degrees Fahrenheit and again check the resistance. The resistance should exceed 1000 ohms. If the resistance values obtained are within the stated limits, the thermostat and heater assembly is operating properly. If the resistance values obtained are outside the stated limits, replace the heater and thermostat assembly.

REBUILDING THE AD-IP™ AIR DRYER

GENERAL

If, after completing the routine operation and leakage tests, it has been determined that one or more components of the air dryer requires replacement or maintenance, refer to the following list to find the appropriate kit(s).

When rebuilding or replacing components of the air dryer use only genuine Bendix® parts. For ease in servicing, the AD-IP™ air dryer has been designed so that any of the following maintenance kits can be installed without removing the air dryer from the vehicle.

MAINTENANCE KITS AVAILABLE:

065624 SERVICE NEW DESICCANT CARTRIDGE KIT

This kit contains the parts necessary to change the desiccant cartridge only.

109493 REMANUFACTURED DESICCANT CARTRIDGE KIT

This kit contains the parts necessary to change the desiccant cartridge only.

5001247 MOUNTING BRACKET KIT

This kit contains the upper and lower brackets as well as the necessary hardware items to mount them.

109498 CARTRIDGE BOLT KIT

Contains a replacement desiccant cartridge bolt and related o-rings.

5003547 PURGE VALVE HOUSING MAINTENANCE KIT

This kit contains the parts necessary to rebuild the purge valve housing.

800404 PURGE VALVE REPLACEMENT KIT

This kit contains the parts necessary to replace the purge valve.

5018313 PURGE VALVE MAINTENANCE KIT

This kit contains the parts necessary to replace and relubricate the purge valve quad-ring and o-rings.

065626 SERVICE NEW PURGE VALVE HOUSING ASSEMBLY

Contains a service new assembly and related components to accomplish replacement.

109494 DELIVERY CHECK VALVE MAINTENANCE KIT

This kit contains the parts necessary to replace the delivery port check valve.

109495 12V HEATER & THERMOSTAT KIT

109496 24V HEATER & THERMOSTAT KIT

Each contains a replacement heater and thermostat assembly and related components required for replacement.

GENERAL SAFETY GUIDELINES

WARNING! PLEASE READ AND FOLLOW THESE INSTRUCTIONS TO AVOID PERSONAL INJURY OR DEATH:

When working on or around a vehicle, the following general precautions should be observed at all times.

1. **Park the vehicle on a level surface, apply the parking brakes, and always block the wheels. Always wear safety glasses.**
2. **Stop the engine and remove ignition key when working under or around the vehicle. When working in the engine compartment, the engine should be shut off and the ignition key should be removed. Where circumstances require that the engine be in operation, EXTREME CAUTION should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated or electrically charged components.**
3. **Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.**
4. **If the work is being performed on the vehicle's air brake system, or any auxiliary pressurized air systems, make certain to drain the air pressure from**

all reservoirs before beginning **ANY** work on the vehicle. If the vehicle is equipped with an AD-IS® air dryer system or a dryer reservoir module, be sure to drain the purge reservoir.

5. Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.
6. Never exceed manufacturer's recommended pressures.
7. Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.
8. Use only genuine Bendix® replacement parts, components and kits. Replacement hardware, tubing, hose, fittings, etc. must be of equivalent size, type and strength as original equipment and be designed specifically for such applications and systems.
9. Components with stripped threads or damaged parts should be replaced rather than repaired. Do not attempt repairs requiring machining or welding unless specifically stated and approved by the vehicle and component manufacturer.
10. Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.
11. For vehicles with Antilock Traction Control (ATC), the ATC function must be disabled (ATC indicator lamp should be ON) prior to performing any vehicle maintenance where one or more wheels on a drive axle are lifted off the ground and moving.

AD-IP™ AIR DRYER REMOVAL

This air dryer removal process is presented in the event it becomes necessary to replace the entire air dryer. **Normal service and parts replacement does not require removal of the air dryer from the vehicle.**

1. Park the vehicle on a level surface and prevent movement by means other than the brakes.
2. Drain **all** reservoirs to 0 p.s.i. — **Caution:** Compressor discharge line may still contain residual pressure.
3. Identify and disconnect the three air lines from the end cover and note the position of end cover ports relative to the vehicle.
4. Unplug the vehicle wiring harness from the heater and thermostat assembly connector on the end cover assembly.

5. Remove the four bolts that secure both the upper and lower mounting brackets to the vehicle, and remove the air dryer from the vehicle.
6. Mark the relationship of the saddle bracket (5) to the end cover assembly (6). Remove the 5/16" cap screw (1) and sleeve nut (3) securing the upper mounting strap (4) to the saddle bracket (5). Earlier models used washer and nut in place of the sleeve nut (3). Remove the upper mounting strap (4) from the end cover assembly (6).
7. Mark the relationship of the lower bracket (9) to the end cover assembly (6). Remove the two 3/8" end cover cap screws (7) and two washers (8) that retain the lower mounting bracket (9) to the end cover (6).

DISASSEMBLY

The following disassembly and assembly procedure is presented for reference purposes and presupposes that a major rebuild of the AD-IP™ air dryer is being undertaken. The replacement parts and maintenance kits available generally do not require full disassembly. The instructions provided with these parts and kits should be followed in lieu of the instructions presented here. Refer to Figure 9 during disassembly.

Caution: While performing service on the AD-IP™ air dryer, it is not recommended that a clamping device (vise, C-clamp, etc.) be used to hold any die cast aluminum component as damage may result. To hold the end cover, install a pipe nipple in the supply port and clamp the nipple into a vise.

1. Using an adjustable or socket wrench, loosen the desiccant cartridge bolt (10), then separate the desiccant cartridge (11) from the end cover (6). Pull the desiccant cartridge bolt out of the end cover (6).

Caution: Disassembly of the desiccant cartridge assembly should not be attempted! Detail parts for the cartridge are not available and the cartridge contains a 150# spring which can not be mechanically caged.

2. Remove both o-rings (12 & 13) from the desiccant cartridge bolt.
3. Remove the retaining ring (14) that secures the purge valve assembly (15) in the end cover (6).
4. Remove the 1/4" shoulder bolt (16) from the bottom of the purge valve housing assembly (19) using a 3/8" socket wrench and a large blade screw driver, inserted in the slot on top of the purge piston (20). Remove the exhaust diaphragm (17), and the purge valve (18) from the purge valve housing (19).
5. Remove the o-rings (23 & 24) from the purge valve housing (19). Discharge Line Unloader (DLU) models do not have o-ring (23).
6. Remove the purge piston (20) and the return spring (22).
7. Remove the o-ring (21) from the purge piston (20).

8. **Vertical check valve models:** Remove the retaining ring (25) that secures the delivery check valve assembly in the end cover (6). Remove and separate the perforated plate (26), spring (27), check valve body (28) and o-ring (29).
9. **Horizontal check valve models:** Remove delivery check valve plug (34) that secures the check valve assembly in the end cover (6). Remove the spring (35), check valve (36) and o-ring (2).
10. Remove the retaining ring (30) that secures the heater and thermostat assembly (31) in the end cover (6). Gently pull the heater and thermostat (31) out of the end cover (6) and remove the o-ring (32).
11. Using a 9/16" wrench, remove the safety valve assembly (33) from the end cover (6).
2. Install and center the exhaust diaphragm (17) over the shoulder bolt (16) making certain that the diaphragm ID is over the bolt shoulder. Then install the purge valve (18) on the shoulder bolt making certain its metal support side is against the diaphragm (17).
3. Push the purge piston (20) into the housing (19) until it bottoms and insert a large blade screw driver in the piston's slotted head. While depressing the purge piston with the screw driver, install the shoulder bolt (16) with exhaust diaphragm (17) and purge valve (18) in the piston. Torque the shoulder bolt (16) to between 60-80 in. lbs.
4. Install the two o-rings (23 & 24) on the purge valve housing (19) placing each in its appropriate location. DLU models do not contain o-ring (23). Install the assembled purge valve housing in the end cover (6) while making certain the purge valve housing is fully seated against the end cover. Secure the purge valve housing in the end cover using the retaining ring (14). Make certain the retaining ring is fully seated in its groove in the end cover (6).
5. Using a 9/16" wrench, install the safety valve assembly (33) into the end cover (6).

CLEANING & INSPECTION

1. Using mineral spirits or an equivalent solvent, clean and thoroughly dry all metal parts except the desiccant cartridge.
2. Inspect the interior and exterior of all metal parts that will be reused for severe corrosion, pitting and cracks. Superficial corrosion and or pitting on the exterior portion of the end cover is acceptable.
3. Inspect the bores of both the end cover and the purge valve housing for deep scuffing or gouges.
4. Make certain that all purge valve housing and end cover passages are open and free of obstructions.
5. Inspect the pipe threads in the end cover. Make certain they are clean and free of thread sealant.
6. Inspect the purge valve housing bore and seats for excessive wear and scuffing.
7. Inspect the purge valve piston seat for excessive wear.
8. Make certain that the purge orifice in the cartridge bolt is open and free of obstructions.
9. Inspect all air line fittings for corrosion. Clean all old thread sealant from the pipe threads.
10. All o-rings removed should be discarded and replaced with new o-rings provided in appropriate kit(s).

ASSEMBLY

Prior to assembly, coat all o-rings, o-ring grooves, and bores with a generous amount of silicone grease. (Refer to Figures 9 and 10 during assembly unless otherwise advised.)

1. Install the quad ring (21) in its groove on the O.D. of the purge piston (20). Place the return spring (22) in the bore of the purge valve housing (19), then insert the purge piston (20) into the I.D. of the spring (22).
7. **Horizontal check valve models:** Install o-ring (2) onto check valve (36). Place the check valve in the delivery check valve port of the end cover (6). Install the spring (35) over the delivery check valve (36) and secure with the delivery check valve plug (34).
8. Install the o-ring (32) on the heater and thermostat assembly (31). After making certain the sponge rubber cushion is positioned between the connector body and thermostat, gently push the heater and thermostat assembly (31) into the end cover (6), making certain the heating element enters the small diameter bore in the larger heater and thermostat bore in the end cover (6). Secure the heater and thermostat assembly in the body using the retaining ring (30). Make certain the retaining ring is fully seated in its groove in the end cover (6).
9. Install both o-rings (12 & 13) on the desiccant cartridge bolt (10) and using a twisting motion, insert the assembled desiccant cartridge bolt in the end cover (6).

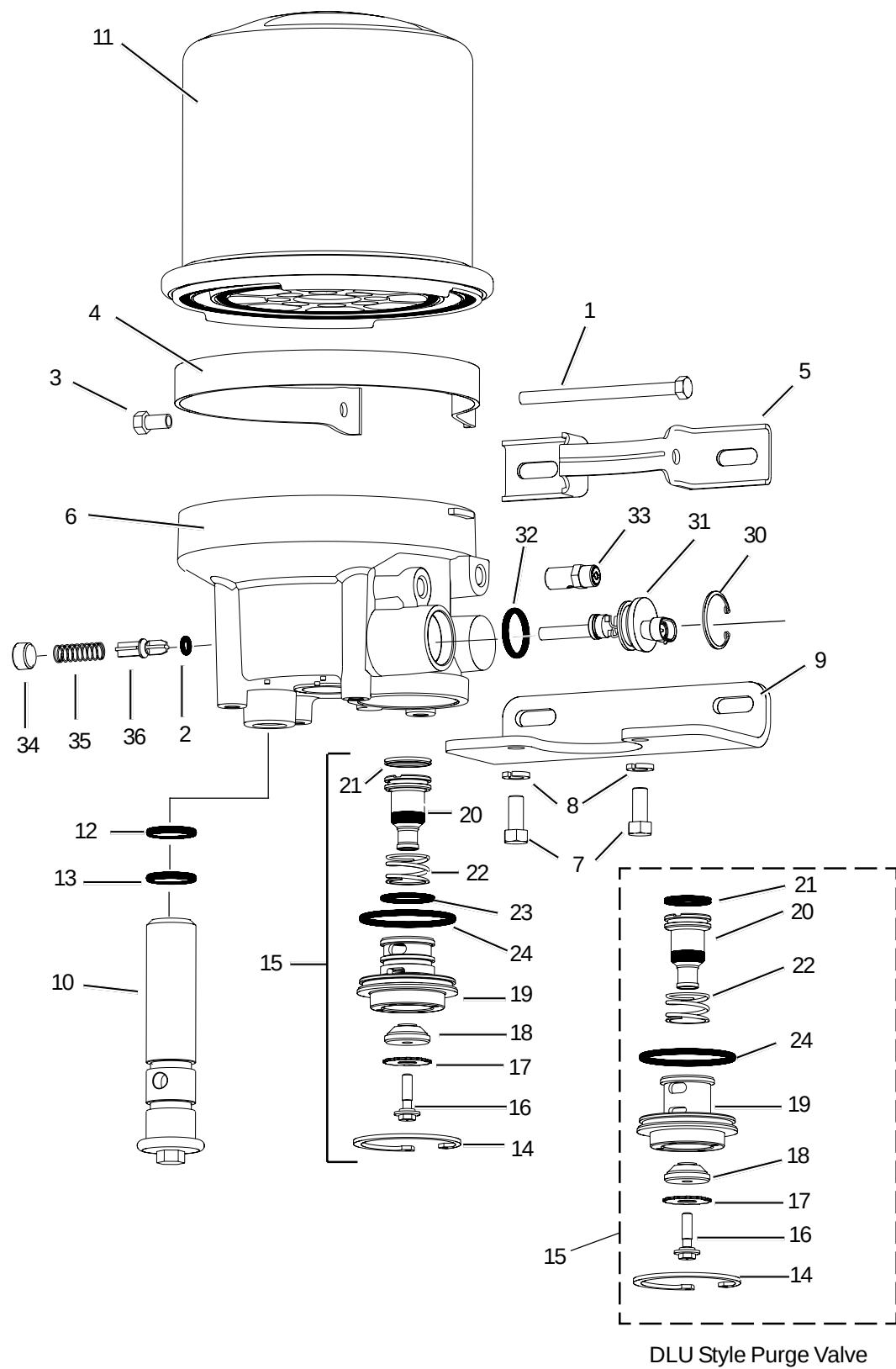


FIGURE 9 - AD-IP™ AIR DRYER INTERNAL COMPONENTS

10. Install the desiccant cartridge (11) on the end cover (6) making certain the cartridge is properly seated and flush on the end cover.
- Note:** It may be necessary to rotate the cartridge slightly until the anti-rotation lugs are properly aligned and allow the cartridge to rest flush against the end cover.
11. Using an adjustable wrench or a socket, tighten the desiccant cartridge bolt (10), to secure the desiccant cartridge (11) to the end cover (6). Torque the desiccant cartridge bolt to 65-75 ft. lbs. (40ft. lbs. minimum).

Caution: Do not over torque.

AD-IP™ AIR DRYER INSTALLATION

1. Using the relationship marks made during step 7 of the “AD-IP™ AIR DRYER REMOVAL”, install the lower mounting bracket (9) on the end cover (6) and secure it using the two 3/8” cap screws and washers (7 & 8). Torque the cap screws to 300-360 in.lbs.
2. Using the relationship marks made during step 6 of the *AD-IP™ Air Dryer Removal Procedure*, install the saddle bracket (5) and mounting strap (4) on the end cover (6), and using the 5/16” cap screw (1) and sleeve nut (3) secure the strap to the saddle bracket. Tighten the 5/16” nut on the upper mounting bracket. Torque to 60-100 in. lbs.
3. Install the AD-IP™ air dryer on the vehicle using the four bolts that secure both the upper and lower mounting brackets.
4. Reconnect the three airlines to the proper ports on the end cover (identified during step 3 of the *AD-IP™ Air Dryer Removal*).
5. Reconnect the vehicle wiring harness to the AD-IP™ air dryer heater and thermostat assembly connector by plugging it into the air dryer connector until its lock tab snaps in place.
6. Before placing vehicle back into service, perform the *Operation and Leakage Tests* stated elsewhere in this manual.

RETROFITTING THE AD-IP™ AIR DRYER

GENERAL

The following retrofit instructions are presented for reference purposes only since Bendix aftermarket retrofit and replacement air dryers are packaged with the most up-to-date installation instructions. The instructions packaged with the AD-IP™ air dryer should be followed in lieu of those presented here.

The preceding portion of this manual deals with “in-service” repair and/or replacement of the AD-IP™ air dryer. The portion of the manual that follows is concerned with installing an AD-IP™ air dryer on a vehicle not previously equipped with one.

VEHICLE APPLICATION REQUIREMENTS

The basic application requirements presented here apply to a standard air dryer installation. The majority of highway vehicles in use today will meet these basic requirements however, some may not. Examples of vehicles that may not meet the requirements include, refuse trucks, city coaches, bulk trailer unloading operations and other high air consumption systems. While the AD-IP™ air dryer can be used on these vehicles the standard installation procedure presented in this manual may require modification to assure proper operation and service life. Consult your local authorized Bendix parts outlet or sales representative for additional information.

Charge Cycle Time — The AD-IP™ air dryer is designed to provide clean, dry air for the brake system. When a vehicle’s air system is used to operate non-brake air accessories it is necessary to determine that, during normal daily operation the compressor should recover from governor “cut-in” to governor “cut-out” (usually 100 psi to 120 psi) in 90 seconds or less at engine RPMs normal to the vehicle vocation. If the recovery time consistently exceeds this limit, it may be necessary to “bypass” the air accessory responsible for the high air usage. Consult your local authorized Bendix parts outlet or sales representative for additional information.

Purge Cycle Time — During normal vehicle operation, the air compressor must remain unloaded for a minimum of 30 seconds. This minimum purge time is required to ensure complete regeneration of the desiccant material. If the purge time is occasionally shorter than the times specified, no permanent ill effect should be expected, however, if the purge time is consistently less than the minimum, an accessory bypass system must be installed. Contact the nearest authorized Bendix parts outlet or Bendix representative for additional information. **Note:** Reservoir Volume - Total vehicle reservoir volume can impact the Charge and Purge Cycle time. The chart below can be used as a guide in determining if additional help is required.

Total Vehicle Reservoir	
Volume	Requirement
Less than 9,000 cu. in.	Standard AD-IP™ Air Dryer
9,000 - 12,500 cu. in.	Extended Purge AD-IP™ Air Dryer
Greater than 12,500 cu. in.	Contact Bendix Rep. or Bendix Engineering

Air Compressor Size — Although the AD-IP™ air dryer can be used in conjunction with larger compressors, it was designed primarily for units rated for up to 30 CFM. It is recommended that when using the AD-IP™ air dryer with a compressor which has a rated displacement exceeding 30

CFM that an authorized Bendix parts outlet or Bendix marketing representative be contacted for assistance.

Holset “E or QE” Type Air Compressors - In order for these Holset compressors to function properly when installed with an AD-IP™ air dryer, the required Holset feedback line and single check valve must be used. The standard AD-IP™ air dryer can be used with a separate feedback line and single check OR the AD-IP™ DI (Drop In) air dryer model can be used. With AD-IP™ DI drop in air dryer in use the separate feed back line and single check valve can be eliminated since these components are part of the air dryer. Refer to Figures 2 & 3.

VEHICLE PREPARATION

1. Park the vehicle on a level surface and prevent movement by means other than the brakes.
2. Drain all reservoirs to 0 p.s.i.

LOCATING AD-IP™ AIR DRYER ON VEHICLE

1. The AD-IP™ air dryer must be mounted vertically (purge exhaust toward road surface) outside the engine compartment in an area of air flow while the vehicle is in motion. The AD-IP™ air dryer must not be exposed to direct wheel splash. If the air dryer is located directly behind the axle, a mud flap is required.
2. Maintain a minimum clearance of 12" between the air dryer and any potential heat source (e.g. vehicle exhaust). If this is not feasible, a heat shield must be used.
3. Make certain that adequate clearance from moving components (e.g. drive shaft, suspension, pitman arm, etc.) is provided.
4. Locate the air dryer on vehicle so that a minimum of 1/2" clearance above the air dryer is available to allow desiccant cartridge removal. A minimum of 8" clearance below the air dryer is required to allow for desiccant cartridge bolt removal.
5. When choosing the mounting location for the AD-IP™ air dryer, note the discharge line length requirements stated under the heading *Connecting the Air Lines*, elsewhere in this manual.

Important Note: Under normal operating conditions, the maximum inlet air temperature for the AD-IP™ air dryer is 160 degrees Fahrenheit.

6. If possible, locate the AD-IP™ air dryer so that the purge exhaust does not expel contaminants on vehicle components. If this is not feasible, the purge exhaust may be redirected away from the vehicle by installing an optional special exhaust cover (pc. no. 112609). The exhaust cover is available as a separate item from authorized Bendix parts outlets. A 1" ID hose can be clamped on this special exhaust cover to allow the exhaust to be redirected.

MOUNTING THE AD-IP™ AIR DRYER (Refer to Figure 10)

1. Install the lower mounting bracket on the AD-IP™ air dryer. To accomplish this, it will be necessary to choose two, of the four available, mounting holes. To determine which two holes to utilize to attach the lower bracket, take into consideration the piping connections required to install the AD-IP™ air dryer and use those that will best position the unit for ease of installation. Utilizing the two cap screws and washers provided with the AD-IP™ air dryer retrofit unit, attach the lower mounting bracket and torque to 300-360 in. lbs.

Note: The bracket mounting holes in the end cover may not be pre-tapped. In this case the mounting bolt will self tap the holes on initial installation.

2. Assemble the mounting strap (4) and saddle bracket (5) as illustrated, by utilizing the 5/16" cap screw (1) and sleeve nut (3) provided. Place the upper bracket strap in the end cover channel provided for it, then install the saddle bracket and secure the strap to the saddle bracket using the cap screw (1) and sleeve nut (3) provided. Install, but do not tighten the cap screw at this time. Orient the strap and saddle bracket (5) so that it is in a flat plane with the lower bracket. Torque the 5/16" nut to 60-100 in. lbs. to tighten strap onto the shell.
3. Components and location used to mount the AD-IP™ air dryer on the vehicle must be rigid enough to minimize air dryer vibration.
4. Mount the AD-IP™ air dryer on the vehicle using 3/8" bolts (grade 5 min.) and washers. Torque to 25 ft. lbs. (300 in.lbs.)

CONNECTING THE AIR LINES

PURGE CONTROL LINE

1. Install a purge control air line having a minimum inside diameter of 3/16 inches between the AD-IP™ air dryer end cover control port and an unused unloader port on the governor. The control line must be connected directly to the governor and not in series with automatic drain valves, lubrication systems, etc.
2. The control line should slope downward to the end cover without forming sharp bends or “dips”.

COMPRESSOR DISCHARGE LINE

GENERAL:

Refer to Appendix A, Table A for recommended discharge line lengths and sizes for various vehicle applications and vocations.

PURGE EXHAUST LINE

1. If it is necessary to direct AD-IP™ air dryer discharge contaminants away from vehicle components it will be necessary to purchase a special exhaust cover for the AD-IP™ air dryer (Pc. No. 112609) and install on the unit. A 1" (25.4 mm) I.D. hose can be clamped on the special AD-IP™ air dryer exhaust cover.

WIRING THE HEATER/THERMOSTAT

1. The air dryer is available with either a 12 or 24 volt heater which uses 90 watts of power. Determine the vehicle's electrical system voltage and make certain that the air dryer that is to be installed contains the same voltage heater. The air dryer's part number can be used to determine the air dryers heater voltage requirement. The heater voltage can also be identified by the color of the heater assembly connector as described in the table below.

Air Dryer Heater Voltage	Air Dryer Connector Identification
12 Volts	White (No other markings)
24 Volts	Gray, or White w/Red Dot

2. A two lead, 24 inch, wire harness with attached weather resistant connector is supplied with all retrofit and replacement AD-IP™ air dryers. Connect one of the two leads of the wire harness to the engine kill or ignition switch. The remaining lead of the wire harness must be connected to a good vehicle ground (not to the air dryer or its mounting bracket). A fuse must be installed in the power carrying wire; install a 10 amp fuse for 12 volt heaters and a 5 amp fuse for a 24 volt heater.
3. Use 14 gauge wire if it is necessary to lengthen the wire harness provided with the AD-IP™ air dryer. Make certain all wire splices are waterproofed using the splice kit provided with all aftermarket AD-IP™ air dryers.
4. Tie wrap or support all electrical wires leading to the AD-IP™ air dryer at 6 - 8 inch intervals.

Note: Wires should have sufficient slack and not completely taught.

INSTALLING AD-IP™ AIR DRYER WITH HOLSET COMPRESSOR

GENERAL

The vehicle installation guidelines presented in the previous section apply to all AD-IP™ air dryer installations. Vehicles equipped with the Holset Type E or QE compressor require the following additional considerations.

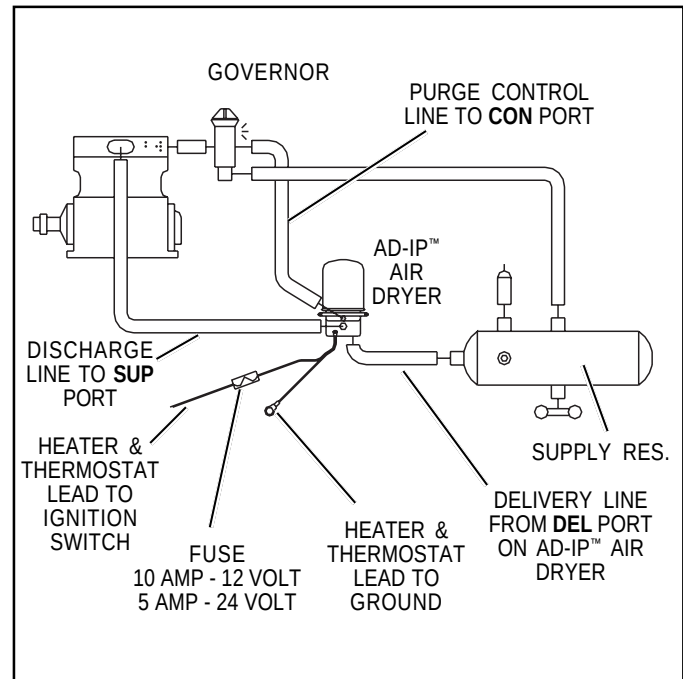


FIGURE 10 - AD-IP™ AIR DRYER INSTALLATION

Standard AD-IP™ Air Dryer (Refer to Figure 3B)

If the AD-IP™ air dryer is being installed on a vehicle that did not previously have an air dryer or air system aftercooler, a separate feedback line and single check valve must be installed.

If the AD-IP™ air dryer is replacing an older style air dryer or air system aftercooler that did not incorporate an integral "Turbo Cutoff" device, the Holset ECON valve must be removed. The feedback line and single check valve must remain in place.

AD-IP™ DI "Drop In" Air Dryer Model (Refer to Figure 3C)

If the AD-IP™ DI "Drop In" air dryer is being installed on a vehicle that did not previously have an air dryer or air system aftercooler, no additional considerations are necessary. Install the AD-IP™ DI drop in air dryer in the manner described in the previous section.

If the AD-IP™ DI drop in air dryer is replacing a standard AD-IP™ air dryer or air system aftercooler which incorporated an integral "Turbo Cutoff" device, the old feedback line and single check valve must be removed.

If the AD-IP™ DI drop in air dryer is replacing an older style air dryer or air system aftercooler that did not incorporate an integral "Turbo Cutoff" device, the Holset ECON valve and the old feedback line and single check valve must be removed.

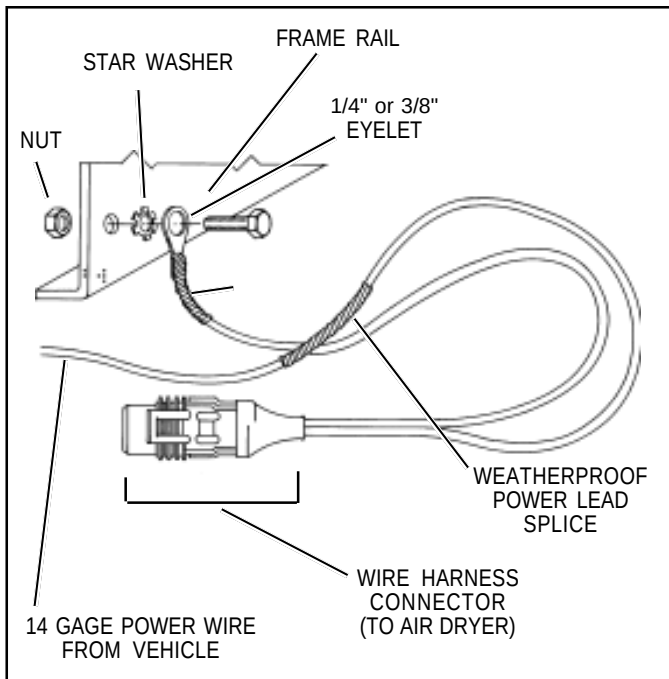


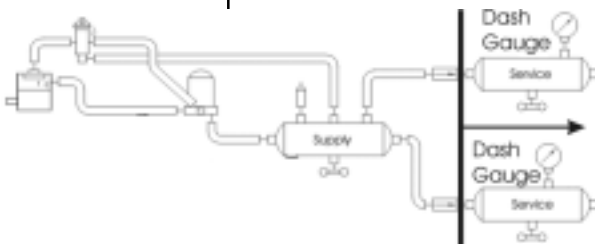
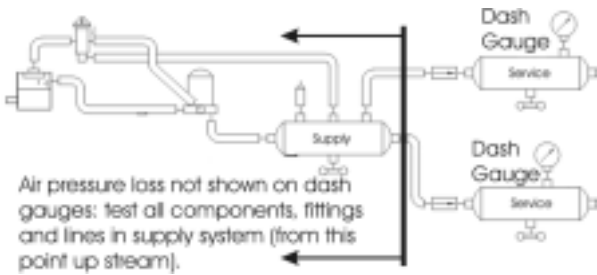
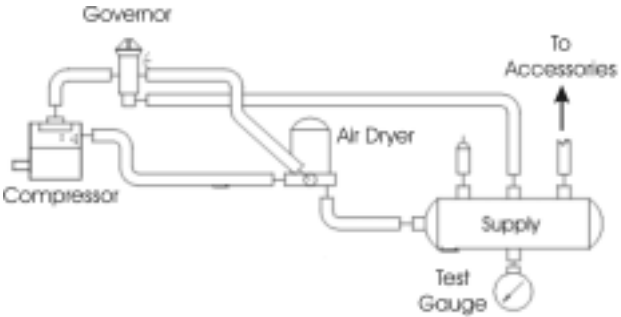
FIGURE 11 - WIRING - REMOTE POWER & LOCAL GROUND

TESTING THE AD-IP™ AIR DRYER

Before placing the vehicle in service, perform the following tests.

1. Close all reservoir drain cocks.
2. Build up system pressure to governor cutout and note that the AD-IP™ air dryer purges with an audible escape of air.
3. “Fan” the service brakes to reduce system air pressure to governor cut-in. Note that the system once again builds to full pressure and is followed by a purge at the AD-IP™ air dryer exhaust.
4. It is recommended that the following items be tested for leakage to assure that the AD-IP™ air dryer will not cycle excessively.
 - (A) Total air system leakage (See Bendix publication BW5057 “Air Brake Handbook.”)
 - (B) Compressor unloader mechanism.
 - (C) Governor.
 - (D) Drain cock and safety valve in first (supply) reservoir.
 - (E) All air connections leading to and from the first (supply) reservoir.
 - (F) Delivery check valve.

AD-IP™ AIR DRYER TROUBLESHOOTING CHART

SYMPTOMS	CAUSE	REMEDY
1. Dryer is constantly "cycling" or purging. Dryer purges frequently (every 4 minutes or less while vehicle is idling).	A. Excessive system leakage. IMPORTANT: Note whether air pressure loss is shown on dash gauge(s). Pressure loss shown on gauges is caused by service brake system or component leakage. Pressure loss NOT SHOWN on gauges is caused by supply system or component leakage.	A. If leakage IS SHOWN on gauges test for excessive service brake system leakage. Allowable leakage: Single vehicle - 1 psi/minute either service reservoir. Tractor trailer - 3 psi/minute either service reservoir. Repair and retest as required.  Air pressure loss shown on dash gauges: test all components, fittings and lines in service brake system (from this point down stream).
		B. If leakage is NOT SHOWN on gauges test for excessive supply system leakage.  Air pressure loss not shown on dash gauges: test all components, fittings and lines in supply system (from this point up stream). Remove drain cock or valve in supply reservoir (wet tank) and install air gauge. Build system pressure, allow air dryer to purge and observe air gauge in supply reservoir. Pressure drop should not exceed 1 psi per minute. Perform tests 1 to 6 in the order presented. 

AD-IP™ AIR DRYER TROUBLESHOOTING CHART (Continued)

SYMPTOMS	CAUSE	REMEDY
1. Dryer is constantly “cycling” or purging. Dryer purges frequently (every 4 minutes or less while vehicle is idling) (continued).		1. Test fittings, hoses, lines and connections. Apply soap solution to detect excessive leakage. Tighten or replace as needed then repeat the air dryer charge-purge cycle and observe the gauge installed in the supply reservoir. If leakage is within limits remove gauge from reservoir and replace drain cock or valve. If excessive leakage is detected, continue testing. 2. Test accessories connected to supply reservoir. Drain all air pressure from system, disconnect all air lines leading to accessories (fan clutch, wipers, air seats, etc.) and plug the reservoir at disconnection point. Build air system pressure until air dryer purges and observe supply reservoir gauge. If leakage is no longer excessive, repair or replace leaking accessory. If excessive leakage is detected, continue testing. 3. Test governor leakage. Build system pressure to governor cut-out, turn off engine and apply soap solution to governor exhaust port and around cap. Leakage should not exceed a 1 in. bubble in 5 seconds. Reduce system pressure to 80 psi or less, and re-apply soap solution. Leakage should not exceed a 1 in. bubble in 5 seconds. If excessive leakage is detected in either test, repair or replace governor. 4. Test compressor unloader leakage. Drain all air pressure from system and remove the governor from the compressor. Temporarily plug the governor unloader port or air line that mated with, or connected to, the compressor. Build air system pressure until air dryer purges then IMMEDIATELY SHUT OFF THE ENGINE. Observe the air gauge in the supply reservoir. If leakage is within limits, replace the compressor unloaders. Re-connect the governor to the compressor (after removing plug installed in governor) and retest while observing supply reservoir gauge. If excessive leakage is detected, continue testing. 5. Test air dryer purge valve and outlet (delivery) check valve. Drain all air pressure from system, remove the control line connection at the air dryer and plug the end of the air line leading to the governor (not the air dryer control port). Build system pressure to governor cut-out and observe air gauge. If little or no pressure drop is observed replace the air dryer check valve. If pressure drop continues, apply soap solution to air dryer purge exhaust and purge control port (where the control line was removed). Leakage should not exceed a 1 in. bubble in 5 seconds. If leakage is excessive repair or replace purge valve assembly.

AD-IP™ AIR DRYER TROUBLESHOOTING CHART (Continued)

SYMPTOMS	CAUSE	REMEDY
1. Dryer is constantly “cycling” or purging. Dryer purges frequently (every 4 minutes or less while vehicle is idling) (continued).		6. With gauge installed at RES port of governor, pressure should not drop below “Cut-In” pressure at the onset of the compressor “Unloaded” cycle. If pressure drops, check for “kinks” or restrictions in line connected to RES port. Line connected to RES port on governor must be same diameter, or preferably larger than, lines connected to UNL port(s) on governor.
	B. Holset “E” type compressor.	B. Test the Holset E Compressor unloader system with feedback line and check valve for proper operation. Make certain Holset ECON is not in use with the drop-in version of the air dryer, if so, remove and retest. Typical Drop-In Air Dryer End Cover When installing a Bendix Drop-In air dryer in a system equipped with a Holset E or QE compressor, remove the Holset ECON valve along with its feedback and governor control line.
2. Water and/or Oil in Supply or Service Reservoir.	A. Improper discharge line length or improper line material. Maximum air dryer inlet temperature is exceeded.	A. Refer to section entitled <i>Connecting the Air Lines</i> as well as Appendix A, Table A columns 1 & 2 then check line size and length.
	B. Air system charged from outside air source (outside air not passing through air dryer).	B. If system must have outside air fill provision, outside air should pass through air dryer. This practice should be minimized.
	C. Air dryer not purging (see Symptom #5).	C. See Symptom #5.

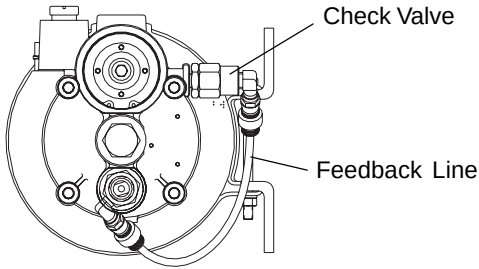
AD-IP™ AIR DRYER TROUBLESHOOTING CHART (Continued)

SYMPTOMS	CAUSE	REMEDY
2. Water and/or Oil in Supply or Service Reservoir (continued).	D. Purge (air exhaust) time insufficient due to excessive system leakage (see causes for Symptom #1).	D. Check causes and remedies for Symptom #1.
	E. Excessive air usage, duty cycle too high - Air dryer not compatible with vehicle air system requirement (Improper air dryer/vehicle application). NOTE: Duty Cycle is the ratio of time the compressor spends building air to total engine running time. Air compressors are designed to build air (run "loaded") up to 25% of the time. Higher duty cycles cause conditions that affect air brake charging system performance which may require additional maintenance. Factors that add to the duty cycle are: air suspension, additional air accessories, use of an undersized compressor, frequent stops, excessive leakage from fittings, connections, lines, chambers or valves, etc.	E. See Appendix A, Table A, column 1, for recommended compressor sizes. If the compressor is "too small" for the vehicle vocation (for example, where a vehicle's vocation has changed or service conditions exceed the original vehicle or engine OE spec's) then upgrade the compressor. Note: The costs incurred (e.g. installing a larger capacity compressor, etc.) are not covered under original compressor warranty. <u>Charge Cycle Time</u> - The AD-IP™ air dryer is designed to provide clean, dry air for the brake system. When a vehicle's air system is used to operate non-brake air accessories it is necessary to determine that; during normal, daily operation the compressor should recover from governor "cut-in" to governor "cut-out" (usually 100 psi to 120 psi) in 90 seconds or less at engine RPM's commensurate with the vehicle vocation. If the recovery time consistently exceeds this limit, it may be necessary to "bypass" the air accessory responsible for the high air usage. An example of where a by-pass system would be required is when the compressor is used to pressurize a tank trailer for purposes of off-loading product. Consult your local authorized Bendix parts outlet or sales representative for additional information. <u>Purge Cycle Time</u> - During normal vehicle operation, the air compressor must remain unloaded for a minimum of 30 seconds. This minimum purge time is required to ensure complete regeneration of the desiccant material. If the purge time is consistently less than the minimum, an accessory by-pass system must be installed. Consult your local authorized Bendix parts outlet or sales representative for additional information. <u>Air Compressor Size</u> - Although the AD-IP™ air dryer can be used in conjunction with larger compressors, it was designed primarily for units rated for up to 30 CFM. It is recommended that when using the AD-IP™ air dryer with a compressor which has a rated displacement exceeding 30 CFM that an authorized Bendix parts outlet or Bendix marketing representative be contacted for assistance.
	F. Air compressor discharge and/or air dryer inlet temperature too high.	F. Restricted discharge line. See Appendix A, Table A, column 1 & 2 for recommended sizes. If discharge line is restricted or more than 1/16" carbon build up is found, replace the discharge line. Replace as necessary.

AD-IP™ AIR DRYER TROUBLESHOOTING CHART (Continued)

SYMPTOMS	CAUSE	REMEDY
2. Water and/or Oil in Supply or Service Reservoir (continued).		Discharge Line Freeze-Up. The discharge line must maintain a constant slope down from the compressor to the air dryer inlet fitting to avoid low points where ice may form and block the flow. If, instead, ice blockages occur at the air dryer inlet, insulation may be added here, or if the inlet fitting is a typical 90 degree fitting, it may be changed to a straight or 45 degree fitting. For more information on how to help prevent discharge line freeze-ups, see Bendix Bulletins TCH-08-21 and TCH-08-22. Shorter discharge line lengths or insulation may be required in cold climates. Insufficient coolant flow through compressor. Inspect coolant line. Replace as necessary (I.D. is 1/2" min.). Inspect the coolant lines for kinks and restrictions and fittings for restrictions. Replace as necessary. Verify coolant lines go from engine block to compressor and back to the water pump. Repair as necessary. Restricted air inlet (not enough air to compressor). Check compressor air inlet line for restrictions, brittleness, soft or sagging hose conditions etc. Repair as necessary. Inlet line size is 3/4 ID. Maximum restriction requirement for compressors is 25 inches of water. Check the engine air filter and service if necessary (if possible, check the air filter usage indicator). Poorly filtered inlet air (poor air quality to compressor). Check for leaking, damaged or malfunctioning compressor air inlet components (e.g. induction line, fittings, gaskets, filter bodies, etc.). Repair inlet components as needed. Note: Dirt ingestion will damage compressor and is not covered under warranty. If you found excessive oil present in the service reservoir and you did not find any issues above, the compressor may be passing oil. Replace compressor. If still under warranty, follow normal warranty process.
	G. Compressor malfunction.	G. If you found excessive oil present in the service reservoir and you did not find any issues above, the compressor may be passing oil. Test the compressor using the BASIC cup method as described in the Bendix compressor service manual and referred to in Appendix A, Table A, column 5. Replace compressor. If still under warranty, follow normal warranty process.
	H. Air by-passes desiccant cartridge assembly.	H. If vehicle uses Holset compressor, inspect feedback check valve for proper installation and operation.

AD-IP™ AIR DRYER TROUBLESHOOTING CHART (Continued)

SYMPTOMS	CAUSE	REMEDY
2. Water and/or Oil in Supply or Service Reservoir (continued).		When replacing the desiccant cartridge, make sure desiccant cartridge assembly is properly installed and sealing rings are in place on mounting surface of desiccant cartridge.  Typical Drop-In Air Dryer End Cover
	I. Desiccant requires replacement.	I. Replace desiccant cartridge assembly. Refer to Appendix A, Table A columns 3 & 4 for recommended intervals.
3. Oil present at air dryer purge exhaust or cartridge during maintenance.	A. Air brake charging system is functioning normally.	A. Air dryers remove water and oil from the air brake charging system. A small amount of oil is normal. Check that regular maintenance is being performed and that the amount of oil in the air tanks (reservoirs) is within the acceptable range shown on the BASIC cup (see also column 5 of Appendix A, Table A). Replace the air dryer cartridge as needed and return the vehicle to service.
4. Safety valve on air dryer "popping off" or exhausting air.	A. Restriction between air dryer and supply (first) reservoir.	A. Check to determine if air is reaching supply reservoir. Inspect for kinked tubing or hose. Check for undrilled or restricted hose or tubing fittings and repair or replace as needed.
	B. Air dryer safety valve malfunction.	B. Verify relief pressure is at vehicle or component manufacturer specifications. Replace if malfunctioning.
	C. Desiccant cartridge maintenance required.	C. Refer to Appendix A Table A and column 3. Check compressor for excessive oil passing and/or correct compressor installation. Repair or replace as necessary. Replace desiccant cartridge.
	D. Malfunctioning discharge check valve in end cover of the AD-IP™ air dryer.	D. Test to determine if air is passing through check valve. Repair or replace.
	E. Excessive pressure pulsations from compressor. (Typical single cylinder type).	E. Increase volume in discharge line by increasing length or diameter. Add a ping tank (small reservoir).

AD-IP™ AIR DRYER TROUBLESHOOTING CHART (Continued)

SYMPTOMS	CAUSE	REMEDY
4. Safety valve on air dryer "popping off" or exhausting air (continued).	F. Governor malfunction. Missing or restricted governor control line installation.	F. Test governor operation and/or inspect the control line leading from the governor UNL (unloader) port to the air dryer control port.
5. Constant exhaust of air at air dryer purge valve exhaust. (Charge mode.)	A. Air dryer purge valve leaking excessively.	A. With compressor loaded, apply soap solution on purge valve exhaust, to test for excessive leakage. Refer to Technical Bulletin TCH-008-040. Repair purge valve as necessary.
	B. Compressor fails to unload (stop compressing air) and air dryer purge exhaust makes "sputtering" or "popping" sound.	B. Confirm failure to unload by increasing & decreasing engine RPM and noting change in the rate of leakage and intensity of accompanying leakage sound. Repair/replace compressor unloaders.
	C. Purge control line connected to reservoir or exhaust port of governor.	C. Purge control line must be connected to unloader port of governor.
	D. Purge valve frozen open - malfunctioning heater and thermostat, wiring, blown fuse.	D. Test heater and thermostat as described in <i>Preventative Maintenance</i> Section.
	E. Excessive system leakage.	E. See Symptom #1.
	F. Purge valve stays open - supply air leaks to control side.	F. Repair purge valve and housing.
6. Can not build system air pressure.	A. Inlet and outlet air connections reversed.	A. Connect compressor discharge to air dryer supply port. Reconnect lines properly.
	B. Check valve between air dryer and first reservoir.	B. Test check valve for proper operation. Repair or replace as necessary.
	C. Kinked or blocked (plugged) discharge line.	C. Check to determine if air passes through discharge line. Check for kinks, bends, excessive carbon deposits, or ice blockage.
	D. Excessive bends in discharge line (water collects and freezes).	D. Discharge line should be constantly sloping from compressor to air dryer with as few bends as possible.
	E. Refer to Symptom 4, Causes E & F.	E. Refer to Symptom #4, Remedies E & F.
7. Air dryer does not purge or exhaust air.	A. Missing, broken, kinked, frozen, plugged or disconnected purge control line.	A. Inspect control line from governor UNL (unloader) port to control port of air dryer. Test to determine if air flows through purge control line when compressor unloaded. Check for undrilled fittings. (See Symptom #4, Remedy C.)
	B. Faulty air dryer purge valve.	B. After determining air reaches purge valve (Remedy A above), repair purge valve.
	C. See Causes, B, E, G for Symptom #4.	C. Refer to Remedies B, E, G for Symptom #4.

AD-IP™ AIR DRYER TROUBLESHOOTING CHART (Continued)

SYMPTOMS	CAUSE	REMEDY
8. Desiccant material being expelled from air dryer purge valve exhaust (may look like whitish liquid or paste or small beads.) - OR - Unsatisfactory desiccant life.	A. This symptom is almost always accompanied by one or more of Symptoms 1, 2, 3, 4 and 5. See related causes for these symptoms above.	A. See Causes and Remedies for Symptoms 1, 2, 3, 4 and 5.
	B. Air dryer not securely mounted. (Excessive vibration.)	B. Vibration should be held to minimum. Add bracket supports or change air dryer mounting location if necessary.
	C. Malfunctioning or saturated desiccant cartridge.	C. Replace desiccant cartridge assembly.
	D. Compressor passing excessive oil.	D. Check for proper compressor installation; if symptoms persist, replace compressor.
	E. Desiccant cartridge not assembled properly to end cover. (Loose attachment)	E. Check the torque on the desiccant cartridge to end cover attachment. Refer to assembly section of this data sheet.
9. "Pinging" noise excessive during compressor loaded cycle.	A. Single cylinder compressor with high pulse cycles.	A. A slight "pinging" sound may be heard during system build up when a single cylinder compressor is used. If this sound is deemed objectionable, it can be reduced substantially by increasing the discharge line volume. This can be accomplished by adding an additional four feet of discharge line or adding a 90 cubic inch reservoir between the compressor and the AD-IP™ air dryer. IMPORTANT: Do not exceed the line lengths requirements specified in this manual.
10. Constant seepage of air at air dryer purge valve exhaust (non-charging mode.)	A. Defective check valve assembly in AD-IP™ air dryer end cover.	A. Refer to Remedy C, Symptom #1.
	B. Leaking Turbo Cutoff valve.	B. Repair or replace purge valve assembly.
	C. Leaking purge valve control piston o-ring.	C. Repair or replace purge valve assembly.
11. The air dryer purge piston cycles rapidly in the compressor unloaded (non-compressing) mode.	A. Compressor fails to "unload".	A. Faulty governor installation; no air line from governor to compressor or line is kinked or restricted. Install or repair air line.

Appendix A

Table A: Maintenance Schedule and Usage Guidelines

Regularly scheduled maintenance is the single most important factor in maintaining the air brake charging system.

Vehicle Used for:	No. of Axles	Column 1	Column 2		Column 3	Column 4	Column 5
		Typical Compressors Spec'd	Discharge Line		Recommended Air Dryer Cartridge Replacement ¹	Recommended Reservoir Drain Schedule ²	Acceptable Reservoir Oil Contents ³ at Regular Drain Interval
			I.D.	Length			
Low Air Use		Bendix® BA-921® air compressor Bendix® Tu-Flo® 550 air compressor	1/2 in.	6 ft.	Every 3 Years	Recommended Every Month - Max of every 90 days	BASIC test acceptable range: 3 oil units per month. See appendix A.
Compressor with less than 15% duty cycle e.g. Line haul single trailer w/o air suspension, air over hydraulic brakes. 	5 or less		For oil carry-over control ⁴ suggested upgrades: 5/8 in. 9 ft.				
Compressor with up to 25% duty cycle e.g. Line haul single trailer with air suspension, school bus. 	5 or less		1/2 in.	9 ft.			
			For oil carry-over control ⁴ suggested upgrades: 5/8 in. 12 ft.				
High Air Use		Bendix® Tu-Flo® 750 air compressor Bendix® BA-921® air compressor Bendix® Tu-Flo® 596 air compressor Bendix® BA-922® or DuraFlo™ 596 air compressor	1/2 in.	12 ft.	Every 2 Years	Every Month	BASIC test acceptable range: 5 oil units per month. See appendix A.
Compressor with up to 25% duty cycle e.g. Double/triple trailer, open highway coach/RV, (most) pick-up & delivery, yard or terminal jockey, off-highway, construction, loggers, concrete mixer, dump truck, fire truck. 	8 or less		For oil carry-over control ⁴ suggested upgrades: 5/8 in. 15 ft.				
Compressor with up to 25% duty cycle e.g. City transit bus, refuse, bulk unloaders, low boys, urban region coach, central tire inflation. 	12 or less		5/8 in.	12 ft.			
			For oil carry-over control ⁴ suggested upgrades: 3/4 in. 15 ft.				

Footnotes:

- 1 With increased air demand the air dryer cartridge needs to be replaced more often.
- 2 Use the drain valves to slowly drain all reservoirs to zero psi.
- 3 Allow the oil/water mixture to fully settle before measuring oil quantity.
- 4 To counter above normal temperatures at the air dryer inlet, (and resultant oil-vapor passing upstream in the air system) replace the discharge line with one of a larger diameter and/or longer length. This helps reduce the air's temperature. If sufficient cooling occurs, the oil-vapor condenses and can be removed by the air dryer. Discharge line upgrades are not covered under warranty. Note: To help prevent discharge line freeze-ups, shorter discharge line lengths or insulation may be required in cold climates. (See Bendix Bulletins TCH-08-21 and TCH-08-22.)
- 5 For certain vehicles/applications, where turbo-charged inlet air is used, a smaller size compressor may be permissible.

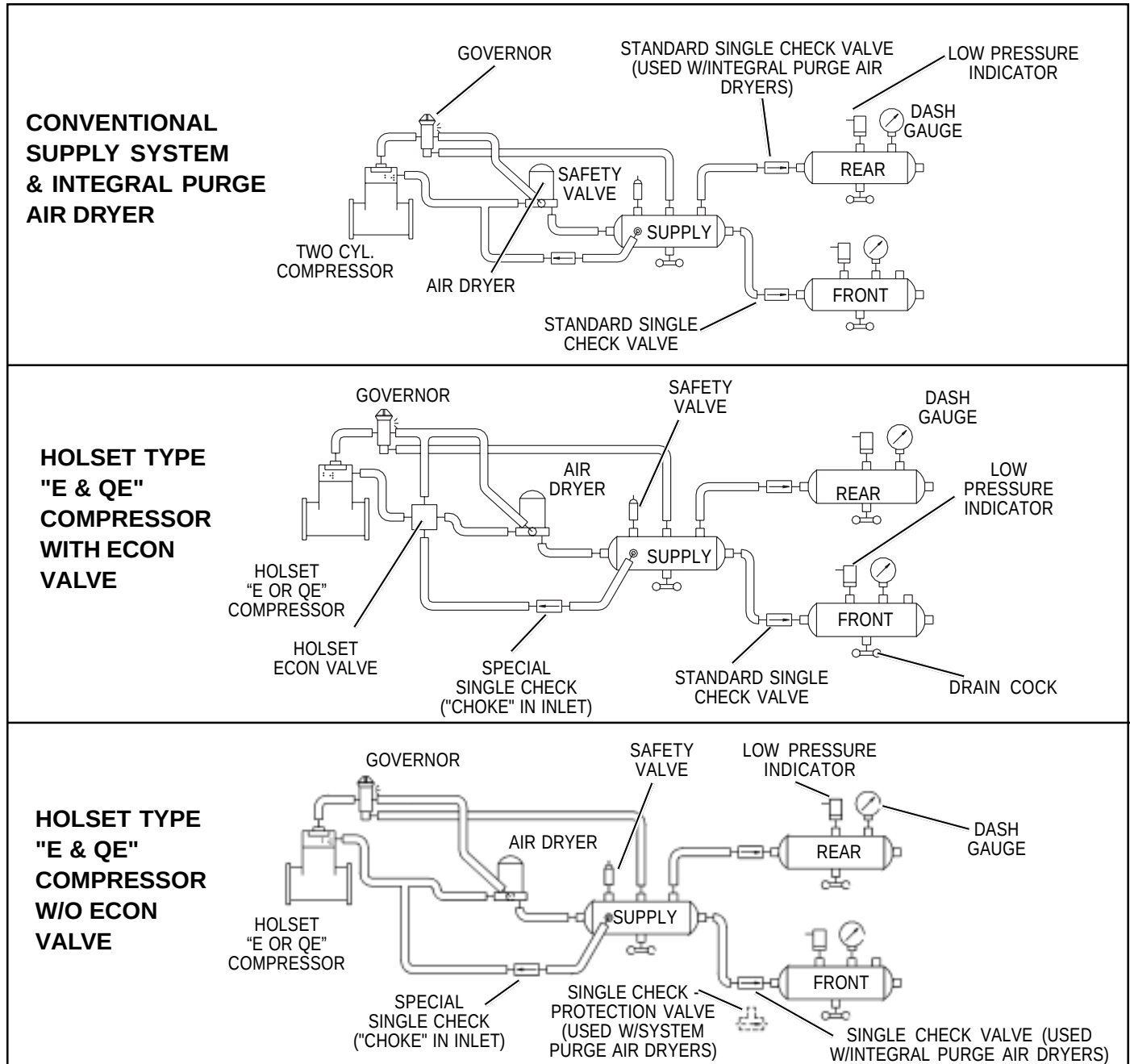
Note: Compressor and/or air dryer upgrades are recommended in cases where duty cycle is greater than the normal range (for the examples above).

For Bendix® Tu-Flo® 550 and 750 compressors, unloader service is recommended every 250,000 miles.

Appendix B

Additional Troubleshooting Information

The troubleshooting procedure presented on the following pages has been excerpted from a laminated card entitled: Troubleshooting Charging and Air Supply Systems. The complete card can be obtained from authorized Bendix parts outlets under literature number BW1779. It is presented here because of the air dryers connection to the supply air system and for convenience. The procedure is not all inclusive but rather represents the most commonly encountered complaints.



COMPLAINTS COMMON TO THE CHARGING & AIR SUPPLY SYSTEM

Complaint: Can Not Build System Pressure

- Discharge line plugged or restricted: see Common Test 1.
- Air pressure trapped between governor and compressor unloaders: see Common Test 2.
- Blow leakage at air dryer exhaust: see Common Test 3.

Complaint: Air System Builds Too Slow

- Discharge line restricted: see Common Test 1.
- Discharge line leakage: see Common Test 5.
- Air leaking at air dryer exhaust: see Common Test 3.
- Compressor head gasket failure: apply soap solution around cylinder head. If leakage between head and block noted repair or replace compressor.
- Air pressure trapped between governor and compressor unloaders: see Common Test 2.
- Air system leakage: see Common Test 4.

Complaint: Can Not Build System Pressure Above "X" psi.

- Blow leakage at compressor unloaders: remove all hardware from compressor inlet then remove governor. With 120 psi shop air applied to compressor unloader port listen for leakage at inlet. If noted, repair leak or replace compressor.
- Incorrect setting on governor: verify safety valve operation. Drain air from system, remove or disconnect governor from compressor and install gauge in governor unloader (UNL) port. Build system pressure and note when pressure on dash gauge and test gauge are equal. Should be equal at maximum setting of governor.
- Discharge line leakage: see Common Test 5.
- Air system leakage: see Common Test 4.
- Compressor head gasket failure: apply soap solution around cylinder head. If leakage between head and block noted repair or replace compressor.

Complaint: Air Dryer Cycles "ON & OFF" Constantly

This complaint caused by leakage, either service system or supply system. Service system leakage is shown on dash gauges supply system leakage is not. *Note: System purge air dryers will purge more often than those with integral purge volume.*

Service system leakage: see Common Test 4.

Supply system component leakage: drain system, install gauge and shop air hose in place of drain cock in supply reservoir. Fill system to 120 psi, shut off shop air and check leakage on following components in order presented:

- Compressor unloader leakage.
- Drain system, remove governor from compressor plug governor UNL port and re-test. If leakage OK repair compressor unloader mechanism or replace compressor. If leakage NOT OK then next.
- Holset ECON valve (used with Holset Type "E & QE" comp.) missing, malfunctioning, leaking.

- Is ECON valve required but missing? If YES, install, along with special Holset check valve w/choke. If NO and ECON valve present replace ECON valve and special check valve. If NO and ECON not required then next.
- Air dryer leakage: Remove line from air dryer inlet and with 120 psi in supply res. soap exhaust and inlet port of air dryer. If leakage greater than 1" bubble in 1 second at exhaust port, repair or replace check valve (on dryers with integral purge volume) or replace body assy. on system purge air dryers. If leakage greater than 1" bubble in 1 second at inlet port, repair or replace purge valve assy. (on dryers with integral purge volume) or replace turbo cut-off valve on system purge air dryers.

Complaint: System Pressure Goes to 150+ psi

- Drain air system to 0 psi, remove/disconnect governor from compressor. Start engine and note air pressure rise on dash gauges. Apply 120 psi shop air to compressor unloader port. If air pressure continues to rise, repair compressor unloaders or replace compressor. If air ceases to rise, repair or replace governor.

Complaint: Low Pressure Warning After Only 1 or 2 Applications

- Brakes out of adjustment: adjust brakes.
- Excessive system leakage on service (application) side of system: Build system pressure to 120 psi and shut off engine. With park brakes released, make full service application and note dash gauges for 2 minutes. Pressure drop on either gauge should not exceed 4 psi. (2 psi per min.) If pressure drop excessive, find leakage in service system, if OK, then next.
- Incorrect low pressure switch in use or setting incorrect: Build system to 120 psi. Engine OFF ignition ON, slowly drain air pressure from one service reservoir. Low pressure warning on at minimum 60 psi, maximum 10-15 psi less than governor cut-in pressure.

TESTS COMMON TO MORE THAN ONE COMPLAINT

1. Discharge plugged or restricted

- Connect temporary discharge line from comp. discharge port to supply res. & re-check build-up. If build-up OK replace plugged discharge line. If build-up NOT OK go to next cause.

2. Air pressure trapped between governor and compressor

- Verify safety valve operation then remove or disconnect governor from compressor & check build-up.
- If build-up OK, repair or replace governor or line between governor and compressor.
- If build-up NOT OK repair or replace compressor.

3. Blow Leakage at Air Dryer Exhaust

- Drain all air from supply reservoir then remove control air line from air dryer, plug line and plug control port in air dryer. Re-check build-up.
- If build-up OK, repair or replace governor or line between governor and air dryer.
- If build-up NOT OK, and below 32 deg. F, turn ignition ON and allow heater to warm air dryer then check build-up. If NOT OK, remove wire (connector or terminal) from air dryer. Using test light, check wire end or terminal for battery voltage with vehicle ignition ON. If voltage OK, repair or replace air dryer heater and thermostat. If voltage NOT OK, repair or replace the vehicle wire connected to air dryer. Retest build-up.

- If build-up still NOT OK or temp. above 32 deg. F, replace air dryer purge valve assembly.

4. Air system leakage

- Build system pressure to governor cut-out, wait 2 minutes for dryer purge completion. Note pressures on dash gauges then watch dash gauges for 2 minutes. Leakage not to exceed 2 psi in 2 mins. for truck, bus, tractor (no trailer).
- If leakage NOT OK on gauges, find leak(s) in service and park system and repair. Retest and if system purge air dryer in use and still not OK repair or replace dryer.
- If leakage OK on gauges, drain air from supply reservoir, remove drain cock and install air gauge. Build system air in supply reservoir and note leakage. If OK continue checking. If NOT OK find leaks and repair.

5. Discharge line leakage

- Soap cover on flex discharge line, if leakage noted replace line.
- Soap fittings to check leakage, tighten as needed.

IMPORTANT: The Complaints, Causes and Remedies presented here should not be considered as the only situations possible. They are only meant to represent the most commonly encountered. It may be necessary to perform additional trouble shooting using the more detailed information presented in service manuals for the specific components.



Bendix® R-12® & R-14® Relay Valves

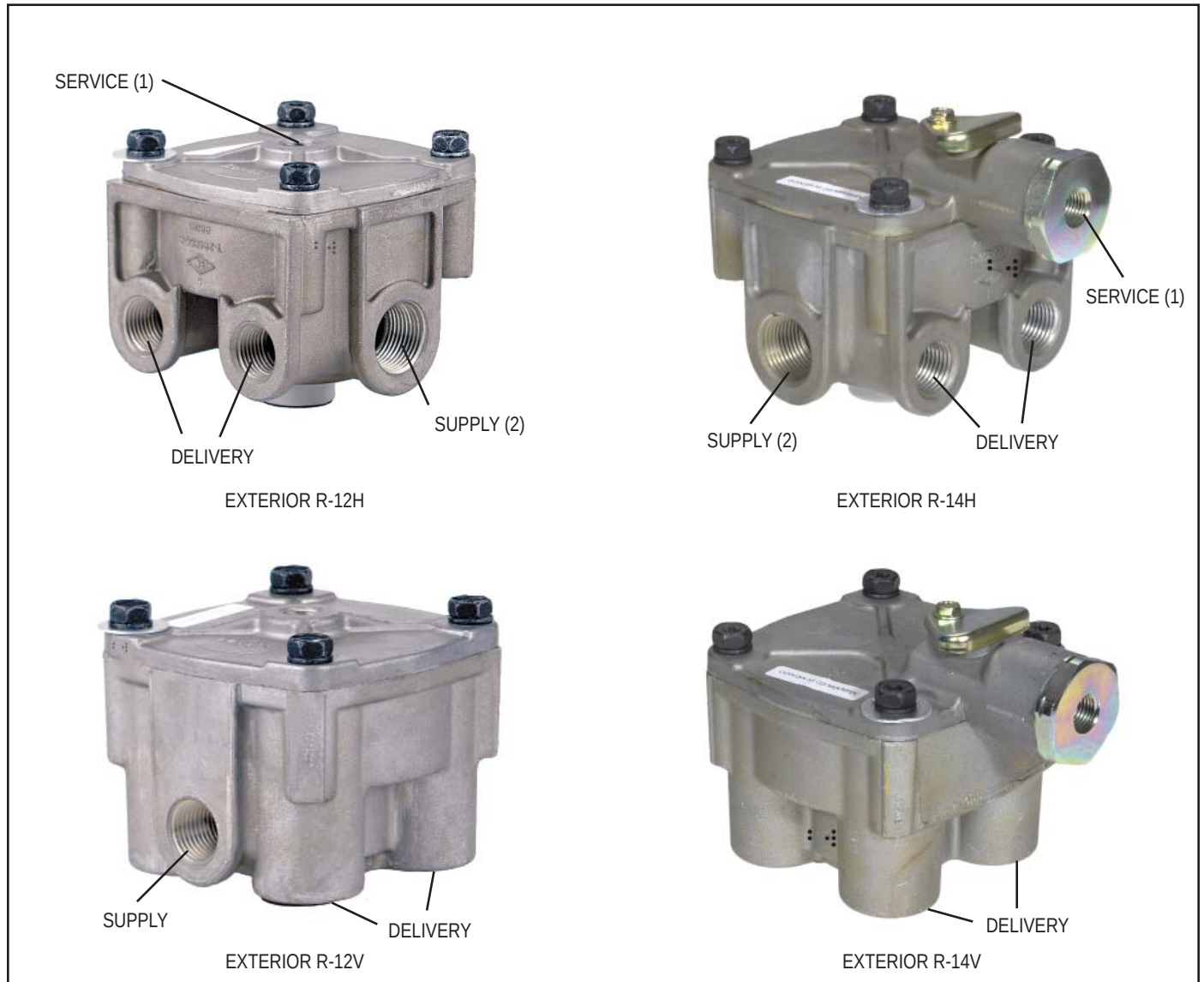


FIGURE 1 - EXTERIOR VIEWS

DESCRIPTION

The relay valve in an air brake system functions as a relay station to speed up the application and release of the brakes. The valve is normally mounted at the rear of the vehicle in proximity to the chambers it serves. The valve operates as a remote controlled brake valve that delivers or releases air to the chambers in response to the control air delivered to it from the foot brake valve or other source.

The R-12® and R-14® relay valves are designed for either reservoir or frame mounting. A universal mounting bracket is furnished that permits easy interchange with other Bendix® relay valves. Both valves are available in the two body styles illustrated in Figure 1. The R-14® valve differs from the R-12® valve in that it incorporates a quick release and anti-compounding feature located above its horizontal service port. The R-14® valve's anti-compound feature allows it to

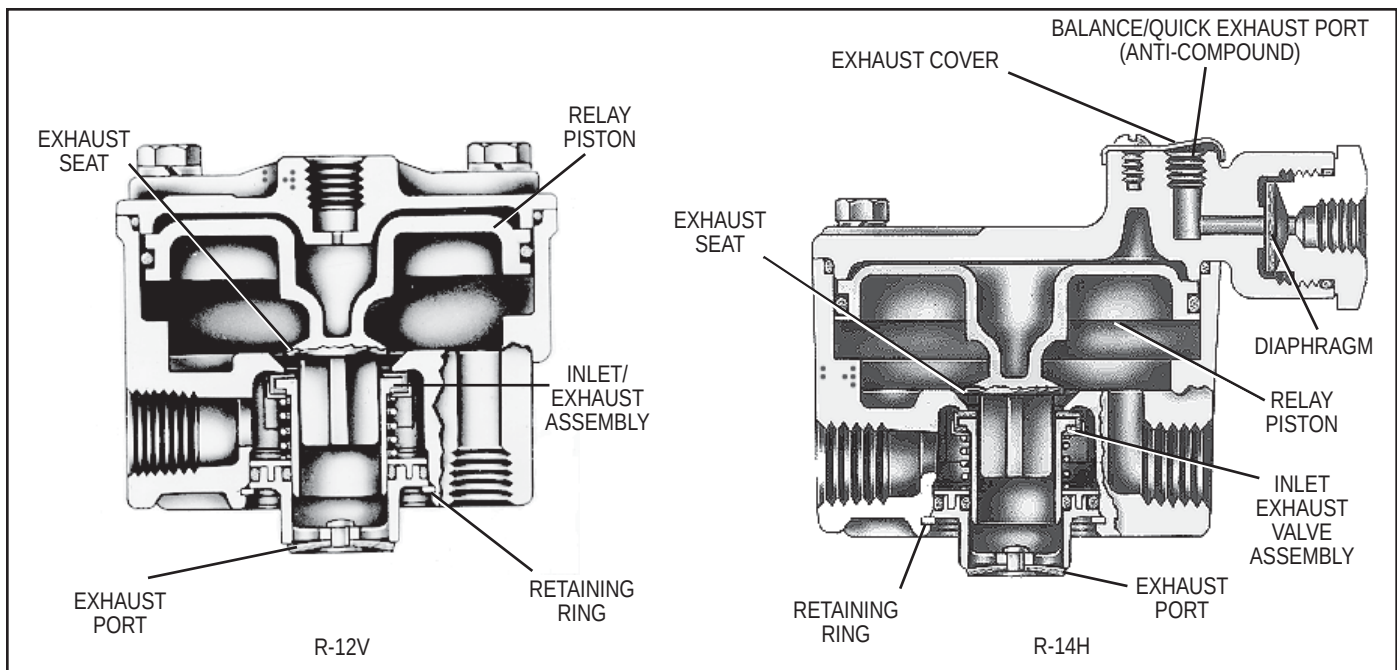


FIGURE 2 - SECTIONAL VIEWS

be conveniently used as either a service or spring brake relay valve. An exhaust cover is installed that protects the 1/8" balance port when the R-14® valve anti-compound feature is not in use.

All parts are interchangeable between the R-12® and R-14® valves with the exception of the detail components of the R-14® valve cover. Both valves make extensive use of non-metallic internal components. For ease of servicing, the inlet/exhaust valve can be replaced without the need for line removal.

OPERATION

APPLICATION

Air pressure delivered to the service port enters the small cavity above the piston and moves the piston down. The exhaust seat moves down with the piston and seats on the inner or exhaust portion of the inlet/exhaust valve, sealing off the exhaust passage. At the same time, the outer or inlet portion of the inlet/exhaust valve moves off its seat, permitting supply air to flow from the reservoir, past the open inlet valve and into the brake chambers.

BALANCE

The air pressure being delivered by the open inlet valve also is effective on the bottom area of the relay piston. When air pressure beneath the piston equals the service air pressure above, the piston lifts slightly and the inlet spring returns the inlet valve to its seat. The exhaust remains closed as the service line pressure balances the delivery pressure. As delivered air pressure is changed, the valve reacts instantly to the change, holding the brake application at that level.

EXHAUST OR RELEASE

When air pressure is released from the service port and air pressure in the cavity above the relay piston is exhausted, air pressure beneath the piston lifts the relay piston and the exhaust seat moves away from the exhaust valve, opening the exhaust passage. With the exhaust passage open, the air pressure in the brake chambers is then permitted to exhaust through the exhaust port, releasing the brakes.

ANTI-COMPOUNDING (SIMULTANEOUS SERVICE AND PARK APPLICATION)

In those applications where the R-14® relay valve is used to control spring brake chambers, the anti-compound feature may be utilized. With the anti-compound feature of the R-14® valve connected, a service application made while the vehicle is parked is countered by a release of the parking brakes. To utilize this feature, the exhaust cover of the quick release portion of the R-14® valve is removed and a line is installed which is connected to the delivery of the service brake valve or relay valve. With no air pressure at the service port of the R-14® valve, the parking brakes are applied. If a service brake application is made, air from the service brake valve enters the exhaust port of the quick release of the R-14® valve and moves the diaphragm, blocking the service port. Air then proceeds into the cavity above the relay piston, forces the piston down, closing the exhaust and opening the inlet to deliver air to the spring brake cavity as described under the section of this manual entitled *Application*.

PREVENTIVE MAINTENANCE

Important: Review the Bendix Warranty Policy before performing any intrusive maintenance procedures. A warranty may be voided if intrusive maintenance is performed during the warranty period.

No two vehicles operate under identical conditions, as a result, maintenance intervals may vary. Experience is a valuable guide in determining the best maintenance interval for air brake system components. At a minimum, the valve should be inspected every 6 months or 1500 operating hours, whichever comes first, for proper operation. Should the valve not meet the elements of the operational tests noted in this document, further investigation and service of the valve may be required.

OPERATIONAL AND LEAKAGE TEST

1. Chock the wheels, fully charge the air brake system and adjust the brakes.
2. Make several brake applications and check for prompt application and release at each wheel.
3. Check for inlet valve and o-ring leakage.
 - A. Make this check with the service brakes released when the R-12® or R-14® valve is used to control the service brakes.
 - B. Make the check with the spring brakes applied (PARK) when the R-14® valve is used to control the spring brakes. Coat the exhaust port and the area around the retaining ring with a soap solution; a 1" bubble in 3 seconds leakage is permitted.
4. Check for exhaust valve leakage.
 - A. Make this check with the service brakes fully applied if the R-12® or R-14® valve control the service brakes.
 - B. Make this check with the spring brakes fully released if the R-14® valve is used to control the spring brakes. Coat the exhaust port with a soap solution; a 1" bubble in 3 seconds leakage is permitted. Coat the outside of the valve where the cover joins the body to check for seal ring leakage; no leakage is permitted.
5. If the R-14® valve is used to control the spring brakes, place the park control in the released position and coat the balance port with a soap solution to check the diaphragm and its seat. Leakage equivalent to a 1" bubble in 3 seconds is permitted.

Note: If the anti-compound feature is in use, the line attached to the balance port must be disconnected to perform this test.

If the valves do not function as described above, or if leakage is excessive, it is recommended that the valves be replaced with new or remanufactured units or repaired with genuine Bendix® parts, available at any authorized Bendix® parts outlet.

REMOVAL AND INSTALLATION

REMOVAL

1. Block and hold vehicle by means other than air brakes.
2. Drain air brake system reservoirs.
3. If entire valve is to be removed, identify air lines to facilitate installation.
4. Disconnect air lines from valve*
5. Remove valve from reservoir or if remotely mounted, remove mounting bolts and then valve.

*It is generally not necessary to remove entire valve to service the inlet/exhaust valve. The inlet/exhaust valve insert can be removed by removing the snap ring, exhaust cover assembly and then inlet/exhaust valve.

Caution: Drain all reservoirs before attempting to remove the inlet exhaust valve.

DISASSEMBLY

Note: Prior to disassembly, mark the location of the mounting bracket to the cover and the cover to the body.

1. Remove the four (4) cap screws and lockwashers securing the cover to the body.
2. Remove the cover, sealing ring, and mounting bracket.
3. Remove the piston and o-ring from the body.
4. While depressing the exhaust cover, remove the retaining ring and slowly relax the spring beneath the exhaust cover.
5. Remove the exhaust cover assembly and o-rings.
6. Remove the inlet/exhaust valve return spring from the body.
7. Remove the inlet/exhaust valve from the body.
8. Remove the valve retainer from the inlet/exhaust valve.
9. Remove the Phillips head screw and exhaust cover from the R-14® valve cover.
10. Remove the service port cap nut and o-ring from the R-14® valve.
11. Remove the diaphragm from the R-14® valve cover.

CLEANING AND INSPECTION

1. Wash all metal parts in mineral spirits and dry them thoroughly.

(**Note:** When rebuilding, all springs and all rubber parts should be replaced.)
2. Inspect all metal parts for deterioration and wear, as evidenced by scratches, scoring and corrosion.
3. Inspect the exhaust valve seat on the relay piston for nicks and scratches which could cause excessive leakage.
4. Inspect the inlet valve seat in the body for scratches and nicks, which could cause excessive leakage.

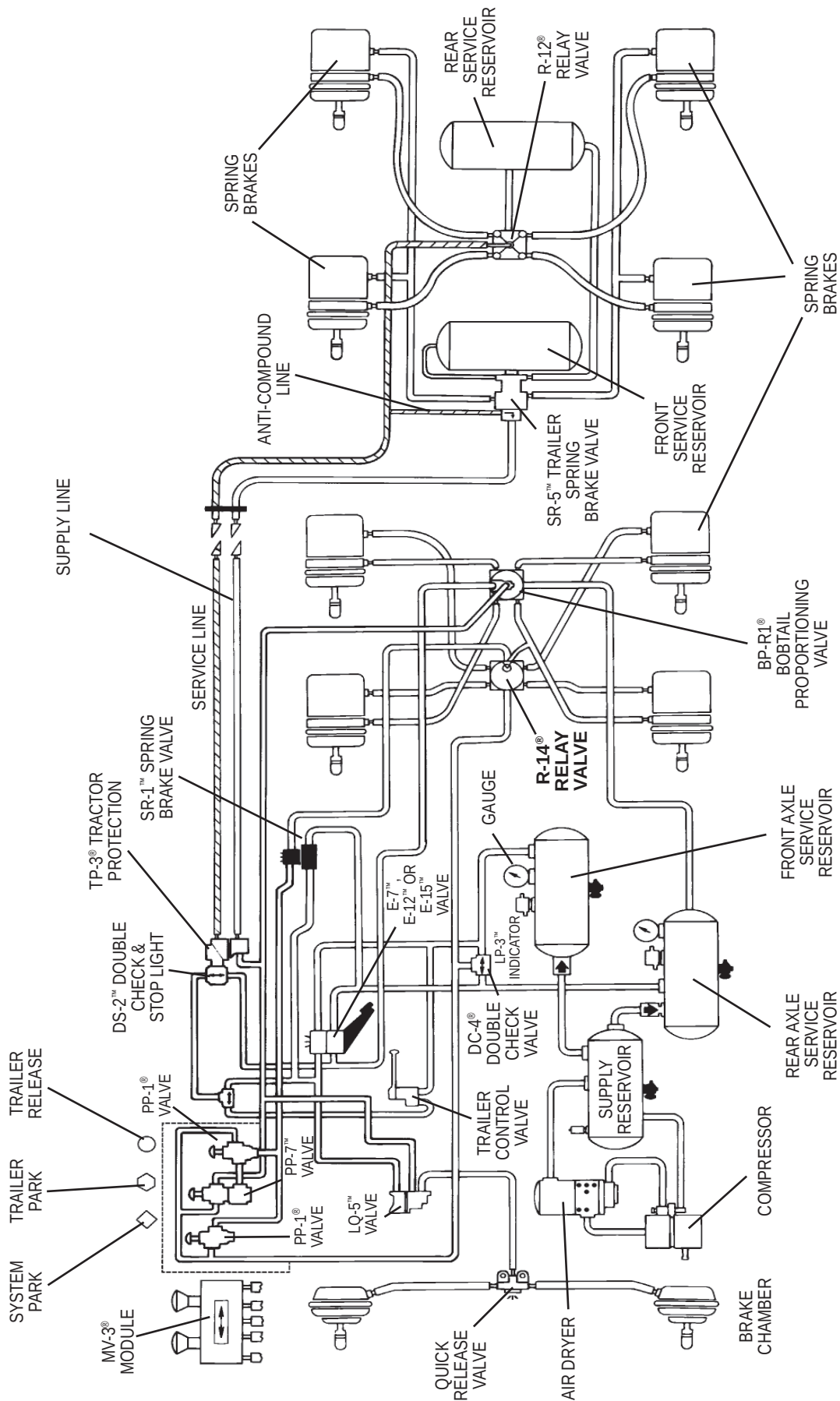


FIGURE 3 - TYPICAL PIPING SCHEMATIC

5. Inspect the exhaust seat of the quick release diaphragm in the R-14® valve cover and make sure all internal air passages in this area are open and clean and free of nicks and scratches.
6. Replace all parts not considered serviceable during these inspections and all springs and rubber parts. Use only genuine Bendix replacement parts, available from any authorized Bendix parts outlet.

ASSEMBLY

Note: All torques specified in this manual are assembly torques and can be expected to fall off slightly after assembly. **Do not re-torque** after initial assembly torque falls. For assembly, hand wrenches are recommended.

Prior to assembly, lubricate all o-rings, o-ring bores and any sliding surface with a silicone lubricant equivalent to Dow Corning #10.

1. Install large piston o-ring on piston.
2. Install inner and outer o-rings in the exhaust cover assembly.
3. Install the sealing ring on the cover.
4. Install piston in body, taking care not to damage the piston o-ring.
5. Noting the reference marks made during disassembly, install the cover on the valve body and the mounting bracket on the cover.
6. Secure the mounting bracket and cover to the body using the four (4) cap screws and lock washers. Torque to 80-120 inch pounds.
7. Install the valve retainer on the inlet/exhaust valve and install in the body.
8. Install the inlet/exhaust valve return spring in the body.
9. Install the exhaust cover assembly in the body, taking care not to damage the o-ring.
10. While depressing the exhaust cover, install the retaining ring. Make certain the retainer is completely seated in its groove in the body.
11. Install the R-14® valve service port cap nut o-ring on the cap nut.
12. Install the diaphragm in the R-14® valve cover making certain it is positioned between the guide ribs in the cover.
13. Install the service port cap nut and torque to 150 inch pounds.
14. If the quick release exhaust port was protected with an exhaust cover, install the cover using the #10-24 Phillips head screw. Torque to approx. 15-25 inch pounds.
15. Test the valves as outlined in the *Operational and Leakage Test* section before returning the valve to service.

INSTALLATION

1. Clean air lines.
2. Inspect all lines and/or hoses for damage and replace as necessary.
3. Install valve and tighten mounting bolts.
4. Connect air lines to valve (plug any unused ports).
5. Test valve as outlined in *Operational and Leakage Tests*.

GENERAL SAFETY GUIDELINES

WARNING! PLEASE READ AND FOLLOW THESE INSTRUCTIONS TO AVOID PERSONAL INJURY OR DEATH:

When working on or around a vehicle, the following general precautions should be observed at all times.

1. **Park the vehicle on a level surface, apply the parking brakes, and always block the wheels. Always wear safety glasses.**
2. **Stop the engine and remove ignition key when working under or around the vehicle. When working in the engine compartment, the engine should be shut off and the ignition key should be removed. Where circumstances require that the engine be in operation, EXTREME CAUTION should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated or electrically charged components.**
3. **Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.**
4. **If the work is being performed on the vehicle's air brake system, or any auxiliary pressurized air systems, make certain to drain the air pressure from all reservoirs before beginning ANY work on the vehicle. If the vehicle is equipped with an AD-IS® air dryer system or a dryer reservoir module, be sure to drain the purge reservoir.**
5. **Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.**
6. **Never exceed manufacturer's recommended pressures.**
7. **Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.**

8. Use only genuine Bendix® replacement parts, components and kits. Replacement hardware, tubing, hose, fittings, etc. must be of equivalent size, type and strength as original equipment and be designed specifically for such applications and systems.
9. Components with stripped threads or damaged parts should be replaced rather than repaired. Do not attempt repairs requiring machining or welding unless specifically stated and approved by the vehicle and component manufacturer.
10. Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.
11. For vehicles with Automatic Traction Control (ATC), the ATC function must be disabled (ATC indicator lamp should be ON) prior to performing any vehicle maintenance where one or more wheels on a drive axle are lifted off the ground and moving.





Service Data

SD-01-700

BENDIX® BA-922® COMPRESSOR

DESCRIPTION

The function of the air compressor is to provide and maintain air under pressure to operate devices in the air brake systems. The Bendix® BA-922® compressor is a two cylinder, reciprocating compressor with a rated displacement of 31.6 cubic feet per minute at 1250 RPM.

The compressor consists of a water-cooled cylinder head, cooling plate, valve plate assembly, and an integral air cooled crankcase and cylinder block. The cast aluminum cylinder head contains the required air and water ports as well as two unloader pistons. The cast aluminum cooling plate provides added cooling and is located between the cylinder head and valve plate assemblies. The valve plate assembly consists of laminated, brazed steel plates which incorporate various valve openings and channels for conducting air and engine coolant into and out of the cylinder head.

The discharge valves are part of the valve plate assembly. The cylinder head, with the cooling and valve plates, comprise a complete cylinder head assembly.

The cast iron crankcase and cylinder block assembly houses the pistons, connecting rods, crankshaft and related bearings.

While not all compressors and charging systems are equipped with an optional discharge line safety valve, this component is recommended. The 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 or blockage.

OPERATION

The compressor is driven by the vehicle engine and functions continuously while the engine is in operation. Actual compression of air is controlled by the compressor unloading mechanism operating in conjunction with a governor.

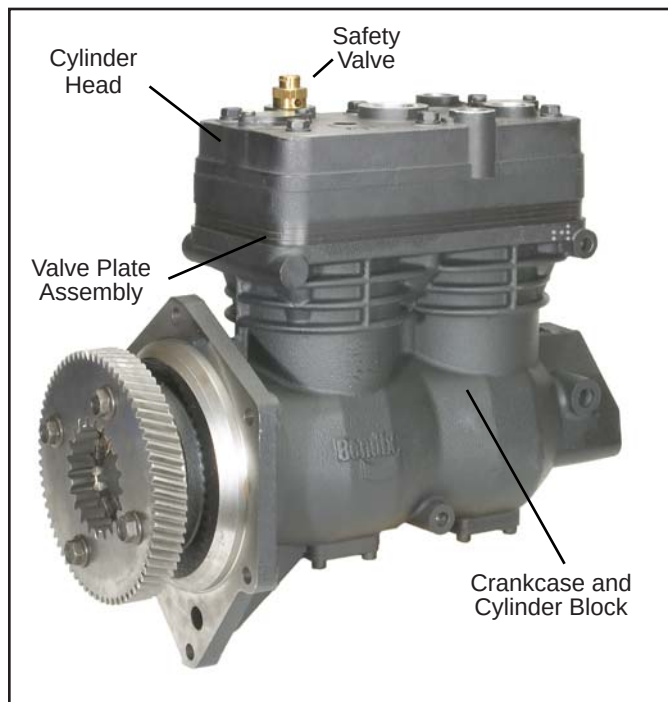


FIGURE 1 - BENDIX® BA-922® COMPRESSOR

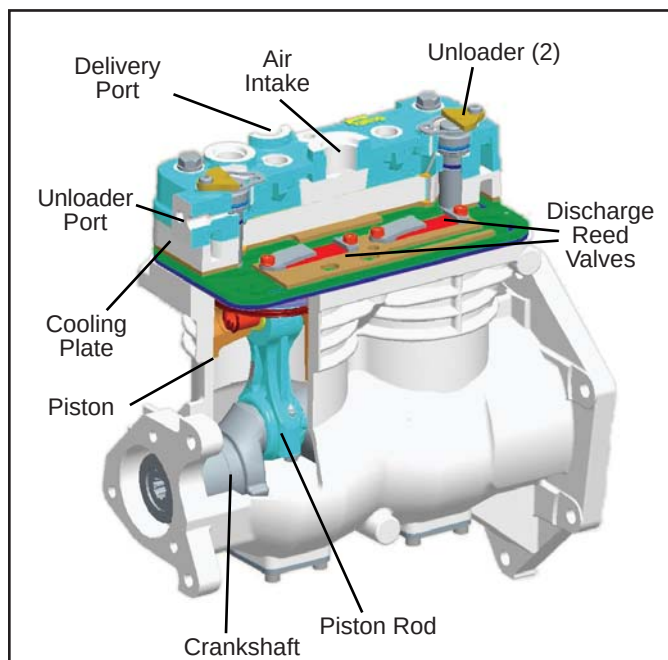


FIGURE 2 - BENDIX® BA-922® COMPRESSOR (CUT-AWAY)

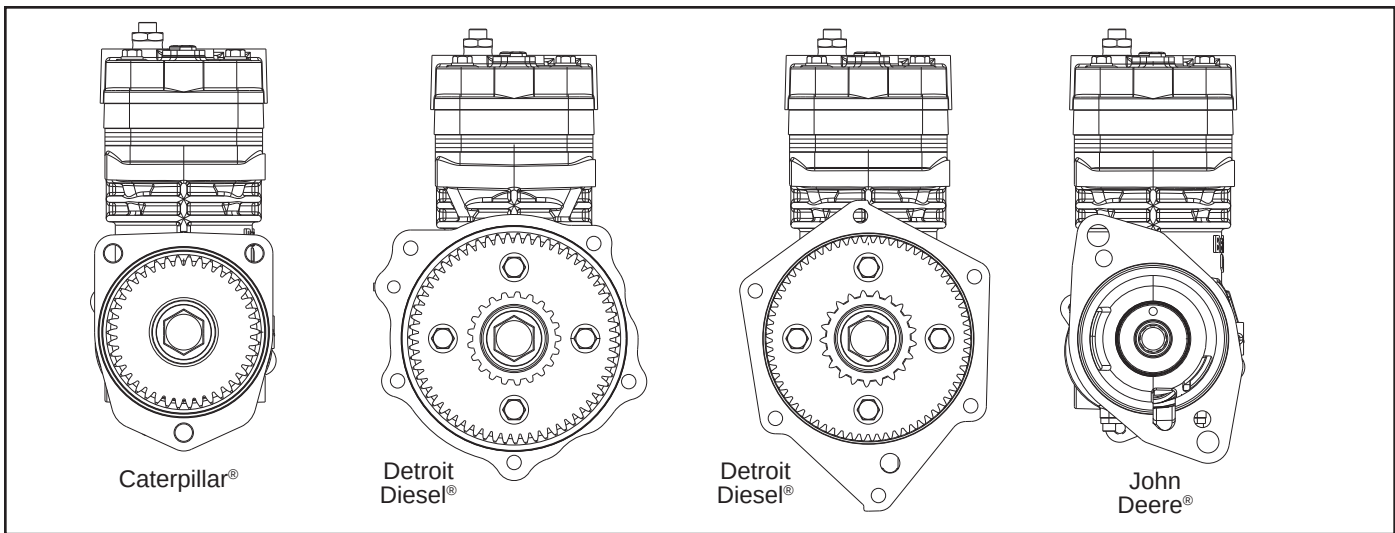


FIGURE 3 - TYPICAL COMPRESSOR DRIVE FLANGES

AIR INTAKE (LOADED)

During the piston down stroke, a vacuum is created in the cylinder bore above the piston. The vacuum causes the inlet reed valve to flex open. Atmospheric air flows through the open inlet valve and fills the cylinder bore above the piston.

AIR COMPRESSION (LOADED)

When the piston reaches approximately bottom dead center (BDC), the inlet reed valve closes. Air above the piston is trapped by the closed inlet reed valve and is compressed as the piston begins to move toward top dead center (TDC). When air in the cylinder bore reaches a pressure greater than that of the system pressure, the discharge reed valves open and air flows into the discharge line and air brake system.

Air, during the compression stroke, flows into the hollow center of the unloader piston through an opening in the end of the piston. Compressed air acts on the interior surfaces of the unloader piston and, along with the unloader piston spring, holds the unloader piston against its seat on the valve plate. See Figure 6.

NON-COMPRESSION OF AIR (UNLOADED)

When air pressure in the supply reservoir reaches the cut-out setting of the governor, the governor delivers system air to the compressor unloader port. Air entering the unloader port acts on the unloader piston, causing it to move away from its seat on the valve plate assembly. When the unloader piston is unseated a passage is opened between the cylinder bore, the air inlet cavity in the cylinder head, and the other cylinder. Air compression ceases. See Figure 7.

As the piston moves from bottom dead center (BDC) to top dead center (TDC), air in the cylinder bore flows past the unseated unloader piston, into the cylinder head inlet

cavity and into the other cylinder. A small amount of air moves out of the inlet port. On the piston down stroke (TDC to BDC), air flows in the reverse direction; from the other cylinder through the unloader piston to the inlet cavity, past the unseated unloader piston and into the cylinder bore.

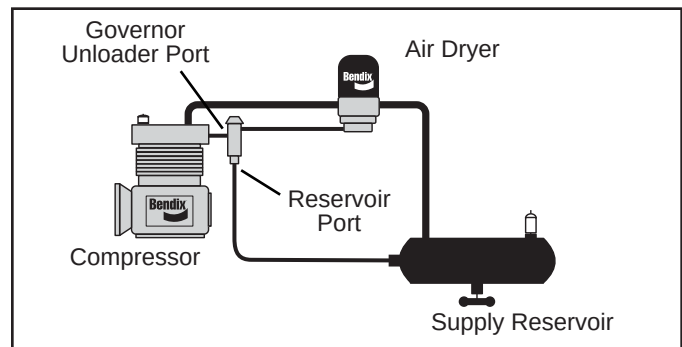


FIGURE 4 - BENDIX® BA-922® COMPRESSOR UNLOADER SYSTEM

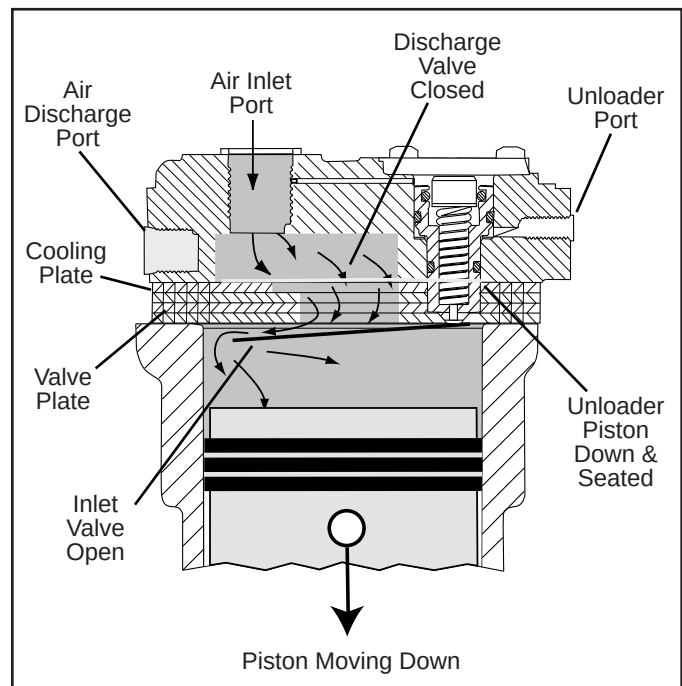


FIGURE 5 - OPERATION - LOADED (INTAKE)

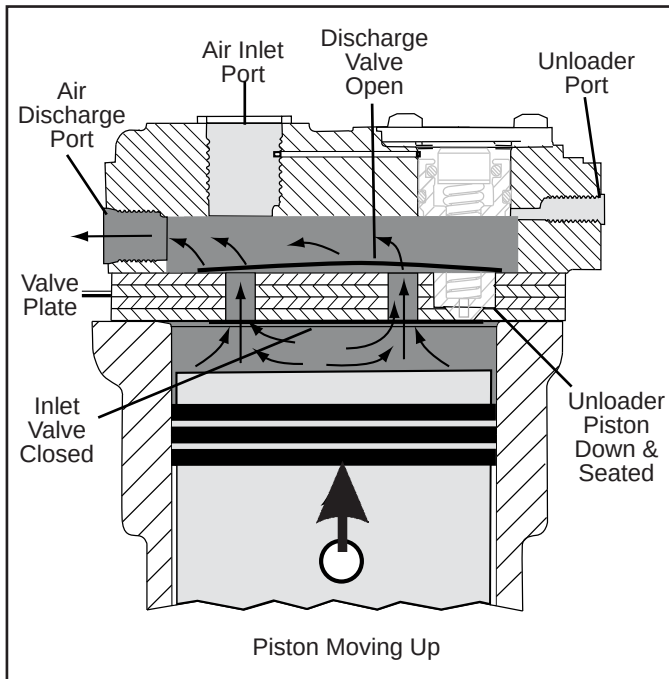


FIGURE 6 - OPERATION - LOADED (COMPRESSION)

LUBRICATION

The vehicle's engine provides a continuous supply of oil to the compressor. Oil is routed from the engine to the compressor oil inlet. An oil passage in the crankshaft conducts pressurized oil to precision sleeve main bearings and to the connecting rod bearings. Spray lubrication of the cylinder bores, connecting rod wrist pin bushings, and ball-type main bearings is obtained as oil is forced out around the crankshaft journals by engine oil pressure. Oil then falls to the bottom of the compressor crankcase and is returned to the engine through drain holes in the compressor mounting flange.

COOLING

Air flowing through the engine compartment – from the action of the engine fan and the movement of the vehicle – assists in cooling the compressor. Cooling fins are part of the crankcase/cylinder block casting. Coolant flowing from the engine cooling system through connecting lines enters the head and passes through internal passages in the cylinder head and valve plate assembly and is returned to the engine. Proper cooling is important in minimizing discharge air temperatures. Figure 8 illustrates the coolant flow connections. See the tabulated technical data in the back of this manual for specific requirements.

PREVENTATIVE MAINTENANCE

Regularly scheduled maintenance is the single most important factor in maintaining the air brake charging system. Refer to Table A in the Troubleshooting section for a guide to various considerations that must be given to maintenance of the compressor and other related charging system components.

Important Note: Review the warranty policy before performing any intrusive maintenance procedures. An extended warranty may be voided if intrusive maintenance is performed during this period.

EVERY 6 MONTHS, 1800 OPERATING HOURS, OR AFTER EACH 50,000 MILES – WHICHEVER OCCURS FIRST – PERFORM THE FOLLOWING INSPECTIONS AND TESTS.

AIR INDUCTION

Bendix® BA-922® compressors are only permitted to be naturally aspirated: use of the engine turbocharger as an air source is not allowed.

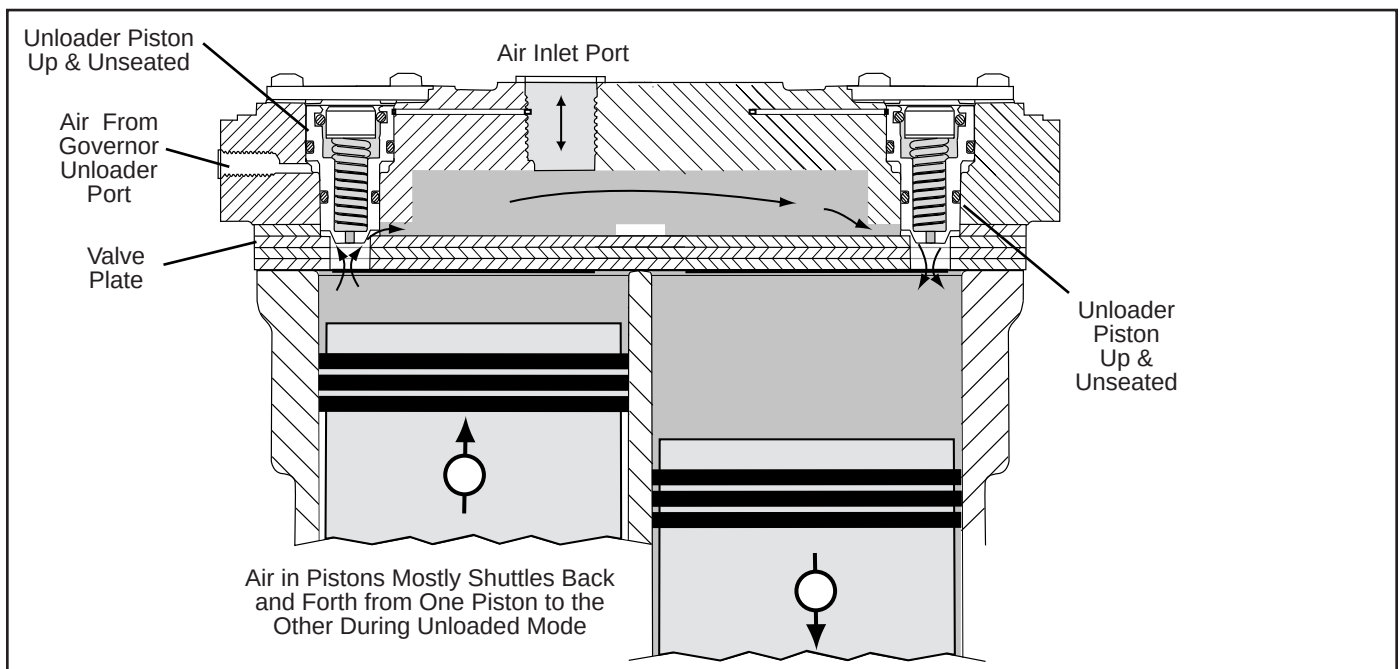


FIGURE 7 - OPERATION - UNLOADED

A supply of clean air is one of the single most important factors in compressor preventative maintenance. Since the Bendix® BA-922® compressor receives supply air from the engine air filter, periodic maintenance of the engine air filter is necessary.

Inspect the compressor intake adapter, and the connecting hoses each time engine air cleaner maintenance is performed.

1. Inspect the intake hose adapters for physical damage. Make certain to check the adapters at both ends of the intake hose or tubing.
2. Inspect the intake hose clamps and tighten them if needed.
3. Inspect the intake hose or line for signs of drying, cracking, chafing and ruptures, and replace it as necessary.

COMPRESSOR COOLING

Inspect the compressor discharge port, inlet cavity, and discharge line for evidence of restrictions and carbon build-up. If more than 1/16" of carbon is found, thoroughly clean or replace the affected parts. Since carbon build-up generally indicates inadequate cooling, closely inspect the compressor cooling system. Check all compressor coolant lines for kinks and restrictions to flow. **Minimum** coolant line size is 3/8" I.D. Check coolant lines for internal clogging from rust scale. If coolant lines appear suspicious, check the coolant flow and compare to the tabulated technical data in the back of this manual. Carefully inspect the air induction system for restrictions.

LUBRICATION

Check the external oil supply line for kinks, bends, or restrictions to flow. Supply lines must be a minimum of 3/16" I.D. Refer to the tabulated technical data in this manual (page 10) for oil pressure minimum values.

Check the exterior of the compressor for the presence of oil seepage and refer to the TROUBLESHOOTING section (page 11) for appropriate tests and corrective action.

OIL PASSING

All reciprocating compressors pass a minimal amount of oil. Air dryers will remove the majority of oil before it can enter the air brake system. For particularly oil sensitive systems, the Bendix® PuraGuard® system filter can be used in conjunction with a Bendix air dryer.

If compressor oil passing is suspected, refer to the TROUBLESHOOTING section and TABLE A (page 13) for the symptoms and corrective action to be taken. In addition, Bendix has developed the "Bendix Air System Inspection Cup" or **BASIC** kit to help substantiate suspected excessive oil passing. The steps to be followed when using the

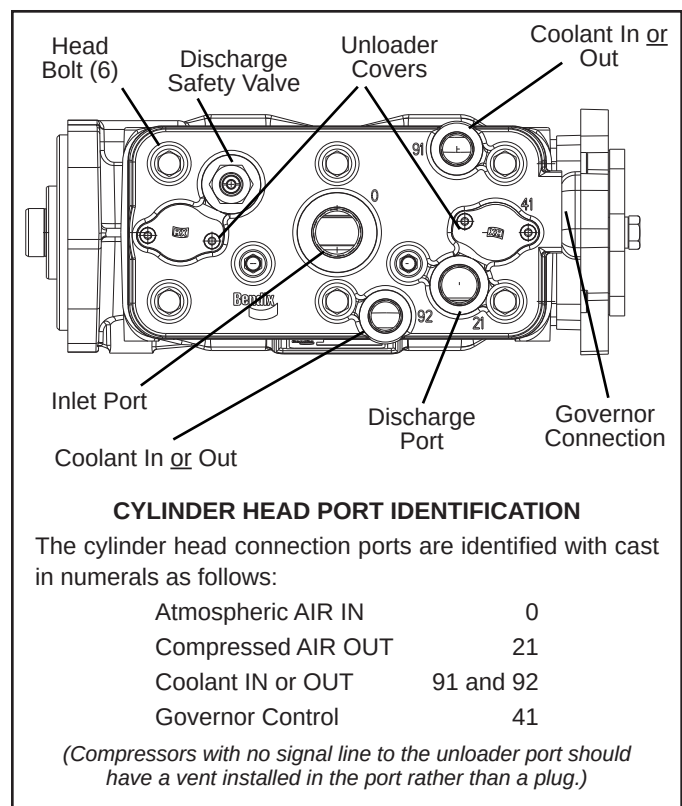


FIGURE 8 - TYPICAL BA-922® COMPRESSOR CYLINDER HEAD

BASIC kit are presented in APPENDIX A at the end of the TROUBLESHOOTING section.

COMPRESSOR DRIVE

Check for noisy compressor operation, which could indicate excessive drive component wear. Adjust and/or replace as necessary. Check all compressor mounting bolts and retighten evenly if necessary. Check for leakage and proper unloader mechanism operation. Repair or replace parts as necessary.

COMPRESSOR UNLOADER & GOVERNOR

Test and inspect the compressor and governor unloader system for proper operation and pressure setting.

1. Check for leakage at the unloader port. Replace leaking or worn o-ring.
2. Make certain the unloader system lines are connected as illustrated in Figure 3.
3. Cycle the compressor through the loaded and unloaded cycle several times. Make certain that the governor cuts in (compressor resumes compressing air) at a minimum of 105 psi (cut-out should be approximately 15-20 psi greater than cut-in pressure). Adjust or replace the governor as required.
4. Note that the compressor cycles to the loaded and unloaded conditions promptly. If prompt action is not noted, repair or replace the governor and/or repair the compressor unloader.

IMPORTANT NOTE

Replacement air governors must have a minimum cut-in pressure of 105 psi. The cut-in pressure is the lowest system pressure registered in the gauges before the compressor resumes compressing air.

Compressors with no signal line to the unloader port should have a vent installed in the port rather than a plug.

SERVICE TESTS: GENERAL

The following compressor operating and leakage tests need not be performed on a regular basis. These tests should be performed when it is suspected that leakage is substantially affecting compressor buildup performance, or when it is suspected that the compressor is “cycling” between the load and unloaded modes due to unloader plunger leakage.

IN-SERVICE OPERATING TESTS

Compressor Performance: Build-up Test

This test is performed with the vehicle parked and the engine operating at maximum recommended governed speed. Fully charge the air system to governor cut-out (air dryer purges). Pump the service brake pedal to lower the system air pressure below 80 psi using the dash gauges. As the air pressure builds back up, time from when the dash air pressure gauge passes 85 to the time it passes 100 psi. The time should not exceed 40 seconds. If the vehicle exceeds 40 seconds, test for (and fix) any air leaks and then re-test the compressor performance. If the vehicle does not pass the test the second time, use the Advanced Troubleshooting Guide for Air Brake Compressors – starting on page 11 of this document – to assist your investigation of the cause(s).

Note: All new vehicles are certified using the FMVSS 121 test (paragraph S5.1.1) by the vehicle manufacturer, however the above test is a useful guide for in-service vehicles.

Optional Comparative Performance Check

It may be useful to also conduct the above test with the engine running at high idle (instead of maximum governed speed), and record the time taken to raise the system pressure a selected range (for example, from 90 to 120 psi, or from 100 to 120 psi, etc.) and record it in the vehicle's maintenance files. Subsequent build-up times throughout the vehicle's service life can then be compared to the first one recorded. (Note: the 40 second guide in the test above does not apply to this build-up time.) If the performance degrades significantly over time, you may use the Advanced Troubleshooting Guide for Air Brake Compressors, starting on page 11 of this document, to assist your investigation of the cause(s).

Note: When comparing build-up times, be sure to make an allowance for any air system modifications which could cause longer times, such as adding air components or reservoirs. Always check for air system leakage.

LEAKAGE TESTS

See the standard Air Brake System and Accessory Leakage test on Page 24 (Test 2).

Note: Leakage in the air supply system (components before the supply reservoir - such as the governor, air dryer, reservoir drain cocks, safety valve and check valves) will **not** be registered on the vehicle dash gauges and must be tested separately. Refer to the various maintenance manuals for individual component leakage tests, and the Bendix “Test and Checklist” published in the Air Brake System Handbook (BW5057) and on the back of the Dual Circuit Brake System Troubleshooting card (BW1396).

Cylinder Head

Check for cylinder head gasket air leakage.

1. With the engine running, lower air system pressure to 60 psi and apply a soap solution around the cylinder head. Check the gasket between the cylinder head and valve plate assembly and the reed valve/gasket between the valve plate assembly and cylinder block for air leakage.
2. No leakage is permitted. If leakage is detected, replace the compressor or repair the cylinder head using a genuine Bendix maintenance kit available from an authorized Bendix parts outlets.

Inlet, Discharge & Unloader

In order to test the inlet and discharge valves and the unloader piston, it is necessary to have shop air pressure and an assortment of fittings. A soap solution is also required.

1. With the engine shut off, drain ALL air pressure from the vehicle.
2. Disconnect the inlet and discharge lines and remove the governor or its line or adapter fitting.
3. Apply 120-130 psi shop air pressure to the unloader port and soap the inlet port. Leakage at the inlet port should not exceed 50 sccm.
4. Apply 120-130 psi shop air pressure to the discharge port and then apply and release air pressure to the inlet port. Soap the inlet port and note that leakage at the inlet port does not exceed 20 sccm.

If excessive leakage is noted in tests 3 or 4, replace or repair the compressor using genuine Bendix® replacements or maintenance kits available from any authorized Bendix parts outlet.

While it is possible to test for inlet, discharge, and unloader piston leakage, it may not be practical to do so. Inlet and discharge valve leakage can generally be detected by longer compressor build-up and recovery times. Compare current compressor build-up times with the last several recorded times. Make certain to test for air system leakage, as described above, before making a determination that compressor performance has been lost.

Unloader leakage is exhibited by excessive compressor cycling between the loaded and unloaded condition.

1. With service and supply system leakage below the maximum allowable limits and the vehicle parked, bring system pressure to governor cut-out and allow the engine to idle.
2. The compressor should remain unloaded for a minimum of 5-10 minutes. If compressor cycling occurs more frequently, and service and supply system leakage is within tolerance (including any leakage that may be present at the air dryer exhaust), replace or repair the compressor unloader system using a genuine Bendix maintenance kit available from authorized Bendix parts outlets.

COMPRESSOR REMOVAL & DISASSEMBLY

GENERAL

The following disassembly and assembly procedure is presented for reference purposes and presupposes that a rebuild or repair of the compressor is being undertaken. Several maintenance kits are available. The instructions provided with these parts and kits should be followed in lieu of the instructions presented here.

MAINTENANCE KITS & SERVICE PARTS

Cylinder Head Gasket Kit	5014472
Unloader Kit.....	5014473
Governor Adapter Kit	5008561
Compressor Seal Kit (crankcase).....	5008559
CAT MD Seal Kit.....	5012367
CAT HD Seal Kit	5012369
Series 60 Seal Kit.....	5012371
ST-4 Discharge Safety Valve (7/8"-14 thrd.).....	801116
ST-4 Discharge Safety Valve (M16-1.5 thrd.)	800534

All components shown in Figure 10 with a key number are available in kits and/or as individual service parts.

GENERAL SAFETY GUIDELINES

WARNING! PLEASE READ AND FOLLOW THESE INSTRUCTIONS TO AVOID PERSONAL INJURY OR DEATH:

When working on or around a vehicle, the following general precautions should be observed **at all times**:

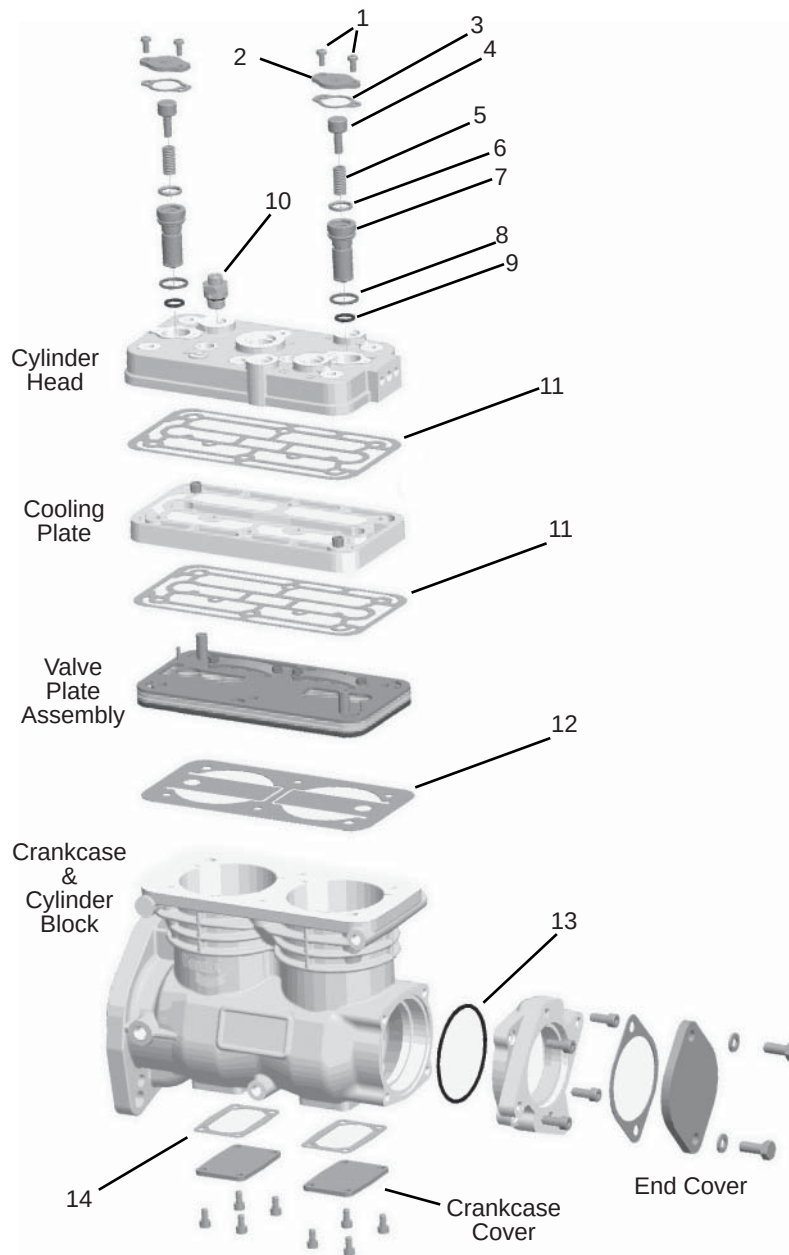
1. **Park the vehicle on a level surface, apply the parking brakes, and always block the wheels. Always wear**

safety glasses. Where specifically directed, the parking brakes may have to be released, and/or spring brakes caged, and this will require that the vehicle be prevented from moving by other means for the duration of these tests/procedures.

2. **Stop the engine and remove ignition key when working under or around the vehicle. When working in the engine compartment, the engine should be shut off and the ignition key should be removed. Where circumstances require that the engine be in operation, EXTREME CAUTION should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated or electrically charged components.**
3. **Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.**
4. **If the work is being performed on the vehicle's air brake system, or any auxiliary pressurized air systems, make certain to drain the air pressure from all reservoirs before beginning ANY work on the vehicle. If the vehicle is equipped with a Bendix® AD-IS® air dryer system or a dryer reservoir module, be sure to drain the purge reservoir.**
5. **Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.**
6. **Never exceed manufacturer's recommended pressures.**
7. **Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.**
8. **Use only genuine Bendix® brand replacement parts, components and kits. Replacement hardware, tubing, hose, fittings, etc. must be of equivalent size, type and strength as original equipment and be designed specifically for such applications and systems.**
9. **Components with stripped threads or damaged parts should be replaced rather than repaired. Do not attempt repairs requiring machining or welding unless specifically stated and approved by the vehicle and component manufacturer.**
10. **Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.**
11. **For vehicles with Automatic Traction Control (ATC), the ATC function must be disabled (ATC indicator lamp should be ON) prior to performing any vehicle maintenance where one or more wheels on a drive axle are lifted off the ground and moving.**

REMOVAL

In many instances it may not be necessary to remove the compressor from the vehicle when installing the various



Item	Qty.	Description	Item	Qty.	Description	Item	Qty	Description
1	2	Unloader Cover Cap Screw	6 ¹	1	O-Ring	11	2 ²	Head Gasket
2 ¹	1	Unloader Cover	7 ¹	1	O-Ring	12	1 ²	Inlet Reed Valve/Gasket
3 ¹	1	Unloader Cap Gasket	8 ¹	1	Unloader Piston	13	1 ³	O-Ring
4 ¹	1	Unloader Balance Piston	9 ¹	1	O-Ring	14	1 ³	Bottom Cover Gasket
5 ¹	1	Spring	10	1	ST-4™ Safety Valve			

Notes: 1. Contained in Unloader Kit 5014473
2. Contained in Cylinder Head Gasket Kit 5014472
3. Contained in Seal Kits 5008559, 5008561, 5008557 & 5008558

FIGURE 9 - BENDIX® BA-922® COMPRESSOR EXPLODED VIEW OF SERVICEABLE PARTS

maintenance kits and service parts. The maintenance technician must assess the installation and determine the correct course of action.

These instructions are general and are intended to be a guide. In some cases additional preparations and precautions are necessary. In all cases follow the instructions contained in the vehicle maintenance manual in lieu of the instructions, precautions and procedures presented in this manual.

1. Block the wheels of the vehicle and drain the air pressure from all the reservoirs in the system.
2. Drain the engine cooling system and the cylinder head of the compressor. Identify and disconnect all air, water and oil lines leading to the compressor.
3. Remove as much road dirt and grease from the exterior of the compressor as possible.

4. Remove the discharge and inlet fittings, if applicable, and note their position on the compressor to aid in reassembly.

Note: If a cylinder head maintenance kit is being installed, stop here and proceed to PREPARATION FOR DISASSEMBLY. If replacing the compressor continue.

5. Remove any supporting bracketing attached to the compressor and note their positions on the compressor to aid in reassembly.
6. Remove the flange mounting bolts and remove the compressor from the vehicle.
7. Inspect gear and associated drive parts for visible wear or damage. Since these parts are precision fitted, they must be replaced if they are worn or damaged. If replacing the compressor or replacing the drive gear, remove the drive gear from the compressor crankshaft using a gear puller.
8. If the compressor is being replaced stop here and proceed to "Installing The Compressor" at the end of the assembly procedure.

PREPARATION FOR DISASSEMBLY

Remove the balance of road dirt and grease from the exterior of the compressor with a cleaning solvent. Mark the rear end cover or end cover adapter in relation to the crankcase. It is recommended, but not specifically necessary, to mark the relationships of the cylinder head, cooling plate, valve plate assembly, crankcase and cylinder block assembly.

A convenient method to indicate the above relationships is to use a metal scribe to mark the parts with numbers or lines. Do not use marking methods such as chalk that can be wiped off or obliterated during rebuilding.

Prior to disassembly make certain that the appropriate kits and/or replacement parts are available. Refer to Figure 9 during the entire disassembly and assembly procedure.

CYLINDER HEAD

1. Remove the discharge safety valve (10) from the cylinder head.
2. To restrain the spring force exerted by balance piston spring (5), hold the unloader cover (2) in place while removing the two unloader cover cap screws (1). Carefully release the hold on the unloader cover until the spring force is relaxed, then remove the unloader cover (2).
3. Remove the unloader cover gasket (3).
4. Remove the balance piston (4) and its spring (5) from the cylinder head.
5. Remove the six hex head bolts and washers from the cylinder head.

6. Remove the two bolts located in the center of the head. Gently tap the head, cooling plate and valve plate assembly with a soft mallet to break the gasket seal. Lift the cylinder head with cooling plate and valve plate assembly off the cylinder block.
7. Remove the metal reed valve/gasket (12).
8. Gently tap the head, cooling plate and valve plate assembly with a soft mallet to break the gasket seals. Then separate the cylinder head from the cooling plate and valve plate assembly and remove the gasket (11) between them.
9. Turn the aluminum cylinder head over to expose the interior portion of the head. Push the unloader piston (7) along with its o-rings (6, 8 & 9) out of the cylinder head.

CRANKCASE COVER

1. Remove the four crankcase cover cap screws securing the crankcase cover to the crankcase. Using a soft mallet, gently tap the crankcase cover to break the gasket seal. Remove the crankcase cover gasket (14).

REAR END COVER OR END COVER ADAPTER

1. Remove the four end cover cap screws that secure the rear end cover or end cover adapter to the crankcase.
2. Remove the rear end cover or end cover adapter from the crankcase. Remove the o-ring seal (13) from the end cover.

CLEANING OF PARTS

GENERAL

All parts should be cleaned in a good commercial grade of solvent and dried prior to inspection.

CYLINDER HEAD

1. Carefully remove all gasket material adhering to the aluminum cylinder head, steel valve plate assembly and cast iron cylinder block. Make certain not to deeply scratch or mar the gasket surfaces. Pay particular attention to the gasket surfaces of the aluminum head.
2. Remove carbon deposits from the discharge and inlet cavities of the cylinder head and valve plate assembly. They must be open and clear in both assemblies. Make certain not to damage the aluminum head.
3. Remove rust and scale from the cooling cavities and passages in the head and valve plate assembly and use shop air to clear debris from the passages.
4. Check the threads in all cylinder head ports for galling. Minor chasing is permitted.
5. Make certain the unloader vent passage under the unloader cover (2) in the head is open and free of debris.

INSPECTION OF PARTS

CYLINDER HEAD & VALVE PLATE

1. Carefully inspect the cylinder head gasket surfaces for deep gouges and nicks. If detected, the compressor must be replaced.
2. Carefully inspect the valve plate assembly gasket surfaces for deep gouges and nicks. Pay particular attention to the metal gasket surface. A metal gasket (12) is used between the valve plate assembly and the cylinder block. This surface must be smooth and free of all but the most minor scratching. If excessive marring or gouging is detected, the compressor must be replaced.
3. Inspect the cylinder head for cracks or damage. With the cylinder head and head gasket secured to the valve plate assembly, apply shop air pressure to one of the coolant ports with all others plugged, and check for leakage by applying a soap solution to the exterior of the head. If leakage is detected in the cylinder head casting, replace the compressor.

END COVER OR END COVER ADAPTER

Check for cracks and external damage. Check the crankshaft main bearing surface in the end cover or end cover adapter, check for excessive wear and flat spots and replace the end cover if necessary. Check for galling of the oil port threads and replace the end cover or end cover adapter if necessary. Minor thread chasing is permitted but do not "recut" the threads if they are badly damaged.

CYLINDER BLOCK

1. Check the cylinder head gasket surface on the cylinder block for nicks, gouges, and marring. A metal gasket is used to seal the cylinder head to the cylinder block. This surface must be smooth and free of all but the most minor scratching. If excessive marring or gouging is detected, the compressor must be replaced.

DISCHARGE LINE

1. Inspect the discharge line for kinks, damage, or carbon deposits. Replace as necessary. See the advanced troubleshooting guide for more information.

ASSEMBLY

General Note: All torques specified in this manual are assembly torques and typically can be expected to fall off after assembly is accomplished. **Do not re-torque** after initial assembly torques fall unless instructed otherwise. A compiled listing of torque specifications is presented on page 11 of this manual.

INCH POUNDS TO FOOT POUNDS

To convert inch pounds to foot pounds of torque, divide inch pounds by 12.

Example: $\frac{12 \text{ Inch Pounds}}{12} = 1 \text{ Foot Pound}$

FOOT POUNDS TO INCH POUNDS

To convert foot pounds to inch pounds of torque, multiply foot pounds by 12.

Example: $1 \text{ Foot Pound} \times 12 = 12 \text{ Inch Pounds}$

CRANKCASE COVER

1. Position the crankcase cover gasket (14) on either the crankcase or crankcase cover and install the crankcase cover on the crankcase using the four cap screws. "Snug" the four cap screws then torque to 62-71 inch pounds (7-8 Nm) using a crossing pattern.

CRANKCASE END COVER OR ADAPTER

1. Install the end cover o-ring (13) on the crankcase end cover.
2. Orient the crankcase end cover or end cover adapter to the crankcase using the reference marks made during disassembly. Carefully install the end cover or end cover adapter in the crankcase making certain not to damage the crankshaft bearing surface in it.
3. Install the four end cover screws or studs. "Snug" the screws then tighten to 195 to 213 inch pounds (22-24 Nm) using a crossing pattern.

CYLINDER HEAD

1. Note the position of the protruding alignment pins on the cylinder block. Install the metal inlet reed valve/gasket (12) over the alignment pins on the cylinder block.
2. Position the valve plate assembly on the cylinder block so that the alignment pins in the cylinder block fit into the corresponding holes in the valve plate assembly.
3. Position and install one of the metal gaskets (11) over the alignment bushings protruding from the valve plate assembly. When properly installed, the outline of the gasket matches the outline of the valve plate.
4. Install the cooling plate over the alignment bushings protruding from the valve plate assembly. Again, when properly installed, the outline of the cooling plate matches the outline of the valve plate.
5. Position and install the other metal gasket (11) over the alignment bushings protruding from the cooling plate assembly. The outline of the gasket matches the outline of the cooling plate.
6. Position and install the cylinder head over the alignment bushings protruding from the cooling plate.
Note: The alignment bushings will only fit into two of the six cylinder head bolt holes.
7. Install the two center bolts and six hex head cylinder head bolts and washers and snug them, then tighten evenly to a torque of 265 to 292 inch pounds (30-33 Nm) using the pattern shown in Figure 9.
8. Install the unloader piston (7) with its pre-installed o-rings (6, 8, 9) in the cylinder head making certain not to damage them in the process.

9. Install the balance piston spring (5) in the unloader piston (7), then install the small diameter of the balance piston (4) through the center of the spring.
10. Install the unloader cover gasket (3) on the cylinder head making certain the unloader vent passage and both screw holes align.
11. Position the unloader cover (2) on top of the balance piston (4) making certain the stamped logo is visible.
12. Press and hold the unloader cover (2) in place on the cylinder head and install both unloader cover cap screws (1). Torque the cover cap screws (1) from 62 to 71 inch pounds (7-8 Nm).

INSTALLING THE COMPRESSOR

1. If the compressor was removed for replacement, install the drive components. **Torque the crankshaft nut to 220 - 254 foot pounds (210-290 Nm).**
2. Install any supporting bracketing on the compressor in the same position noted and marked during removal.
3. Install the gasket on the drive flange of the compressor. Make certain oil supply or return holes in the gasket are properly aligned with the compressor and engine. Gasket sealants are not recommended. Secure the compressor on the engine and tighten the mounting bolts.
4. Install the discharge, inlet and governor adapter fittings, if applicable, in the same position on the compressor noted and marked during disassembly. Make certain the threads are clean and the fittings are free of corrosion. Replace as necessary. See the Torque Specifications for various fitting sizes and types of thread on page 11 of this manual.
5. Inspect all air, oil, and coolant lines and fittings before reconnecting them to the compressor. Make certain o-ring seals are in good or new condition. Tighten all hose clamps.
6. Clean oil supply line. Before connecting this line to the compressor. Run the engine briefly to be sure oil is flowing freely through the supply line.
7. Before returning the vehicle to service, perform the Operation and Leakage Tests specified in this manual. Pay particular attention to all lines reconnected during installation and check for air, oil, and coolant leaks at compressor connections. Also check for noisy operation.

TESTING REBUILT COMPRESSOR

In order to properly test a compressor under operating conditions, a test rack for correct mounting, cooling, lubricating, and driving the compressor is necessary. Such tests are not compulsory if the unit has been carefully rebuilt by an experienced person. A compressor efficiency, or build-up test, can be run with realite ease. An engine

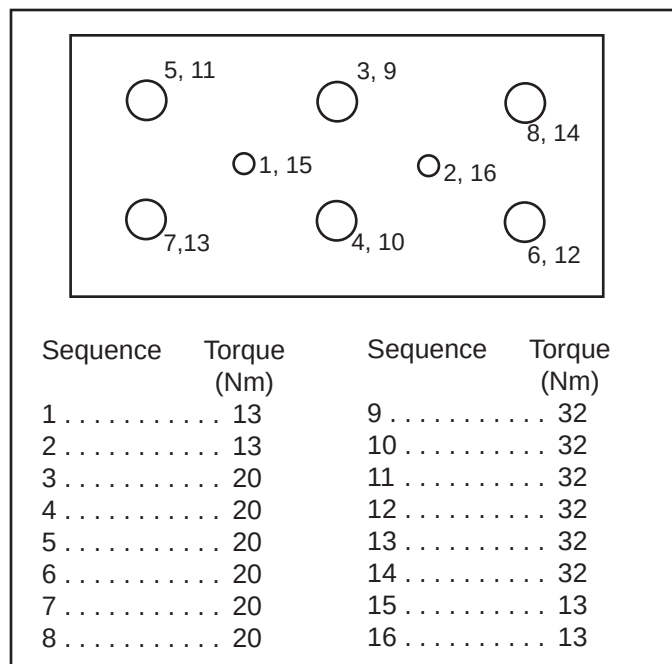


FIGURE 10 - BENDIX® BA-922® COMPRESSOR HEAD BOLT TORQUE SEQUENCE

lubricated compressor must be connected to an oil supply line of at least 15 psi pressure during the test and an oil return line must be installed to keep the crankcase drained. Connect to the compressor discharge port, a reservoir with a volume of 1500 cubic inches, including the volume of the connecting line. With the compressor operating at 2100 RPM, the time required to raise the reservoir(s) pressure from 85 psi to 100 psi should not exceed 5 seconds. During this test, the compressor should be checked for gasket leakage and noisy operation, as well as unloader operation and leakage. If the compressor functions as indicated, reinstall on the vehicle connecting all lines as marked in the disassembly procedure.

BENDIX® BA-922® COMPRESSOR SPECIFICATIONS

Typical weight	60 lbs.
Number of cylinders	2
Bore Diameter	3.622 in. (92.005 mm)
Stroke	2.125 in. (53.970 mm)
Calculated displacement at 1250 RPM	31.7 CFM
Flow Capacity @ 1800 RPM & 120 PSI	25.2 CFM
Flow Capacity @ 3000 RPM & 120 PSI	38.4 CFM
Maximum recommended RPM	3000 RPM
Minimum coolant flow maximum RPM	2.0 Gals./Min.
Approximate horsepower required:	
Loaded 1800 RPM at 120 PSIG	8.73 HP
Unloaded 1800 RPM	1.96 HP
Maximum inlet air temperature	170°F
Maximum discharge air temperature	350°F
Minimum oil pressure required	15 PSI
Minimum oil-supply line size	3/16" I.D.
Minimum unloader-line size	3/16" I.D.
Minimum Governor Cut-out Pressure.....	120 PSI

TORQUE SPECIFICATIONS

Assembly Torques in inch pounds (in. lbs.)

M8x1.25-6g Cylinder Head	265-292 In. Lbs. (30-33 Nm)
M5x0.75-6g Unloader Cap	62-71 In. Lbs. (7-8 Nm)
M8x1.25-6g Governor Adapter	195-213 In. Lbs. (22-24 Nm)
M8x1.25-6g Rear End Cover	195-213 In. Lbs. (22-24 Nm)
M6x1.00-6g Crankcase Cover	62-71 In. Lbs. (7-8 Nm)
M20x2.50-6g Crankshaft Nut	1858-2567 In. Lbs. (210-290 Nm)

Inlet Port Fittings

1 3/16"-12 UN-2B	575-637 In. Lbs. (65-72 Nm)
M27 x 2.0.....	575-637 In. Lbs. (65-72 Nm)

Discharge Port Fittings

7/8"-14 UNF-2B	460-504 In. Lbs. (52-57 Nm)
M22 x 1.5.....	195-213 In. Lbs. (22-24 Nm)

Water Port Fittings

3/4"-16 UNF-2B	319-245 In. Lbs. (36-39 Nm)
M18 x 1.5-6g.....	230-257 In. Lbs. (26-29 Nm)

Unloader Port Fittings

1/8"-27 NPT	2 - 3 TFFT ¹
M10 x 1.5-6g.....	120-145 In. Lbs. (14-16 Nm)

Safety Valve Port

M16 x 1.5.....	230-257 In. Lbs. (26-29 Nm)
3/4"-16 UNF-2B	319-345 In. Lbs. (36-39 Nm)
7/8"-14 UNF-2A	319-345 In. Lbs. (36-39 Nm)
1/2"-14 NPT	2 - 3 TFFT ¹

Oil Port

7/16"-20 UNF.....	97-115 In. Lbs. (11-13 Nm)
M12 x 1.5-6g.....	142-159 In. Lbs. (16-18 Nm)

¹Note: TFFT = Turns From Finger Tight

Advanced Troubleshooting Guide for Air Brake Compressors

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Introduction to the Air Brake Charging System

Powered by the vehicle engine, the **air compressor** builds the air pressure for the air brake system. The air compressor is typically cooled by the engine coolant system and lubricated by the engine oil supply.

The compressor's unloader mechanism and **governor** (along with a synchro valve for the Bendix® DuraFlo 596™ air compressor) control the brake system air pressure between a preset maximum and minimum pressure level by monitoring the pressure in the service (or “supply”) reservoir. When the air pressure becomes greater than that of the preset “cut-out”, the governor controls the unloader mechanism of the compressor to stop the compressor from building air and also causes the air dryer to purge. As the service reservoir air pressure drops to the “cut-in” setting of the governor, the governor returns the compressor back to building air and the air dryer to air drying mode.

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.

The **duty cycle** is the ratio of time the compressor spends building air to the total engine running time. Air compressors are designed to build air (run “loaded”) up to 25% of the time. Higher duty cycles cause conditions that affect air brake charging system performance which may require additional maintenance. Factors that add to the duty cycle are: air suspension, additional air accessories, use of an undersized compressor, frequent stops, excessive leakage from fittings, connections, lines, chambers or valves, etc.

The **discharge line** allows the air, water-vapor and oil-vapor mixture to cool between the compressor and air dryer. The typical size of a vehicle's discharge line, (see

column 2 of Table A on page 13) assumes a compressor with a normal (less than 25%) duty cycle, operating in a temperate climate. See Bendix and/or other air dryer manufacturer guidelines as needed.

When the **temperature** of the compressed air that enters the air dryer is within the normal range, the air dryer can remove most of the charging system oil. If the temperature of the compressed air is above the normal range, oil as oil-vapor is able to pass through the air dryer and into the air system. Larger diameter discharge lines and/or longer discharge line lengths can help reduce the temperature.

The discharge line must maintain a **constant slope** down from the compressor to the air dryer inlet fitting to avoid low points where ice may form and block the flow. If, instead, ice blockages occur at the air dryer inlet, insulation may be added here, or if the inlet fitting is a typical 90 degree fitting, it may be changed to a straight or 45 degree fitting. For more information on how to help prevent discharge line freeze-ups, see Bendix Bulletins TCH-008-021 and TCH-008-022 (see pages 30-32). Shorter discharge line lengths or insulation may be required in cold climates.

The **air dryer** contains a filter that collects oil droplets, and a desiccant bed that removes almost all of the remaining water vapor. The compressed air is then passed to the air brake service (supply) reservoir. The oil droplets and the water collected are automatically purged when the governor reaches its “cut-out” setting.

For vehicles with accessories that are sensitive to small amounts of oil, we recommended installation of a Bendix® PuraGuard® system filter, designed to minimize the amount of oil present.

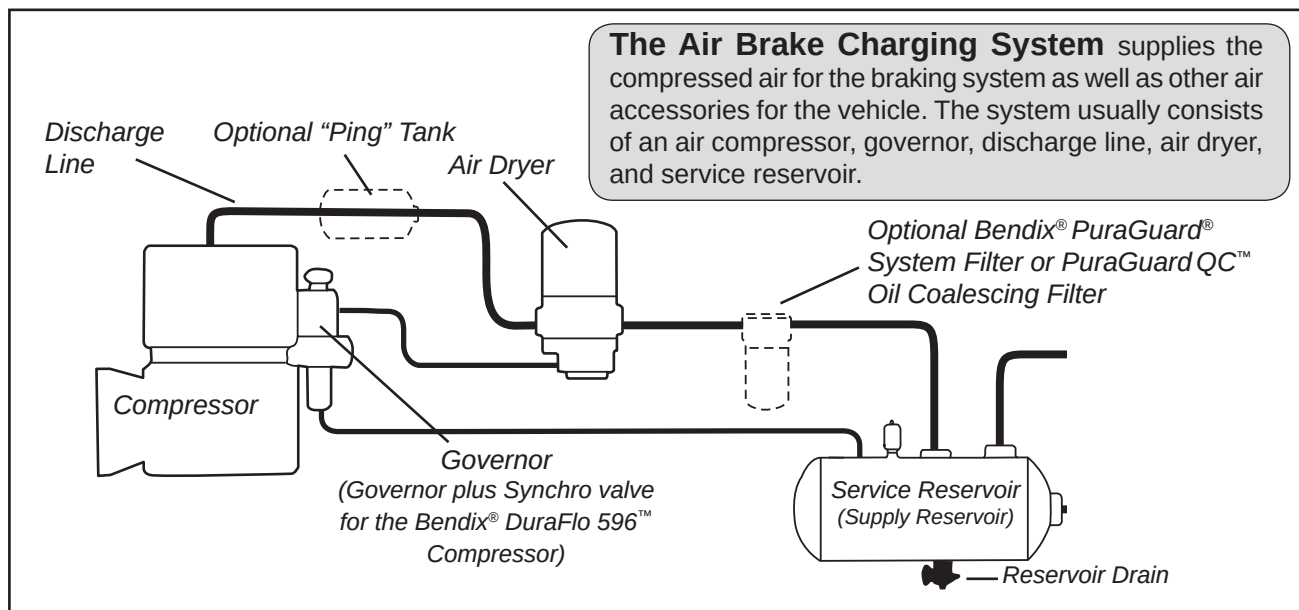


Table A: Maintenance Schedule and Usage Guidelines

Regularly scheduled maintenance is the single most important factor in maintaining the air brake charging system.

Vehicle Used for:		No. of Axles	Column 1	Column 2		Column 3	Column 4	Column 5
			Typical Compressors Spec'd (See footnote 7)	Discharge Line I.D. Length		Recommended Air Dryer Cartridge Replacement ¹	Recommended Reservoir Drain Schedule ²	Acceptable Reservoir Oil Contents ³ at Regular Drain Interval
Low Air Use		5 or less	Bendix® BA-921® air compressor Bendix® Tu-Flo® 550 air compressor	1/2 in.	6 ft.	Every 3 Years	Recommended Every Month - Max of every 90 days	BASIC test acceptable range: 3 oil units per month. See appendix A.
Compressor with less than 15% duty cycle e.g. Line haul single trailer w/o air suspension, air over hydraulic brakes. 				For oil carry-over control ⁴ suggested upgrades: 5/8 in. 9 ft.				
Compressor with up to 25% duty cycle e.g. Line haul single trailer with air suspension, RV school bus. 		1/2 in.		9 ft.				
		For oil carry-over control ⁴ suggested upgrades: 5/8 in. 12 ft.						
High Air Use		8 or less	Bendix® BA-921® 750 air compressor Bendix® Tu-Flo® 596™ air compressor	1/2 in.	12 ft.	Every 2 Years	Every Month	BASIC test acceptable range: 5 oil units per month. See appendix A.
Compressor with up to 25% duty cycle e.g. Double/triple trailer, open highway coach, (most) pick-up & delivery, yard or terminal jockey, off-highway, construction, loggers, concrete mixer, dump truck, fire truck. 				For oil carry-over control ⁴ suggested upgrades: 5/8 in. 15 ft.				
Compressor with up to 25% duty cycle e.g. City transit bus, refuse, bulk unloaders, low boys, urban region coach, central tire inflation. 		3/4 in.		12 ft.	Every Year			

Footnotes:

1. With increased air demand the air dryer cartridge needs to be replaced more often.
2. Use the drain valves to slowly drain all reservoirs to zero psi.
3. Allow the oil/water mixture to fully settle before measuring oil quantity.
4. To counter above normal temperatures at the air dryer inlet, (and resultant oil-vapor passing upstream in the air system) replace the discharge line with one of a larger diameter and/or longer length. This helps reduce the air's temperature. If sufficient cooling occurs, the oil-vapor condenses and can be removed by the air dryer. Discharge line upgrades are not covered under warranty. Note: To help prevent discharge line freeze-ups, shorter discharge line lengths or insulation may be required in cold climates. (See Bendix

Bulletins TCH-008-021 and TCH-008-022, included in Appendix B, for more information.)

5. For certain vehicles/applications, where turbo-charged inlet air is used, a smaller size compressor may be permissible.
6. Note: Compressor and/or air dryer upgrades are recommended in cases where duty cycle is greater than the normal range (for the examples above).
7. For correct compressor upgrades consult Bendix - Please note that because a compressor is listed in the same area of the chart does not necessarily mean that it would be a suitable candidate for upgrade purposes.

For Bendix® Tu-Flo® 550 and 750 compressors, unloader service is recommended every 250,000 miles.

Air Brake Charging System Troubleshooting

How to use this guide:

Find the **symptom(s)** that you see, then move to the right to find the possible causes ("**What it may indicate**") and remedies ("**What you should do**").

Review the warranty policy before performing any intrusive compressor maintenance. Unloader or cylinder head gasket replacement and resealing of the bottom cover plate are usually permitted under warranty. Follow all standard safety procedures when performing any maintenance.

Look for:

 **Normal**

Normal - Charging system is working within normal range.

 **Check**

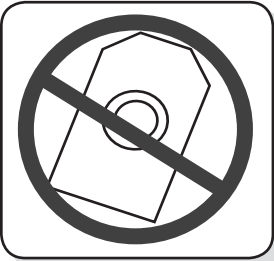
Check - Charging system needs further investigation.

WARNING! Please READ and follow these instructions to avoid personal injury or death:

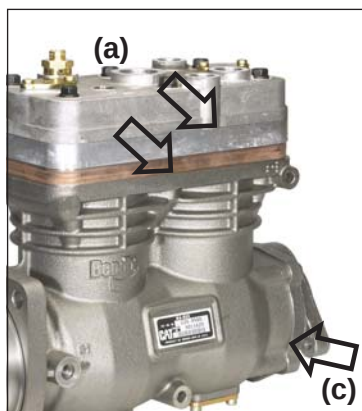
When working on or around a vehicle, the following general precautions should be observed at all times.

1. Park the vehicle on a level surface, apply the parking brakes, and always block the wheels. Always wear safety glasses.
2. Stop the engine and remove ignition key when working under or around the vehicle. When working in the engine compartment, the engine should be shut off and the ignition key should be removed. Where circumstances require that the engine be in operation, EXTREME CAUTION should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated or electrically charged components.
3. Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.
4. If the work is being performed on the vehicle's air brake system, or any auxiliary pressurized air systems, make certain to drain the air pressure from all reservoirs before beginning ANY work on the vehicle. If the vehicle is equipped with a Bendix® AD-IS® air dryer system or a dryer reservoir module, be sure to drain the purge reservoir.

5. Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.
6. Never exceed manufacturer's recommended pressures.
7. Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.
8. Use only genuine Bendix® brand replacement parts, components and kits. Replacement hardware, tubing, hose, fittings, etc. must be of equivalent size, type and strength as original equipment and be designed specifically for such applications and systems.
9. Components with stripped threads or damaged parts should be replaced rather than repaired. Do not attempt repairs requiring machining or welding unless specifically stated and approved by the vehicle and component manufacturer.
10. Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.
11. For vehicles with Automatic Traction Control (ATC), the ATC function must be disabled (ATC indicator lamp should be ON) prior to performing any vehicle maintenance where one or more wheels on a drive axle are lifted off the ground and moving.

Symptom:	What it may indicate:	What you should do:
1.0 Oil Test Card Results 	Not a valid test.	Discontinue using this test. Do not use this card test to diagnose compressor "oil passing" issues. They are subjective and error prone. Use only the Bendix Air System Inspection Cup (BASIC) test and the methods described in this guide for advanced troubleshooting.
	 Bendix® BASIC Test 	The Bendix® BASIC test should be the definitive method for judging excessive oil fouling/oil passing. (See Appendix A, on page 27 for a flowchart and expanded explanation of the checklist used when conducting the BASIC test.)

Symptom:	What it may indicate:	What you should do:
2.0 Oil on the Outside of the Compressor	Engine and/or other accessories leaking onto compressor.	Find the source and repair. Return the vehicle to service.
2.1 Oil leaking at compressor / engine connections:	(a) Leak at the front or rear (fuel pump, etc.) mounting flange.	⇒ Repair or replace as necessary. If the mounting bolt torques are low, replace the gasket.
	(b) Leak at air inlet fitting.	⇒ Replace the fitting gasket. Inspect inlet hose and replace as necessary.
	(c) Leak at air discharge fitting.	⇒ Replace gasket or fitting as necessary to ensure good seal.
	(d) Loose/broken oil line fittings.	⇒ Inspect and repair as necessary.
2.2 Oil leaking from compressor:	(a) Excessive leak at head gasket.	⇒ Go to Test 1 on page 24.
	(b) Leak at bottom cover plate.	⇒ Reseal bottom cover plate using RTV silicone sealant.
	(c) Leak at internal rear flange gasket.	⇒ Replace compressor.
	(d) Leak through crankcase.	⇒ Replace compressor.
	(e) (If unable to tell source of leak.)	⇒ Clean compressor and check periodically.



Head gaskets and rear flange gasket locations.

? Check

3.0 Oil at air dryer purge/exhaust or surrounding area	Air brake charging system functioning normally.	⇒ Air dryers remove water and oil from the air brake charging system. Check that regular maintenance is being performed. Return the vehicle to service. An optional kit (Bendix piece number 5011327 for the Bendix® AD-IS® or AD-IP® air dryers, or 5003838 for the Bendix® AD-9® air dryer) is available to redirect the air dryer exhaust.
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✓ Normal

Symptom:**What it may indicate:****What you should do:****4.0 Oil in Supply or Service Reservoir (air dryer installed)**

(If a maintained Bendix® PuraGuard® system filter or Bendix® PuraGuard QC™ oil coalescing filter is installed, call 1-800-AIR-BRAKE (1-800-247-2725) and speak to a Tech Team member.)



See Table A, on page 13, for maintenance schedule information.

Maintenance

- (a) **If** air brake charging system maintenance **has not been performed**. That is, reservoir(s) **have not** been drained per the schedule in Table A on page 13, Column 4 **and/or** the air dryer maintenance **has not** been performed as in Column 3.
- (b) **If** the vehicle maintenance **has been performed** as recommended in Table A on page 13, some oil in the reservoirs is normal.



Drain all air tanks (reservoirs) into the Bendix® BASIC test cup. (Bendix kit P/N 5013711).

- ⇒ Drain all air tanks and check vehicle at next service interval using the Bendix® BASIC test. See Table A on page 13, column 3 and 4, for recommended service schedule.

? Check

- ⇒ Drain all air tanks into Bendix® BASIC test cup (Bendix Air System Inspection Cup). If less than one unit of reservoir contents is found, the vehicle can be returned to service. **Note: If more than one oil unit of water (or a cloudy emulsion mixture) is present, change the vehicle's air dryer, check for air system leakage (Test 2, on page 24), stop inspection and check again at the next service interval. See the BASIC test kit for full details.** If less than one "oil unit" of water (or water/cloudy emulsion mixture) is present, use the BASIC cup chart on the label of the cup to determine if the amount of oil found is within the acceptable level.
- ⇒ If within the normal range, return the vehicle to service. For vehicles with accessories that are sensitive to small amounts of oil, consider a Bendix® PuraGuard QC™ oil coalescing filter.
- ⇒ If outside the normal range go to Symptom 4.0(c).
- Also see the Table A on page 13, column 3 for recommended air dryer cartridge replacement schedule.

Duty cycle too high

- (c) Air brake system leakage.
- (d) Compressor may be undersized for the application.

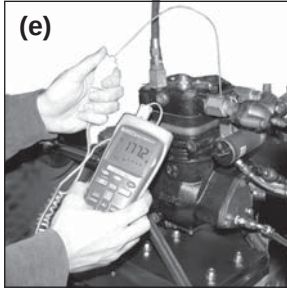
- ⇒ Go to Test 2 on page 24.
- ⇒ See Table A, column 1, on page 13 for recommended compressor sizes.
- ⇒ If the compressor is "too small" for the vehicle's role (for example, where a vehicle's use has changed or service conditions exceed the original vehicle or engine OE spec's) then upgrade the compressor. Note: The costs incurred (e.g. installing a larger capacity compressor, etc.) are not covered under original compressor warranty.
- ⇒ If the compressor is correct for the vehicle, go to Symptom 4.0 (e).

The **duty cycle** is the ratio of time the compressor spends building air to total engine running time. Air compressors are designed to build air (to "run loaded") up to 25% of the time. Higher duty cycles cause conditions that affect air brake charging system performance which may require additional maintenance. Factors that add to the duty cycle are: air suspension, additional air accessories, use of an undersized compressor, frequent stops, excessive leakage from fittings, connections, lines, chambers or valves, etc.

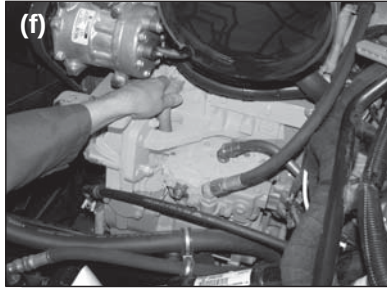
Symptom:**What it may indicate:****What you should do:****4.0 Oil in Supply
or Service
Reservoir*
(air dryer installed)
(continued)****Temperature**

(e) Air compressor discharge and/or air dryer inlet temperature too high.

(f) Insufficient coolant flow.



Testing the temperature at the discharge fitting.



Inspecting the coolant hoses.

(g) Restricted discharge line.



Kinked discharge line shown.

⇒ Check temperature as outlined in Test 3 on page 24. If temperatures are normal go to 4.0(h).

⇒ Inspect coolant line. Replace as necessary (I.D. is 1/2").

⇒ Inspect the coolant lines for kinks and restrictions and fittings for restrictions. Replace as necessary.

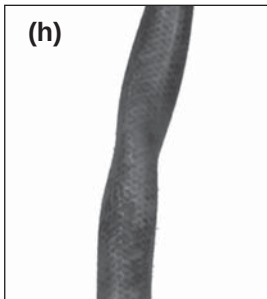
⇒ Verify coolant lines go from engine block to compressor and back to the water pump. Repair as necessary.

⇒ If discharge line is restricted or more than 1/16" carbon build up is found, replace the discharge line. See Table A, column 2, on page 13 for recommended size. Replace as necessary.

⇒ The discharge line must maintain a **constant slope** down from the compressor to the air dryer inlet fitting to avoid low points where ice may form and block the flow. If, instead, ice blockages occur at the air dryer inlet, insulation may be added here, or if the inlet fitting is a typical 90 degree fitting, it may be changed to a straight or 45 degree fitting. For more information on how to help prevent discharge line freeze-ups, see Bendix Bulletins TCH-008-021 and TCH-008-022 (Appendix B). Shorter discharge line lengths or insulation may be required in cold climates.

Other

(h) Restricted air inlet (not enough air to compressor).



Partly collapsed inlet line shown.

⇒ Check compressor air inlet line for restrictions, brittleness, soft or sagging hose conditions etc. Repair as necessary. Inlet line size is 3/4 ID. Maximum restriction requirement for compressors is 25 inches of water.

⇒ Check the engine air filter and service if necessary (if possible, check the air filter usage indicator).

? Check

*If a maintained Bendix® PuraGuard® system filter or Bendix® PuraGuard QC™ oil coalescing filter is installed, call 1-800-AIR-BRAKE (1-800-247-2725) and speak to a Tech Team member.

Symptom:	What it may indicate:	What you should do:
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4.0 Oil in Supply or Service Reservoir* (air dryer installed) (continued)

Other (cont.)

- (i) Poorly filtered inlet air (poor air quality to compressor).



Inspect the engine air cleaner.

⇒ Check for leaking, damaged or defective compressor air inlet components (e.g. induction line, fittings, gaskets, filter bodies, etc.). Repair inlet components as needed. Note: Dirt ingestion will damage compressor and is not covered under warranty.

? Check

- (j) Governor malfunction or setting.

⇒ Go to Test 4 on page 25.

- (k) Compressor malfunction.

⇒ If you found excessive oil present in the service reservoir in step 4.0 (b) above and you did not find any issues in steps 4.0 (c) through 4.0 (j) above, the compressor may be passing oil.

Replace compressor. If still under warranty, follow normal warranty process. Note: After replacing a compressor, residual oil may take a considerable period of time to be flushed from the air brake system.

Crankcase Flooding

Consider installing a compressor bottom drain kit (where available) in cases of chronic oil passing where all other operating conditions have been investigated. Bendix compressors are designed to have a 'dry' sump and the presence of excess oil in the crankcase can lead to oil carryover.

*If a maintained Bendix® PuraGuard® system filter or Bendix® PuraGuard QC™ oil coalescing filter is installed, call 1-800-AIR-BRAKE (1-800-247-2725) and speak to a Tech Team member.

5.0 Oil present at valves (e.g. at exhaust, or seen during servicing).

Air brake system valves are required to tolerate a light coating of oil.

✓ Normal

⇒ A small amount of oil does not affect SAE J2024** compliant valves.

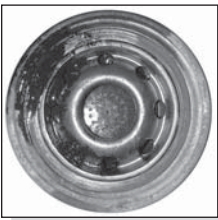
⇒ Check that regular maintenance is being performed and that the amount of oil in the air tanks (reservoirs) is within the acceptable range shown on the Bendix® BASIC test cup (see also column 5 of Table A on page 13). Return the vehicle to service.

For oil-sensitive systems, see page 12.



Genuine Bendix valves are all SAE J2024 compliant.

** SAE J2024 outlines tests all air brake system pneumatic components need to be able to pass, including minimum levels of tolerance to contamination.

Symptom:	What it may indicate:	What you should do:
6.0 Excessive oil consumption in engine.	A problem with engine or other engine accessory.  The engine service manual has more information.	⇒ See engine service manual. ? Check
7.0 Oil present at air dryer cartridge during maintenance.	Air brake charging system is functioning normally.  Oil shown leaking from an air dryer cartridge. ✓ Normal	⇒ Air dryers remove water and oil from the air brake charging system. A small amount of oil is normal. Check that regular maintenance is being performed and that the amount of oil in the air tanks (reservoirs) is within the acceptable range shown by the BASIC Test (see also column 5 of Table A on page 13). Replace the air dryer cartridge as needed and return the vehicle to service.
8.0 Oil in ping tank or compressor discharge aftercooler.	Air brake charging system is functioning normally. ✓ Normal	⇒ Follow vehicle O.E. maintenance recommendation for these components.
9.0 Air brake charging system seems slow to build pressure.	(a) Air brake charging system functioning normally. ✓ Normal (b) Air brake system leakage. (c) Compressor may be undersized for the application. (d) Compressor unloader mechanism malfunction. (e) Damaged compressor head gasket.	⇒ Using dash gauges, verify that the compressor builds air system pressure from 85-100 psi in 40 seconds or less with engine at full governed rpm. Return the vehicle to service. ⇒ Go to Test 2 on page 24. ⇒ See Table A, column 1, on page 13 for some typical compressor applications. If the compressor is "too small" for the vehicle's role, for example, where a vehicle's use has changed, then upgrade the compressor. Note: The costs incurred (e.g. installing a larger capacity compressor, etc.) are not covered under original compressor warranty. ⇒ Go to Test 6 on page 25. ⇒ An air leak at the head gasket may indicate a downstream restriction such as a freeze-up or carbon blockage and/or could indicate a defective or missing safety valve. Find blockage (go to 9.0(f) for details) and then replace the compressor. Do not re-use the safety valve without testing. See Symptom 12.0(a).

Symptom:**What it may indicate:****What you should do:**

9.0 Air brake charging system seems slow to build pressure. (continued)



Dash gauges.

(f) Restricted discharge line.

? Check

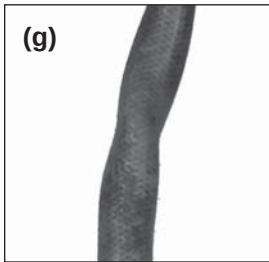


Kinked discharge line shown.

Engine Oil Quality

Inadequate oil change intervals, the formulation of the oil and/or the quality of oil filter used can all lead to poor oil quality. These can increase the rate at which carbon builds up in the discharge line. Bendix recommends oil soot (solids) be maintained at less than 3%.

- ⇒ If discharge line is restricted:
 - ⇒ By more than 1/16" carbon build up, replace the discharge line (see Table A, column 2, on page 13 for recommended size) and go to Test 3 on page 24.
 - ⇒ By other restrictions (e.g. kinks). Replace the discharge line. See Table A, column 2, on page 13 for recommended size. Retest for air build. Return vehicle to service or, if problem persists, go to 9.0(a).
- ⇒ The discharge line must maintain a **constant slope** down from the compressor to the air dryer inlet fitting to avoid low points where ice may form and block the flow. If, instead, ice blockages occur at the air dryer inlet, insulation may be added here, or if the inlet fitting is a typical 90 degree fitting, it may be changed to a straight or 45 degree fitting. For more information on how to help prevent discharge line freeze-ups, see Bendix Bulletins TCH-008-021 and TCH-008-022 (Appendix B). Shorter discharge line lengths or insulation may be required in cold climates.



Partly collapsed inlet line shown.

(g) Restricted air inlet (not enough air to compressor).

? Check

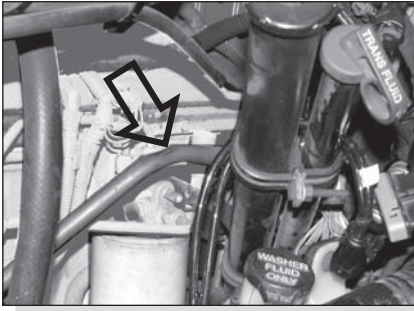
(h) Poorly filtered inlet air (poor air quality to compressor).

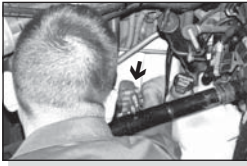
? Check

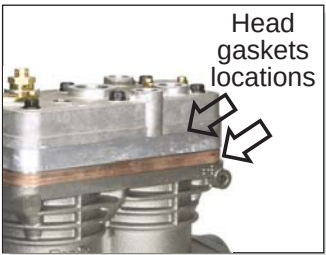
(i) Compressor malfunction.

? Check

- ⇒ Check compressor air inlet line for restrictions, brittleness, soft or sagging hose conditions etc. Repair as necessary. Refer to vehicle manufacturer's guidelines for inlet line size.
- ⇒ Check the engine air filter and service if necessary (if possible, check the air filter usage indicator).
- ⇒ Check for leaking, damaged or defective compressor air inlet components (e.g. induction line, fittings, gaskets, filter bodies, etc.). Repair inlet components as needed. Note: Dirt ingestion will damage compressor and is not covered under warranty.
- ⇒ Replace the compressor only after making certain that none of the preceding conditions, 9.0 (a) through 9.0 (h), exist.

Symptom:	What it may indicate:	What you should do:
10.0 Air charging system doesn't build air.	(a) Governor malfunction*.	⇒ Go to Test 4 on page 25.
	(b) Restricted discharge line.	⇒ See 9.0(f).
	(c) Air dryer heater malfunction: exhaust port frozen open.	⇒ Replace air dryer heater.
	(d) Compressor malfunction.	⇒ Replace the compressor only after making certain the preceding conditions do not exist.
* Note: For the Bendix® DuraFlo 596™ air compressor, not only the governor, but also the SV-1™ synchro valve used would need to be tested. See Bulletin TCH-001-048.		
11.0 Compressor safety valve releases air (Compressor builds too much air).	(a) Restricted discharge line. ? Check	⇒ If discharge line is restricted: ⇒ By more than 1/16" carbon build up, replace the discharge line (see Table A, column 2, on page 13 for recommended size) and go to Test 3 on page 24. ⇒ By other restrictions (e.g. kinks). Replace the discharge line. See Table A, column 2, on page 13 for recommended size. ⇒ The discharge line must maintain a constant slope down from the compressor to the air dryer inlet fitting to avoid low points where ice may form and block the flow. If, instead, ice blockages occur at the air dryer inlet, insulation may be added here, or if the inlet fitting is a typical 90 degree fitting, it may be changed to a straight or 45 degree fitting. For more information on how to help prevent discharge line freeze-ups, see Bendix Bulletins TCH-008-021 and TCH-008-022 (Appendix B). Shorter discharge line lengths or insulation may be required in cold climates.
 Damaged discharge line shown.		
	(b) Downstream air brake system check valves or lines may be blocked or damaged.	⇒ Inspect air lines and verify check valves are operating properly.
	(c) Air dryer lines incorrectly installed.	⇒ Ensure discharge line is installed into the inlet of the air dryer and delivery is routed to the service reservoir.
	(d) Compressor safety valve malfunction.	⇒ Verify relief pressure is 250 psi. Replace if defective.
	(e) Compressor unloader mechanism malfunction.	⇒ Go to Test 6 on page 25.
	(f) Governor malfunction.	⇒ Go to Test 4 on page 25.

Symptom:	What it may indicate:	What you should do:
12.0 Air dryer safety valve releases air.   Technician removes governor.	(a) Restriction between air dryer and reservoir. (b) Air dryer safety valve malfunction. (c) Air dryer maintenance not performed. (d) Air dryer malfunction. (e) Improper governor control line installation to the reservoir. (f) Governor malfunction.	⇒ Inspect delivery lines to reservoir for restrictions and repair as needed. ⇒ Verify relief pressure is at vehicle or component manufacturer specifications. Replace if defective. ⇒ See Maintenance Schedule and Usage Guidelines (Table A, column 3, on page 13). ⇒ Verify operation of air dryer. Follow vehicle O.E. maintenance recommendations and component Service Data information. ⇒ Go to Test 5 on page 25. ⇒ Go to Test 4 on page 25.
13.0 Reservoir safety valve releases air	(a) Reservoir safety valve malfunction. (b) Governor malfunction. (c) Compressor unloader mechanism malfunction.	⇒ Verify relief pressure is at vehicle or component manufacturer's specifications (typically 150 psi). Replace if defective. ⇒ Go to Test 4 on page 25. ⇒ Go to Test 6 on page 25.
14.0 Air dryer doesn't purge. (Never hear exhaust from air dryer.)	(a) Air dryer malfunction. (b) Governor malfunction. (c) Air brake system leakage. (d) Improper governor control line installation to the reservoir.	⇒ Verify operation of air dryer. Follow vehicle O.E. maintenance recommendations. ⇒ Go to Test 4 on page 25. ⇒ Go to Test 2 on page 24. ⇒ Go to Test 5 on page 25.
15.0 Compressor constantly cycles (compressor remains unloaded for a very short time.)	(a) Air brake charging system maintenance not performed.  Check (b) Compressor unloader mechanism malfunction. (c) Air dryer purge valve or delivery check valve malfunction. (d) Air brake system leakage.	⇒ Available reservoir capacity may be reduced by build up of water etc. Drain and perform routine maintenance per Table A, columns 3 & 4, on page 13. ⇒ Go to Test 6 on page 25. ⇒ Verify operation of air dryer. Follow vehicle O.E. maintenance recommendations and component Service Data information. ⇒ Go to Test 2 on page 24.

Symptom:	What it may indicate:	What you should do:
16.0 Compressor leaks air  Testing for leaks with soap solution.	(a) Compressor leaks air at connections or ports. (b) Compressor unloader mechanism malfunction. (c) Damaged compressor head gasket(s). 	⇒ Check for leaking, damaged or defective compressor fittings, gaskets, etc. Repair or replace as necessary. ⇒ Go to Test 6 on page 25. ⇒ An air leak at the head gasket(s) may indicate a downstream restriction such as a freeze-up or carbon blockage and/or could indicate a defective or missing safety valve. Find blockage (go to 9.0(f) for details) and then replace the compressor. Do not re-use the safety valve without testing. See Symptom 12.0(a).
17.0 Compressor leaks coolant	(a) Improperly installed plugs or coolant line fittings. (b) Damaged compressor head gasket. (c) Porous compressor head casting.	⇒ Inspect for loose or over-torqued fittings. Reseal and tighten loose fittings and plugs as necessary. If overtightened fittings and plugs have cracked ports in the head, replace the compressor. ⇒ An air leak at the head gasket may indicate a downstream restriction such as a freeze-up or carbon blockage and/or could indicate a defective or missing safety valve. Find blockage (go to 9.0(f) for details) and then replace the compressor. Do not re-use the safety valve without testing. See Symptom 12.0(a). ⇒ If casting porosity is detected, replace the compressor.
18.0 Noisy compressor (Multi-cylinder compressors only)	(a) Damaged compressor.	⇒ Replace the compressor.

Other Miscellaneous Areas to Consider

This guide attempts to cover most compressor system problems. Here are some rare sources of problems not covered in this guide:

- Turbocharger leakage. Lubricating oil from leaking turbocharger seals can enter the air compressor intake and give misleading symptoms.

- Where a compressor does not have a safety valve installed, if a partial or complete discharge line blockage has occurred, damage can occur to the connecting rod bearings. Damage of this kind may not be detected and could lead to compressor problems at a later date.

Tests

Test 1: Excessive Oil Leakage at the Head Gasket

Exterior leaks at the head gasket are not a sign that oil is being passed into the air charging system. Oil weepage at the head gasket does not prevent the compressor from building air.

Observe the amount of weepage from the head gasket.

If the oil is only around the cylinder head area, it is acceptable (return the vehicle to service), but, if the oil weepage extends down to the nameplate area of the compressor, the gasket can be replaced.



Test 2: Air Brake System and Accessory Leakage

Inspect for air leaks when working on a vehicle and repair them promptly.

Park the vehicle on level ground and chock wheels. Build system pressure to governor cut-out and allow the pressure to stabilize for one minute.

Step 1: Observe the dash gauges for two additional minutes without the service brakes applied.

Step 2: Apply the service brakes and allow the pressure to stabilize. Continue holding for two minutes (you may use a block of wood to hold the

pedal in position.) Observe the dash gauges.

If you see any noticeable decrease of the dash air gauge readings (i.e. more than 4 psi, plus two psi for each additional trailer) during either two minute test, **repair the leaks** and repeat this test to confirm that they have been repaired.

Air leaks can also be found in the charging system, parking brakes, and/or other components - inspect and repair as necessary.

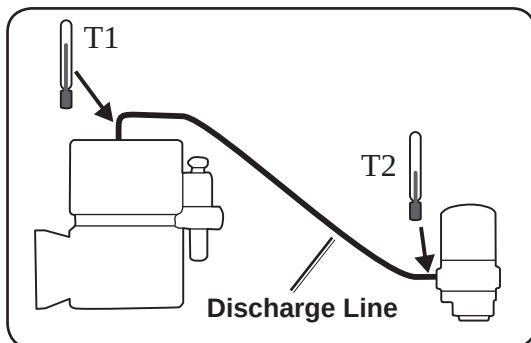
Test 3: Air Compressor Discharge Temperature and Air Dryer Inlet Temperature*

Caution: The temperatures used in this test are not normal vehicle conditions.

Above normal temperatures can cause oil (as vapor) to pass through the air dryer into the air brake system.

This test is run with the engine at normal operating temperature, with engine at max. rpm. If available, a dyno may be used.

1. Allow the compressor to build the air system pressure to governor cut-in.
2. Pump the brakes to bring the dash gauge pressure to 90 psi.
3. Allow the compressor to build pressure from 95 to 105 psi gauge pressure and maintain this pressure range by cycling the brakes **for five (5) minutes.**



(* Note that only vehicles that have passed Test 2 would be candidates for this test.)

4. Then, while maintaining max rpm and pressure range, measure and **record the surface temperature** of the **fittings**:
 - ⇒ at the compressor discharge port. (T1).
 - ⇒ at the air dryer inlet fitting. (T2).
 Use a touch probe thermocouple for measuring the temperature.
5. See table below.
6. Retest before returning the vehicle to service.

T1 Compressor Discharge Fitting	T2 Air Dryer Inlet Fitting	Action
under 360°F	under 200°F	Temperatures are within normal range for this test, check other symptoms. Go to 4.0 (h).
under 360°F	over 200°F	This could indicate a discharge line problem (e.g. restriction). Call 1-800-AIR-BRAKE (1-800-247-2725) and speak with our Tech Team.
over 360°F	—	Compressor is running hot. Check coolant 4(f) and/or discharge line 4(g).

Tests (continued)

Test 4: Governor Malfunction

1. Inspect control lines to and from the governor for restrictions (e.g. collapsed or kinked). Repair as necessary.
2. Using a calibrated external gauge in the supply reservoir, service reservoir, or reservoir port of the D-2[®] governor, verify cut-in and cut-out pressures are within vehicle OEM specification.
3. If the governor is malfunctioning, replace it.

Test 5: Governor Control Line

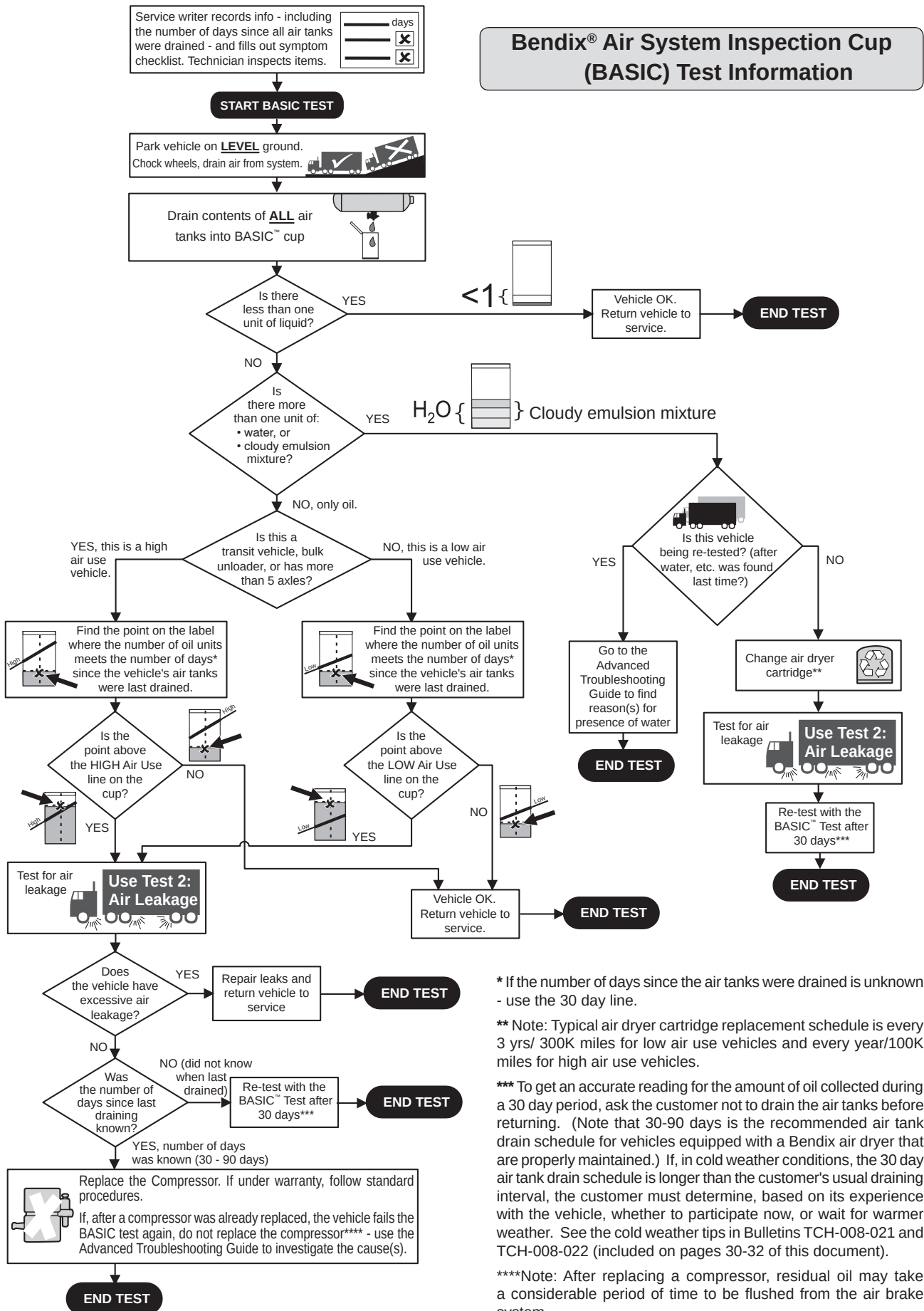
1. Ensure that the governor control line from the reservoir is located at or near the top of the reservoir. (This line, if located near the bottom of the reservoir, can become blocked or restricted by the reservoir contents e.g. water or ice.)
2. Perform proper reservoir drain intervals and air dryer cartridge maintenance per Maintenance Schedule and Usage Guidelines (Table A on page 13).
3. Return the vehicle to service.

Test 6: Compressor Unloader Leakage

Bendix[®] Compressors: Park vehicle, chock wheels, and follow all standard safety procedures. Remove the governor and install a fitting to the unloader port. Add a section of air hose (min 1 ft long for a 1/2" diameter line) and a gauge to the fitting followed by a shut-off valve and an air source (shop air or small air tank). Open the

shut off and charge the unloader port by allowing air pressure to enter the hose and unload the compressor. Shut off the air supply and observe the gauge. A steady reading indicates no leakage at the unloader port, but a falling reading shows that the unloader mechanism is leaking and needs to be serviced.

Appendix A: Information about the BASIC Test Kit (Bendix P/N 5013711)



Appendix A continued: Information about the BASIC Test Kit (Bendix P/N 5013711)

Filling in the Checklist for the Bendix® Air System Inspection Cup (BASIC) Test

Note: Follow all standard safety precautions. For vehicles using a desiccant air dryer.

The Service Writer fills out these fields with information gained from the customer

Number of Days Since Air Tanks Were Last Drained: _____		Date: _____	Vehicle #: _____
Engine SN _____	Vehicle Used for: _____		Typical Load: _____ (lbs.)
No. of Axles: ____ (tractor) ____ (trailer)	No. of Lift Axles: ____	Technician's Name: _____	

The Service Writer also checks off any complaints that the customer makes to help the Technician in investigating.

Customer's complaint? (Please check all that apply)	Checklist for Technician Have you confirmed
☐ "Relay valve leaks oil / ☐ malfunctions"	☐ no ☐ yes*
☐ "Dash valve leaks oil / ☐ malfunctions"	☐ no ☐ yes*
☐ "Air dryer leaks oil"	☐ no ☐ yes*
☐ "Governor malfunction"	☐ no ☐ yes*
☐ "Oil in gladhands"	☐ no ☐ yes*
how much oil did you find? _____	
☐ "Oil on ground or vehicle exterior"	☐ no ☐ yes*
amount described: _____	
☐ "Short air dryer cartridge life"	
replaces every: _____ ☐ miles, ☐ kms, or ☐ months	
☐ "Oil in air tanks" amount described: _____	
We will measure amount currently found when we get to step B of the test.	
☐ "Excessive engine oil loss" amount described: _____	
Is the engine leaking oil?	☐ no ☐ yes*
Is the compressor leaking oil?	☐ no ☐ yes*
☐ Other complaint: _____	
☐ No customer complaint.	

The Technician checks boxes for any of the complaints that can be confirmed.

* Note: A confirmed complaint above **does NOT** mean that the compressor must be replaced. The full BASIC test below will investigate the facts.

BASIC test starts here:

STEP A - Select one:

- ☐ This is a low air use vehicle: Line haul (single trailer) with 5 or less axles, **or**
- ☐ This is a high air use vehicle: Garbage truck, transit bus, bulk unloader, or line haul with more than 5 axles.
- Then go to Step B.**

The Technician selects the air use category for the vehicle. This decided which of the two acceptance lines on the cup will be used for the test below.

STEP B - Measure the Charging System Contents

1. Park and chock vehicle on level ground. Drain the air system by pumping the service brakes.
2. Completely drain **ALL** the air tanks into a single **BASIC** cup.
3. If there is less than one unit of contents total, end the test now and return the vehicle to service. Vehicle passes.
4. **If more than one oil unit of water (or a cloudy emulsion mixture) is found:**
 - (a) Change the vehicle's air dryer cartridge - see Footnote 1,
 - (b) Conduct the 4 minute leakage test (Step D),
 - (c) **STOP the inspection, and check the vehicle again after 30 days** - see Footnote 2.



For an accurate test, the contents of all the air tanks on the vehicle should be used.

Note for returning vehicles that are being retested after a water/cloudy emulsion mixture was found last time and the air dryer cartridge replaced: If more than one oil unit of water or a cloudy emulsion mixture is found **again**, stop the BASIC test and consult the air dryer's Service Data sheet troubleshooting section.

Otherwise, go to Step C.

Footnote 1: Note: Typical air dryer cartridge replacement schedule is every 3 yrs/ 300K miles for low air use vehicles and every year/100K miles for high air use vehicles.

Footnote 2: To get an accurate reading for the amount of oil collected during a 30 day period, ask the customer not to drain the air tanks before returning. (Note that 30-90 days is the recommended air tank drain schedule for vehicles equipped with a Bendix air dryer that are properly maintained.) If, in cold weather conditions, the 30 day air tank drain schedule is longer than the customer's usual draining interval, the customer must determine, based on its experience with the vehicle, whether to participate now, or wait for warmer weather. See the cold weather tips in Bulletins TCH-008-021 and TCH-008-022 (included in Appendix B of the advanced troubleshooting guide).

Appendix A continued: Information about the BASIC Test Kit (Bendix P/N 5013711)

Filling in the Checklist for the Bendix® Air System Inspection Cup (BASIC) Test

Note: Follow all standard safety precautions. For vehicles using a desiccant air dryer.

STEP C - How to Use the BASIC Test

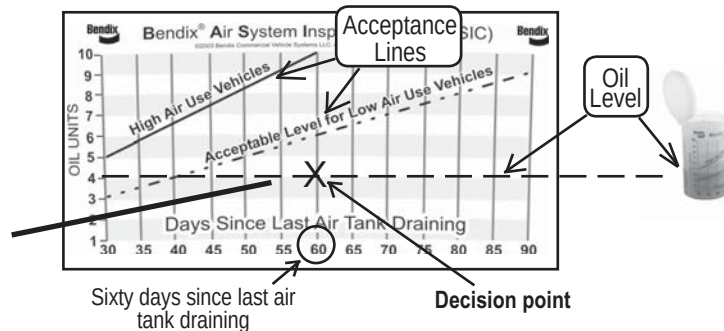
The Technician uses the chart (label) on the BASIC test cup to help decide the action to take, based on the amount of oil found. Use the lower acceptance line for low air use vehicles, and upper line for high air use vehicles (from Step A).

1. Record days since air tanks were last drained. _____ days	2. Record amount of oil found: _____ units	3. Action to take
If number of days is: 30-60 days (high air use) or 30-90 days (low air use) →	if oil level is at or below acceptance line for number of days →	System OK. Return to service. STOP TEST
	if oil level is above acceptance line for number of days →	Go to Step D
Otherwise . . . → (if the number of days is unknown, or outside the limits above)	if oil level is at or below 30-day acceptance line →	System OK. Return to service. STOP TEST
	if oil level is above 30-day acceptance line →	Stop inspection. Test again after 30 days. See Footnote 2. STOP + CK.

BASIC Test Example

An oil level of 4 units in a sixty-day period is within the acceptance area (at or below the line) for both low and high air use vehicles. Return the vehicle to service.

The Technician looks for the point where the number of days since the air tanks were drained meets the oil level. If it is at or below the (low or high use) acceptance line, the vehicle has passed the test. If the point is above the line then go to the leakage test.



STEP D - Air Brake System Leakage Test

Park the vehicle on level ground and chock wheels. Build system pressure to governor cut-out and allow the pressure to stabilize for one minute.

1: Observe the dash gauges for two additional minutes without the service brakes applied.

2: Apply service brakes for two minutes (allow pressure to stabilize) and observe the dash gauges.

If you see any noticeable decrease of the dash air gauge readings, repair leaks. Repeat this test to confirm that air leaks have been repaired and return vehicle to service. Please repeat BASIC test at next service interval. Note: Air leaks can also be found in the charging system, parking brakes, and/or other components - inspect and repair as necessary.

Air leakage is the number one cause of compressors having to pump excessive amounts of air, in turn run too hot and pass oil vapor along into the system. Here the Technician conducts a four-minute test to see if leakage is a problem with the vehicle being tested.

If no air leakage was detected, and if you are conducting this test after completing Step C, go to Step E.

STEP E - If no air leakage was detected in Step D

Replace the compressor.

Note: If the compressor is within warranty period, please follow standard warranty procedures. Attach the completed checklist to warranty claim.

The Technician only reaches Step E if the amount of oil found, for the amount of time since the air tanks were last drained exceeds the acceptance level, AND the vehicle passes the four-minute leakage test (no noticeable leakage was detected).



Technical Bulletin

Bulletin No.: TCH-008-021

Effective Date: 3-5-2010

Cancels PRO-08-21 dated 2-6-2008

Page: 1 of 2

Subject: **Air Brake System - Cold Weather Operation Tips**

As the cold weather approaches, operators and fleets alike begin to look to their vehicles with an eye toward “winterization”, and particularly what can be done to guard against air system freeze-up. Here are some basic “Tips” for operation in the cold weather.

Engine Idling

Avoid idling the engine for long periods of time! In addition to the fact that most engine manufacturers warn that long idle times are detrimental to engine life, winter idling is a big factor in compressor discharge line freeze-up. Discharge line freeze-ups account for a significant number of compressor failures each year. The discharge line recommendations under “Discharge Lines” are important for all vehicles, but are especially so when some periods of extended engine idling can not be avoided.

Discharge Lines

The discharge line should slope downward from the compressor discharge port without forming water traps, kinks, or restrictions. Cross-overs from one side of the frame rail to the other, if required, should occur as close as possible to the compressor.

Dryer Inlet Temperature

The dryer inlet air temperature should typically be within the range of no more than 160°F and no less than 45°F above low ambient (surrounding) temperature to prevent freeze-ups. (For example, if low ambient is minus 40°F, the dryer inlet must be above 5°F.) Lower dryer inlet temperatures should be avoided to minimize the risk of freeze-up upstream of the air dryer. Higher temperatures should also be avoided to minimize the risk of heat damage to the air dryer seals and to avoid a loss of drying performance.

Compressor Line Size

The line size and length is established by the vehicle manufacturer and should not be altered without the vehicle manufacturers approval. As a reference, the line length from the compressor to the air dryer should be less than 16 feet and the minimum line sizes should be as follows:

Minimum Length	Minimum I.D.	Application
6 ft.	1/2 in.	Low Compressor Duty Cycle Applications (0-20%)
10 ft.	5/8 in.	High Compressor Duty Cycle Applications (20-40%)

Line Insulation

To guard against freez-ups in Low Duty Cycle applications, the discharge line can be insulated if it is greater than 9 feet in length. The line can only be insulated back to 9 feet and a maximum of 3 feet. For example, if the line is 10 feet, insulate the fitting and the last one foot of the line. If the line is 15 feet, insulate the fitting and the last 3 feet of the line.

System Leakage

Check the air brake system for excessive air leakage using the Bendix “Dual System Air Brake Test and Check List” (BW1279). Excessive system leakage causes the compressor to “pump” more air and also reduce the life of the air dryer desiccant cartridge.

Reservoir Draining (System without an Air Dryer)

Routine reservoir draining is the most basic step in reducing the possibility of freeze-up. All reservoirs in a brake system can accumulate water and other contamination and must be drained! The best practice is to drain all reservoirs daily if the air brake system does not include an air dryer. When draining reservoirs; turn the ENGINE OFF and drain ALL AIR from the reservoir, better still, open the drain cocks on all reservoirs and leave them open over night to assure all contamination is drained (reference Service Data Sheet SD-04-400 for Bendix Reservoirs). If automatic drain valves are installed, check their operation before the weather turns cold (reference Service Data Sheet SD-03-2501 for Bendix® DV-2™ Automatic Drain Valves). It should be noted that, while the need for daily reservoir draining is eliminated through the use of an automatic drain valve, periodic manual draining is still required.

Reservoir Draining (System with an Air Dryer)

Daily reservoir draining should not be performed on systems with an air dryer. This practice will cause the dryer to do excessive work (i.e. build pressure from 0-130 psi instead of the normal 110-130 psi).

Alcohol Evaporator or Injector Systems

Bendix Commercial Vehicle Systems LLC discourages the use of alcohol in the air brake system as a means of preventing system freeze-up in cold temperatures. Studies indicate that using alcohol and alcohol based products sold for this purpose removes the lubrication from the components of the air braking system. In addition, the materials used for the internal seals of the air system components may be adversely impacted by the residue that some anti-freeze additives leave behind. Both are detrimental to air system component life expectancy, causing premature wear. Because of this, Bendix® air system components warranty will be void if analysis shows that alcohol was added to the air brake system.

Alcohol is not an acceptable substitute for having adequate air drying capacity. If the air dryer is maintained in accordance with the manufacturer's recommended practices and moisture is found to be present in the system reservoirs, more drying capacity is required. Bendix has several viable options including extended purge air dryers, extended purge tandem dryers in parallel with common control, and air dryers arranged to provide continuous flow as with the Bendix® EverFlow® continuous flow air dryer module. To address concerns with contaminants in trailer air brake systems, the Bendix® Cyclone DuraDrain™ water separator and the Bendix® System-Guard® trailer air dryer are available. Refer to Bendix Technical Bulletin TCH-008-042 “Alcohol in the Air Brake System” for additional information.

Air Dryers

Make certain air brake system leakage is within the limits stated in BW1279. Check the operation and function of the air dryer using the appropriate Service Data Sheet for the air dryer.

Air Dryer	Service Data Sheet
AD-2® air dryer	SD-08-2403
AD-4® air dryer	SD-08-2407
AD-9® air dryer	SD-08-2412
AD-IP® air dryer	SD-08-2414
AD-IS® air dryer	SD-08-2418
AD-IS® EverFlow® air dryer	SD-08-2417
AD-SP® air dryer	SD-08-2415
Cyclone DuraDrain™ water separator	SD-08-2402
PuraGuard® QC system filter	SD-08-187B
Trailer System-Guard® air dryer	SD-08-2416

Bendix literature is
available to order or
download on Bendix.com





Technical Bulletin

Bulletin No.: TCH-008-022

Effective Date: 1/1/1994

Page: 1 of 1

Subject: **Additional Cold Weather Operation Tips for the Air Brake System**

Last year we published Bulletin PRO-08-21 which provided some guidelines for "winterizing" a vehicle air brake system. Here are some additional suggestions for making cold weather vehicle operation just a little more bearable.

Thawing Frozen Air Lines

The old saying; "Prevention is the best medicine" truly applies here! Each year this activity accounts for an untold amount of unnecessary labor and component replacement. Here are some Do's and Don'ts for prevention and thawing.

Do's

1. Do maintain freeze prevention devices to prevent road calls. Don't let evaporators or injectors run out of methanol alcohol or protection will be degraded. Check the air dryer for proper operation and change the desiccant when needed.
2. Do thaw out frozen air lines and valves by placing the vehicle in a warmed building. This is the only method for thawing that will not cause damage to the air system or its components.
3. Do use dummy hose couplings on the tractor and trailer.
4. Do check for sections of air line that could form water traps. Look for "drooping" lines.

Don'ts

1. Do not apply an open flame to air lines and valves. Beyond causing damage to the internal nonmetallic parts of valves and melting or burning non-metallic air lines. **WARNING: THIS PRACTICE IS UNSAFE AND CAN RESULT IN VEHICLE FIRE!**
2. Do not introduce (pour) fluids into air brake lines or hose couplings ("glad hands"). Some fluids used can cause immediate and severe damage to rubber components. Even methanol alcohol, which is used in Alcohol Evaporators and Injectors, should not be poured into air lines. Fluids poured into the system wash lubricants out of valves, collect in brake chambers and valves and can cause malfunction. Loss of lubricant can affect valve operating characteristics, accelerate wear and cause premature replacement.
3. Do not park a vehicle outside after thawing its air system indoors. Condensation will form in the system and freeze again. Place the vehicle in operation when it is removed to the outdoors.

Supporting Air and Electrical Lines

Make certain tie wraps are replaced and support brackets are re-assembled if removed during routine maintenance. These items prevent the weight of ice and snow accumulations from breaking or disconnecting air lines and wires.

Automatic Drain Valves (System without Air Dryer)

As we stated last year, routine reservoir draining is the most basic step (although not completely effective) in reducing the possibility of freeze-up. While automatic drain valves relieve the operator of draining reservoirs on a daily basis, these valves **MUST** be routinely checked for proper operation. Don't overlook them until they fail and a road call is required.



Bendix® D-2® Governor

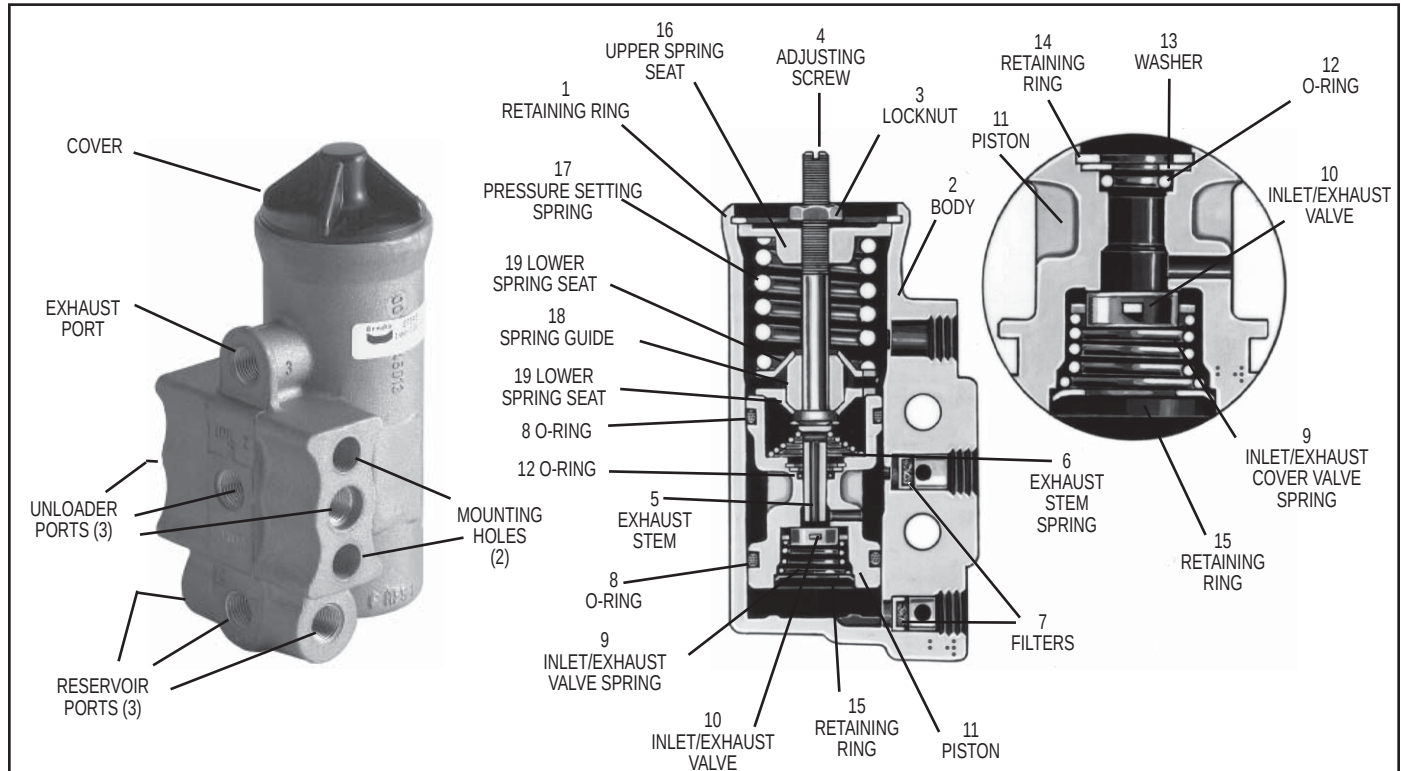


FIGURE 1 - D-2® GOVERNOR

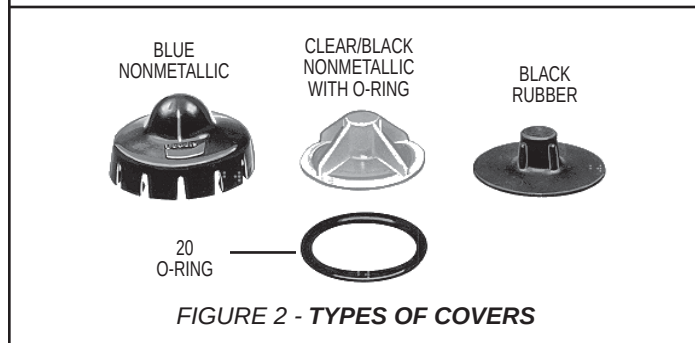


FIGURE 2 - TYPES OF COVERS

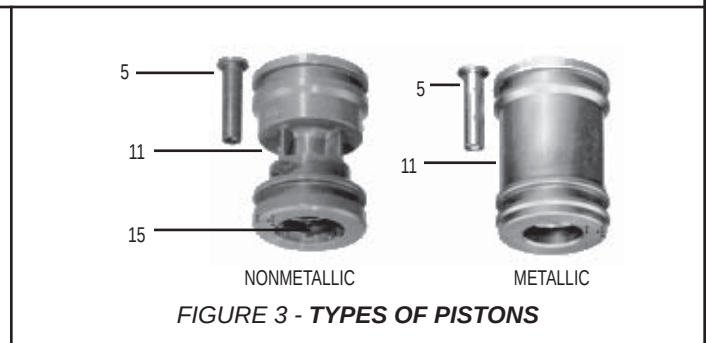


FIGURE 3 - TYPES OF PISTONS

DESCRIPTION

The Bendix® D-2® governor, operating in conjunction with the unloading mechanism, automatically controls the air pressure in the air brake or air supply system between a maximum (cut-out) pressure and a minimum (cut-in) pressure. The compressor runs continually while the engine runs, but the actual compression of air is controlled by the governor actuating the compressor unloading mechanism which stops or starts the compression of air when the maximum or minimum reservoir pressures are reached.

D-2® governors are provided with mounting holes which allow direct mounting to the compressor or remote mounting.

Porting consists of three reservoir ports (1/8 inch P.T.), three unloader ports (1/8 inch P.T.) and one exhaust port (1/8 inch P.T.).

OPERATION

Reservoir air pressure enters the D-2® governor at one of its reservoir ports and acts on the piston and inlet/exhaust valve. As the air pressure builds up, the piston and valve move together against the resistance of the pressure setting spring. When the reservoir air pressure reaches the cut-out setting of the governor, the exhaust stem seats on the inlet/exhaust valve, closing the exhaust passage, and then opens the inlet passage. Reservoir air pressure then flows around the inlet valve, through the passage in the piston and out the unloader port to the compressor unloading mechanism. Air also flows around the piston which is slightly larger at the upper end. The added force resulting from this larger area assures a positive action and fully opens the inlet valve.

As the system reservoir air pressure drops to the cut-in setting of the governor, the force exerted by the air pressure on the piston will be reduced so that the pressure setting spring will move the piston down. The inlet valve will close and the exhaust will open. With the exhaust open, the air in the unloader line will escape back through the piston, through the exhaust stem and out the exhaust port.

PREVENTIVE MAINTENANCE

Important: Review the Bendix Warranty Policy before performing any intrusive maintenance procedures. A warranty may be voided if intrusive maintenance is performed during the warranty period.

No two vehicles operate under identical conditions, as a result, maintenance intervals may vary. Experience is a valuable guide in determining the best maintenance interval for air brake system components. At a minimum, the D-2® governor should be inspected every 6 months or 1500 operating hours, whichever comes first, for proper operation. Should the D-2® governor not meet the elements of the operational tests noted in this document, further investigation and service of the governor may be required.

SERVICE TESTS

OPERATING TESTS

Start the vehicle engine and build up air pressure in the air brake system and check the pressure registered by a dash or test gauge at the time the governor cuts-out, stopping the compression of air by the compressor. The cut-out pressure should be in accordance with the pressure setting of the piece number being used. (Common cut-out pressures are between 105-125 psi.) With the engine still running, make a series of brake applications to reduce the air pressure and observe at what pressure the governor cuts-in the compressor. As in the case of the cut-out pressure, the cut-in pressure should be in accordance with the pressure setting of the piece number being used. (Common cut-in pressures are between 90-105 psi.)

Never condemn or adjust the governor pressure settings unless they are checked with an accurate test gauge or a dash gauge that is registering accurately. If the pressure settings of the D-2® governor are inaccurate or it is necessary that they be changed, the adjustment procedure follows. Note: If the governor cover is marked nonadjustable and the adjusting stem has been sheared off, this is a non-serviceable governor and must be replaced with a new or remanufactured unit.

- A. Remove the top cover from the governor.
- B. Loosen the adjusting screw locknut.
- C. To raise the pressure settings, turn the adjusting screw counter-clockwise. To lower the pressure settings, turn the adjusting screw clockwise. Note: Be careful not to over adjust. Each 1/4 turn of the adjusting screw raises or lowers the pressure setting approximately 4 psi.
- D. When proper adjustment is obtained, tighten the adjusting screw locknut and replace the cover.

(Note: The pressure range between cut-in and cut-out is not adjustable.)

LEAKAGE TEST

Leakage tests on the D-2® governor should be made in both cut-in and cut-out positions.

CUT-IN POSITION

Apply soap solution around the cover and to the exhaust port. Slight bubble leakage permitted. Excessive leakage indicates a faulty inlet valve or lower piston o-ring.

CUT-OUT POSITION

Apply soap solution around the cover and to the exhaust port. Slight bubble leakage permitted. Excessive leakage indicates a faulty exhaust valve seat, exhaust stem o-ring, or o-ring at the top of the piston.

If the governor does not function as described or leakage is excessive, it is recommended that it be replaced with a new or remanufactured unit, or repaired with genuine Bendix parts available at authorized Bendix parts outlets.

GENERAL SAFETY GUIDELINES

WARNING! PLEASE READ AND FOLLOW THESE INSTRUCTIONS TO AVOID PERSONAL INJURY OR DEATH:

When working on or around a vehicle, the following general precautions should be observed at all times.

1. **Park the vehicle on a level surface, apply the parking brakes, and always block the wheels. Always wear safety glasses.**

2. Stop the engine and remove ignition key when working under or around the vehicle. When working in the engine compartment, the engine should be shut off and the ignition key should be removed. Where circumstances require that the engine be in operation, **EXTREME CAUTION** should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated or electrically charged components.
3. Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.
4. If the work is being performed on the vehicle's air brake system, or any auxiliary pressurized air systems, make certain to drain the air pressure from all reservoirs before beginning **ANY** work on the vehicle. If the vehicle is equipped with an AD-IS® air dryer system or a dryer reservoir module, be sure to drain the purge reservoir.
5. Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.
6. Never exceed manufacturer's recommended pressures.
7. Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.
8. Use only genuine Bendix® replacement parts, components and kits. Replacement hardware, tubing, hose, fittings, etc. must be of equivalent size, type and strength as original equipment and be designed specifically for such applications and systems.
9. Components with stripped threads or damaged parts should be replaced rather than repaired. Do not attempt repairs requiring machining or welding unless specifically stated and approved by the vehicle and component manufacturer.
10. Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.
11. For vehicles with Automatic Traction Control (ATC), the ATC function must be disabled (ATC indicator lamp should be ON) prior to performing any vehicle maintenance where one or more wheels on a drive axle are lifted off the ground and moving.

REMOVING AND INSTALLING

REMOVING

1. Block and hold vehicle by means other than air brakes.
2. Drain air brake system.
3. If the governor is compressor-mounted type, disconnect reservoir air line. If the governor is remote-mounted, disconnect both the unloader and reservoir air lines.
4. Remove governor mounting bolts, then governor.

Caution: Prior to disassembly, it is required to have the proper maintenance kit available to replace parts to be discarded during disassembly.

DISASSEMBLY

1. Clean the governor exterior of dirt and grease.
2. If the governor cover is marked nonadjustable and the adjusting screw has been sheared off, this is a non-serviceable governor and must be replaced with a new or remanufactured unit.
3. If the governor has a blue nonmetallic cover, (refer to Figure 2) hold governor with one hand, with the other hand grip cover from the top and pull up with thumb until cover disengages from the governor body. If top cover on governor is made of rubber or clear nonmetallic material unscrew cover until it releases from the adjusting screw (4) of governor. Remove o-ring (20, Figure 2) if present. Note: O-ring (20) is used on Hi-Temp and waterproof governors only.
4. With a pair of retaining ring pliers, remove the spring assembly retaining ring (1) and save.
5. Pull the adjusting screw (4) and spring assembly out of the governor body (2).

Note: Disassembly of the spring assembly normally is not required. (Reuse and do not wash the assembly because lubrication may be removed.) If Disassembly of the spring assembly is necessary, the following instructions apply; otherwise, proceed to Step 6.

Remove the lock nut (3), then the hex-shaped upper spring seat (16) from the adjusting screw (4). Remove the pressure setting spring (17), lower spring seat (19), spring guide (18) and the other lower spring seat (19) from the adjusting screw (4).

6. Gently tap the open end of the valve body on a flat surface to remove the exhaust stem (5), the exhaust stem spring (6), and piston assembly (11). Items 5 and 11 may be made of metal or nonmetallic material.
7. Remove and discard the two o-rings (8) on the piston O.D. and with a hooked wire remove and discard the o-ring (12) from the piston I.D. On nonmetallic piston, washer (13) and retaining ring (14) may be removed to facilitate removal of o-ring (12).

8. If piston assembly is nonmetallic (Figure 3), use a small screwdriver and carefully insert blade of screwdriver between two of the ears of the retainer ring in the bottom of the piston (11) and pry retainer ring (15) out of the piston and discard. Remove inlet/exhaust valve spring (9) and the inlet/exhaust valve (10) and discard. If piston assembly is metallic, disengage inlet/exhaust valve spring (9) from recess in bottom of piston (11), remove inlet/exhaust valve spring (9), and the inlet exhaust valve (10) and discard.
9. Remove and discard filters (7) from unloader and reservoir ports in governor body.

CLEANING AND INSPECTION

1. Clean all remaining parts in mineral spirits.
2. Inspect body for cracks or other damage. Be particularly careful that all air passages in the body, exhaust stem, and piston are not obstructed.
3. Check springs for cracks, distortion, or corrosion.
4. Replace all parts which are worn or damaged.

ASSEMBLY

Prior to assembly, lubricate the two lower body bores, all o-rings and o-ring grooves with lubricant provided. Note: Also spring guide and adjusting screw (if disassembled).

1. Install o-ring (12) in piston (11). Replace washer (13) and retaining ring (14) on nonmetallic piston if removed during disassembly.
2. Drop the inlet/exhaust valve (10) into place at the bottom of the piston (11).
3. Nonmetallic Piston: Install the inlet/exhaust valve spring (9) with the small end against the valve, place the retaining ring (15) on top of the large end of the valve spring (9) [concave side of retaining ring (15) facing away from piston (11)], press into piston with thumb, making sure ears of retaining ring (15) are seated into piston (11) as far as possible.

Note: Do not use a press or hammer to install retaining ring. Excessive force may damage the piston.

Metallic Piston: Install the inlet/exhaust valve spring (9) with the small end against the valve. Press the spring down until the larger coiled end snaps into the recess inside the piston (11).

4. Install the piston o-rings (8) on the piston (11).
5. Install the exhaust stem spring (6) in the piston (11) with the large coil end next to the piston.
6. Install the exhaust stem (5) through spring (6) and into piston (11).
7. Install assembled piston (11) into the governor body (2).

8. If the spring assembly was not disassembled, proceed to Step 9. If the spring assembly was disassembled, the following instructions apply: install on the adjusting screw (4) in this order; lower spring seat (19), spring guide (18), spring seat (19), pressure setting spring (17), hex-shaped upper spring seat (16). Screw the upper spring seat onto the adjusting screw until the distance from the top of the seat to the bottom of the adjusting screw head is approximately 1-7/8 inches. Install the lock nut (3).
9. Install the adjusting screw (4) and spring assembly into the governor body (2).

10. Install retaining ring (1) making certain that it seats completely into the groove in the governor body (2).

If cover provided in kit is black rubber, (refer to Figure 2) install by pushing it onto the adjusting screw.

If cover provided in kit is clear nonmetallic, install o-ring (20) and screw cover onto the adjusting screw. Tighten until cover bottoms on governor body. Note: O-ring (20) is used only on Hi-Temp and waterproof governors. If cover provided in kit is blue nonmetallic place cover over one edge of top of governor; with index finger catch knob on top of cover and pull until cover snaps into place.

Note: Nonmetallic cover should be at room temperature for ease of assembly. Do not attempt to force cover on square to the governor body.

11. Install filters (7) in governor body. The head of a pencil makes a satisfactory installation tool.

INSTALLATION

1. If the governor is compressor-mounted, clean the mounting pad on both the compressor and governor. Clean connecting line, or lines. Be certain the unloading port is clear and clean. If the governor is mounted remotely, it should be positioned so that its exhaust port points down. It should be mounted higher than the compressor so that its connecting lines will drain away from the governor.
2. Install governor.
3. If compressor-mounted type, use the governor mounting gasket provided.
4. Connect air lines to governor.
5. Perform operating and leakage tests as outlined under Service Tests section.



Advanced Troubleshooting Guide for Air Brake Compressors*

The guide consists of an introduction to air brake charging system components, a table showing recommended vehicle maintenance schedules, and a troubleshooting symptom and remedy section with tests to diagnose most charging system problems.

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*This guide is only for vehicles that use desiccant air dryers.

Introduction to the Air Brake Charging System

Powered by the vehicle engine, the **air compressor** builds the air pressure for the air brake system. The air compressor is typically cooled by the engine coolant system and lubricated by the engine oil supply.

The compressor's unloader mechanism and **governor** (along with a synchro valve for the Bendix® DuraFlo™ 596 air compressor) control the brake system air pressure between a preset maximum and minimum pressure level by monitoring the pressure in the service (or “supply”) reservoir. When the air pressure becomes greater than that of the preset “cut-out”, the governor controls the unloader mechanism of the compressor to stop the compressor from building air and also causes the air dryer to purge. As the service reservoir air pressure drops to the “cut-in” setting of the governor, the governor returns the compressor back to building air and the air dryer to air drying mode.

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.

The **duty cycle** is the ratio of time the compressor spends building air to the total engine running time. Air compressors are designed to build air (run “loaded”) up to 25% of the time. Higher duty cycles cause conditions that affect air brake charging system performance which may require additional maintenance. Factors that add to the duty cycle are: air suspension, additional air accessories, use of an undersized compressor, frequent stops, excessive leakage from fittings, connections, lines, chambers or valves, etc.

The **discharge line** allows the air, water-vapor and oil-vapor mixture to cool between the compressor and

air dryer. The typical size of a vehicle's discharge line, (see column 2 of Table A on page 3) assumes a compressor with a normal (less than 25%) duty cycle, operating in a temperate climate. See Bendix and/or other air dryer manufacturer guidelines as needed.

When the **temperature** of the compressed air that enters the air dryer is within the normal range, the air dryer can remove most of the charging system oil. If the temperature of the compressed air is above the normal range, oil as oil-vapor is able to pass through the air dryer and into the air system. Larger diameter discharge lines and/or longer discharge line lengths can help reduce the temperature.

The discharge line must maintain a **constant slope** down from the compressor to the air dryer inlet fitting to avoid low points where ice may form and block the flow. If, instead, ice blockages occur at the air dryer inlet, insulation may be added here, or if the inlet fitting is a typical 90 degree fitting, it may be changed to a straight or 45 degree fitting. For more information on how to help prevent discharge line freeze-ups, see Bendix Bulletins TCH-08-21 and TCH-08-22 (see pages 20-22). Shorter discharge line lengths or insulation may be required in cold climates.

The **air dryer** contains a filter that collects oil droplets, and a desiccant bed that removes almost all of the remaining water vapor. The compressed air is then passed to the air brake service (supply) reservoir. The oil droplets and the water collected are automatically purged when the governor reaches its “cut-out” setting. For vehicles with accessories that are sensitive to small amounts of oil, we recommended installation of a Bendix® PuraGuard® system filter, designed to minimize the amount of oil present.

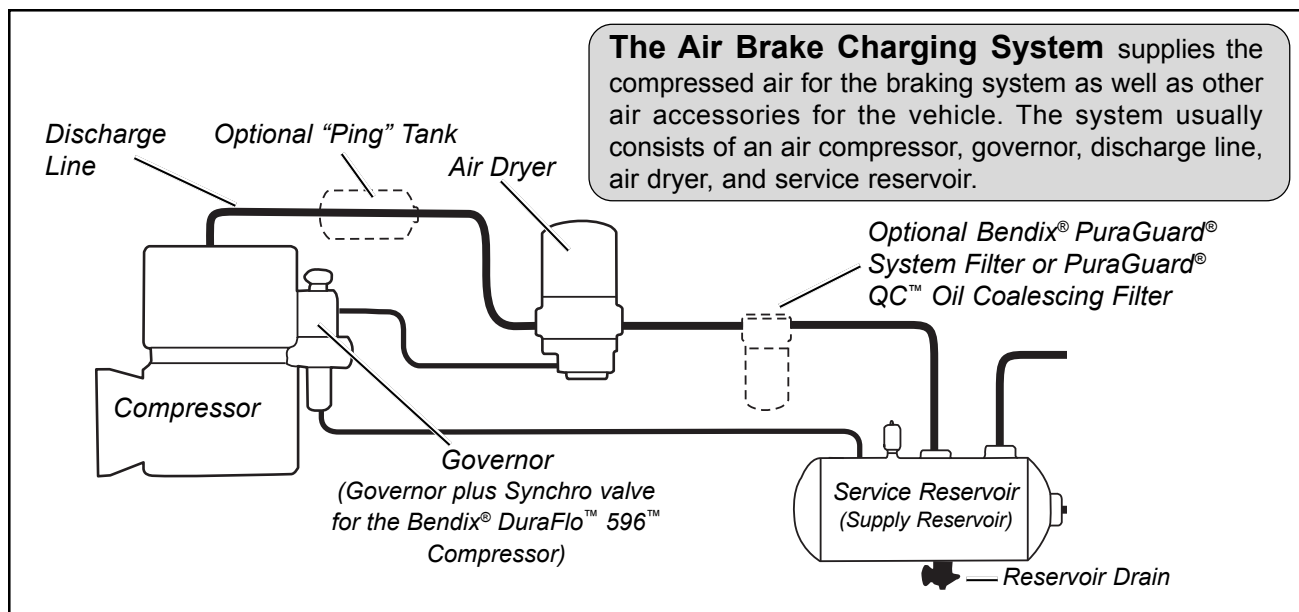


Table A: Maintenance Schedule and Usage Guidelines

Regularly scheduled maintenance is the single most important factor in maintaining the air brake charging system.

Vehicle Used for:	No. of Axles	Column 1	Column 2		Column 3	Column 4	Column 5
		Typical Compressors Spec'd	Discharge Line		Recommended Air Dryer Cartridge Replacement ¹	Recommended Reservoir Drain Schedule ²	Acceptable Reservoir Oil Contents ³ at Regular Drain Interval
			I.D.	Length			
Low Air Use		Bendix® BA-921™ air compressor Bendix® Tu-Flo® 550 air compressor	1/2 in.	6 ft.	Every 3 Years	Recommended Every Month - Max of every 90 days	BASIC test acceptable range: 3 oil units per month. See appendix A.
Compressor with less than 15% duty cycle e.g. Line haul single trailer w/o air suspension, air over hydraulic brakes. 	5 or less		For oil carry-over control ⁴ suggested upgrades: 5/8 in. 9 ft.				
Compressor with up to 25% duty cycle e.g. Line haul single trailer with air suspension, school bus. 	5 or less		1/2 in.	9 ft.			
			For oil carry-over control ⁴ suggested upgrades: 5/8 in. 12 ft.				
High Air Use		Bendix® Tu-Flo® 750 air compressor Bendix® BA-922™, or DuraFlo™ 596 air compressor	1/2 in.	12 ft.	Every 2 Years	Every Month	BASIC test acceptable range: 5 oil units per month. See appendix A.
Compressor with up to 25% duty cycle e.g. Double/triple trailer, open highway coach/RV, (most) pick-up & delivery, yard or terminal jockey, off-highway, construction, loggers, concrete mixer, dump truck, fire truck. 	8 or less		For oil carry-over control ⁴ suggested upgrades: 5/8 in. 15 ft.				
Compressor with up to 25% duty cycle e.g. City transit bus, refuse, bulk unloaders, low boys, urban region coach, central tire inflation. 	12 or less		5/8 in.	12 ft.			
			For oil carry-over control ⁴ suggested upgrades: 3/4 in. 15 ft.				

Footnotes:

- 1 With increased air demand the air dryer cartridge needs to be replaced more often.
- 2 Use the drain valves to slowly drain all reservoirs to zero psi.
- 3 Allow the oil/water mixture to fully settle before measuring oil quantity.
- 4 To counter above normal temperatures at the air dryer inlet, (and resultant oil-vapor passing upstream in the air system) replace the discharge line with one of a larger diameter and/or longer length. This helps reduce the air's temperature. If sufficient cooling occurs, the oil-vapor condenses and can be removed by the air dryer. Discharge line upgrades are not covered under warranty. Note: To help prevent discharge line freeze-ups, shorter discharge line lengths or insulation may be required in cold climates. (See Bendix Bulletins TCH-08-21 and TCH-08-22, included in Appendix B, for more information.)
- 5 For certain vehicles/applications, where turbo-charged inlet air is used, a smaller size compressor may be permissible.

Note: Compressor and/or air dryer upgrades are recommended in cases where duty cycle is greater than the normal range (for the examples above).

For Bendix® Tu-Flo® 550 and 750 compressors, unloader service is recommended every 250,000 miles.

Air Brake Charging System Troubleshooting

How to use this guide:

Find the **symptom(s)** that you see, then move to the right to find the possible causes ("**What it may indicate**") and remedies ("**What you should do**").

Review the warranty policy before performing any intrusive compressor maintenance. Unloader or cylinder head gasket replacement and resealing of the bottom cover plate are usually permitted under warranty. Follow all standard safety procedures when performing any maintenance.

Look for:

 **Normal**

Normal - Charging system is working within normal range.

 **Check**

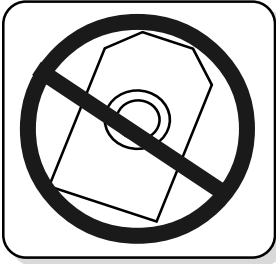
Check - Charging system needs further investigation.

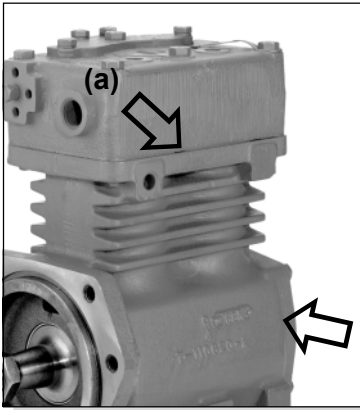
WARNING! Please READ and follow these instructions to avoid personal injury or death:

When working on or around a vehicle, the following general precautions should be observed at all times.

1. Park the vehicle on a level surface, apply the parking brakes, and always block the wheels. Always wear safety glasses.
2. Stop the engine and remove ignition key when working under or around the vehicle. When working in the engine compartment, the engine should be shut off and the ignition key should be removed. Where circumstances require that the engine be in operation, EXTREME CAUTION should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated or electrically charged components.
3. Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.
4. If the work is being performed on the vehicle's air brake system, or any auxiliary pressurized air systems, make certain to drain the air pressure from all reservoirs before beginning ANY work on the vehicle. If the vehicle is equipped with an AD-IS™ air dryer system or a dryer reservoir module, be sure to drain the purge reservoir.

5. Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.
6. Never exceed manufacturer's recommended pressures.
7. Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.
8. Use only genuine Bendix® replacement parts, components and kits. Replacement hardware, tubing, hose, fittings, etc. must be of equivalent size, type and strength as original equipment and be designed specifically for such applications and systems.
9. Components with stripped threads or damaged parts should be replaced rather than repaired. Do not attempt repairs requiring machining or welding unless specifically stated and approved by the vehicle and component manufacturer.
10. Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.
11. For vehicles with Antilock Traction Control (ATC), the ATC function must be disabled (ATC indicator lamp should be ON) prior to performing any vehicle maintenance where one or more wheels on a drive axle are lifted off the ground and moving.

Symptom:	What it may indicate:	What you should do:
1.0 Oil Test Card Results 	Not a valid test. 	Discontinue using this test. Do not use this card test to diagnose compressor "oil passing" issues. They are subjective and error prone. Use only the Bendix Air System Inspection Cup (BASIC) test and the methods described in this guide for advanced troubleshooting. The Bendix® BASIC test should be the definitive method for judging excessive oil fouling/oil passing. (See Appendix A, on page 17 for a flowchart and expanded explanation of the checklist used when conducting the BASIC test.)

Symptom:	What it may indicate:	What you should do:
2.0 Oil on the Outside of the Compressor	Engine and/or other accessories leaking onto compressor.	Find the source and repair. Return the vehicle to service.
2.1 Oil leaking at compressor / engine connections:	(a) Leak at the front or rear (fuel pump, etc.) mounting flange. (b) Leak at air inlet fitting. (c) Leak at air discharge fitting. (d) Loose/broken oil line fittings.	⇒ Repair or replace as necessary. If the mounting bolt torques are low, replace the gasket. ⇒ Replace the fitting gasket. Inspect inlet hose and replace as necessary. ⇒ Replace gasket or fitting as necessary to ensure good seal. ⇒ Inspect and repair as necessary.
2.2 Oil leaking from compressor:	(a) Excessive leak at head gasket. (b) Leak at bottom cover plate. (c) Leak at internal rear flange gasket. (d) Leak through crankcase. (e) (If unable to tell source of leak.)	⇒ Go to Test 1 on page 14. ⇒ Reseal bottom cover plate using RTV silicone sealant. ⇒ Replace compressor. ⇒ Replace compressor. ⇒ Clean compressor and check periodically.
 Head gasket and rear flange gasket locations. ? Check		
3.0 Oil at air dryer purge/exhaust or surrounding area	Air brake charging system functioning normally. ✓ Normal	⇒ Air dryers remove water and oil from the air brake charging system. Check that regular maintenance is being performed. Return the vehicle to service. An optional kit (Bendix piece number 5011327 for the Bendix® AD-IS™ or AD-IP™ air dryers, or 5003838 for the Bendix® AD-9™ air dryer) is available to redirect the air dryer exhaust.

Symptom:	What it may indicate:	What you should do:
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4.0 Oil in Supply or Service Reservoir (air dryer installed)

(If a maintained Bendix® PuraGuard™ system filter or Bendix® PuraGuard® QC™ oil coalescing filter is installed, call 1-800-AIR-BRAKE (1-800-247-2725) and speak to a Tech Team member.)



See Table A, on page 3, for maintenance schedule information.

Maintenance

- (a) If air brake charging system maintenance **has not been performed**.

That is, reservoir(s) **have not** been drained per the schedule in Table A on page 3, Column 4 **and/or** the air dryer maintenance **has not** been performed as in Column 3.

- (b) If the vehicle maintenance **has been performed** as recommended in Table A on page 3, some oil in the reservoirs is normal.



Drain all air tanks (reservoirs) into the Bendix® BASIC test cup. (Bendix kit P/N 5013711).

- ⇒ Drain all air tanks and check vehicle at next service interval using the Bendix® BASIC test. See Table A on page 3, column 3 and 4, for recommended service schedule.

? Check

- ⇒ Drain all air tanks into Bendix® BASIC test cup (Bendix Air System Inspection Cup). If less than one unit of reservoir contents is found, the vehicle can be returned to service. **Note: If more than one oil unit of water (or a cloudy emulsion mixture) is present, change the vehicle's air dryer, check for air system leakage (Test 2, on page 14), stop inspection and check again at the next service interval. See the BASIC test kit for full details.**

If less than one "oil unit" of water (or water/cloudy emulsion mixture) is present, use the BASIC cup chart on the label of the cup to determine if the amount of oil found is within the acceptable level.

⇒ If within the normal range, return the vehicle to service. For vehicles with accessories that are sensitive to small amounts of oil, consider a Bendix® PuraGuard® QC™ oil coalescing filter.

⇒ If outside the normal range go to Symptom 4.0(c).

Also see the Table A on page 3, column 3 for recommended air dryer cartridge replacement schedule.

Duty cycle too high

- (c) Air brake system leakage.

- ⇒ Go to Test 2 on page 14.

- (d) Compressor may be undersized for the application.

- ⇒ See Table A, column 1, on page 3 for recommended compressor sizes.

⇒ If the compressor is "too small" for the vehicle's role (for example, where a vehicle's use has changed or service conditions exceed the original vehicle or engine OE spec's) then upgrade the compressor. Note: The costs incurred (e.g. installing a larger capacity compressor, etc.) are not covered under original compressor warranty.

⇒ If the compressor is correct for the vehicle, go to Symptom 4.0 (e).

The **duty cycle** is the ratio of time the compressor spends building air to total engine running time. Air compressors are designed to build air (to "run loaded") up to 25% of the time. Higher duty cycles cause conditions that affect air brake charging system performance which may require additional maintenance. Factors that add to the duty cycle are: air suspension, additional air accessories, use of an undersized compressor, frequent stops, excessive leakage from fittings, connections, lines, chambers or valves, etc.

Symptom:	What it may indicate:	What you should do:
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**4.0 Oil in Supply
or Service
Reservoir*
(air dryer installed)
(continued)**

Temperature

(e) Air compressor discharge and/or
air dryer inlet temperature too high.

(f) Insufficient coolant flow.



Testing the temperature
at the discharge fitting.



Inspecting the coolant hoses.

(g) Restricted discharge line.



Kinked discharge line shown.

⇒ Check temperature as outlined in Test 3
on page 14. If temperatures are normal
go to 4.0(h).

⇒ Inspect coolant line. Replace as necessary
(I.D. is 1/2").

⇒ Inspect the coolant lines for kinks and
restrictions and fittings for restrictions.
Replace as necessary.

⇒ Verify coolant lines go from engine block
to compressor and back to the water pump.
Repair as necessary.

⇒ If discharge line is restricted or more than
1/16" carbon build up is found, replace the
discharge line. See Table A, column 2, on
page 3 for recommended size. Replace as
necessary.

⇒ The discharge line must maintain a
constant slope down from the compressor
to the air dryer inlet fitting to avoid low
points where ice may form and block the
flow. If, instead, ice blockages occur at the
air dryer inlet, insulation may be added
here, or if the inlet fitting is a typical 90
degree fitting, it may be changed to a
straight or 45 degree fitting. For more
information on how to help prevent discharge
line freeze-ups, see Bendix Bulletins
TCH-08-21 and TCH-08-22 (Appendix B).
Shorter discharge line lengths or insulation
may be required in cold climates.

Other

(h) Restricted air inlet (not enough air
to compressor).



Partly
collapsed
inlet line
shown.

⇒ Check compressor air inlet line for
restrictions, brittleness, soft or sagging
hose conditions etc. Repair as necessary.
Inlet line size is 3/4 ID. Maximum
restriction requirement for compressors is
25 inches of water.

⇒ Check the engine air filter and service if
necessary (if possible, check the air filter
usage indicator).

? Check

*If a maintained Bendix® PuraGuard™ system filter or Bendix® PuraGuard® QC™ oil coalescing filter is installed, call 1-800-AIR-BRAKE (1-800-247-2725) and speak to a Tech Team member.

Symptom:	What it may indicate:	What you should do:
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4.0 Oil in Supply or Service Reservoir* (air dryer installed) (continued)

Other (cont.)

- (i) Poorly filtered inlet air (poor air quality to compressor).



Inspect the engine air cleaner.

- ⇒ Check for leaking, damaged or defective compressor air inlet components (e.g. induction line, fittings, gaskets, filter bodies, etc.). Repair inlet components as needed. Note: Dirt ingestion will damage compressor and is not covered under warranty.

? Check

- (j) Governor malfunction or setting.

- ⇒ Go to Test 4 on page 15.

- (k) Compressor malfunction.

- ⇒ If you found excessive oil present in the service reservoir in step 4.0 (b) above and you did not find any issues in steps 4.0 (c) through 4.0 (j) above, the compressor may be passing oil.

Replace compressor. If still under warranty, follow normal warranty process. Note: After replacing a compressor, residual oil may take a considerable period of time to be flushed from the air brake system.

Crankcase Flooding

Consider installing a compressor bottom drain kit (where available) in cases of chronic oil passing where all other operating conditions have been investigated. Bendix compressors are designed to have a 'dry' sump and the presence of excess oil in the crankcase can lead to oil carryover.

*If a maintained Bendix® PuraGuard™ system filter or Bendix® PuraGuard® QC™ oil coalescing filter is installed, call 1-800-AIR-BRAKE (1-800-247-2725) and speak to a Tech Team member.

5.0 Oil present at valves (e.g. at exhaust, or seen during servicing).

Air brake system valves are required to tolerate a light coating of oil.

✓ Normal

- ⇒ A small amount of oil does not affect SAE J2024** compliant valves.

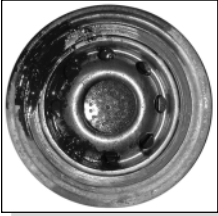
- ⇒ Check that regular maintenance is being performed and that the amount of oil in the air tanks (reservoirs) is within the acceptable range shown on the Bendix® BASIC test cup (see also column 5 of Table A on page 3). Return the vehicle to service.

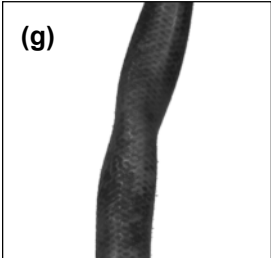
For oil-sensitive systems, see page 2.

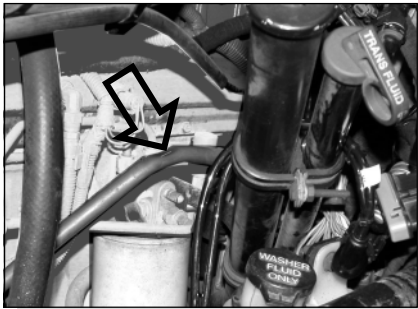


Genuine Bendix valves are all SAE J2024 compliant.

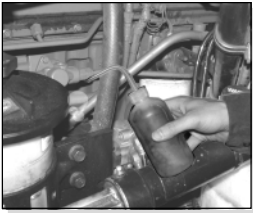
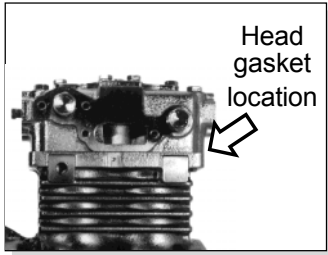
** SAE J2024 outlines tests all air brake system pneumatic components need to be able to pass, including minimum levels of tolerance to contamination.

Symptom:	What it may indicate:	What you should do:
6.0 Excessive oil consumption in engine.	A problem with engine or other engine accessory.  The engine service manual has more information.	⇒ See engine service manual. ? Check
7.0 Oil present at air dryer cartridge during maintenance.	Air brake charging system is functioning normally.  Oil shown leaking from an air dryer cartridge. ✓ Normal	⇒ Air dryers remove water and oil from the air brake charging system. A small amount of oil is normal. Check that regular maintenance is being performed and that the amount of oil in the air tanks (reservoirs) is within the acceptable range shown by the BASIC Test (see also column 5 of Table A on page 3). Replace the air dryer cartridge as needed and return the vehicle to service.
8.0 Oil in ping tank or compressor discharge aftercooler.	Air brake charging system is functioning normally. ✓ Normal	⇒ Follow vehicle O.E. maintenance recommendation for these components.
9.0 Air brake charging system seems slow to build pressure.	(a) Air brake charging system functioning normally. ✓ Normal (b) Air brake system leakage. (c) Compressor may be undersized for the application. (d) Compressor unloader mechanism malfunction. (e) Damaged compressor head gasket.	⇒ Using dash gauges, verify that the compressor builds air system pressure from 85-100 psi in 40 seconds or less with engine at full governed rpm. Return the vehicle to service. ⇒ Go to Test 2 on page 14. ⇒ See Table A, column 1, on page 3 for some typical compressor applications. If the compressor is "too small" for the vehicle's role, for example, where a vehicle's use has changed, then upgrade the compressor. Note: The costs incurred (e.g. installing a larger capacity compressor, etc.) are not covered under original compressor warranty. ⇒ Go to Test 6 on page 15. ⇒ An air leak at the head gasket may indicate a downstream restriction such as a freeze-up or carbon blockage and/or could indicate a defective or missing safety valve. Find blockage (go to 9.0(f) for details.) and then replace the compressor. Do not re-use the safety valve without testing. See Symptom 12.0(a).

Symptom:	What it may indicate:	What you should do:
9.0 Air brake charging system seems slow to build pressure. (continued)  Dash gauges.	(f) Restricted discharge line. ? Check  (f) Kinked discharge line shown.	⇒ If discharge line is restricted: ⇒ By more than 1/16" carbon build up, replace the discharge line (see Table A, column 2, on page 3 for recommended size) and go to Test 3 on page 14. ⇒ By other restrictions (e.g. kinks). Replace the discharge line. See Table A, column 2, on page 3 for recommended size. Retest for air build. Return vehicle to service or, if problem persists, go to 9.0(a). ⇒ The discharge line must maintain a constant slope down from the compressor to the air dryer inlet fitting to avoid low points where ice may form and block the flow. If, instead, ice blockages occur at the air dryer inlet, insulation may be added here, or if the inlet fitting is a typical 90 degree fitting, it may be changed to a straight or 45 degree fitting. For more information on how to help prevent discharge line freeze-ups, see Bendix Bulletins TCH-08-21 and TCH-08-22 (Appendix B). Shorter discharge line lengths or insulation may be required in cold climates.
 (g) Partly collapsed inlet line shown.	(g) Restricted air inlet (not enough air to compressor). ? Check	⇒ Check compressor air inlet line for restrictions, brittleness, soft or sagging hose conditions etc. Repair as necessary. Refer to vehicle manufacturer's guidelines for inlet line size. ⇒ Check the engine air filter and service if necessary (if possible, check the air filter usage indicator).
	(h) Poorly filtered inlet air (poor air quality to compressor). ? Check	⇒ Check for leaking, damaged or defective compressor air inlet components (e.g. induction line, fittings, gaskets, filter bodies, etc.). Repair inlet components as needed. Note: Dirt ingestion will damage compressor and is not covered under warranty.
	(i) Compressor malfunction. ? Check	⇒ Replace the compressor only after making certain that none of the preceding conditions, 9.0 (a) through 9.0 (h), exist.

Symptom:	What it may indicate:	What you should do:
11.0 Air charging system doesn't build air.	(a) Governor malfunction*.	⇒ Go to Test 4 on page 15.
	(b) Restricted discharge line.	⇒ See 9.0(f).
	(c) Air dryer heater malfunction: exhaust port frozen open.	⇒ Replace air dryer heater.
	(d) Compressor malfunction.	⇒ Replace the compressor only after making certain the preceding conditions do not exist.
* Note: For the Bendix® DuraFlo™ 596 air compressor, not only the governor, but also the SV-1™ synchro valve used would need to be tested. See Bulletin TCH-001-048.		
11.0 Compressor safety valve releases air (Compressor builds too much air).	(a) Restricted discharge line. ? Check	⇒ If discharge line is restricted: ⇒ By more than 1/16" carbon build up, replace the discharge line (see Table A, column 2, on page 3 for recommended size) and go to Test 3 on page 14. ⇒ By other restrictions (e.g. kinks). Replace the discharge line. See Table A, column 2, on page 3 for recommended size. ⇒ The discharge line must maintain a constant slope down from the compressor to the air dryer inlet fitting to avoid low points where ice may form and block the flow. If, instead, ice blockages occur at the air dryer inlet, insulation may be added here, or if the inlet fitting is a typical 90 degree fitting, it may be changed to a straight or 45 degree fitting. For more information on how to help prevent discharge line freeze-ups, see Bendix Bulletins TCH-08-21 and TCH-08-22 (Appendix B). Shorter discharge line lengths or insulation may be required in cold climates.
 Damaged discharge line shown.		
	(b) Downstream air brake system check valves or lines may be blocked or damaged.	⇒ Inspect air lines and verify check valves are operating properly.
	(c) Air dryer lines incorrectly installed.	⇒ Ensure discharge line is installed into the inlet of the air dryer and delivery is routed to the service reservoir.
	(d) Compressor safety valve malfunction.	⇒ Verify relief pressure is 250 psi. Replace if defective.
	(e) Compressor unloader mechanism malfunction.	⇒ Go to Test 6 on page 15.
	(f) Governor malfunction.	⇒ Go to Test 4 on page 15.

Symptom:	What it may indicate:	What you should do:
12.0 Air dryer safety valve releases air.   Technician removes governor.	(a) Restriction between air dryer and reservoir. (b) Air dryer safety valve malfunction. (c) Air dryer maintenance not performed. (d) Air dryer malfunction. (e) Improper governor control line installation to the reservoir. (f) Governor malfunction.	⇒ Inspect delivery lines to reservoir for restrictions and repair as needed. ⇒ Verify relief pressure is at vehicle or component manufacturer specifications. Replace if defective. ⇒ See Maintenance Schedule and Usage Guidelines (Table A, column 3, on page 3). ⇒ Verify operation of air dryer. Follow vehicle O.E. maintenance recommendations and component Service Data information. ⇒ Go to Test 5 on page 15. ⇒ Go to Test 4 on page 15.
13.0 Reservoir safety valve releases air	(a) Reservoir safety valve malfunction. (b) Governor malfunction. (c) Compressor unloader mechanism malfunction.	⇒ Verify relief pressure is at vehicle or component manufacturer's specifications (typically 150 psi). Replace if defective. ⇒ Go to Test 4 on page 15. ⇒ Go to Test 6 on page 15.
14.0 Air dryer doesn't purge. (Never hear exhaust from air dryer.)	(a) Air dryer malfunction. (b) Governor malfunction. (c) Air brake system leakage. (d) Improper governor control line installation to the reservoir.	⇒ Verify operation of air dryer. Follow vehicle O.E. maintenance recommendations. ⇒ Go to Test 4 on page 15. ⇒ Go to Test 2 on page 14. ⇒ Go to Test 5 on page 15.
15.0 Compressor constantly cycles (compressor remains unloaded for a very short time.)	(a) Air brake charging system maintenance not performed.  Check (b) Compressor unloader mechanism malfunction. (c) Air dryer purge valve or delivery check valve malfunction. (d) Air brake system leakage.	⇒ Available reservoir capacity may be reduced by build up of water etc. Drain and perform routine maintenance per Table A, columns 3 & 4, on page 3. ⇒ Go to Test 6 on page 15. ⇒ Verify operation of air dryer. Follow vehicle O.E. maintenance recommendations and component Service Data information. ⇒ Go to Test 2 on page 14.

Symptom:	What it may indicate:	What you should do:
16.0 Compressor leaks air  Testing for leaks with soap solution.	(a) Compressor leaks air at connections or ports. (b) Compressor unloader mechanism malfunction. (c) Damaged compressor head gasket. 	⇒ Check for leaking, damaged or defective compressor fittings, gaskets, etc. Repair or replace as necessary. ⇒ Go to Test 6 on page 15. ⇒ An air leak at the head gasket may indicate a downstream restriction such as a freeze-up or carbon blockage and/or could indicate a defective or missing safety valve. Find blockage (go to 9.0(f) for details.) and then replace the compressor. Do not re-use the safety valve without testing. See Symptom 12.0(a).
17.0 Compressor leaks coolant	(a) Improperly installed plugs or coolant line fittings. (b) Damaged compressor head gasket. (c) Porous compressor head casting.	⇒ Inspect for loose or over-torqued fittings. Reseal and tighten loose fittings and plugs as necessary. If overtightened fittings and plugs have cracked ports in the head, replace the compressor. ⇒ An air leak at the head gasket may indicate a downstream restriction such as a freeze-up or carbon blockage and/or could indicate a defective or missing safety valve. Find blockage (go to 9.0(f) for details.) and then replace the compressor. Do not re-use the safety valve without testing. See Symptom 12.0(a). ⇒ If casting porosity is detected, replace the compressor.
18.0 Noisy compressor (Multi-cylinder compressors only)	(a) Damaged compressor.	⇒ Replace the compressor.

Other Miscellaneous Areas to Consider

This guide attempts to cover most compressor system problems. Here are some rare sources of problems not covered in this guide:

- Turbocharger leakage. Lubricating oil from leaking turbocharger seals can enter the air compressor intake and give misleading symptoms.

- Where a compressor does not have a safety valve installed, if a partial or complete discharge line blockage has occurred, damage can occur to the connecting rod bearings. Damage of this kind may not be detected and could lead to compressor problems at a later date.

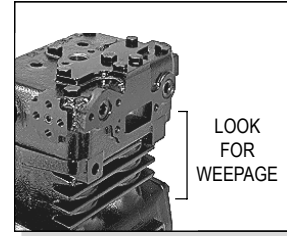
Tests

Test 1: Excessive Oil Leakage at the Head Gasket

Exterior leaks at the head gasket are not a sign that oil is being passed into the air charging system. Oil weepage at the head gasket does not prevent the compressor from building air.

Observe the amount of weepage from the head gasket.

If the oil is only around the cylinder head area, it is acceptable (return the vehicle to service), but, if the oil weepage extends down to the nameplate area of the compressor, the gasket can be replaced.



Test 2: Air Brake System and Accessory Leakage

Inspect for air leaks when working on a vehicle and repair them promptly.

Park the vehicle on level ground and chock wheels. Build system pressure to governor cut-out and allow the pressure to stabilize for one minute.

Step 1: Observe the dash gauges for two additional minutes without the service brakes applied.

Step 2: Apply the service brakes and allow the pressure to stabilize. Continue holding for two minutes (you may use a block of wood to hold the

pedal in position.) Observe the dash gauges.

If you see **any noticeable decrease** of the dash air gauge readings (i.e. more than 4 psi, plus two psi for each additional trailer) during either two minute test, **repair the leaks** and repeat this test to confirm that they have been repaired.

Air leaks can also be found in the charging system, parking brakes, and/or other components - inspect and repair as necessary.

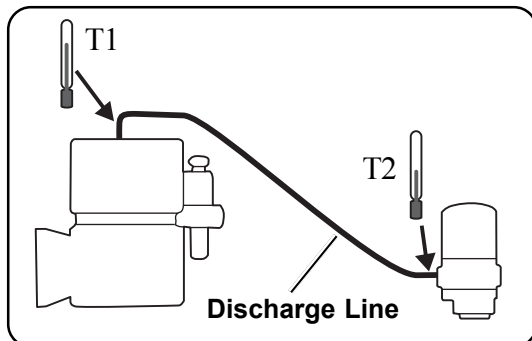
Test 3: Air Compressor Discharge Temperature and Air Dryer Inlet Temperature*

Note: The temperatures used in this test are not normal vehicle conditions.

Above normal temperatures can cause oil (as vapor) to pass through the air dryer into the air brake system.

This test is run with the engine at normal operating temperature, with engine at max. rpm. If available, a dyno may be used.

1. Allow the compressor to build the air system pressure to governor cut-in.
2. Pump the brakes to bring the dash gauge pressure to 90 psi.
3. Allow the compressor to build pressure from 95 to 105 psi gauge pressure and maintain this pressure range by cycling the brakes **for five (5) minutes.**



(* Note that only vehicles that have passed Test 2 would be candidates for this test.)

4. Then, while maintaining max rpm and pressure range, measure and **record the surface temperature** of the **fittings**:
 - ⇒ at the compressor discharge port. (T1).
 - ⇒ at the air dryer inlet fitting. (T2).
 Use a touch probe thermocouple for measuring the temperature.
5. See table below.
6. Retest before returning the vehicle to service.

T1 Compressor Discharge Fitting	T2 Air Dryer Inlet Fitting	Action
under 360°F	under 200°F	Temperatures are within normal range for this test, check other symptoms. Go to 4.0 (h).
under 360°F	over 200°F	This could indicate a discharge line problem (e.g. restriction). Call 1-800-AIR-BRAKE (1-800-247-2725) and speak with our Tech Team.
over 360°F	—	Compressor is running hot. Check coolant 4(f) and/or discharge line 4(g).

Tests (continued)

Test 4: Governor Malfunction

1. Inspect control lines to and from the governor for restrictions (e.g. collapsed or kinked). Repair as necessary.
2. Using a calibrated external gauge in the supply reservoir, service reservoir, or reservoir port of the D-2™ governor, verify cut-in and cut-out pressures are within vehicle OEM specification.
3. If the governor is malfunctioning, replace it.

Test 5: Governor Control Line

1. Ensure that the governor control line from the reservoir is located at or near the top of the reservoir. (This line, if located near the bottom of the reservoir, can become blocked or restricted by the reservoir contents e.g. water or ice.)
2. Perform proper reservoir drain intervals and air dryer cartridge maintenance per Maintenance Schedule and Usage Guidelines (Table A on page 3).
3. Return the vehicle to service.

Test 6: Compressor Unloader Leakage

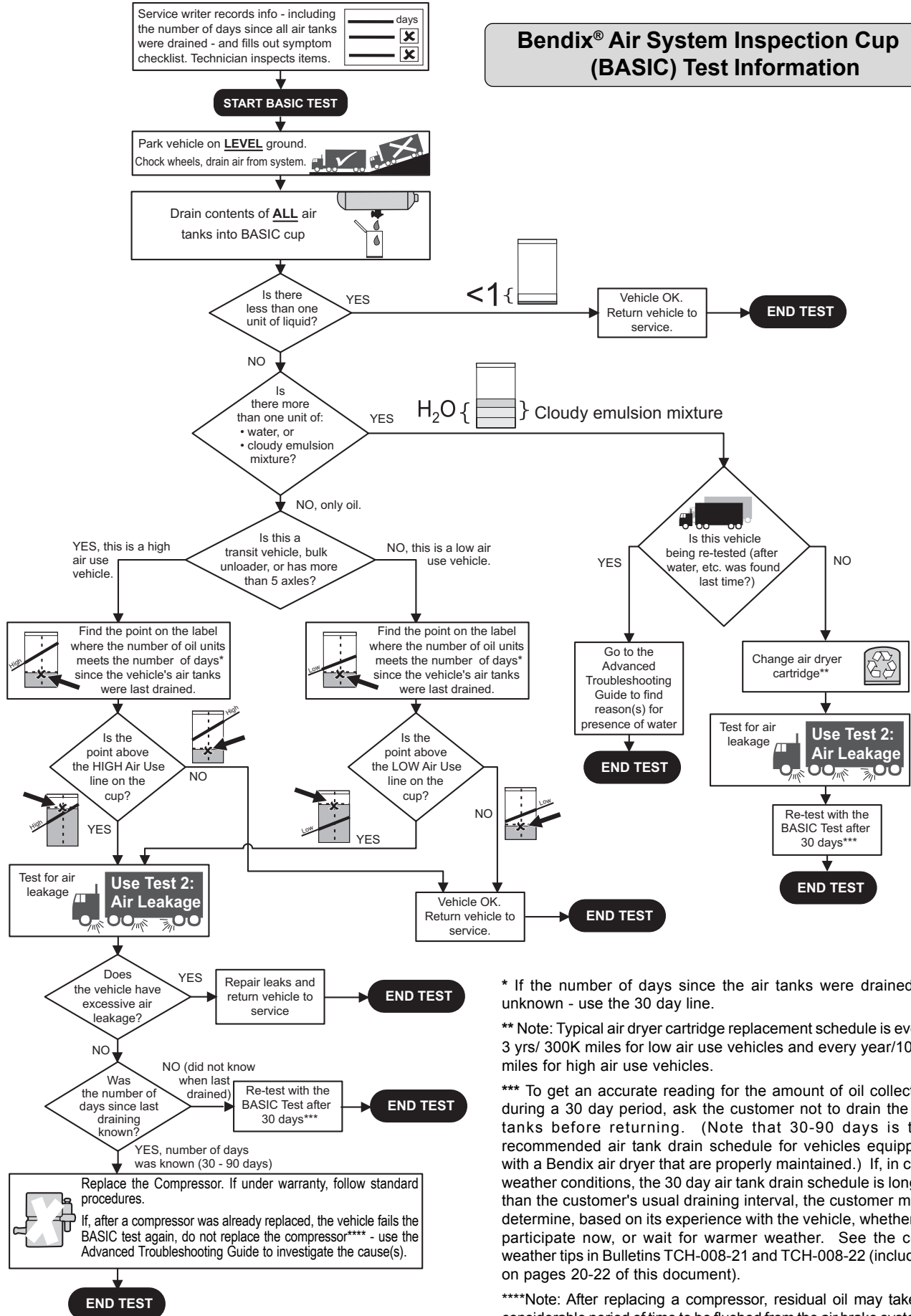
Bendix® Compressors: Park vehicle, chock wheels, and follow all standard safety procedures. Remove the governor and install a fitting to the unloader port. Add a section of air hose (min 1ft long for a 1/2" diameter line) and a gauge to the fitting followed by a shut-off valve and an air source (shop air or small air tank). Open the shut

off and charge the unloader port by allowing air pressure to enter the hose and unload the compressor. Shut off the air supply and observe the gauge. A steady reading indicates no leakage at the unloader port, but a falling reading shows that the unloader mechanism is leaking and needs to be serviced.

NOTES

[illegible]

Appendix A: Information about the BASIC Test Kit (Bendix P/N 5013711)



* If the number of days since the air tanks were drained is unknown - use the 30 day line.

** Note: Typical air dryer cartridge replacement schedule is every 3 yrs/ 300K miles for low air use vehicles and every year/100K miles for high air use vehicles.

*** To get an accurate reading for the amount of oil collected during a 30 day period, ask the customer not to drain the air tanks before returning. (Note that 30-90 days is the recommended air tank drain schedule for vehicles equipped with a Bendix air dryer that are properly maintained.) If, in cold weather conditions, the 30 day air tank drain schedule is longer than the customer's usual draining interval, the customer must determine, based on its experience with the vehicle, whether to participate now, or wait for warmer weather. See the cold weather tips in Bulletins TCH-008-21 and TCH-008-22 (included on pages 20-22 of this document).

****Note: After replacing a compressor, residual oil may take a considerable period of time to be flushed from the air brake system.

Appendix A continued: Information about the BASIC Test Kit (Bendix P/N 5013711)

Filling in the Checklist for the Bendix® Air System Inspection Cup (BASIC) Test

Note: Follow all standard safety precautions. For vehicles using a desiccant air dryer.

The Service Writer fills out these fields with information gained from the customer

Number of Days Since Air Tanks Were Last Drained: _____	Date: _____	Vehicle #: _____
Engine SN _____	Vehicle Used for: _____	Typical Load: _____ (lbs.)
No. of Axles: ____ (tractor) ____ (trailer)	No. of Lift Axles: ____	Technician's Name: _____

The Service Writer also checks off any complaints that the customer makes to help the Technician in investigating.

Customer's Complaint (Please check all that apply)	Checklist for Technician Have you confirmed complaint?
☐ "Relay valve leaks oil / malfunctions"	☐ no ☐ yes*
☐ "Dash valve leaks oil / malfunctions"	☐ no ☐ yes*
☐ "Air dryer leaks oil"	☐ no ☐ yes*
☐ "Governor malfunction"	☐ no ☐ yes*
☐ "Oil in gladhands"	☐ no ☐ yes*
how much oil did you find? _____	
☐ "Oil on ground or vehicle exterior"	☐ no ☐ yes*
amount described: _____	
☐ "Short air dryer cartridge life"	
replaces every: _____ miles, ☐ kms, or ☐ months	
☐ "Oil in air tanks" amount described: _____	
We will measure amount currently found when we get to step B of the test.	
☐ "Excessive engine oil loss" amount described: _____	
Is the engine leaking oil?	☐ no ☐ yes*
Is the compressor leaking oil?	☐ no ☐ yes*
☐ Other complaint: _____	
☐ No customer complaint.	

The Technician checks boxes for any of the complaints that can be confirmed.

* Note: A confirmed complaint above **does NOT** mean that the compressor must be replaced. The full BASIC test below will investigate the facts.

BASIC test starts here:

STEP A - Select one:

- ☐ This is a low air use vehicle: Line haul (single trailer) with 5 or less axles, or
- ☐ This is a high air use vehicle: Garbage truck, transit bus, bulk unloader, or line haul with 6 or more axles.

Then go to Step B.

The Technician selects the air use category for the vehicle. This decided which of the two acceptance lines on the cup will be used for the test below.

STEP B - Measure the Charging System Contents

1. Park and chock vehicle on level ground. Drain the air system by pumping the service brakes.
2. Completely drain **ALL** the air tanks into a single **BASIC** cup.
3. If there is less than one unit of contents total, end the test now and return the vehicle to service. Vehicle passes.
4. **If more than one oil unit of water (or a cloudy emulsion mixture) is found:**
 - (a) Change the vehicle's air dryer cartridge - see Footnote 1,
 - (b) Conduct the 4 minute leakage test (Step D),
 - (c) **STOP the inspection, and check the vehicle again after 30 days** - see Footnote 2.



STOP + CK

Otherwise, go to Step C.

For an accurate test, the contents of all the air tanks on the vehicle should be used.

Note for returning vehicles that are being retested after a water/cloudy emulsion mixture was found last time and the air dryer cartridge replaced: If more than one oil unit of water or a cloudy emulsion mixture is found **again**, stop the BASIC test and consult the air dryer's Service Data sheet troubleshooting section.

Footnote 1: Note: Typical air dryer cartridge replacement schedule is every 3 yrs/ 300K miles for low air use vehicles and every year/100K miles for high air use vehicles.

Footnote 2: To get an accurate reading for the amount of oil collected during a 30 day period, ask the customer not to drain the air tanks before returning. (Note that 30-90 days is the recommended air tank drain schedule for vehicles equipped with a Bendix air dryer that are properly maintained.) If, in cold weather conditions, the 30 day air tank drain schedule is longer than the customer's usual draining interval, the customer must determine, based on its experience with the vehicle, whether to participate now, or wait for warmer weather. See the cold weather tips in Bulletins TCH-008-21 and TCH-008-22 (included in Appendix B of the advanced troubleshooting guide).

Appendix A continued: Information about the BASIC Test Kit (Bendix P/N 5013711)

Filling in the Checklist for the Bendix® Air System Inspection Cup (BASIC) Test

Note: Follow all standard safety precautions. For vehicles using a desiccant air dryer.

STEP C - How to Use the BASIC Test

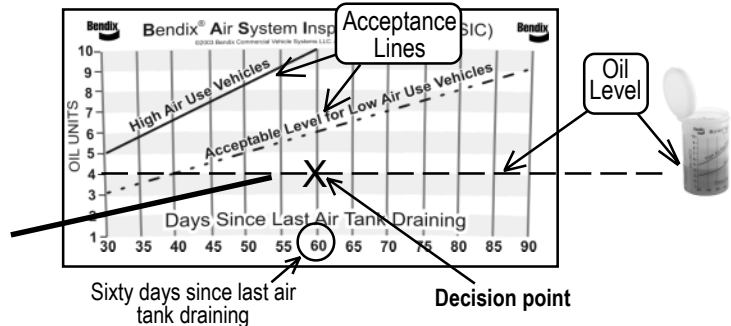
The Technician uses the chart (label) on the BASIC test cup to help decide the action to take, based on the amount of oil found. Use the lower acceptance line for low air use vehicles, and upper line for high air use vehicles (from Step A).

1. Record days since air tanks were last drained.	2. Record amount of oil found:	3. Action to take
days	units	
↓	↓	↓
If number of days is: 30-60 days (high air use) or 30-90 days (low air use) →	if oil level is at or below acceptance line for number of days → if oil level is above acceptance line for number of days →	System OK. Return to service. STOP TEST Go to Step D
Otherwise . . . → (if the number of days is unknown, or outside the limits above)	if oil level is at or below 30-day acceptance line → if oil level is above 30-day acceptance line →	System OK. Return to service. STOP TEST Stop inspection. Test again after 30 days. See Footnote 2. STOP + CK

BASIC Test Example

An oil level of 4 units in a sixty-day period is within the acceptance area (at or below the line) for both low and high air use vehicles. Return the vehicle to service.

The Technician looks for the point where the number of days since the air tanks were drained meets the oil level. If it is at or below the (low or high use) acceptance line, the vehicle has passed the test. If the point is above the line we go to the leakage test.



STEP D - Air Brake System Leakage Test

Park the vehicle on level ground and chock wheels. Build system pressure to governor cut-out and allow the pressure to stabilize for one minute.

1: Observe the dash gauges for two additional minutes without the service brakes applied.

2: Apply service brakes for two minutes (allow pressure to stabilize) and observe the dash gauges.

If you see any noticeable decrease of the dash air gauge readings repair leaks. Repeat this test to confirm that air leaks have been repaired and return vehicle to service. Please repeat BASIC test at next service interval. Note: Air leaks can also be found in the charging system, parking brakes, and/or other components - inspect and repair as necessary.

Air leakage is the number one cause of compressors having to pump excessive amounts of air, in turn run too hot and pass oil vapor along into the system. Here the Technician conducts a four-minute test to see if leakage is a problem with the vehicle being tested.

If no air leakage was detected, and if you are conducting this test after completing Step C, go to Step E.

STEP E - If no air leakage was detected in Step D

Replace the compressor.

Note: If the compressor is within warranty period, please follow standard warranty procedures. Attach the completed checklist to warranty claim.

The Technician only reaches Step E if the amount of oil found, for the amount of time since the air tanks were last drained exceeds the acceptance level, AND the vehicle passes the four-minute leakage test (no noticeable leakage was detected).

Technical Bulletin



Bulletin No.: TCH-008-021

Effective Date: 11/1/92

Page: 1 of 2

Subject: **Air Brake System - Cold Weather Operation Tips**

As the cold weather approaches, operators and fleets alike begin to look to their vehicles with an eye toward “winterization”, and particularly what can be done to guard against air system freeze-up. Here are some basic “Tips” for operation in the cold weather.

Engine Idling

Avoid idling the engine for long periods of time! In addition to the fact that most engine manufacturers warn that long idle times are detrimental to engine life, winter idling is a big factor in compressor discharge line freeze-up. Discharge line freeze-ups account for a significant number of compressor failures each year. The discharge line recommendations under “Discharge Lines” are important for all vehicles but are especially so when some periods of extended engine idling can not be avoided.

Discharge Lines

The discharge line should slope downward from the compressor discharge port without forming water traps, kinks, or restrictions. Cross-overs from one side of the frame rail to the other, if required, should occur as close as possible to the compressor. Fitting extensions must be avoided. Recommended discharge line lengths and inside diameters are dependent on the vehicle application and are as follows.

Typical P&D, School Bus and Line Haul

The maximum discharge line length is 16 feet.

Length	I.D. Min.	Other Requirements
6.0-9.5 ft.	½ in.	None
9.5-12 ft.	½ in.	Last 3 feet, including fitting at the end of the discharge line, must be insulated with ½ inch thick closed cell polyethylene pipe insulation.
12-16 ft.	5/8 in.	Last 3 feet, including fitting at the end of the discharge line, must be insulated with ½ inch thick closed cell polyethylene pipe insulation.

If the discharge line length must be less than 6 feet or greater than 16 feet, contact your local Bendix representative.

High Duty Cycle Vehicles (City Transit Coaches, Refuse Haulers, Etc.)

The maximum discharge line length is 16 feet.

Length	I.D. min.	Other Requirements
10-16 ft.	½ in.	None

If the discharge line length must be less than 10 feet or greater than 16 feet, contact your local Bendix representative.

System Leakage

Check the air brake system for excessive air leakage using the Bendix "Dual System Air Brake Test and Check List" (BW1279). Excessive system leakage causes the compressor to "pump" more air and also more moisture into the brake system.

Reservoir Draining (System Without Air Dryer)

Routine reservoir draining is the most basic step (although not completely effective) in reducing the possibility of freeze-up. **All reservoirs** in a brake system can accumulate water and other contamination and must be drained! The best practice is to drain all reservoirs daily. When draining reservoirs; turn the ENGINE OFF and drain ALL AIR from the reservoir, better still, open the drain cocks on all reservoirs and leave them open over night to assure all contamination is drained (reference Service Data Sheet SD-04-400 for Bendix Reservoirs). If automatic drain valves are installed, check their operation **before** the weather turns cold (reference Service Data Sheet SD-03-2501 for Bendix® DV-2™ Automatic Drain Valves). It should be noted that, while the need for daily reservoir draining is eliminated through the use of an automatic drain valve, periodic manual draining is still required.

Alcohol Evaporator or Injector Systems

Check for proper operation of these systems by monitoring alcohol consumption for a few days (Reference Service Data Sheet SD-08-2301 for the Bendix Alcohol Evaporator). Too little means the system is not receiving adequate protection and too much simply wastes alcohol. As a general guide, these systems should consume approximately 1 to 2 ounces of alcohol per hour of compressor loaded time (compressing air). City pick-up and delivery vehicles will operate with the compressors loaded (compressing air) more while compressors on highway vehicles will be loaded less. These figures are approximate and assume that air system leakage is within the limits of the Bendix "Dual System Air Brake Test and Check List" (BW1279). Last but not least, begin using alcohol several weeks prior to freezing weather to ensure that the system is completely protected. Use only methanol alcohol, such as Bendix "Air Guard", in evaporators or injectors.

Air Dryers

Make certain air brake system leakage is within the limits stated in BW1279. Check the operation and function of the air dryer using the appropriate Service Data Sheet for the air dryer.

AD-9™ Air Dryer	Service Data Sheet SD-08-2412
AD-4™ Air Dryer	Service Data Sheet SD-08-2407
AD-2™ Air Dryer	Service Data Sheet SD-08-2403
AD-IP™ Air Dryer	Service Data Sheet SD-08-2414
AD-SP™ Air Dryer	Service Data Sheet SD-08-2415
Trailer System-Guard Air Dryer	Service Data Sheet SD-08-2414



Technical Bulletin

Bulletin No.: TCH-008-022

Effective Date: 1/1/1994

Page: 1 of 2

Subject: **Additional Cold Weather Operation Tips for the Air Brake System**

Last year we published Bulletin PRO-08-21 which provided some guidelines for "winterizing" a vehicle air brake system. Here are some additional suggestions for making cold weather vehicle operation just a little more bearable.

Thawing Frozen Air Lines

The old saying; "Prevention is the best medicine" truly applies here! Each year this activity accounts for an untold amount of unnecessary labor and component replacement. Here are some Do's and Don'ts for prevention and thawing.

Do's

1. Do maintain freeze prevention devices to prevent road calls. Don't let evaporators or injectors run out of methanol alcohol or protection will be degraded. Check the air dryer for proper operation and change the desiccant when needed.
2. Do thaw out frozen air lines and valves by placing the vehicle in a warmed building. This is the only method for thawing that will not cause damage to the air system or its components.
3. Do use dummy hose couplings on the tractor and trailer.
4. Do check for sections of air line that could form water traps. Look for "drooping" lines.

Don'ts

1. Do not apply an open flame to air lines and valves. Beyond causing damage to the internal nonmetallic parts of valves and melting or burning non-metallic air lines, THIS PRACTICE IS UNSAFE AND CAN RESULT IN VEHICLE FIRE!
2. Do not introduce (pour) fluids into air brake lines or hose couplings ("glad hands"). Some fluids used can cause immediate and severe damage to rubber components. Even methanol alcohol, which is used in Alcohol Evaporators and Injectors, should not be poured into air lines. Fluids poured into the system wash lubricants out of valves, collect in brake chambers and valves and can cause malfunction. Loss of lubricant can affect valve operating characteristics, accelerate wear and cause premature replacement.
3. Do not park a vehicle outside after thawing its air system indoors. Condensation will form in the system and freeze again. Place the vehicle in operation when it is removed to the outdoors.

Supporting Air and Electrical Lines

Make certain tie wraps are replaced and support brackets are re-assembled if removed during routine maintenance. These items prevent the weight of ice and snow accumulations from breaking or disconnecting air lines and wires.

Automatic Drain Valves (System without Air Dryer)

As we stated last year, routine reservoir draining is the most basic step (although not completely effective) in reducing the possibility of freeze-up. While automatic drain valves relieve the operator of draining reservoirs on a daily basis, these valves **MUST** be routinely checked for proper operation. Don't overlook them until they fail and a road call is required.

