BENDIX® SNA-01™ COMPRESSOR

The Bendix® SNA-01™ compressor is a service new single cylinder compressor developed exclusively for the following engines; Volvo® D11, D13 and D16; and the Mack® MP7 and MP8 engines manufactured from 2006 through 2010.

NOTE: A retrofit kit is included with the compressor and is intended to support the retrofit of this compressor only on the engines and time frame specified above.

DESCRIPTION

The function of the air compressor is to provide and maintain air under pressure to operate devices in air brake systems. The Bendix® SNA-01™ Compressor is a single-cylinder reciprocating compressor with a rated displacement of 15.8 cubic feet per minute at 1250 RPM.

The compressor consists of a water-cooled cylinder head assembly and an integral air-cooled crankcase assembly.

The cylinder head assembly is made up of the cylinder head, discharge jumper, cooling plate, and valve plate assembly. It uses two sealing gaskets and two o-rings.

The cylinder head, discharge jumper and cooling plate are made from aluminum. The cylinder head contains air and water ports as well as an unloader assembly. The discharge jumper is connected to the cylinder head and re-routes the discharge air to the discharge port of the cylinder head assembly. It assists in cooling the compressor. A cooling plate is located between the cylinder head and valve plate assemblies and also assists in cooling.

The valve plate assembly consists of brazed steel plates which have valve openings and passages for air and engine coolant to flow into and out of the cylinder head. The compressor's discharge valves are part of the valve plate assembly. The inlet reed valve/gasket is installed between the valve plate assembly and the top of the crankcase. The cast iron crankcase houses the piston assembly, connecting rod, crankshaft, and related bearings.

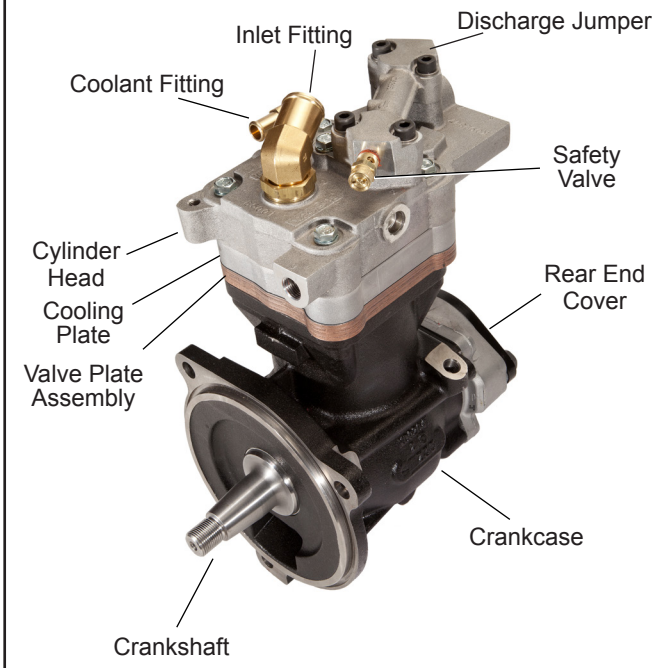


FIGURE 1 - ***BENDIX® SNA-01™ COMPRESSOR***

All SNA-01 compressors are equipped with a safety valve to protect the compressor head in the event of, for example, a discharge line blockage downstream of the compressor. Excessive air pressure will cause the safety valve to unseat, release air pressure, and give an audible alert to the operator. The safety valve is installed in the safety valve port of the discharge jumper. The discharge jumper's function is to relocate the discharge port such that easy installation to the existing vehicle discharge line is permitted. It also enhances discharge air cooling.

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 guidelines should be observed AT ALL TIMES:

- **Park the vehicle on a level surface, apply the parking brakes and always block the wheels. Always wear personal protection equipment.**
- **Stop the engine and remove the 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.**
- **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.**
- **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, a Bendix® DRM™ dryer reservoir module, or a Bendix® AD-9si® air dryer, be sure to drain the purge reservoir.**
- **Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.**
- **Never exceed manufacturer's recommended pressures.**
- **Never connect or disconnect a hose or line containing pressure; it may whip and/or cause hazardous airborne dust and dirt particles. Wear eye protection. Slowly open connections with care, and verify that no pressure is present. Never remove a component or plug unless you are certain all system pressure has been depleted.**
- **Use only genuine Bendix® brand replacement parts, components and kits. Replacement hardware, tubing, hose, fittings, wiring, etc. must be of equivalent size, type and strength as original equipment and be designed specifically for such applications and systems.**
- **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.**
- **Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.**
- **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.**
- **The power MUST be temporarily disconnected from the radar sensor whenever any tests USING A DYNAMOMETER are conducted on a vehicle equipped with a Bendix® Wingman® system.**
- **You should consult the vehicle manufacturer's operating and service manuals, and any related literature, in conjunction with the Guidelines above.**

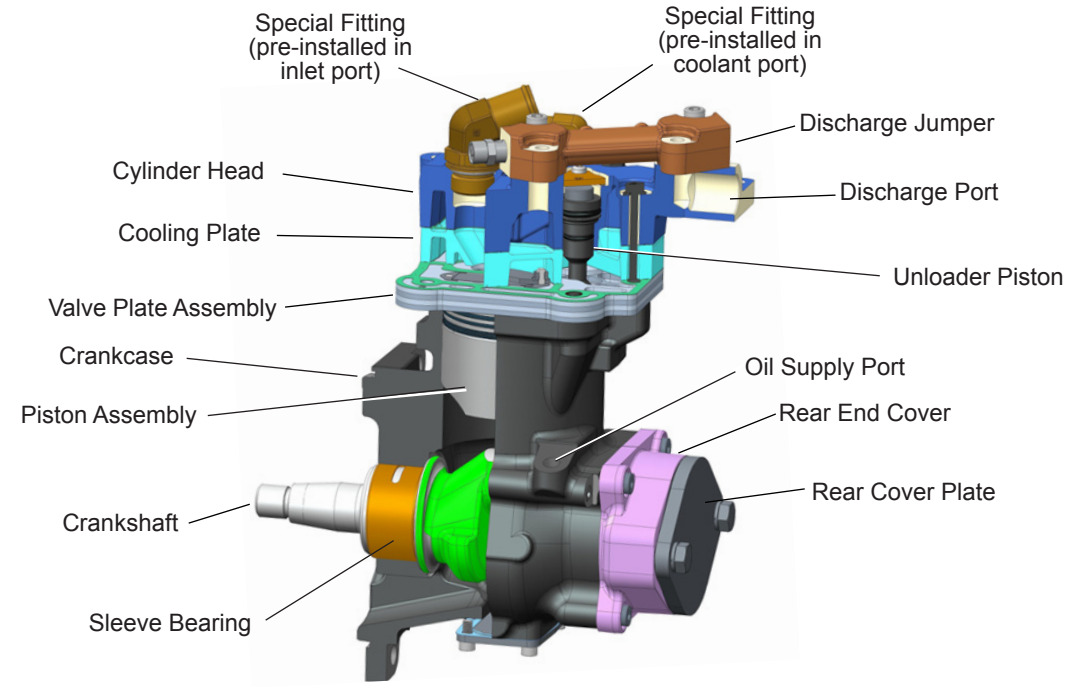


FIGURE 2 - ***BENDIX® SNA-01™ COMPRESSOR (CUT-AWAY)***

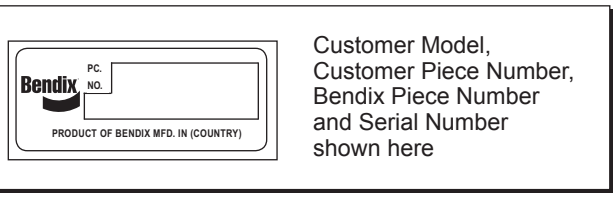


FIGURE 3 - ***NAMEPLATE INFORMATION***

A nameplate; attached to the outboard side of the crankcase; is stamped with information identifying the Bendix piece number and serial number of the compressor. *See Figure 3.*

2006–2010 Volvo® D11, D13 & D16 Engines

2006–2010 Mack® MP7 & MP8 Engines

FIGURE 4 - ***TYPICAL COMPRESSOR APPLICATIONS***

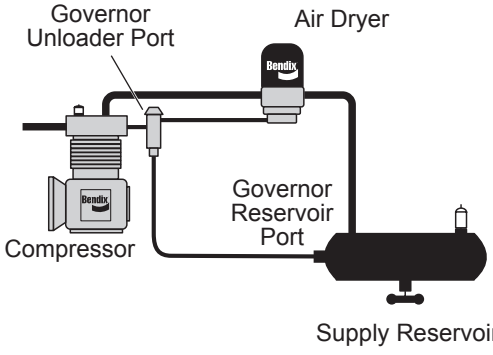


FIGURE 5 - ***CHARGING SYSTEM WITH BENDIX SNA-01 COMPRESSOR***

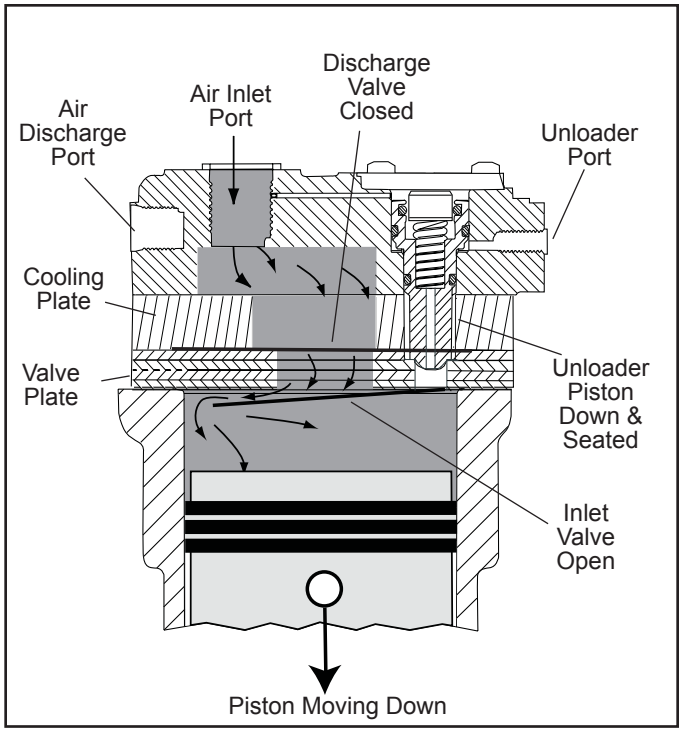


FIGURE 6 - ***OPERATION - LOADED (INTAKE)***

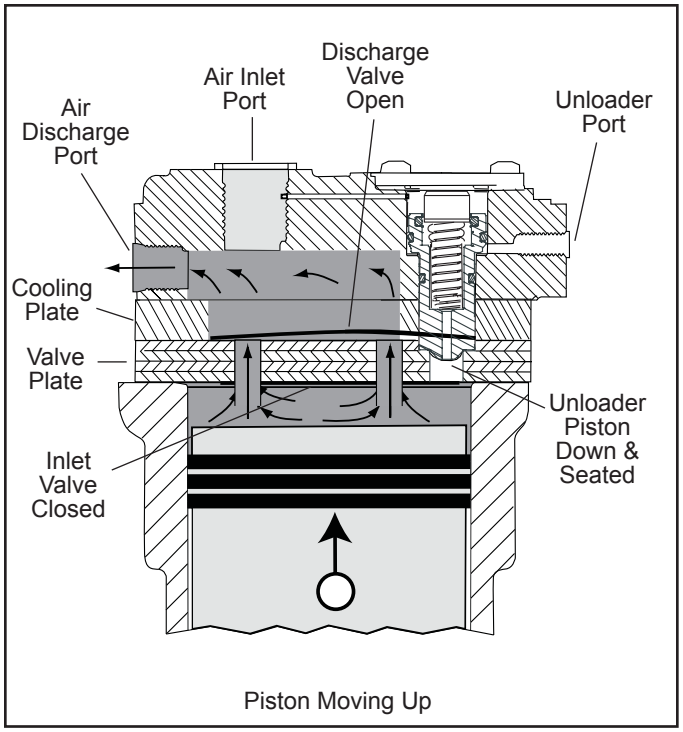


FIGURE 7 - ***OPERATION - LOADED (COMPRESSION)***

OPERATION

The compressor is driven by the vehicle's 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.

AIR INTAKE (LOADED)

Just as the piston begins the down stroke, (a position known as Top Dead Center, or TDC), the vacuum created in the cylinder bore above the piston causes the inlet reed valve to flex open. Atmospheric air flows through the open inlet valve and fills the cylinder bore above the piston. *See Figure 6.*

AIR COMPRESSION (LOADED)

When the piston reaches the bottom of the stroke, (a position known as Bottom Dead Center, or BDC), the inlet reed valve closes. Air above the piston is trapped by the closed inlet reed valve and is compressed as the piston moves upwards. When air in the cylinder bore reaches a pressure greater than that of the system pressure, the discharge reed valves open and allow air to flow into the discharge line and air brake system.

At the same time, air 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 in the down position, against its seat on the valve plate. *See Figure 7.*

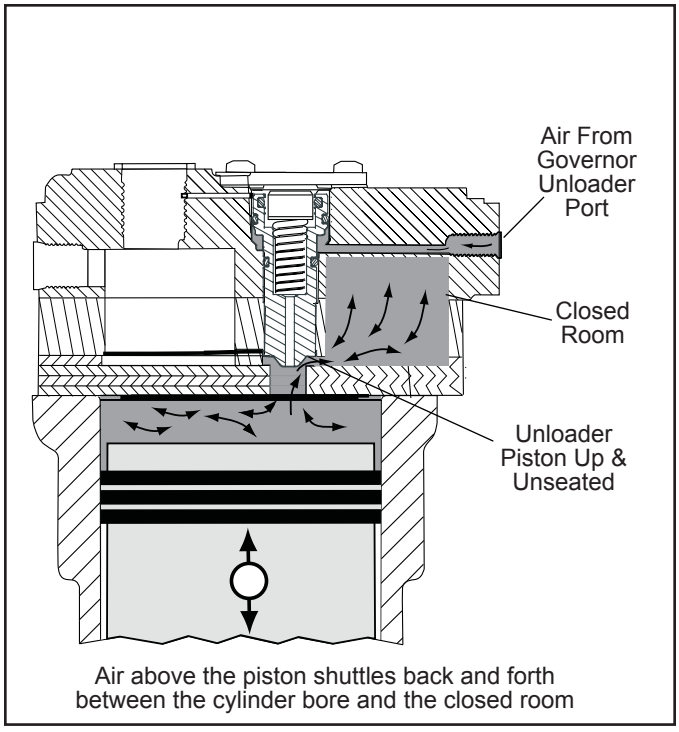


FIGURE 8 - ***OPERATION - UNLOADED***

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 the piston to move away from its seat on the valve plate assembly. When the unloader piston is unseated, an air passageway is opened between the cylinder bore and a secondary compartment—or "closed room"—in the interior of the cylinder head.

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 "closed room". The size of the closed room is sufficient to accept the compressed air provided by the compressor piston without creating excessive air pressure in the "closed room". On the piston down stroke (TDC to BDC) air flows in the reverse direction—from the "closed room" past the unseated unloader piston and inlet reed valve—and into the cylinder bore. Note: For optimum performance, it is recommended that the air dryer installed in the system be equipped with a "turbo cut-off" feature. *See Figure 8.*

LUBRICATION

The vehicle's engine provides a continuous supply of oil to the compressor. Pressurized oil is routed from the engine to the compressor's oil inlet port at the rear of the crankcase. From there the oil flows through a passageway on the inboard side of the crankcase to the front crankshaft journal and sleeve bearing. An oil passage in the crankshaft routes pressurized oil to the connecting rod journal and the rear crankshaft journal. Spray lubrication of the cylinder bores and connecting rod wrist pin bushings 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

Bendix® SNA-01™ compressors are cooled by air flowing through the engine compartment as it passes the compressor's crankcase bore and by the flow of engine coolant through the cylinder head. Coolant supplied by the engine cooling system passes through connecting lines into the cylinder head. It passes through internal passages in the cylinder head, cooling plate, and valve plate assembly and returns to the engine. *Figure 9 illustrates the coolant port locations and proper flow path.* Proper cooling is important in minimizing discharge air temperatures - see the tabulated technical data in the compressor specification section of this manual for specific requirements.

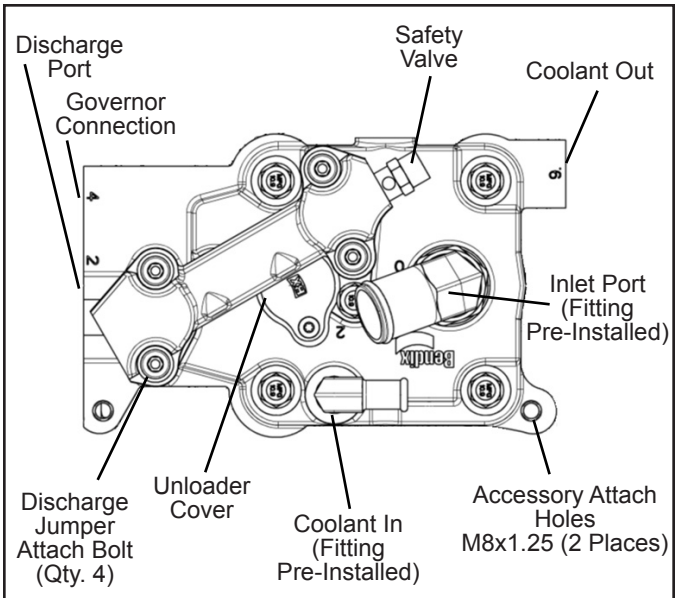
AIR INDUCTION

Bendix SNA-01 air compressors are only permitted to be naturally aspirated — use of engine turbocharger as an air source is not allowed. *See Figure 5 for an example of a naturally aspirated air induction system.*

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 of this manual, 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.



CYLINDER HEAD PORT IDENTIFICATION

The cylinder head connection ports are identified with cast in numerals as follows:

0 Air In

2 Compressed Air Out

9 Coolant In or Out

4 Governor Control

*FIGURE 9 - **BENDIX® SNA-01™ COMPRESSOR CYLINDER HEAD***

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

AIR INDUCTION

The Bendix® SNA-01™ compressor is designed for connection to the vacuum side of the engine's air induction system only.

A supply of clean air is one of the single most important factors in compressor preventive maintenance. Since the air supply for SNA-01 compressor and engine is the engine air cleaner, periodic maintenance of the engine air filter is necessary.

Inspect the compressor air induction system 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 if necessary.
4. Verify that the compressor inlet fitting is tight (check torque) and aligned properly to the hose. If kinks exist, the fitting should be loosened, realigned and retightened.
5. Any metal tubes should also be tight (torqued properly) to the mating fitting. Inspect the metal tubes for any cracks or breaks and replace if necessary.

COMPRESSOR COOLING

Inspect the compressor discharge port, inlet cavity, and discharge line for evidence of restrictions and carbon buildup. If more than 1/16" of carbon is found, thoroughly clean or replace the affected parts. In some case, carbon buildup 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" Inside Diameter (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 pass a minimal amount of oil. Air dyers will remove the majority of oil before it can enter the air brake system. For particularly oil sensitive systems, the Bendix® PuraGuard® system can be used in conjunction with a Bendix® air dryer.

If compressor oil passing is suspected, refer to the TROUBLESHOOTING section (starting on page A-1) for the symptoms and corrective action to be taken. In addition, Bendix has developed the "Bendix Air System Inspection Cup" (BASIC™) kit to help substantiate suspected excessive oil passing. *The steps to be followed when using the BASIC kit are presented in APPENDIX B, on page A-16.*

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-rings.
2. Make certain the unloader system lines are connected as illustrated in Figure 5.
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 100 psi. The cut-in pressure is the lowest system pressure registered in the gauges before the compressor resumes compressing air.

SERVICE TESTS

GENERAL

The following compressor operating and leakage tests need not be performed on a regular basis. These tests should be performed: a) when it is suspected that leakage is substantially affecting compressor buildup performance; or b) when it is suspected that the compressor is “cycling” between the loaded (pumping) and unloaded (non-pumping) modes due to unloader 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, 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 this test is a useful guide for in-service vehicles.

Optional Comparative Performance Check

It may be useful to also conduct the previous 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.

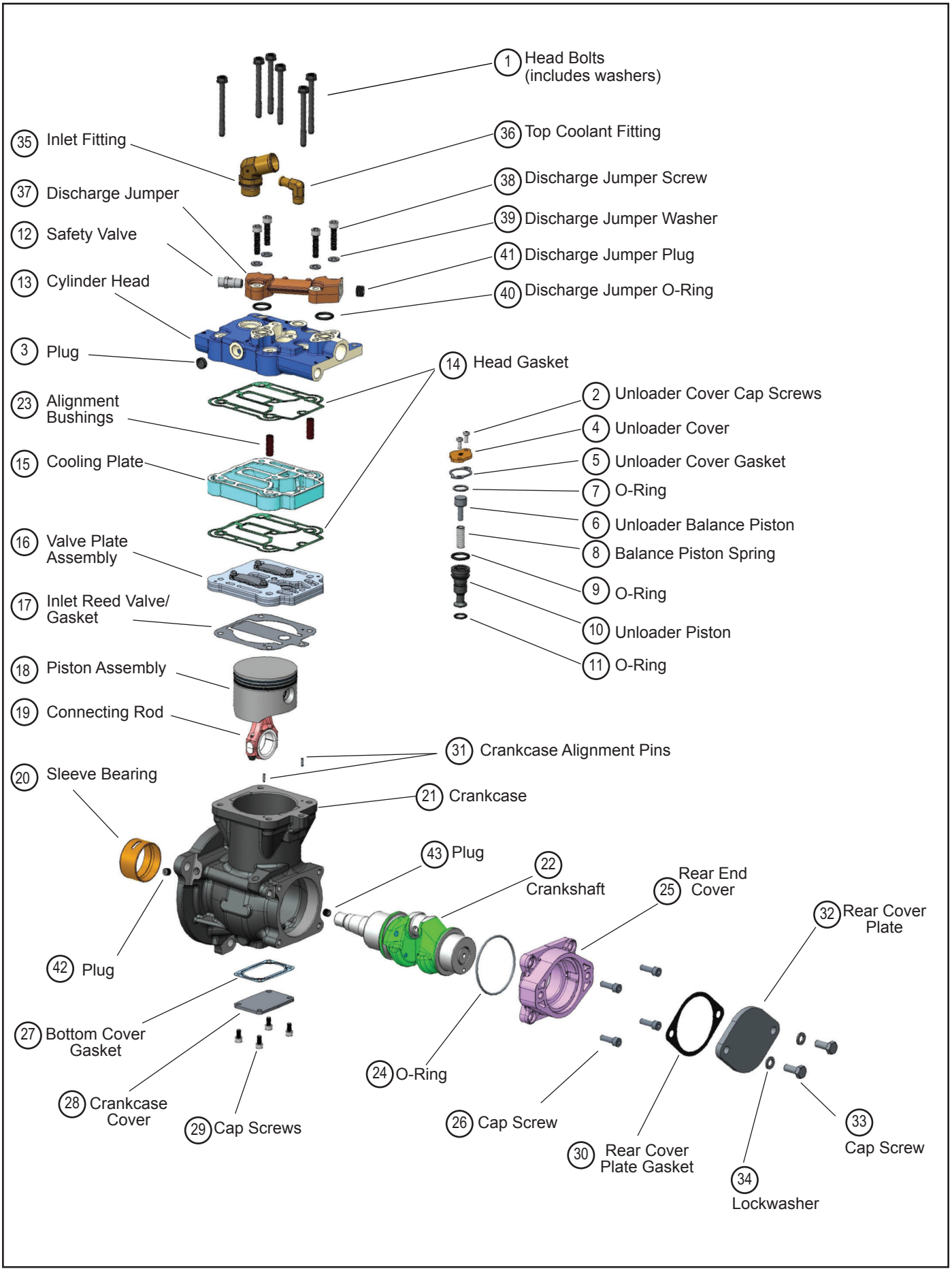


FIGURE 10 - ***BENDIX® SNA-01™ COMPRESSOR EXPLODED VIEW.***

Component Identification		
Item	**Quantity**	**Description**
1	6	Head Bolts
2	2	Unloader Cover Screw
3	1	Plug
4	1	Unloader Cover
5	1	Unloader Cover Gasket
6	1	Unloader Balance Piston
7	1	O-Ring
8	1	Balance Piston Spring
9	1	O-Ring
10	1	Unloader Piston
11	1	O-Ring
12	1	Bendix® ST-4™ Safety Valve
13	1	Cylinder Head
14	2	Head Gasket
15	1	Cooling Plate
16	1	Valve Plate Assembly
17	1	Inlet Reed Valve Gasket
18	1	Piston Assembly
19	1	Connecting Rod
20	1	Sleeve Bearing
21	1	Crankcase
22	1	Crankshaft
23	2	Alignment Bushings
24	1	O-Ring
25	1	Rear End Cover
26	4	Cap Screw
27	1	Bottom Cover Gasket
28	1	Crankcase Cover
29	4	Cap Screws
30	1	Rear Cover Plate Gasket
31	2	Crankcase Alignment Pins
32	1	Rear Cover Plate
33	2	Cap Screw
34	2	Lockwasher
35	1	Inlet Fitting
36	1	Top Coolant Fitting
37	1	Discharge Jumper
38	4	Discharge Jumper Screw
39	4	Discharge Jumper Washer
40	2	Discharge Jumper O-Ring
41	1	Discharge Jumper Plug
42	1	Plug
43	1	Plug

Maintenance Kits and Service Parts		
Item	**Quantity**	**Description**
Cylinder Head Gasket Kit P/N K023764		
14	2	Head Gasket
17	1	Inlet Reed Valve Gasket
Discharge Jumper Kit P/N K092848		
12	1	Bendix ST-4 Safety Valve
37	1	Discharge Jumper
38	4	Discharge Jumper Screw
39	4	Discharge Jumper Washer
40	2	Discharge Jumper O-Ring
41	1	Discharge Jumper Plug
Safety Valve P/N K035675		
12	1	Bendix® ST-4™ Safety Valve
Seal Kit P/N K115315		
24	1	O-Ring
27	1	Bottom Cover Gasket
30	1	Rear Cover Plate Gasket
40	2	Discharge Jumper O-Ring
Special Fittings Kit P/N K115314		
35	1	Inlet Fitting
36	1	Coolant Fitting
Unloader Kit P/N K109119		
2	2	Unloader Cover Screw
5	1	Unloader Cover Gasket
6	1	Unloader Balance Piston
7	1	O-Ring
8	1	Balance Piston Spring
9	1	O-Ring
10	1	Unloader Piston
11	1	O-Ring
N/A	1	Grease Pack
Installation Kit P/N K092868		
N/A	1	Inlet Hose
N/A	1	Coolant Hose
N/A	1	Coolant Fitting (Union)
N/A	3	Hose Clamp (Coolant)
N/A	3	Hose Clamp (Inlet)
N/A	1	Synflex® Tubing
N/A	1	Unloader Line Fitting (Union)
Volvo® P/N 992065		
N/A	1	Front Flange O-Ring (see note 1)
Volvo P/N 977650		
N/A	1	Oil Supply Line (see notes 1 & 2)

1. Available from Volvo® distributor or dealer only.
2. Required to retrofit the Bendix® SNA-01™ compressor on a Mack® MP7 or MP8 engine.

LEAKAGE TESTS

See the standard Air Brake System and Accessory Leakage test on Page A-14 (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 the 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, the inlet reed valve/gasket between the valve plate assembly and crankcase and between the cylinder head and discharge jumper 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 outlet.

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 to 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 to 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 in the Service Operating Tests section of this manual—before making a determination that performance has been lost.

Unloader leakage is generally 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 to 10 minutes. If the 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 and service parts are available. The instructions provided with these parts and kits should be followed in lieu of the instructions presented here. *See the Maintenance and Service Parts section in this manual.*

REMOVAL

In many instances it may not be necessary to remove the compressor from the vehicle when installing the various 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 front flange mounting bolts/nuts and remove the compressor from the vehicle.
7. Inspect the drive gear and associated drive parts for visible wear or damage. If the compressor drive gear is worn or damaged, the drive gear must be removed and replaced. *Refer the Engine Manufacturer's service manual to address the associated engine drive parts.*
8. If the compressor is being replaced, stop here and proceed to "Installing the Compressor" at the end of the assembly procedure. (Note: Replacement compressors do not come with the drive gear pre-assembled on the compressor. If the drive gear is in good condition, the drive gear and attachment nut can be removed from the old compressor and transferred to the new compressor or a new drive gear must be purchased through a Volvo® distributor and installed on the compressor.

PREPARATION FOR DISASSEMBLY

Remove the balance of road dirt and grease from the exterior of the compressor with a cleaning solvent. If a rear end cover or end cover adapter is used on the compressor being worked on, mark it in relation to the crankcase. It is recommended, but not specifically necessary, to mark the relationships of the cylinder head (13), cooling plate (15), valve plate assembly (16), and crankcase (21).

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.

What follows is a description of a complete disassembly, actual maintenance may only need to include portions of these instructions.

DISCHARGE JUMPER ASSEMBLY & FITTINGS

Note: The discharge jumper (37) must be removed in order to remove the inlet fitting (35) and to service the unloader mechanism.

1. Loosen and remove the four discharge jumper washers (39) and discharge jumper screws (38) that secure the discharge jumper (37) to the cylinder head (13). Remove the discharge jumper (37) and the two o-rings (40). Loosen and remove the safety valve (12) from the discharge jumper (37), if necessary.
2. The inlet fitting (35) and top coolant fitting (36) were pre-installed on the compressor by Bendix to ensure proper positioning when the coolant and air induction lines are installed. Unless the inlet fitting (35) and top coolant fitting (36) have been damaged they should stay intact. If it is necessary to remove the fittings, first loosen the jam nut of the inlet fitting (35) and remove it from the cylinder head (13). Then, loosen and remove the top coolant fitting (36) from the cylinder head (13).

CYLINDER HEAD ASSEMBLY

3. To restrain the spring force exerted by balance piston spring (8) of the unloader assembly, hold the unloader cover (4) in place while removing the two unloader cover cap screws (2). Carefully release the hold on the unloader cover until the spring force is relaxed, then remove the unloader cover.
4. Remove the unloader cover gasket (5).
5. Remove the unloader balance piston (6), its spring (8) and the unloader piston (10) along with its o-rings (7, 9 & 11) from the cylinder head (13).
6. Remove the six head bolts (1) from the cylinder head (13).

   Note: The five head bolts located towards the perimeter of the cylinder head retain the cylinder head directly to the crankcase. The single head bolt in the center of the cylinder head holds the cylinder head, cooling plate and valve plate assembly together; independent of the crankcase.
7. Gently tap the cylinder head, cooling plate (15) and valve plate assembly (16) with a soft mallet to break the gasket seal between the valve plate assembly and the crankcase (21). Lift the cylinder head with cooling plate and valve plate assembly off the crankcase.
8. Remove the metal inlet reed valve/gasket (17).
9. Gently tap the cylinder 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 (15) and valve plate assembly and remove the two gaskets (14) between them.

CRANKCASE COVER

1. Remove the four crankcase cover cap screws (29) securing the crankcase cover (28) to the crankcase (21). Using a soft mallet, gently tap the crankcase cover to break the gasket seal. Remove the crankcase cover gasket (27).

REAR END COVER & COVER PLATE ASSEMBLY

NOTE: Mark position of the rear end cover. It should be re-installed in the same orientation.

1. Remove the two cap screws (33) and lock washers (34) from the rear end cover (25).
2. Remove the rear cover plate (32) and rear cover plate gasket (30).
3. Remove the four end cover cap screws (26) that secure the rear end cover to the crankcase.
4. Remove the rear end cover (25) from the crankcase.
5. Remove the o-ring seal (24) from the rear end cover (25).

CLEANING OF PARTS GENERAL

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

CYLINDER HEAD ASSEMBLY

1. Carefully remove all gasket material adhering to the cylinder head (13), cooling plate (15), valve plate assembly (16) and cast iron crankcase (21). Make certain not to scratch or mar the gasket surfaces. Pay particular attention to the gasket surfaces of the head.
2. Remove carbon deposits from the discharge and inlet plate assembly. They must be open and clear in both assemblies. Make certain not to damage the head.
3. Remove rust and scale from the cooling cavities and passages in the cylinder head, cooling plate 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 (e.g. abrasion, chafing). Minor thread chasing (damage) is permitted.

INSPECTION OF PARTS

CYLINDER HEAD, COOLING PLATE, VALVE PLATE ASSEMBLY AND UNLOADER MECHANISM

1. Carefully inspect the head gasket surfaces on the cylinder head (13) for deep gouges and nicks. Also, inspect the cylinder head for any cracks or port thread damage. If detected, the compressor must be replaced. If large amounts of carbon build-up are present in the discharge cavity such that it restricts the air flow through the cylinder head, the compressor should be replaced.
2. Carefully inspect both sides of the head gasket surfaces on the cooling plate (15) for deep gouges and nicks. Also, inspect the cooling plate for any cracks or other damage. If found, the compressor must be replaced.
3. Carefully inspect the valve plate assembly (16) gasket surfaces (both sides) for deep gouges and nicks. Pay particular attention to the gasket surface. An inlet reed valve/gasket (17) is used between the valve plate assembly and crankcase. This gasket surface must be smooth and free of all but the most minor scratches. If excessive marring or gouging is detected, the compressor must be replaced. If large amounts of carbon build-up are present on the two main surfaces, in the two discharge valve holes or between the discharge valve and the discharge seat, the compressor should be replaced.
4. If the unloader assembly has been removed from the cylinder head, the unloader assembly must be serviced using the unloader kit. *See the Maintenance and Service Parts listing in this manual for kit contents and part numbers.*
5. If large amounts of carbon build-up are present on the unloader piston (10) seat or orifice or if the return spring exhibits compression set, the unloader components must be replaced with an unloader kit.

REAR COVER PLATE

Inspect the surface in direct contact with the gasket and rear end cover plate (32). Remove any remaining gasket material from the surface. There should be no gouges in the surface directly in contact with the gasket.

If the rear cover plate (32) has been removed, it must be serviced with the seal kit. *See the Maintenance and Service Parts listing in this manual for kit contents and part numbers.*

REAR END COVER

Check for cracks and external damage. Check the crankshaft rear journal diameter for excessive wear, flat spots or galling. Check the cover plate threaded mounting holes for thread damage. Minor thread chasing is permitted but do not re-cut the threads. Carefully inspect the gasket surface on the back of the rear end cover (25). (Note: This is the surface the rear cover plate is in contact with). Remove any remaining gasket material on the surface. This gasket surface must be smooth and free of all but the most minor scratches. If excessive marring or gouging is detected, the compressor must be replaced.

DISCHARGE JUMPER ASSEMBLY

Inspect the o-ring grooves on the discharge jumper (37) for damage. Inspect the air passageways of the discharge jumper for excessive carbon which would restrict the air flow from the compressor. If the carbon build-up exceeds 1/16" in any of the passageways, the discharge jumper must be replaced with its service kit. *See the Maintenance and Service Parts listing in this manual for kit contents and part numbers.*

Inspect the safety valve (12). If there are signs that the safety valve was "popping off", it should be replaced with the safety valve kit. *See the Maintenance and Service Parts listing in this manual for kit contents and part numbers.*

CRANKCASE

Check the cylinder head gasket surface on the deck (top) of the crankcase (21) for nicks, gouges, and marring. A metal gasket is used to seal the cylinder head to the crankcase. 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 later in this manual.

INCH POUNDS TO FOOT POUNDS

To convert inch pounds (in-lbs) to foot pounds (ft-lbs) of torque, divide inch pounds by 12.

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

FOOT POUNDS TO INCH POUNDS

To convert foot pounds (ft-lbs) to inch pounds (in-lbs) of torque, multiply foot pounds by 12.

Example: 1 Foot Pound x 12 = 12 Inch Pounds

REAR END COVER

1. Install the o-ring (24) on the rear end cover (25).
2. Orient the rear end cover (25) to the crankcase (21) using the reference marks made during disassembly. Carefully install the rear end cover on the crankcase making certain not to damage the crankshaft bearing surface. Note: The rear end cover should be fully seated against the crankcase at this point.
3. Install the four end cover cap screws (26). "Snug" the screws then tighten to 195–213 in-lbs (22-24 N•m) using a crossing pattern.

REAR COVER PLATE

1. Place the rear cover plate gasket (30) onto the rear cover plate (32). Note: This should be the same surface that the old gasket was removed from.
2. Place the gasketed side of the cover plate (32) against the rear end cover (25) making sure to line up the two bolt holes.
3. Install the two cap screws (33) and lock washers (34) into the threaded holes of the end cover and hand tighten both cap screws.
4. Torque the two cap screws (33) to 239–292 in-lbs (27-33 N•m) to secure the rear cover plate (32) to the rear end cover (25).

CRANKCASE COVER

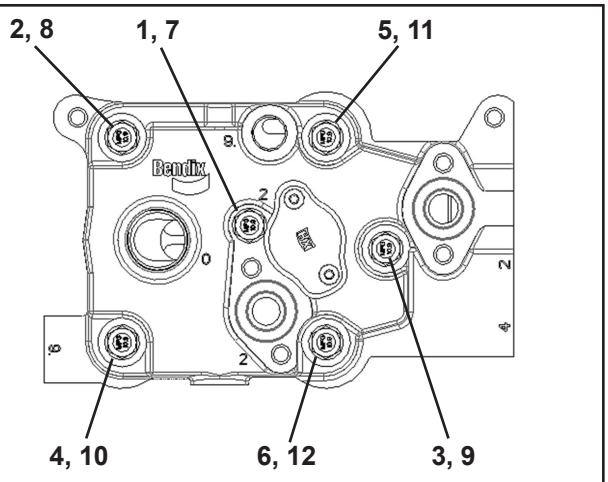
1. Position the crankcase cover gasket (27) on either the crankcase (21) or crankcase cover (28) and install the crankcase cover on the crankcase using the four cap screws. "Snug" all four cap screws then torque to 62-71 in-lbs (7-8 N•m) using a crossing pattern.

CYLINDER HEAD ASSEMBLY

PART ONE: HEAD INSTALLATION

1. Note the position of the protruding crankcase alignment pins (31) on the deck (top) of the crankcase (21). Install the metal inlet reed valve/gasket (17) over the alignment pins on the crankcase.
2. Position the valve plate assembly (16) on the crankcase (21) so that the crankcase alignment pins (31) fit into the corresponding holes in the valve plate assembly.
3. Position and install one of the embossed metal gaskets (14) over the alignment bushings (23) protruding from the cooling plate (15). Position and install the second embossed metal gasket over the alignment bushings on the opposite side of the cooling plate. When properly installed, the outline of the two embossed gaskets will match the outline of the cooling plate.
4. Install the cooling plate (15) onto the valve plate assembly (16) by lining up the alignment bushings (23) on the cooling plate over the oversized countersunk holes of 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 cylinder head (13) over the alignment bushings (23) protruding from the cooling plate. When properly installed, the outline of the cylinder head assembly will match the outline of the cooling plate and valve plate assembly.

   Note: The alignment bushings will only fit into two of the cylinder head bolt holes.
6. Install the six head bolts with washers (1) and snug them (finger tight), then torque the bolts in the sequence specified in Figure 11.



Sequence	Torque (Nm)
1 through 6	20
7 through 12	31-34

FIGURE 11 - ***COMPRESSOR HEAD BOLT TORQUE SEQUENCE***

PART TWO: UNLOADER INSTALLATION

7. Apply a coating of the lubricant—provided in the unloader kit—into the two unloader bores. Apply additional lubricant to the three o-ring grooves on the unloader piston (10). Install the three o-rings (7, 9, 11) into the appropriate o-ring grooves on the unloader piston. Note that the o-ring (7) installs inside the top of the unloader piston. Apply another coating of the lubricant onto the exposed o-ring surfaces and onto the large diameter of the balance piston (6). Install the unloader piston with the pre-installed o-rings into the cylinder head unloader bore making certain not to damage them in the process.
8. Install the balance piston spring (8) in the unloader piston (10).
9. Apply a coating of lubricant to the largest diameter of the balance piston (6). Install the small diameter end of the balance piston through the center of the balance piston spring (8).
10. Install the unloader cover gasket (5) on the cylinder head (13) making certain both screw holes align.
11. Position the unloader cover (4) on top of the balance piston (6) making certain the stamped logo on the unloader cover (4) is visible.
12. Press and hold the unloader cover in place on the cylinder head. Install both unloader cover cap screws (2). Torque the unloader cover cap screws (2) to 62–71 in-lbs (7–8 N•m).

PART THREE: INLET & TOP COOLANT FITTING INSTALLATION

If the inlet fitting (35) and/or the top coolant fitting (36) where previously removed, they should now be installed; otherwise skip step 13.

13. There are two options for the top coolant fitting (36). Identify the fitting you have from the two options shown in Figure 12a and follow the steps for installation.

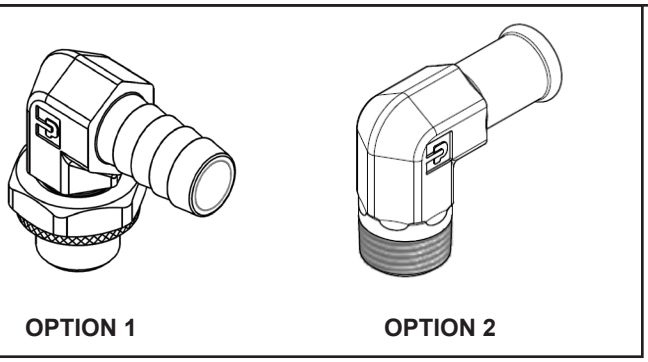
    Option 1: M16 x 1.5–6g (ISO 9974) fitting. Back off lock nut as far as possible. Screw fitting into port until the leading surface of the lock nut contacts the face of the port. Light wrenching may be necessary. To align the tube end to the position as defined in Figure 12, unscrew the fitting by the required amount, but not more than one full turn. Using two wrenches, hold fitting in desired position and tighten locknut to 319–354 in-lbs (36–39.5 N•m).

    Option 2: M16 (tapered thread) fitting. *Note: It may be necessary to apply Teflon tape to the threads of the fitting to aid sealing of the threads*. Install the fitting into the coolant port to "finger tight". Then install 2 additional turns plus turn to position.

    Next, install the inlet fitting (35) into the inlet port of the compressor. Back off the lock nut as far as possible. Make sure the back-up washer is not loose and is pushed up as far as possible. Screw fitting into port until the back-up washer contacts the face of the port. Light wrenching may be necessary. To align the tube end to the position as defined in Figure 12, unscrew the fitting by the required amount, but not more than one full turn. Using two wrenches, hold fitting in desired position and tighten locknut to 575–633 in-lbs (65–72 N•m).

PART FOUR: DISCHARGE JUMPER ASSEMBLY INSTALLATION (REFER TO FIGURE 12)

14. Apply a coating of lubricant to the two discharge jumper o-rings (40) and install the o-rings into the two o-ring grooves on the cylinder head (13).
15. If the safety valve (12) was previously removed from the discharge jumper (41), screw the safety valve into the side port of the discharge jumper (37) and torque to 200–249 in-lbs (22.5–28 N•m).
16. Position the discharge jumper (37) over the cylinder head (13) such that it lines up with the four attachment bolt holes. *Refer to Figure 13* to ensure proper orientation on the cylinder head (13) Note: There is only one way the discharge jumper can be installed on the cylinder head.
17. Install the discharge jumper washer (39) and cap screw (38) in each of the four holes on the discharge jumper (37). Hand tighten the four cap screws and torque in a cross pattern to 115–133 in-lbs (13–15 N•m).



OPTION 1 OPTION 2

FIGURE 12A - ***TOP COOLANT FITTING OPTIONS***

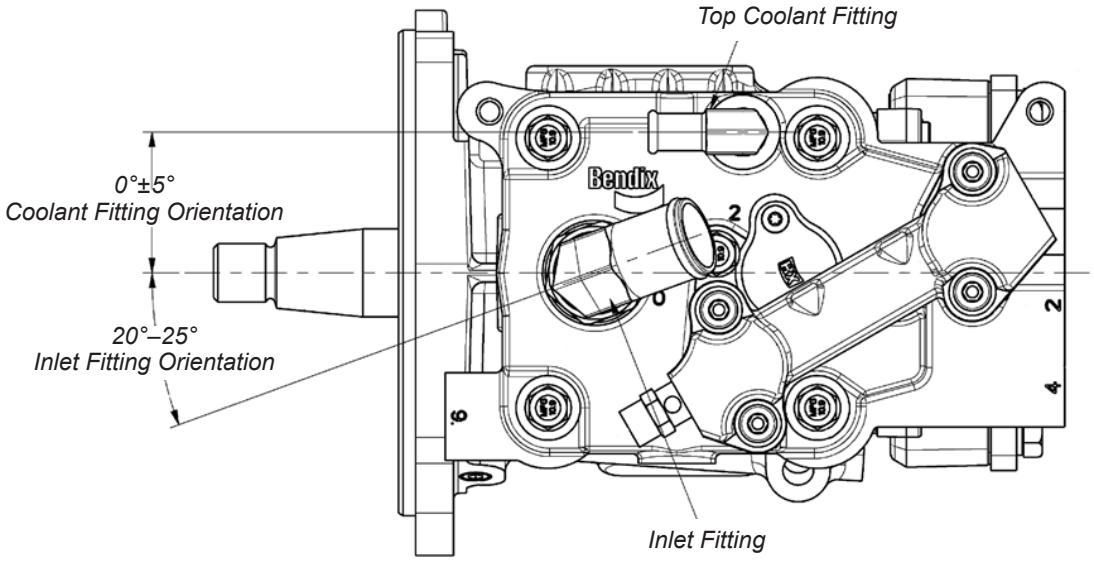


FIGURE 12 - ***REQUIRED ORIENTATION OF THE INLET AND TOP COOLANT FITTINGS***

INSTALLING THE COMPRESSOR

1. Install the front flange o-ring on the pilot of the front flange of the compressor. Gasket sealants are not recommended. Secure the compressor on the engine and tighten the mounting bolts per the Engine Manufacturer's recommended torque requirements.
2. Install any supporting brackets on the compressor in the same position(s) noted and marked during removal. If a rear support bracket was on the original installation, hand tighten the bolts on both ends before torquing the bolts. Note: It is important that the rear support bracket is flush to both surfaces before the bolts are torqued.

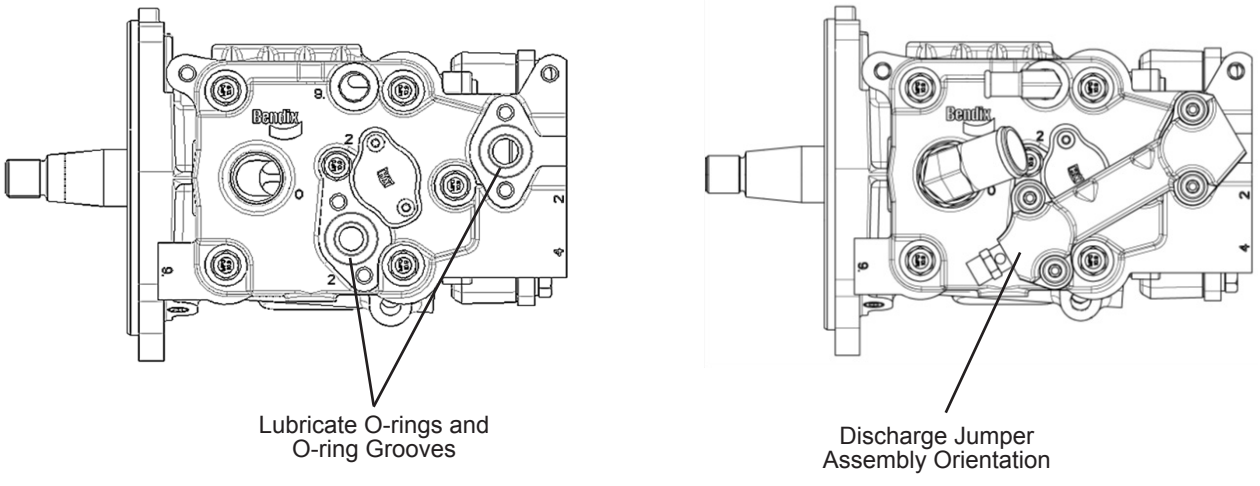


FIGURE 13 - ***DISCHARGE JUMPER ASSEMBLY***

3. 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, the threads are clean, and the fittings are free of corrosion. Replace as necessary.
4. Install the discharge, inlet, coolant and governor adapter fittings, if applicable, in the same position on the compressor noted and marked during disassembly. *See the Torque Specifications for various fitting sizes and types of thread at the rear of this manual.* Tighten all hose clamps.
5. Before returning the vehicle to service, perform the Operation and Leakage Tests specified in this manual. Pay particular attention to all lines and hoses disconnected during the maintenance and check for air, oil, and coolant leaks at compressor connections. Also check for noisy operation.

TESTING THE 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—which is not too difficult—can be run. An engine lubricated compressor must be connected to an oil supply line of at least 15 psi pressure during the test: an oil return line must be installed to keep the crankcase drained. Connect to the compressor discharge port to a reservoir with a volume of 1,500 cubic inches, including the volume of the connecting line. With the compressor operating at 2,100 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® SNA-01™ COMPRESSOR SPECIFICATIONS

Compressor weight.....41 lbs.
Number of cylinders 1
Bore diameter ..... 3.622 in. (92 mm)
Stroke ..... 2.126 in. (54 mm)
Calculated displacement at 1250 RPM .....15.8 CFM
Flow capacity @ 1800 RPM & 120 PSI.....11.6 CFM
Flow capacity @ 3000 RPM & 120 PSI.....16.5 CFM
Approximate horsepower required:
Loaded 1800 RPM at 120 PSIG.....4.6 HP
Unloaded 1800 RPM.....0.8 HP
Minimum coolant flow at maximum RPM ..... 2.5 Gals./Min.
Maximum inlet air temperature .....250°F
Maximum discharge air temperature .....400°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

M8x1.25-6g Cylinder Head .....270–305 in-lbs (30.5–34.5 N•m)
M5x0.75-6g Unloader Cap .....62–71 in-lbs (7-8 N•m)
M8x1.25-6h Discharge Jumper .....115–133 in-lbs (13–15 N•m)
M8x1.25-6g Rear End Cover .....195–213 in-lbs (22–24 N•m)
M6x1.00-6g Crankcase Cover ……..…..62–71 in-lbs (7–8 N•m)

Inlet Port Fitting (Piece No. K092863)
(Refer to Figure 12 for Orientation)
M27x2-6g.....575–633 in-lbs (65–72 N•m)

Discharge Port Fitting
M22x1.5-6H..... 970–1150 in-lbs (110–130 N•m)

Side Water Port Fitting (Straight)
M16 Tapered Thread.....<310 in-lbs (<35 N•m)

Top Water Port Fitting (Elbow)
Piece No. K108817 (Refer to Figure 12 for Orientation)
M16 Tapered Thread. .....2 turns from finger tight (TFFT) plus turn to position
M16x1.5–6g (ISO 9974) ..... 319–354 in-lbs (36–39.5 N•m)

Unloader Port Fittings
M16x1.5 .....230–257 in-lbs (26–29 N•m)

Oil Supply Port Fitting
M12x1.5……142–159 in-lbs (16–18 N•m)

Crankshaft / Drive Gear Attach Nut
M20x1.5-6-RH……..2213–2567 in-lbs (250–290 N•m)

Safety Valve Port
½”-18 NPT.....200-249 in-lbs (22.5–28 N•m)

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.

INDEX

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° fitting, it may be changed to a straight or 45° 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 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.

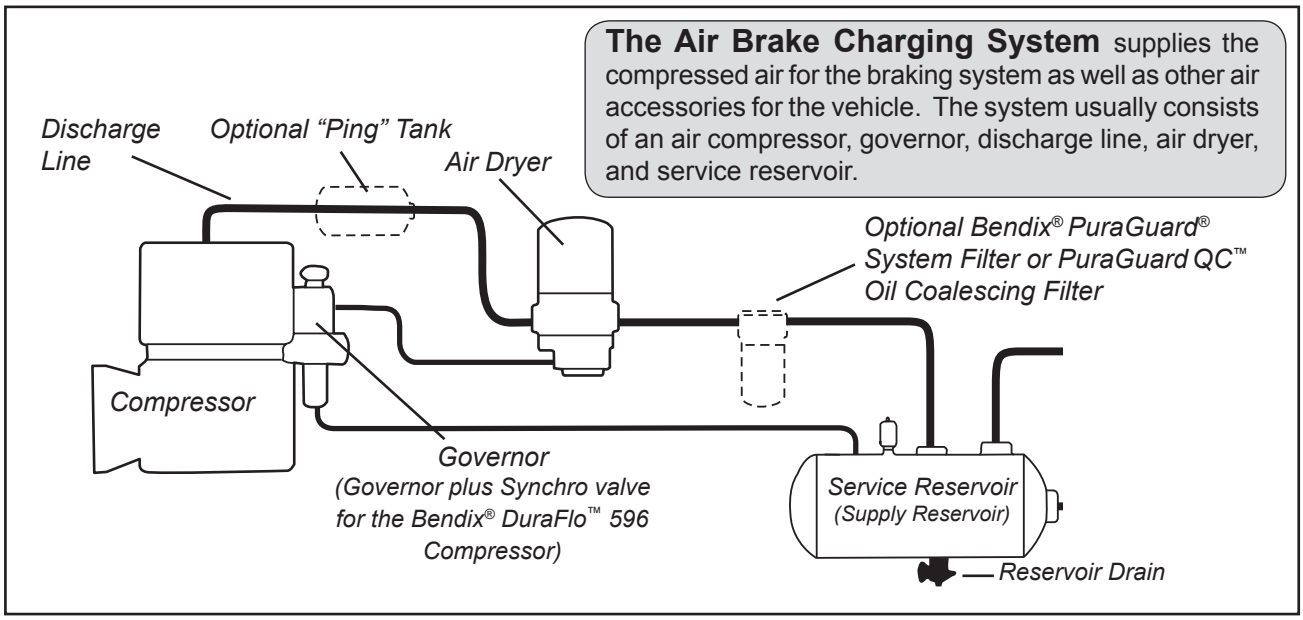
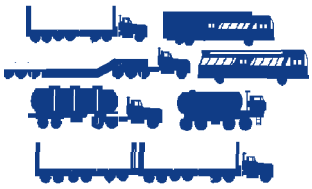


Table A: Maintenance Schedule and Usage Guidelines

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

Vehicle Used for:	No. of Axles	Column 1: Typical Compressors Spec'd (See footnote 7)	Column 2: Discharge Line I.D.	Column 2: Discharge Line Length	Column 3: Recommended Air Dryer Cartridge Replacement[1]	Column 4: Recommended Reservoir Drain Schedule[2]	Column 5: Acceptable Reservoir Oil Contents[3] at Regular Drain Interval
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® Tu-Flo® 750 air compressor Bendix® BA-921® or SNA-01™ air compressor Bendix® Tu-Flo® 550 air compressor Bendix® BA-922®, or DuraFlo 596™ air compressor	1/2 in.	6 ft.	Every 3 Years	Recommended Every Month - Max of every 90 days	Bendix® BASIC™ test acceptable range: 3 oil units per month. See Appendix A.
			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							*For the BASIC Test Kit: Order Bendix P/N 5013711*
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		1/2 in.	12 ft.	Every 2 Years	Every Month	BASIC test acceptable range: 5 oil units per month. See Appendix A.
			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		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 it 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.

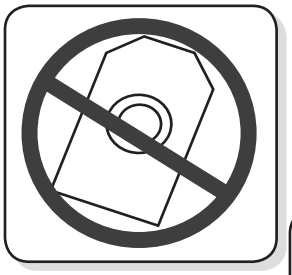
GENERAL SAFETY GUIDELINES

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

When working on or around a vehicle, the following guidelines should be observed AT ALL TIMES:

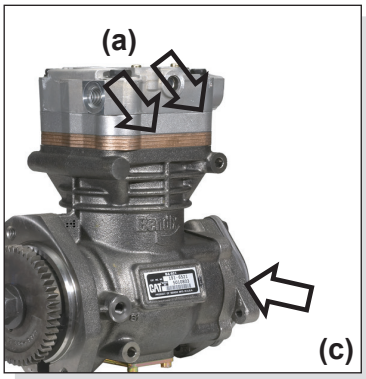
- **Park the vehicle on a level surface, apply the parking brakes and always block the wheels. Always wear personal protection equipment.**
- **Stop the engine and remove the ignition key when working under or around the vehicle. When working in the engine compartment, the engine should be shut off and 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.**
- **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.**
- **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, a Bendix® DRM™ dryer reservoir module, or a Bendix® AD-9si® air dryer, be sure to drain the purge reservoir.**
- **Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.**
- **Never exceed manufacturer's recommended pressures.**
- **Never connect or disconnect a hose or line containing pressure; it may whip and/or cause hazardous airborne dust and dirt particles. Wear eye protection. Slowly open connections with care, and verify that no pressure is present. Never remove a component or plug unless you are certain all system pressure has been depleted.**
- **Use only genuine Bendix® brand replacement parts, components and kits. Replacement hardware, tubing, hose, fittings, wiring, etc. must be of equivalent size, type and strength as original equipment and be designed specifically for such applications and systems.**
- **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.**
- **Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.**
- **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.**
- **The power MUST be temporarily disconnected from the radar sensor whenever any tests USING A DYNAMOMETER are conducted on a vehicle equipped with a Bendix® Wingman® system.**
- **You should consult the vehicle manufacturer's operating and service manuals, and any related literature,**

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.)



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.	⇨ 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. ✓ 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:

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), option 2, 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.

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

? Check

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

⇨ 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.

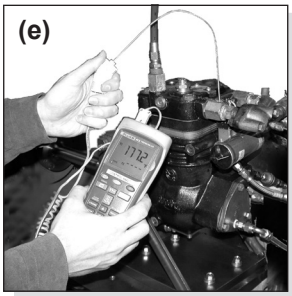
⇨ Go to Test 2 on page **A-14**.

(d) Compressor may be undersized for the application.

⇨ 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).

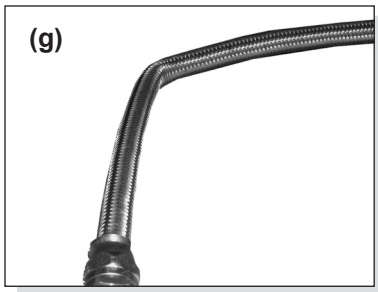
The **duty cycle** is the ratio of time the compressor spends building air to total engine running time. Air compressors are designed to build air (to "run loaded") up to 25% of the time. Higher duty cycles cause conditions that affect air brake charging system performance which may require additional 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.	⇨ Check temperature as outlined in Test 3 on page A-14. If temperatures are normal go to 4.0(h).
	(f) Insufficient coolant flow.	⇨ Inspect the 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.
	(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 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° fitting, it may be changed to a straight or 45° 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).	⇨ Check the compressor air inlet line for restrictions, brittleness, soft or sagging hose conditions etc. Repair as necessary. Inlet line size is 3/4 I.D. 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**

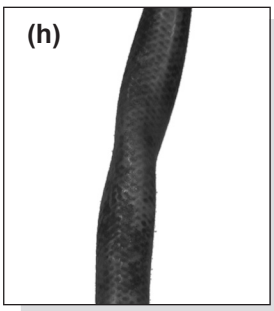


Testing the temperature at the discharge fitting.

Inspecting the coolant hoses.



Kinked discharge line shown.



Partly collapsed inlet line shown.

*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), option 2, 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.

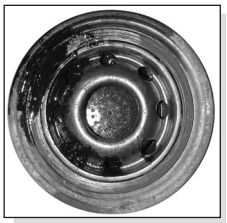
*If a maintained Bendix® PuraGuard® system filter or Bendix® PuraGuard QC™ oil coalescing filter is installed, call 1-800-AIR-BRAKE (1-800-247-2725) and speak to a Tech Team member.

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.

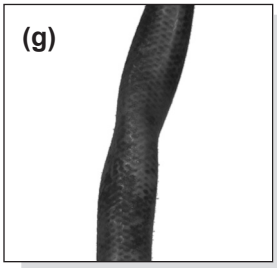
Symptom:	What it may indicate:	What you should do:
6.0 Excessive oil consumption in engine.	A problem with engine or other engine accessory.  The engine service manual has more information.	⇨ See engine service manual. ? Check
7.0 Oil present at air dryer cartridge during maintenance.	Air brake charging system is functioning normally. ✓ Normal  Oil shown leaking from an air dryer cartridge.	⇨ 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	⇨ 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.
	(b) Air brake system leakage.	⇨ Go to Test 2 on page A-14.
	(c) Compressor may be undersized for the application.	⇨ 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.
	(d) Compressor unloader mechanism malfunction.	⇨ Go to Test 6 on page A-15.
	(e) Damaged compressor head gasket.	⇨ 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 reuse 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)	(f) 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 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 the vehicle to service or, if the problem persists, go to 9.0(a). ⇨ The 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° fitting, it may be changed to a straight or 45° 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.
	(g) Restricted air inlet (not enough air to compressor). **? Check**	⇨ Check the 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 the inlet components as needed. Note: Dirt ingestion will damage the 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.

Dash gauges.

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%.



Partly collapsed inlet line shown.

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 the 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

Damaged discharge line shown.

⇨ If the 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.

⇨ 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° fitting, it may be changed to a straight or 45° 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 the air lines and verify the check valves are operating properly.

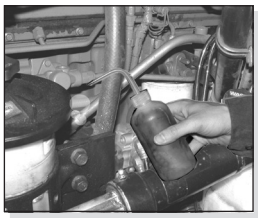
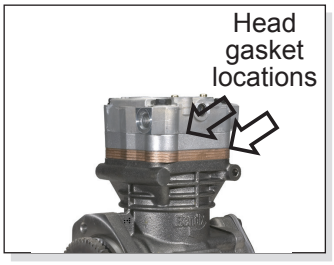
(c) Air dryer lines incorrectly installed. ⇨ Ensure discharge line is installed into the inlet of the air dryer and delivery is routed to the service reservoir.

(d) Compressor safety valve malfunction. ⇨ Verify the 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.

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.	⇨ Inspect the delivery lines to reservoir for restrictions and repair as needed.
	(b) Air dryer safety valve malfunction.	⇨ Verify the relief pressure is at the vehicle or component manufacturer's specifications. Replace if defective.
	(c) Air dryer maintenance not performed.	⇨ See Maintenance Schedule and Usage Guidelines *(Table A, column 3, on page A-3).*
	(d) Air dryer malfunction.	⇨ Verify operation of air dryer. Follow vehicle OE maintenance recommendations and component Service Data information.
	(e) Improper governor control line installation to the reservoir.	⇨ Go to Test 5 on page A-15.
	(f) Governor malfunction.	⇨ Go to Test 4 on page A-15.
13.0 Reservoir safety valve releases air	(a) Reservoir safety valve malfunction.	⇨ Verify the relief pressure is at vehicle or component manufacturer's specifications (typically 150 psi). Replace if defective.
	(b) Governor malfunction.	⇨ Go to Test 4 on page A-15.
	(c) Compressor unloader mechanism malfunction.	⇨ 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.	⇨ Verify operation of air dryer. Follow vehicle OE maintenance recommendations.
	(b) Governor malfunction.	⇨ Go to Test 4 on page A-15.
	(c) Air brake system leakage.	⇨ Go to Test 2 on page A-14.
	(d) Improper governor control line installation to the reservoir.	⇨ 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**	⇨ 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.
	(b) Compressor unloader mechanism malfunction.	⇨ Go to Test 6 on page A-15.
	(c) Air dryer purge valve or delivery check valve malfunction.	⇨ Verify the operation of air dryer. Follow vehicle OE maintenance recommendations and component Service Data information.
	(d) Air brake system leakage.	⇨ Go to Test 2 on page A-14.

Symptom:	What it may indicate:	What you should do:
16.0 Compressor leaks air	(a) Compressor leaks air at connections or ports.	⇨ Check for leaking, damaged or defective compressor fittings, gaskets, etc. Repair or replace as necessary.
 Testing for leaks with soap solution.	(b) Compressor unloader mechanism malfunction.	⇨ Go to Test 6 on page A-15.
	(c) Damaged compressor head gasket(s). 	⇨ 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 reuse the safety valve without testing. See Symptom 12.0(a).
17.0 Compressor leaks coolant	(a) Improperly installed plugs or coolant line fittings.	⇨ Inspect for loose or over-torqued fittings. Reseal and tighten loose fittings and plugs as necessary. If overtorqued fittings and plugs have cracked ports in the head, replace the compressor.
	(b) Damaged compressor head gasket.	⇨ 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).
	(c) Porous compressor head casting.	⇨ 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 (e.g. 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.

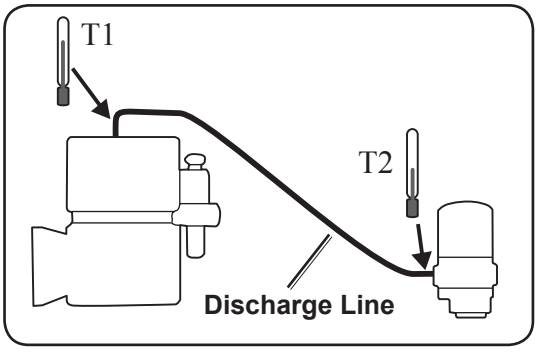
Air leaks can also be found in the charging system, parking brakes, and/or other components - inspect and repair as necessary.

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 Bendix® D-2® governor, verify cut-in and cut-out pressures are within vehicle OEM specification.
3. If the governor is malfunctioning, replace it.

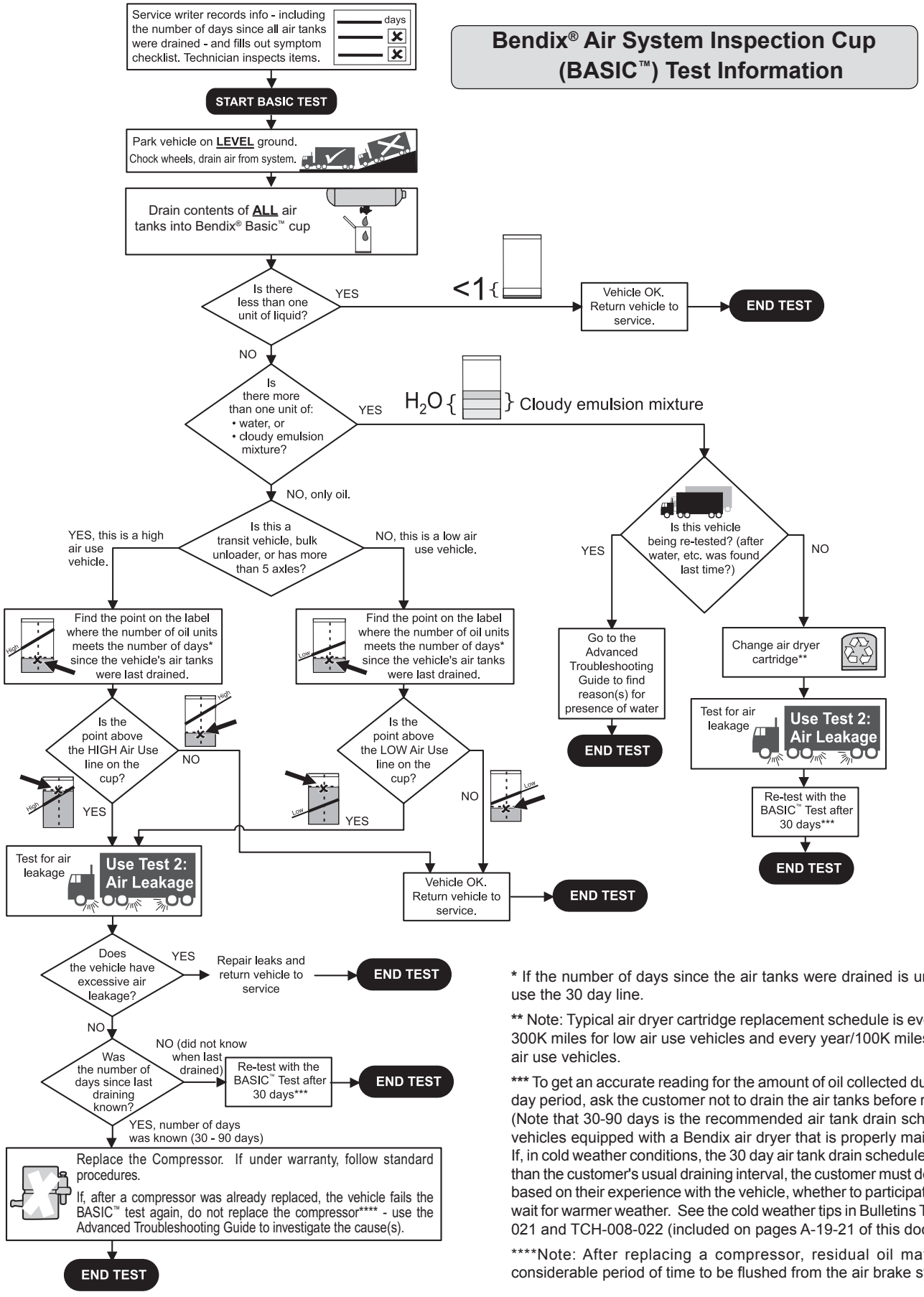
Test 5: Governor Control Line

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.

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-008-021 and TCH-008-022 (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.

Filling in the Checklist for the **B**endix® **A**ir **S**ystem **I**nspection **C**up (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:**

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.

- ❑ 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.

STEP B - Measure the Charging System Contents

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

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.

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.

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).

Filling in the Checklist for the **B**endix® **A**ir **S**ystem **I**nspection **C**up (BASIC™) Test

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

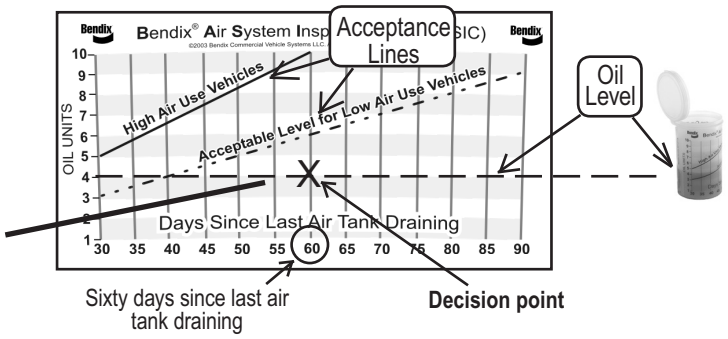
STEP C - How to Use the BASIC™ Test

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

Bendix

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" (BW1396). 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 ensure 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 (e.g. 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 BW1396. 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 www.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 Dos and Don'ts for prevention and thawing.

Dos

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 non-metallic 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.

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