

Advanced Troubleshooting Guide for Air Brake Compressors*

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

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

Introduction to the Air Brake Charging System

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

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

As the atmospheric air is compressed, all the water vapor originally in the air is carried along into the air system, as well as a small amount of the lubricating oil as vapor.

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

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

air dryer. The typical size of a vehicle's discharge line, (see column 2 of Table A on page 3) assumes a compressor with a normal (less than 25%) duty cycle, operating in a temperate climate. See Bendix and/or other air dryer manufacturer guidelines as needed.

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

The discharge line must maintain a **constant slope** down from the compressor to the air dryer inlet fitting to avoid low points where ice may form and block the flow. If, instead, ice blockages occur at the air dryer inlet, insulation may be added here, or if the inlet fitting is a typical 90 degree fitting, it may be changed to a straight or 45 degree fitting. For more information on how to help prevent discharge line freeze-ups, see Bendix Bulletins TCH-08-21 and TCH-08-22 (see pages 20-22). Shorter discharge line lengths or insulation may be required in cold climates.

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

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

The Air Brake Charging System supplies the compressed air for the braking system as well as other air accessories for the vehicle. The system usually consists of an air compressor, governor, discharge line, air dryer, and service reservoir.

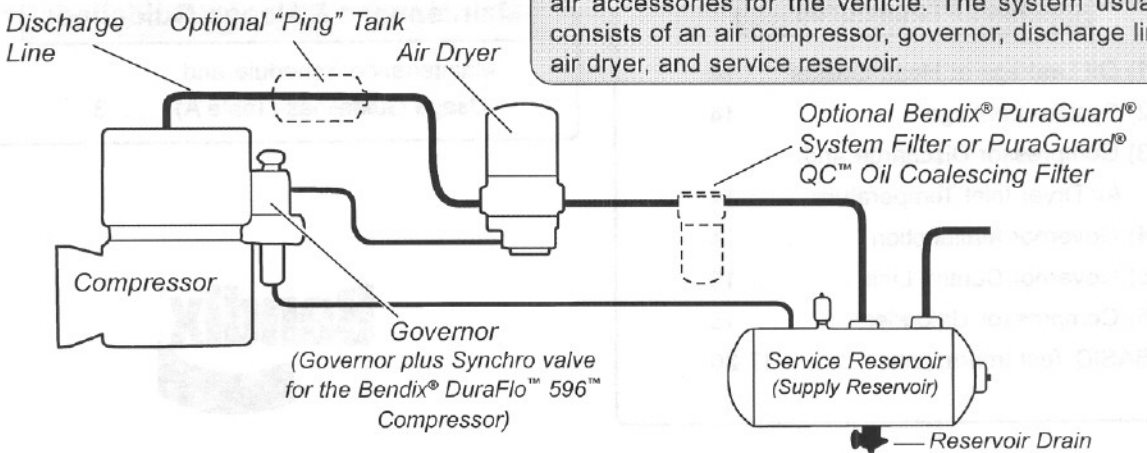


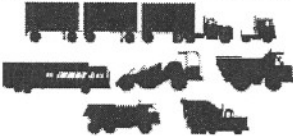



Table A: Maintenance Schedule and Usage Guidelines

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

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

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

Footnotes:

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

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

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

Air Brake Charging System Troubleshooting

How to use this guide:

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

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

Look for:

 **Normal**

Normal - Charging system is working within normal range.




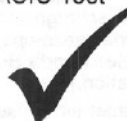
 **Check**

Check - Charging system needs further investigation.

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

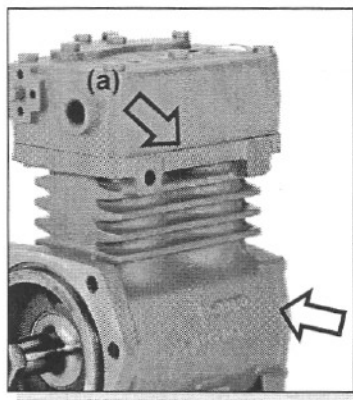
When working on or around a vehicle, the following general precautions should be observed at all times.

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

Symptom:	What it may indicate:	What you should do:
1.0 Oil Test Card Results   	Not a valid test.	<p>Discontinue using this test.</p> <p>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.</p> <p>The Bendix® BASIC test should be the definitive method for judging excessive oil fouling/oil passing. (See Appendix A, on page 17 for a flowchart and expanded explanation of the checklist used when conducting the BASIC test.)</p> 

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 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 gasket 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) and speak to a Tech Team member.)



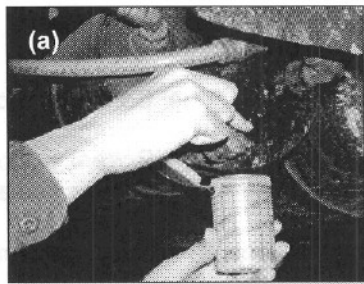
See Table A, on page 3, for maintenance schedule information.

Maintenance

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

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

- (b) If the vehicle maintenance **has been performed** as recommended in Table A on page 3, some oil in the reservoirs is normal.



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

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

? Check

- ⇒ Drain all air tanks into Bendix® BASIC test cup (Bendix Air System Inspection Cup). If less than one unit of reservoir contents is found, the vehicle can be returned to service. **Note: If more than one oil unit of water (or a cloudy emulsion mixture) is present, change the vehicle's air dryer, check for air system leakage (Test 2, on page 14), stop inspection and check again at the next service interval. See the BASIC test kit for full details.** If less than one "oil unit" of water (or water/cloudy emulsion mixture) is present, use the BASIC cup chart on the label of the cup to determine if the amount of oil found is within the acceptable level.
- ⇒ If within the normal range, return the vehicle to service. For vehicles with accessories that are sensitive to small amounts of oil, consider a Bendix® PuraGuard® QC™ oil coalescing filter.
- ⇒ If outside the normal range go to Symptom 4.0(c).
- Also see the Table A on page 3, column 3 for recommended air dryer cartridge replacement schedule.

Duty cycle too high

- (c) Air brake system leakage.

- ⇒ Go to Test 2 on page 14.

- (d) Compressor may be undersized for the application.

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

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.

- ⇒ 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).

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

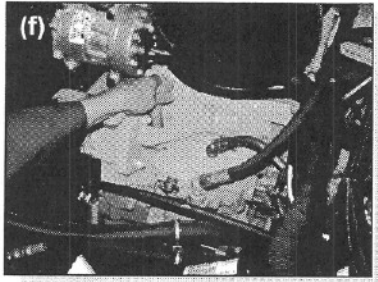
4.0 Oil in Supply or Service Reservoir* (air dryer installed) (continued)

Temperature

- (e) Air compressor discharge and/or air dryer inlet temperature too high.
- (f) Insufficient coolant flow.

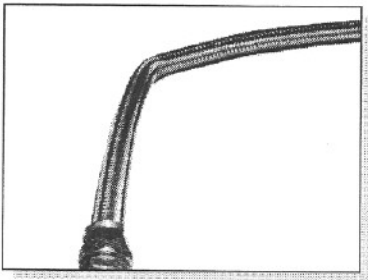


Testing the temperature at the discharge fitting.



Inspecting the coolant hoses.

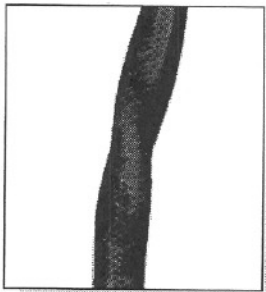
- (g) Restricted discharge line.



Kinked discharge line shown.

Other

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



Partly collapsed inlet line shown.

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

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

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

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

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

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

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

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

? Check

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

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

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



Inspect the engine air cleaner.

- (j) Governor malfunction or setting.
(k) Compressor malfunction.

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

? Check

- ⇒ Go to Test 4 on page 15.

- ⇒ If you found excessive oil present in the service reservoir in step 4.0 (b) above and you did not find any issues in steps 4.0 (c) through 4.0 (j) above, the compressor may be passing oil. Replace compressor. If still under warranty, follow normal warranty process. Note: After replacing a compressor, residual oil may take a considerable period of time to be flushed from the air brake system.

Crankcase Flooding

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

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

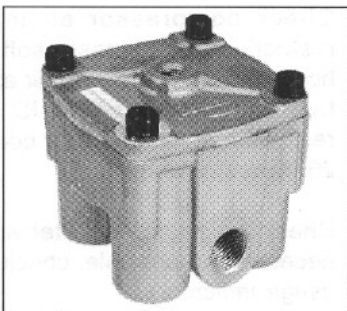
5.0 Oil present at valves (e.g. at exhaust, or seen during servicing).

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

✓ Normal

- ⇒ A small amount of oil does not affect SAE J2024** compliant valves.
- ⇒ Check that regular maintenance is being performed and that the amount of oil in the air tanks (reservoirs) is within the acceptable range shown on the Bendix® BASIC test cup (see also column 5 of Table A on page 3). Return the vehicle to service.

For oil-sensitive systems, see page 2.



Genuine Bendix valves are all SAE J2024 compliant.

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

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

6.0 Excessive oil consumption in engine.

A problem with engine or other engine accessory.

⇒ See engine service manual.



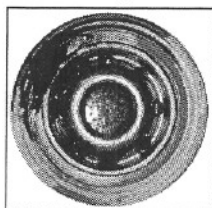
The engine service manual has more information.

? 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 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.

⇒ Follow vehicle O.E. maintenance recommendation for these components.

✓ Normal

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 14.

(c) Compressor may be undersized for the application.

⇒ See Table A, column 1, on page 3 for some typical compressor applications. If the compressor is "too small" for the vehicle's role, for example, where a vehicle's use has changed, then upgrade the compressor. Note: The costs incurred (e.g. installing a larger capacity compressor, etc.) are not covered under original compressor warranty.

(d) Compressor unloader mechanism malfunction.

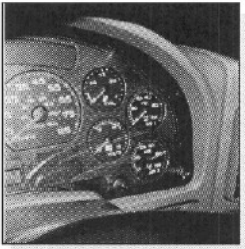
⇒ Go to Test 6 on page 15.

(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 re-use the safety valve without testing. See Symptom 12.0(a).

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

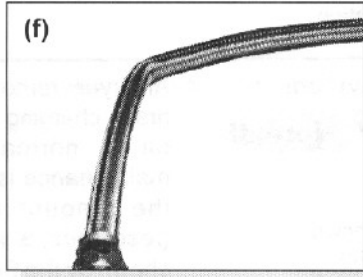
9.0 Air brake charging system seems slow to build pressure. (continued)



Dash gauges.

(f) Restricted discharge line.

? Check



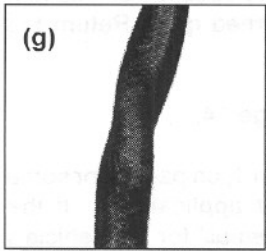
Kinked discharge line shown.

⇒ If discharge line is restricted:

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

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

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



Partly collapsed inlet line shown.

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

? Check

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

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

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

? Check

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

(i) Compressor malfunction.

? Check

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

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

10.0 Air charging system doesn't build air.

- (a) Governor malfunction*.
- (b) Restricted discharge line.
- (c) Air dryer heater malfunction: exhaust port frozen open.
- (d) Compressor malfunction.

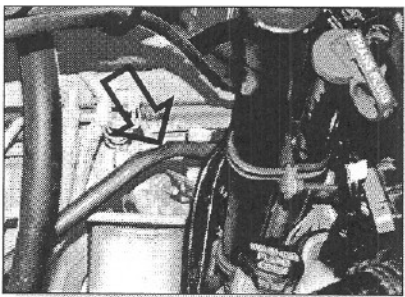
- ⇒ Go to Test 4 on page 15.
- ⇒ See 9.0(f).
- ⇒ Replace air dryer heater.
- ⇒ Replace the compressor only after making certain the preceding conditions do not exist.

* 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 discharge line is restricted:
 - ⇒ By more than 1/16" carbon build up, replace the discharge line (see Table A, column 2, on page 3 for recommended size) and go to Test 3 on page 14.
 - ⇒ By other restrictions (e.g. kinks). Replace the discharge line. See Table A, column 2, on page 3 for recommended size.
- ⇒ The discharge line must maintain a **constant slope** down from the compressor to the air dryer inlet fitting to avoid low points where ice may form and block the flow. If, instead, ice blockages occur at the air dryer inlet, insulation may be added here, or if the inlet fitting is a typical 90 degree fitting, it may be changed to a straight or 45 degree fitting. For more information on how to help prevent discharge line freeze-ups, see Bendix Bulletins TCH-08-21 and TCH-08-22 (Appendix B). Shorter discharge line lengths or insulation may be required in cold climates.

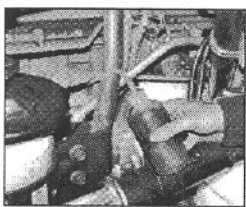
- (b) Downstream air brake system check valves or lines may be blocked or damaged.
- (c) Air dryer lines incorrectly installed.
- (d) Compressor safety valve malfunction.
- (e) Compressor unloader mechanism malfunction.
- (f) Governor malfunction.

- ⇒ Inspect air lines and verify check valves are operating properly.
- ⇒ Ensure discharge line is installed into the inlet of the air dryer and delivery is routed to the service reservoir.
- ⇒ Verify relief pressure is 250 psi. Replace if defective.
- ⇒ Go to Test 6 on page 15.
- ⇒ Go to Test 4 on page 15.

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

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

16.0 Compressor leaks air



Testing for leaks with soap solution.

(a) Compressor leaks air at connections or ports.

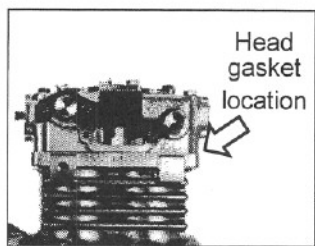
⇒ Check for leaking, damaged or defective compressor fittings, gaskets, etc. Repair or replace as necessary.

(b) Compressor unloader mechanism malfunction.

⇒ Go to Test 6 on page 15.

(c) 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).



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 overtightened 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.

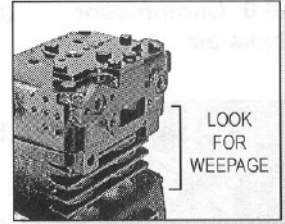
Tests

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 (i.e. more than 4 psi, plus two psi for each additional trailer) during either two minute test, **repair the leaks** and repeat this test to confirm that they have been repaired.

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

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

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

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

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

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

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

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

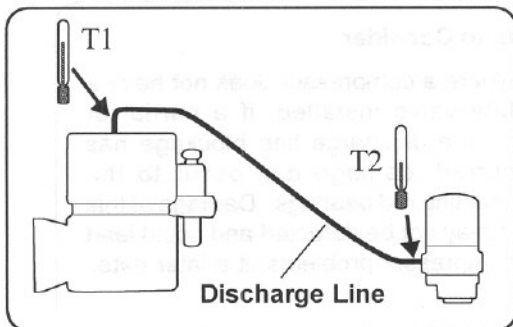
⇒ at the compressor discharge port. (T1).

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

Use a touch probe thermocouple for measuring the temperature.

5. See table below.

6. Retest before returning the vehicle to service.



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

Tests (continued)

Test 4: Governor Malfunction

1. Inspect control lines to and from the governor for restrictions (e.g. collapsed or kinked). Repair as necessary.
2. Using a calibrated external gauge in the supply

reservoir, service reservoir, or reservoir port of the D-2™ governor, verify cut-in and cut-out pressures are within vehicle OEM specification.

3. If the governor is malfunctioning, replace it.

Test 5: Governor Control Line

1. Ensure that the governor control line from the reservoir is located at or near the top of the reservoir. (This line, if located near the bottom of the reservoir, can become blocked or restricted by the reservoir contents e.g. water or ice.)

2. Perform proper reservoir drain intervals and air dryer cartridge maintenance per Maintenance Schedule and Usage Guidelines (Table A on page 3).
3. Return the vehicle to service.

Test 6: Compressor Unloader Leakage

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

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

Tests (continued)

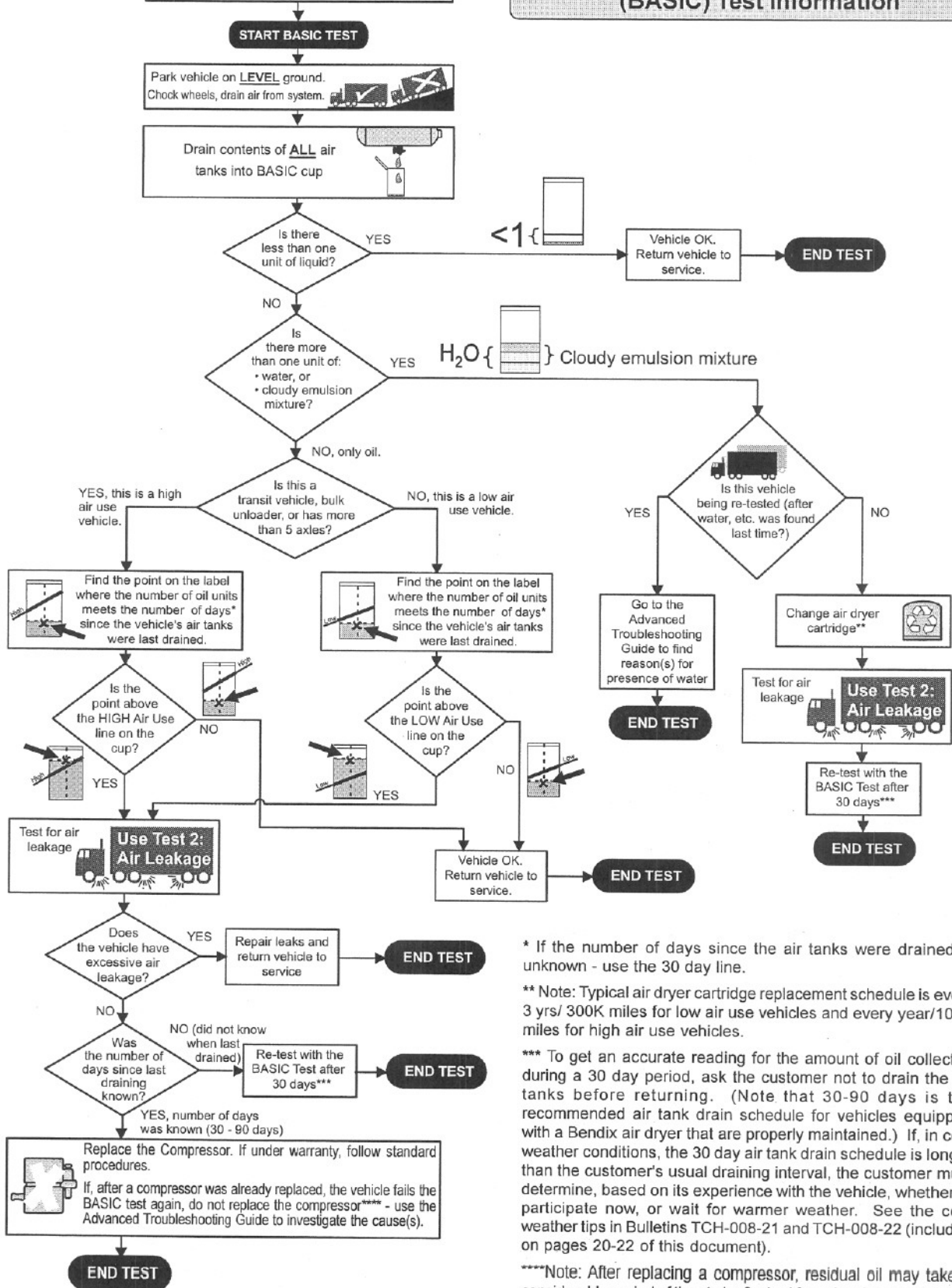
NOTES

<p>the test is a test of the null hypothesis, H_0, against the alternative hypothesis, H_1. The test is a test of the null hypothesis, H_0, against the alternative hypothesis, H_1.</p>	<p>Test 4: Chi-Square Test</p> <p>the test is a test of the null hypothesis, H_0, against the alternative hypothesis, H_1. The test is a test of the null hypothesis, H_0, against the alternative hypothesis, H_1.</p>
<p>the test is a test of the null hypothesis, H_0, against the alternative hypothesis, H_1. The test is a test of the null hypothesis, H_0, against the alternative hypothesis, H_1.</p>	<p>Test 5: F-Test</p> <p>the test is a test of the null hypothesis, H_0, against the alternative hypothesis, H_1. The test is a test of the null hypothesis, H_0, against the alternative hypothesis, H_1.</p>
<p>the test is a test of the null hypothesis, H_0, against the alternative hypothesis, H_1. The test is a test of the null hypothesis, H_0, against the alternative hypothesis, H_1.</p>	<p>Test 6: T-Test</p> <p>the test is a test of the null hypothesis, H_0, against the alternative hypothesis, H_1. The test is a test of the null hypothesis, H_0, against the alternative hypothesis, H_1.</p>
<p>the test is a test of the null hypothesis, H_0, against the alternative hypothesis, H_1. The test is a test of the null hypothesis, H_0, against the alternative hypothesis, H_1.</p>	<p>Test 7: Z-Test</p> <p>the test is a test of the null hypothesis, H_0, against the alternative hypothesis, H_1. The test is a test of the null hypothesis, H_0, against the alternative hypothesis, H_1.</p>

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

Bendix® Air System Inspection Cup (BASIC) Test Information

Service writer records info - including the number of days since all air tanks were drained - and fills out symptom checklist. Technician inspects items.



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

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

*** To get an accurate reading for the amount of oil collected during a 30 day period, ask the customer not to drain the air tanks before returning. (Note that 30-90 days is the recommended air tank drain schedule for vehicles equipped with a Bendix air dryer that are properly maintained.) If, in cold weather conditions, the 30 day air tank drain schedule is longer than the customer's usual draining interval, the customer must determine, based on its experience with the vehicle, whether to participate now, or wait for warmer weather. See the cold weather tips in Bulletins TCH-008-21 and TCH-008-22 (included on pages 20-22 of this document).

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

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

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

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

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

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

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

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

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

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

BASIC test starts here:

STEP A - Select one:

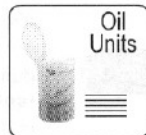
- This is a low air use vehicle: Line haul (single trailer) with 5 or less axles, or
- This is a high air use vehicle: Garbage truck, transit bus, bulk unloader, or line haul with 6 or more axles.

Then go to Step B.

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

STEP B - Measure the Charging System Contents

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



STOP + Ck.

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

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

Otherwise, go to Step C.

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

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

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

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

STEP C - How to Use the BASIC Test

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

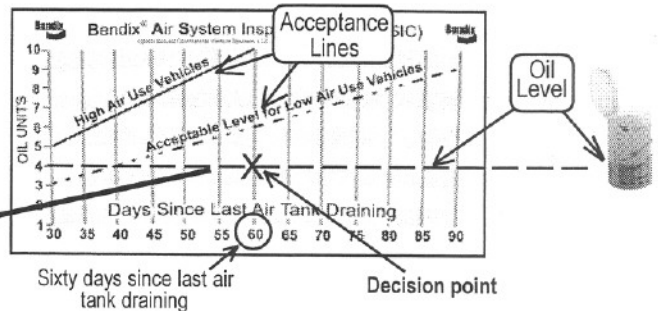
1. Record days since air tanks were last drained. _____ days	2. Record amount of oil found: _____ units	3. Action to take
---	---	-------------------

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

BASIC Test Example

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

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



STEP D - Air Brake System Leakage Test

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

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

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

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

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

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

Replace the compressor.

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

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

Technical Bulletin



Bulletin No.: TCH-008-021

Effective Date: 11/1/92

Page: 1 of 2

Subject: Air Brake System - Cold Weather Operation Tips

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

Engine Idling

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

Discharge Lines

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

Typical P&D, School Bus and Line Haul

The maximum discharge line length is 16 feet.

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

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

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

The maximum discharge line length is 16 feet.

Length	I.D. min.	Other Requirements
10-16 ft.	½ in.	None

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

System Leakage

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

Reservoir Draining (System Without Air Dryer)

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

Alcohol Evaporator or Injector Systems

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

Air Dryers

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

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

Technical Bulletin



Bulletin No.: TCH-008-022

Effective Date: 1/1/1994

Page: 1 of 2

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

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

Thawing Frozen Air Lines

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

Do's

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

Don'ts

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

Supporting Air and Electrical Lines

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

Automatic Drain Valves (System without Air Dryer)

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

