Bendix® BP-1™ Brake Proportioning Valves

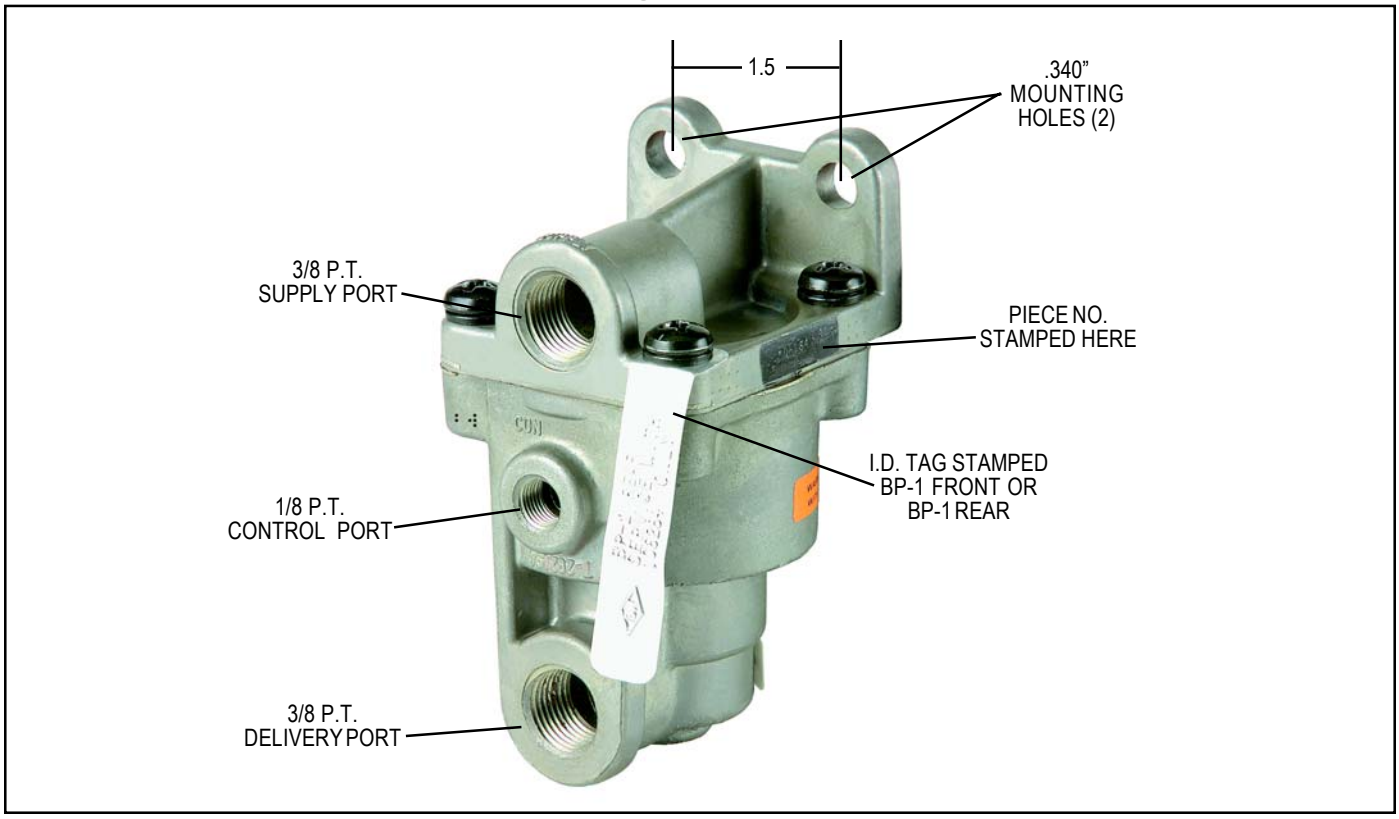


FIGURE 1 BP-1™ BRAKE PROPORTIONING VALVES

DESCRIPTION OF THE BP-1™ VALVES

The BP-1™ brake proportioning valves are incorporated into the air brake systems to improve the controllability and reduce the stopping distance of bobtail tractors during braking. BP-1™, front and rear, valves reacting to the lack of pressure in the trailer supply line reduce the braking effort on the rear axles and increase the braking effort on the front axle of tractors operating in the bobtail mode. Treadle application force during bobtail operation resembles treadle application force during normal operation with a connected trailer.

A typical brake proportioning system is shown in *Figure* 6. The system consists of a front and a rear brake proportioning valve and a TR-3™ valve.

Caution: The BP-1™ front and BP-1™ rear valves are similar in appearance but are NOT interchangeable. Note identification tag attached to one of the cover screws (Figure 1); it will be stamped 'BP-1 Front' or 'BP-1 Rear'. The BP-1™ rear valve can be used without installing a BP-1™ front valve, providing the vehicle does not have a front axle ratio valve. If the vehicle has a front axle ratio valve, the ratio valve must be replaced with a BP-1™ front valve.

OPERATION

A tractor that is equipped with the BP-1™ rear brake proportioning valve and TR-3™ valve only will respond in the following manner. With the trailer supply valve pushed in and a service brake application made, equal pressure (100% of service application) will be delivered to each axle of the tractor and trailer. When the trailer is disconnected from the tractor and the trailer supply valve is pulled out, the front axle of the tractor will receive 100% of the service brake application pressure and the rear axle or axles approximately 25%. As application pressure increases, the differences between the front axle and the rear axle(s) pressures diminish.

A tractor that is equipped with both a front and rear axle brake proportioning valve with the trailer supply valve activated (tractor/trailer mode) will experience 50% of service brake application pressure on the front axle up to 40 psi. With service applications above 40 psi the differential between the supply and delivery diminishes until at 60 psi it is a one-to-one ratio. The rear axles receive 100% of the service application. With the trailer supply valve pulled out, (bobtail mode) the front axle of the tractor will receive 100% of service brake application and the rear axle(s) approximately 25% during normal brake applications. As application pressure increases, the differences between the front axle and rear axle(s) pressures diminishes.

BP-1™ REAR VALVE *(REFER TO FIGURE 4)*

When the trailer supply valve is activated, air pressure is delivered to the trailer via the supply line. At the same time air is delivered to the TR-3™ inversion valve which exhausts the air to the control port of the BP-1™ valve and a brake application is made, air entering the supply port works upon the total area of the upper and inner pistons and delivery pressure equals supply pressure. See *Figure* 2, full delivery mode.

With the trailer supply valve released, air pressure in the supply line to the trailer is exhausted to atmosphere. At the same time the air pressure to the control port of the TR-3™ inversion valve is also exhausted. This sequence causes full reservoir pressure to be delivered to the control port of the BP-1™ rear valve. This air is contained on the underside of the upper piston and when a brake application is made the air entering the supply port of the BP-1™ rear valve can only affect the surface of the lower and inner pistons. Due to the reduced area of the lower and inner pistons, the valve delivers approximately 25% of the supply pressure to the relay valve. See *Figure* 2, limiting mode. In addition, spring #8, *Figure 4* causes the lower piston to be initially held open until initial delivery pressure closes the lower piston and the valve will limit normally. The purpose of this initial delivery is to offset the relay valve crack pressure when the vehicle is operating bobtailed and enhance the performance of the proportioning system.

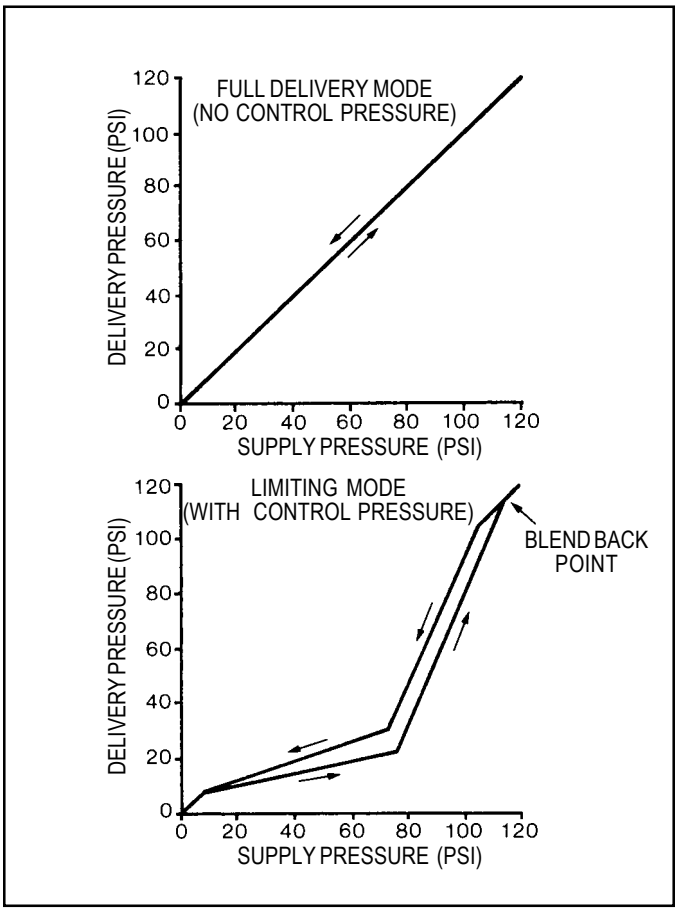


FIGURE 2 PERFORMANCE CURVE FOR NOMINAL BP-1™ BRAKE PROPORTIONING REAR VALVE

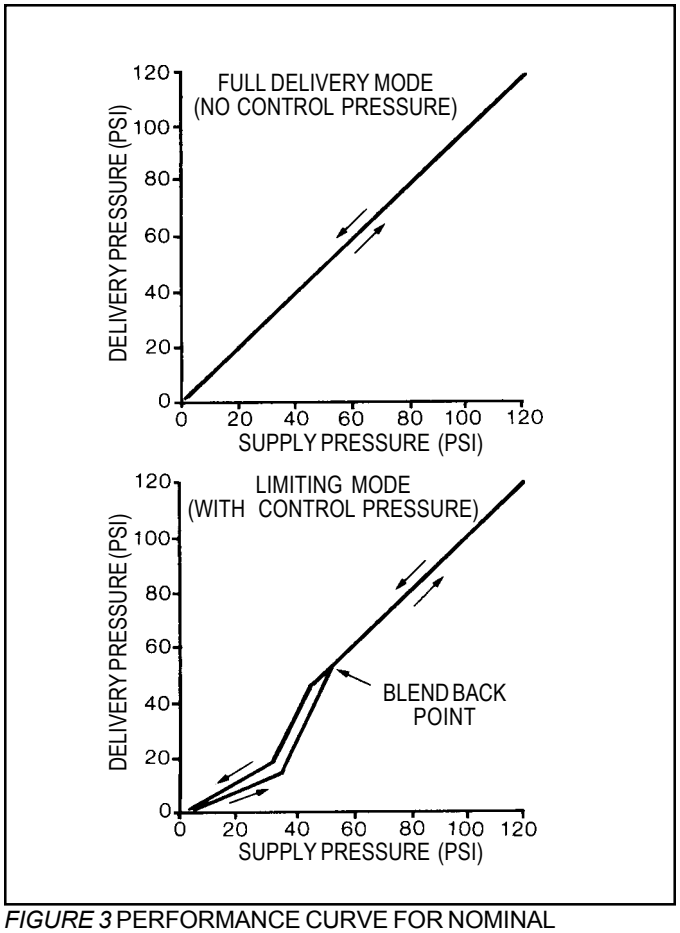
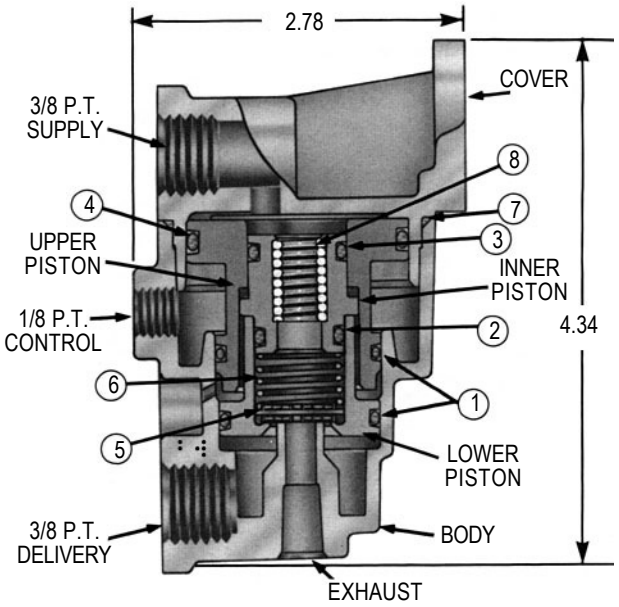


FIGURE 3 PERFORMANCE CURVE FOR NOMINAL BP-1™ BRAKE PROPORTIONING FRONT VALVE

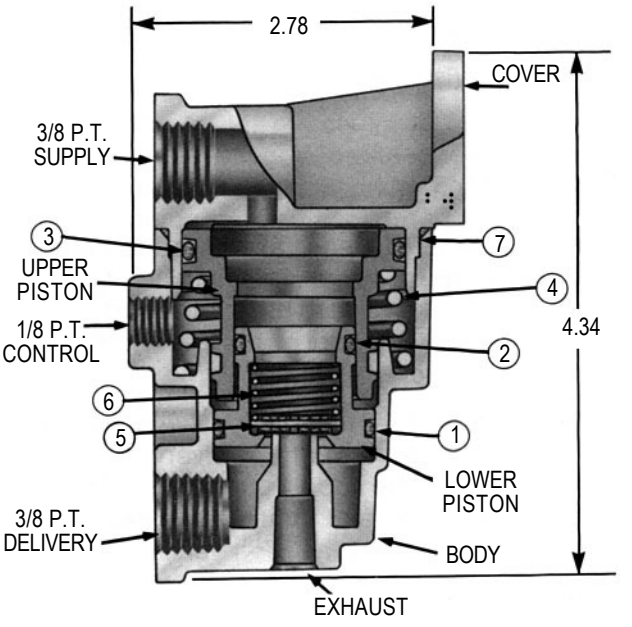
BP-1™ FRONT VALVE *(REFER TO FIGURE 5)*

When the trailer supply valve is activated air is supplied to the trailer via the supply line at the same time air is delivered to the TR-3™ inversion valve which exhausts the air to the control port of the BP-1™ front brake proportioning valve. With air pressure removed from the control port of the BP-1™ valve and a brake application is made, air entering the supply port works upon the total surface area of the upper and lower piston. The upper piston is restricted by the piston spring up to 40 psi; therefore, brake applications up to 40 psi can only displace the lower piston, which due to its surface area



Key	Description	Qty.			
1	O-Ring	2	5	Inlet/Exhaust Valve	1
2	O-Ring	1	6	Spring	1
3	O-Ring	1	7	Sealing Ring	1
4	O-Ring	1	8	Spring	1

FIGURE 4 BP-1™ REAR BRAKE PROPORTIONING VALVE CUTAWAY VIEW



Key	Description	Qty.			
1	O-Ring	1	4	Spring	1
2	O-Ring	1	5	Inlet/Exhaust Valve	1
3	O-Ring	1	6	Spring	1
			7	Sealing Ring	1

FIGURE 5 BP-1™ FRONT BRAKE PROPORTIONING VALVE CUTAWAY VIEW

delivers 50% of the service application to the actuators. Service pressures above 40 psi begin to displace the upper piston and the differential between the supply and delivery diminishes until at 60 psi the spring force under the upper piston is totally overcome and the valve delivers a one-to-one ratio. See *Figure 3,* limiting mode.

With the trailer supply valve released, air pressure to the trailer is exhausted to atmosphere. At the same time the air pressure to the control port of the TR-3™ inversion valve is also exhausted. This sequence causes full reservoir pressure to be delivered to the control port of the BP-1™ valves. The air entering the control port of the BP-1™ front valve acts upon the lower piston, closing the exhaust and holding the inlet open. In this position when a service brake application is made, 100% of the pressure received at the supply port of the BP-1™ front valve is delivered to the actuators on the front axle. See *Figure 3,* full delivery mode.

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.**

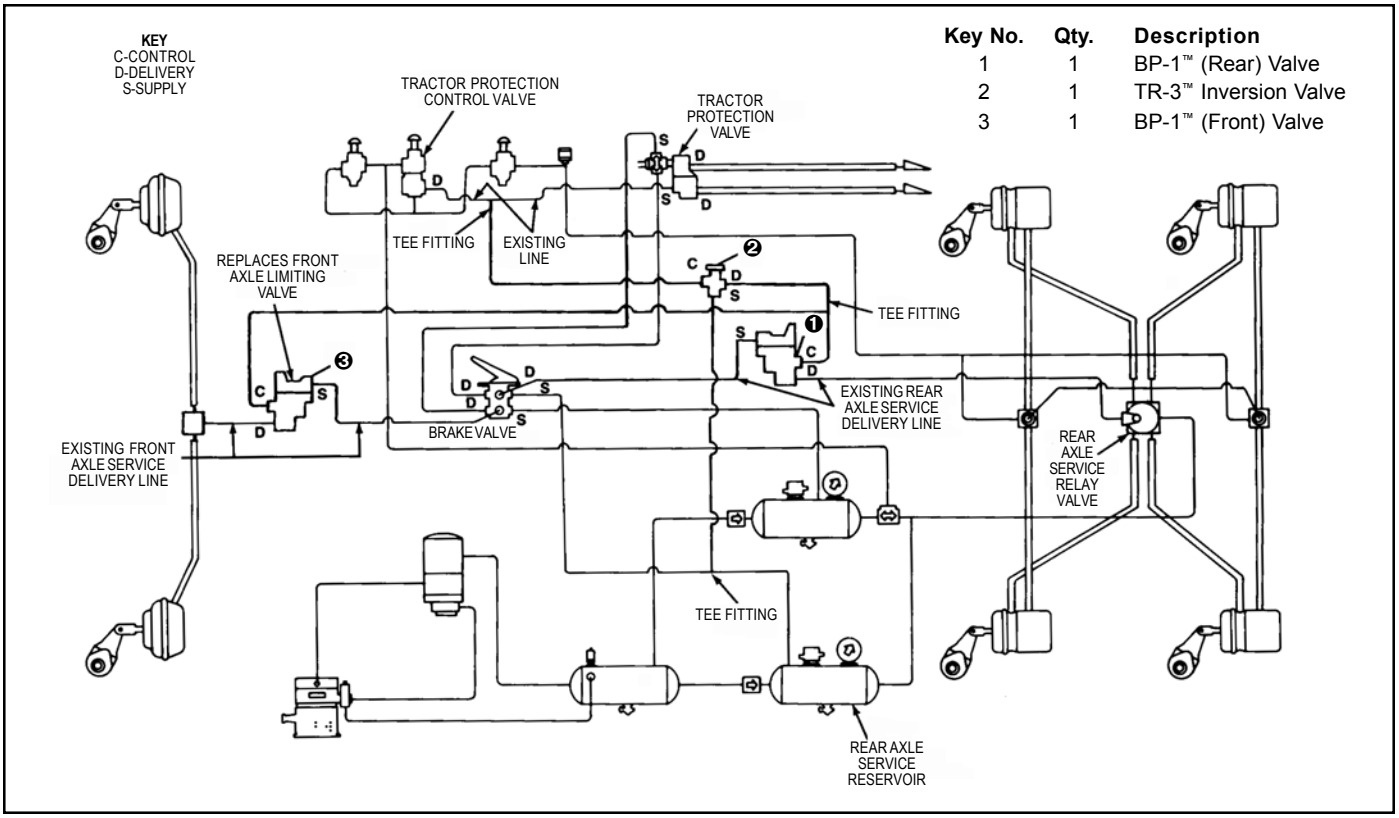


FIGURE 6 TYPICAL INSTALLATION SCHEMATIC OF BRAKE PROPORTIONING SYSTEM

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.**

INSTALLATION *(REFER TO FIGURE 6)*

1. The vehicle being fitted with a BP-1™ rear brake proportioning valve must be equipped with a rear axle service relay valve. It cannot be installed on a vehicle utilizing a quick release valve system without a relay valve.
2. For vehicles equipped with a front axle service ratio or limiting valve (such as the Bendix® LQ-4™ valve) it must be removed and replaced by the BP-1™ front valve provided in kit #209924.

Caution: *The front and rear BP-1™ valves are not interchangeable. They are identified with a metal tag stamped 'BP-1 Front' or 'BP-1 Rear' attached to one of the cap screws on the cover.*

3. Mount the BP-1™ rear valve and the TR-3™ inversion valve in a protected area that is convenient to the service line between the brake valve and the relay valve.
4. Install the BP-1™ rear valve into the service line from the brake valve. Connect the delivery line from the brake valve to the supply port of the BP-1™ valve and the delivery port of the BP-1™ valve to the control port on the relay valve.
5. Connect the TR-3™ inversion valve as follows. Tee the control port to the delivery of the trailer supply valve, the supply port to the supply line of the brake valve, and connect the delivery port to the control port of the BP-1™ valve.

Note: *If vehicle does not have a front axle ratio or limiting valve, proceed to "Operational Checks". If vehicle has a front axle ratio or limiting valve, continue with Step 6.*

6. Remove the existing front axle ratio or limiting valve and replace it with the BP-1™ front valve. Connect the front axle brake valve delivery line to the supply port of the BP-1™ valve, the delivery port of the BP-1™ valve to the front axle actuators, and the control port of the BP-1™ valve to the delivery of the TR-3™ inversion valve.

OPERATIONAL CHECKS

After components have been installed and all connections made, perform the following checks.

1. With the trailer supply valve pulled out (bobtail running position) install two air gauges in the service system; one at an actuator on the front axle and one at an actuator on a rear axle.

2. Build system pressure to governor cut-out setting.
3. Make a service brake application with the foot valve and have another person or persons observe the gauges. When the front axle gauge reaches a 40 psi application the rear axle gauge should read approximately 10-20 psi depending on rear axle relay valve differential. The differential between the front axle and rear axles will decrease as the application pressure is increased.
4. For vehicles without a front axle service ratio or limiting valve with the trailer connected, push the trailer supply valve in (applied position) and repeat check made in Step 3. Gauges should read approximately equal throughout range of service applications. For vehicles with a BP-1™ front valve push the trailer supply valve in (applied position) and repeat check made in Step 3. When the front axle gauge reads 20 psi, the rear axle gauge should read approximately 40 psi. As system pressure increases, the differential between the front and rear axles diminishes.
5. Test drive the vehicle in a safe area at slow speed and with the trailer supply valve in the bobtail position make several brake applications to become familiar with the brake characteristics prior to placing the unit back into service.

PREVENTIVE MAINTENANCE

Important: Review the Bendix Warranty Policy before performing any intrusive maintenance procedures. A warranty may be voided if intrusive maintenance is performed during the warranty period.

No two vehicles operate under identical conditions, as a result, maintenance intervals may vary. Experience is a valuable guide in determining the best maintenance interval for air brake system components. At a minimum, the BP-1™ valve should be inspected every 6 months or 1500 operating hours, whichever comes first, for proper operation. Should be BP-1™ valve not meet the elements of the operational tests noted in this document, further investigation and service of the valve may be required.

REMOVAL OF THE BP-1™ REAR VALVE FROM VEHICLE

1. Secure the vehicle on a level surface by means other than the brakes.
2. Drain the air system completely making sure all reservoirs are at atmospheric pressure.
3. Remove and identify the air lines from the BP-1™ rear valve. This valve is usually located along the frame rail between the brake valve and the rear axle.
4. Remove the two bolts attaching the BP-1™ rear valve to the vehicle and move the valve to a bench.
5. Clean the exterior of the valve taking care to prevent contaminates from entering the open ports of the valve.

DISASSEMBLY OF THE BP-1™ REAR VALVE

(REFER TO FIGURE 4)

1. Remove the four Sems screws from the cover. Retain the screws and the metal tag with 'BP-1 Rear' stamped on it. Separate the cover from the body. Remove and discard o-ring(7).
2. Remove the spring (8) from the I.D. of the inner piston, remove the upper piston from the body and push the inner piston out of the center of the upper piston.
3. Remove the lower piston from the body of the BP-1™ rear valve and tip the piston over to remove the spring(6) and the inlet/exhaust valve(5).
4. Remove the o-rings (1), (2), (3), (4) from the pistons.

CLEAN AND INSPECT

1. Wipe the interior of the cover, body, and the pistons with a clean dry cloth to remove any contaminates.
2. Visually inspect all components for cracks, scoring, or damage of any kind. If any of these conditions exist, the valve should be replaced.

ASSEMBLY

1. Coat the bore surfaces of the cover, body, and upper piston with a light coating of silicone lubricant.
2. Lubricate the six o-rings with the same material used in Step 1.
3. Install the o-rings onto the pistons and the cover as shown in Figure 4.
4. Install the inlet/exhaust valve into the bore of the lower piston. Place the spring(6) on top of the inlet/exhaust valve.
5. Install the inner piston into the bore of the upper piston and then place the lower piston into the bottom of the upper piston.
6. Place the piston assemblies into the body of the valve and install the spring (8) into the I.D. of the inner piston as shown in Figure 4.
7. Place the cover with o-ring(7). in place onto the body with the supply port directly above the control port.
8. Install the four Sems screws and torque to 50-80 inch pounds.

Note: Be sure that the identification tag stamped 'BP-1 Rear' has been reinstalled on one of the screws.

9. Reinstall the BP-1™ rear valve on the vehicle and reconnect the airlines as identified in 'Removal' instructions.
10. Refer to section titled 'Operational Checks'.

REMOVAL OF BP-1™ FRONT VALVE FROM VEHICLE

1. Secure the vehicle on a level surface by means other than the brakes.
2. Drain the air system completely making sure all reservoirs are at atmospheric pressure.
3. Remove and identify the air lines from the BP-1™ front valve. The BP-1™ front valve is usually located along the frame rail between the brake valve and front axle.
4. Remove the two bolts attaching the BP-1™ front valve to the vehicle and move the valve to a bench.
5. Clean the exterior of the valve taking care to prevent contaminates from entering the open ports of the valve.

DISASSEMBLY OF BP-1™ FRONT VALVE

(REFER TO FIGURE 5)

1. Remove the four Sems screws from the cover. *Caution: Hold cover down against spring load and release gently when screws are removed. Retain the screws and the metal tag with 'BP-1 Front' stamped on it. Separate the cover from the body. Remove and discard o-ring(7).*
2. Remove the upper piston from the cover and the piston spring(4) and lower piston from the body.
3. With a pair of needle nose pliers grasp the end of the valve spring(6) inside the lower piston and remove by pulling and turning the spring in a clockwise manner.
4. Remove the inlet/exhaust valve(5) from the lower piston.
5. Remove the o-rings(1), (2), (3) from the pistons.

CLEAN & INSPECT

1. Wipe the interior of the body, cover and the pistons with a clean dry cloth to remove any contaminates.
2. Visually inspect all components for cracks, scoring, or damage of any kind. If any of these conditions exist, the valve should be replaced.

ASSEMBLY (REFER TO FIGURE 5)

1. Coat bore surfaces of both the cover and the body with a light film of silicone lubricant.
2. Lubricate the four o-rings in kit with the same material as Step 1.
3. Install o-rings(1) and (2) on the lower piston, o-ring(3) on the upper piston and o-ring(7) on the cover. Refer to Figure 4.
4. Install the large end of the upper piston into the bore of the cover of the valve.
5. Place the inlet/exhaust valve(5) into the I.D. of the lower piston and retain with valve spring(6). Use needle nose pliers to install spring(6) by grasping spring on the bar that intersects the end of the spring and twisting in a clockwise motion while pressing down.

Caution: Be sure inlet/exhaust valve is seated flat against the bottom of the piston *and the* spring is fully seated below the step on the I.D. of the piston wall. Refer to Figure 5.

6. Install the lower piston assembly into the body of the valve. (Large end to enter the bore first.)
7. Install the piston spring into the body of the valve. (Large diameter of the spring to enter first.)
8. Place the cover and upper piston onto the body so that the supply port is directly above the control port. Place the valve on a firm surface and compress the spring by pushing down on the cover. Hold in this position and install two of the four 1/4" Sems screws.
9. Place the metal tag stamped 'BP-1 Front' onto one of the remaining 1/4" Sems screws. Install all Sems screws and torque to 50-80 inch pounds.
10. Reinstall the BP-1™ front valve on the vehicle and reconnect the air lines as identified in 'Removal' instructions.
11. Refer to section titled 'Operational Checks'.