BODY BUILDER INSTRUCTIONS

Mack Trucks

Body builder; Brakes and Air Systems
MD
Section 5

Introduction

This information provides design and function, specification and procedure details for Brake and Air Systems for MACK vehicles.

Note: We have attempted to cover as much information as possible. However, this information does not cover all the unique variations that a vehicle chassis may present. Note that illustrations are typical but may not reflect all the variations of assembly.
.
All data provided is based on information that was current at time of release. However, **this information is subject to change without notice** .

Contents:

Air Brake System

Air Brake System MVSS Requirements

MVSS Compliance

As manufactured by Mack Trucks, Inc., the air brake system on MACK chassis (both incomplete and complete) comply with the applicable requirements of U.S. Federal and Canada Motor Vehicle Safety Standards (MVSS) 106, Brake Hoses, and 121, Air Brake Systems. Any change or addition to the system may cause the vehicle to no longer be in compliance with these MVSS.

MVSS 121 requirements cover (but are not limited to) the following:

- Air compressor build-up time
- Air reservoir volume
- Service brake stopping distance
- Brake actuation time
- Brake release time
- Parking brake hold on grades
- Emergency brake stopping distance

For a complete list of certification requirements, refer to U.S. Federal MVSS 121 or Canada MVSS 121. These motor vehicle safety standards can be accessed at the following web addresses:

- **Federal Motor Vehicle Safety Standards** https://www.gpo.gov/
- **Canada Motor Vehicle Safety Standards** http://www.tc.gc.ca/eng/acts-regulations/regulations-crc-c1038.htm

It is the responsibility of the body/equipment installer/alterer to ensure that the MACK vehicle remains in compliance with applicable MVSS. It is also the responsibility of the body/equipment installer/alterer to comply with applicable vehicle certification regulations.

Air Brake System Truck Tractor

There are basic differences between straight truck and truck tractor air systems. On a straight truck, a spring brake control valve is added to the emergency brake air circuit. This gives the driver modulated control of the spring brakes through the treadle valve in the event of a primary system air loss. Also, spring brake cylinders are installed on both axles of a tandem rear axle unit so that if there is a partial air system pressure loss, the emergency brake system will stop the vehicle within the required stopping distance, and also to meet parking brake system requirements.

A truck air system is designed to be operated as that of a truck, and a truck tractor air system is designed to be operated as that of a truck tractor. When converting chassis for use other than as originally intended (e.g., converting a truck tractor to a truck), the air system must also be changed to ensure that the vehicle remains in compliance with MVSS. Contact MACK Trucks, Inc. Product Support for more information.

Air Compressor Capacity

If increased air system volume is necessary, it is also necessary to determine if the air compressor has the capacity to supply the air system without having to run in the loaded mode (compressing) for long periods of time. Motor Vehicle Safety Standards (MVSS) 121 requires that the air compressor must be able to increase pressure in the supply and service (primary and secondary) reservoirs from 586 – 690 kPa (85–100 psi), with the engine running at maximum governed RPM, in a specific amount of time, depending on required and actual reservoir capacity. If the existing compressor cannot accomplish this, a larger compressor must be used. First, however, make sure that an air compressor malfunction or other type of problem with the air system is not causing the slow build-up time.

Build-up time may be calculated as shown.

$$\textbf{Build-up Time} = \frac{\textbf{Actual Reservoir Capacity}}{\textbf{Required Reservoir Capacity}} \textbf{ x 25}$$

Example:

$$\textbf{Build-up Time} = \frac{\textbf{7500}}{\textbf{6900}} \textbf{ x 25}$$

$$\textbf{Build-up Time = 1.087 x 25}$$

$$\textbf{Build-up Time = 27.2 Seconds}$$

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Calculating Air System Build-up Time

Air Solenoid Valves

MACK chassis now incorporate electrically operated air solenoid valves to direct air pressure to the various accessory air circuits such as air suspension control, inter-axle lockout, power takeoff (PTO), etc. Additional air solenoid valves can be added to the air solenoid valve pack which is located and mounted behind the intermediate cross member.

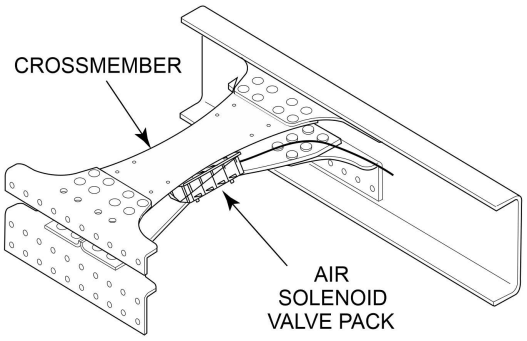

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Fig. 1 Air Solenoid Valve Pack Location

To add an air solenoid to the solenoid valve pack, disconnect the valve pack connector from the chassis harness, and then remove the valve pack from the mounting bracket. Remove the end cap from the valve back by twisting the cap counterclockwise. Engage the new solenoid into the locking ring of the last solenoid in the pack, and then twist the solenoid clockwise to lock the solenoids together. Reinstall the end cap in the same manner.

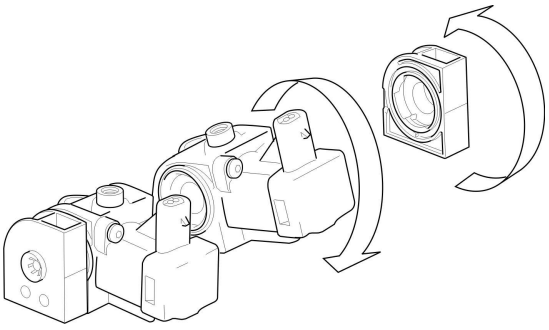

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Fig. 2 Assembling Solenoid Valve

Run the wires for the new solenoid(s) along the existing valve pack harness, and then connect the terminal ends for the solenoid(s) into the appropriate cavities (pins D and S for the PTO control solenoid and pins K and N for neutral control) of the valve pack connector body. The following table lists the solenoid valve pack pin assignments:

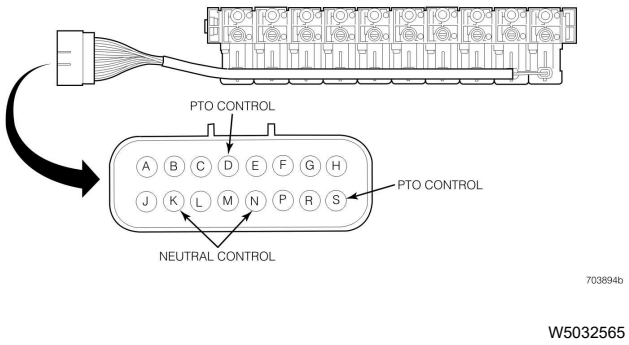

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Fig. 3 Air Solenoid Valve Pack Connector Pin Assignments

Pin +	Pin	Description
B	L	Inter-Wheel Lock
C	R	Air Suspension Control (dump valve)
D	R	PTO Control
E	S	Inter-Axle Lock
F	R	Inside/Outside Air
G	M	
H	A	
K	N	Air Horn or Neutral Control
J	R	
J	R	
G	M	
J	R	
G	M	
P	M	

Air Solenoid Valve Pack Connector and Pin Part Numbers

Should replacement of the valve pack connector body, pins, seals and plugs be necessary, refer to the following illustration for the applicable part numbers.

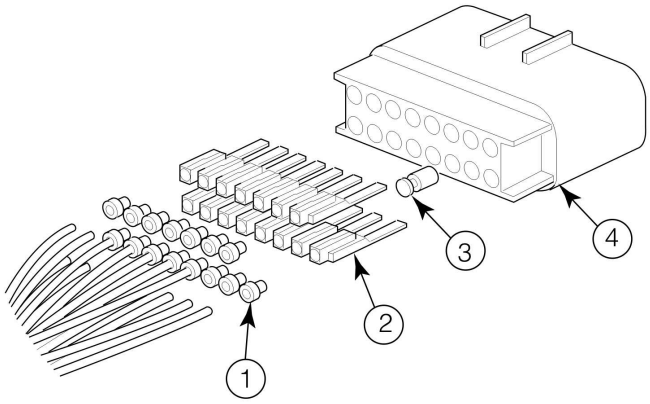

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Fig. 4 Connector Component Part Numbers

Key	Part No.	Description
1	20739620	Seal
2	20739618	Terminal
3	20388120	Plug (for unused connector cavities)
4	20387692	Connector body

Air Line Hose Installation

Flexible air line hose may eventually fail. However, by following proper installation, clamping and routing procedures, hose life can be maximized. Also, when selecting an air line hose, make sure that the hose is the same diameter as the hose being replaced. Replacing an air line hose with a different size hose may affect brake timing.

Avoid Twisting Hoses are imprinted with a layline along the length of the hose to help determine if the hose is twisted. The hose is twisted if the layline spirals around the hose. Swivel fittings make it possible to install a hose without a twist. When installing a hose, install one fitting so that the layline is visible when the fitting is tight. While the other fitting is still loose, the hose may be rotated as needed until the layline follows the hose routing without spiraling around the hose. Similarly, elbow fittings can be aligned to avoid hose twist.

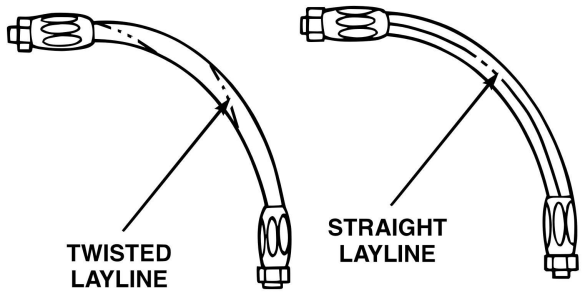

Fig. 5 Twisted and Straight Laylines

Notes

Avoid Excessive Torque on Fittings Unlike pipe threads, swivel fittings do not depend on thread compression to seal. DO NOT overtighten a swivel fitting, as this will damage the fitting or sealing surfaces.

An air line should be installed as follows:

1 Tighten male pipe ends of hose assemblies first, then tighten the swivel fittings.
2 Whenever possible, install any adapters needed in accessories (as a bench procedure) first.
3 Use an adjustable or open end wrench to install air hose assemblies. DO NOT use pipe wrenches as they will mar the fittings and damage the plating material.
4 DO NOT use pipe thread-sealing compound on swivel-nut hose fittings. Thread sealant should only be used on pipe threads.
5 When installing male-end fittings, use the nipple hex, not the socket hex, to tighten the fitting.

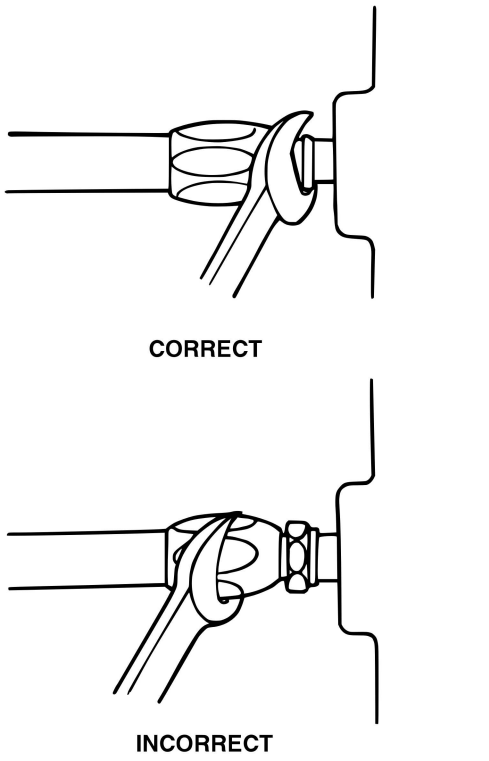

Fig. 6 Tightening Male-End Fittings

Air Fittings Quick Disconnect

Quick connect style (push-to-connect) air fittings may be used for various applications in the chassis air system. The following guidelines for fitting disassembly and assembly will greatly reduce the possibility of an air leak.

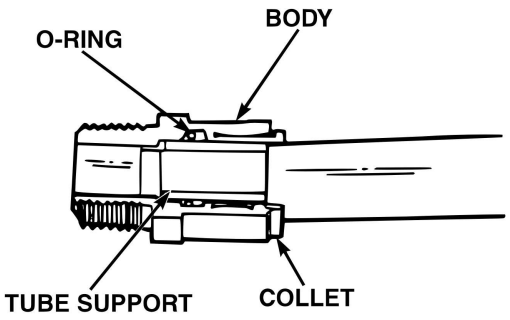

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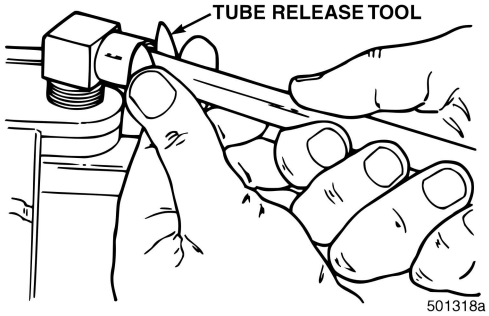
Fig. 7 Push-to-Connect Fitting Cross-Sectional View

Notes

Fitting Disassembly

1 Ensure that all pressure has been exhausted from the line before disassembling.

2 Using either the tube release tool (Weatherhead part No. 1800TRK or equivalent) or fingers, press the collet head to release the grip on the tubing.



3 With the collet pressed, pull the tubing from the fitting.

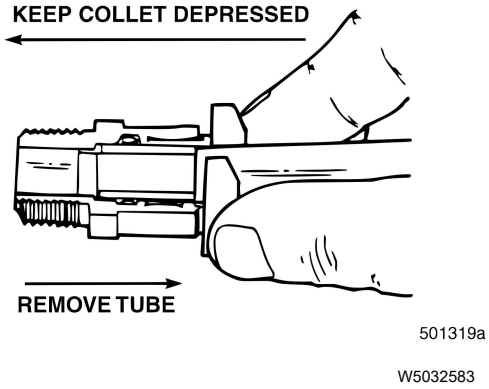


Fig. 8 Remove Tube

Notes

Fitting Assembly Guidelines

1 When installing a fitting, install hand-tight, then make final adjustments with a wrench on the hex or flats of the fitting body. Do not use a wrench near the tubing entry or collet head of the fitting.

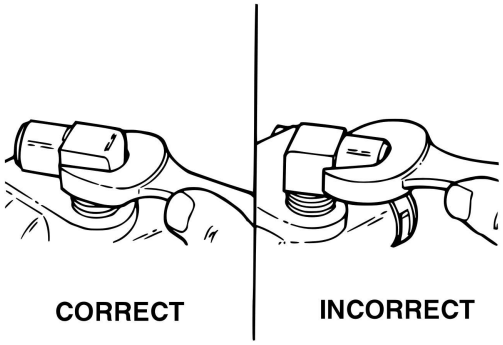


Fig. 9 Proper Fitting Installation

2 When preparing the tube for installation, a square (90-degree°), clean cut edge is recommended. An angled cut up to 15°, however, is acceptable.

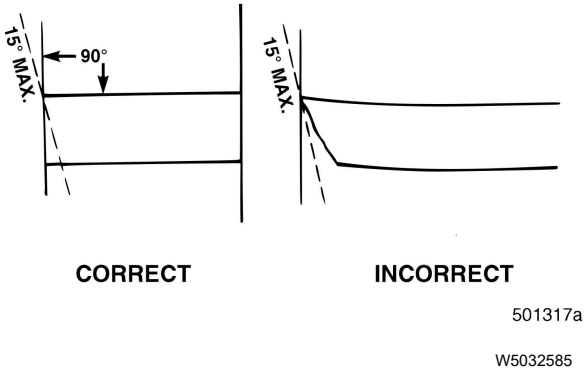


Fig. 10 Clean, Square Cut Tubing Edge

Use a tubing cutter (Weatherhead part No. T919 or equivalent) to ensure a good clean cut. Dull knives, side-cutters or other types of cutting tools may not ensure a good, clean cut. Burrs, oval tubing and contamination can damage seals and other air system components.

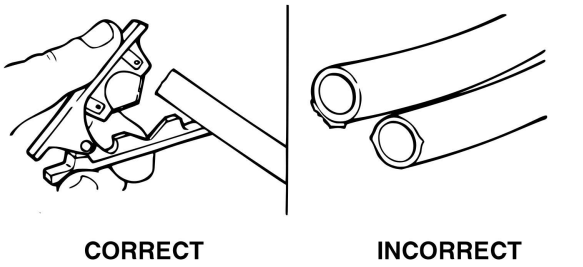


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Fig. 11 Use a Tubing Cutter for Proper Cut Edges

3 Install the tubing straight into the fitting until a solid stop is felt. The tubing grip and seal (on the O-ring) is then accomplished. Always protect against contaminants in cartridges and fittings during assembly

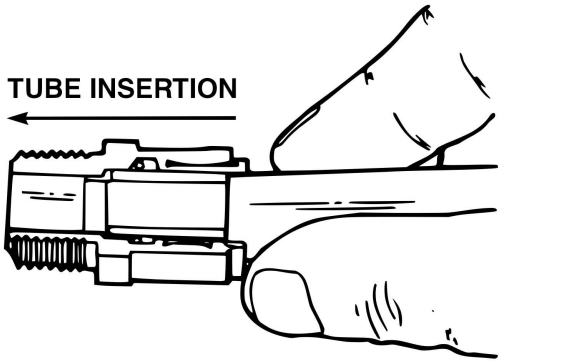

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Fig. 12 Insert Tube

Note: DO NOT use detergent, soap and water, or similar types of solutions as a lubricant when installing the tube.

4 After the tube is fully inserted, gently tug on the tubing to ensure that it is secure in the fitting.

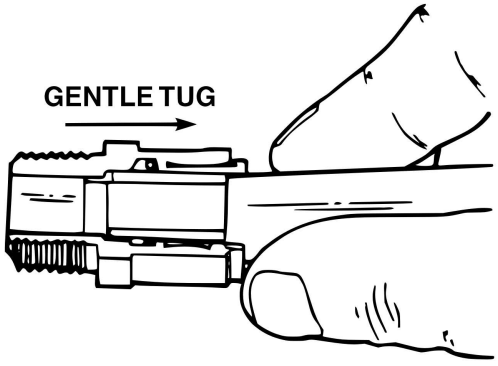

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Fig. 13 Ensure Tubing is Secure

5. Check the completed installation. Allow the tube ample room for a gradual bend. Severe bends can collapse the tubing, resulting in line blockage, flow restrictions and an eventual air leak.

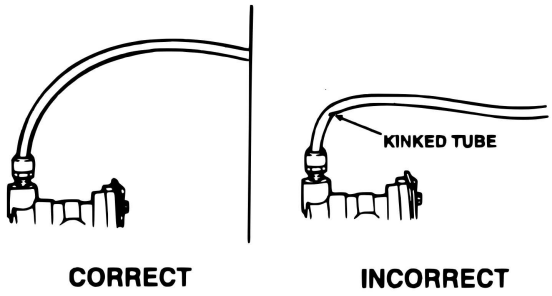

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Fig. 14 Inspect Final Installation

6. Start the engine and allow the air system to build pressure to governor cut-out. Stop the engine. Then, using soap and water solution, check the installation for leaks.

Air Lines Routing

A leading cause of flexible air line leakage is routing. Hoses that are too long, too short, twisted, have sharp bends or that rub against other components will eventually leak.

The following basic rules apply when installing and routing flexible air line:

- A flexible air line should be routed in a straight line or should follow the contours of the equipment to which it is clamped.

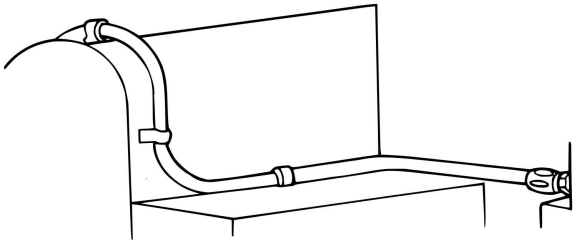

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Fig. 15 Flexible Air Line Following Contour of Equipment

- Pairs of flexible air line should be routed together and parallel.

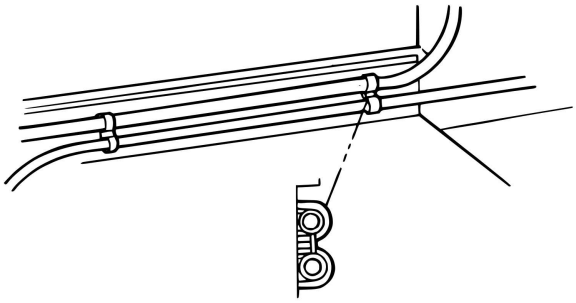

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Fig. 16 Air Line Pairs Routed Parallel

- A flexible air line should be routed and clamped to prevent contact with points of abrasion. When clamping air lines, use clamps that are suitably sized for the diameter of hose. Clamps that are too large allow the hose to move in the clamp, and clamps that are too small may pinch the hose.

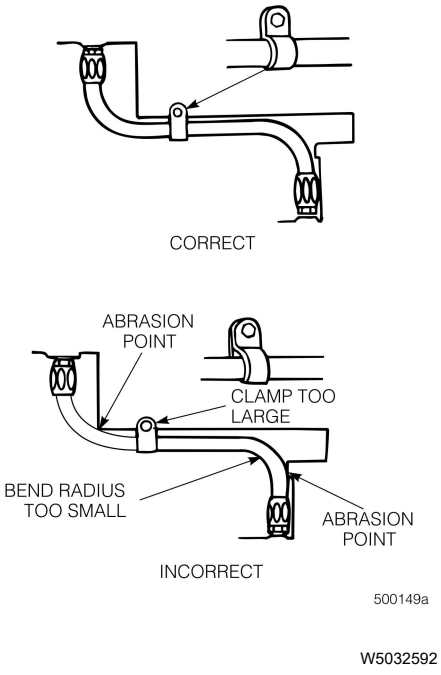

Fig. 17 Route and Clamp Line to Prevent Abrasion

- A flexible air line must be routed and adequately clamped to avoid contact with sharp edges. Clamps should be installed so that the air line is properly supported to prevent drooping and contacting a sharp edge

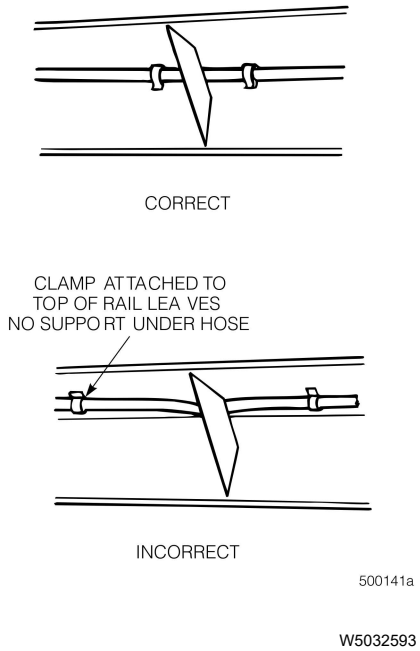

Fig. 18 Route and clip lines to avoid sharp edges

- Route flexible air line to avoid moving parts. If necessary, use a stand-off bracket to clamp the line away from a moving part.

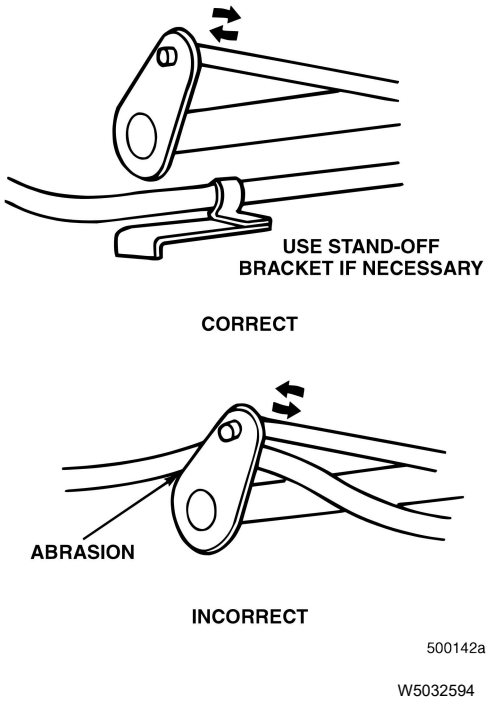

Fig. 19 Route to Avoid Moving Parts

Notes

• DO NOT crisscross flexible air lines. The sawing action between crisscrossed hoses eventually causes the line to leak. Use suitable clamps to keep the crisscrossed hoses apart.

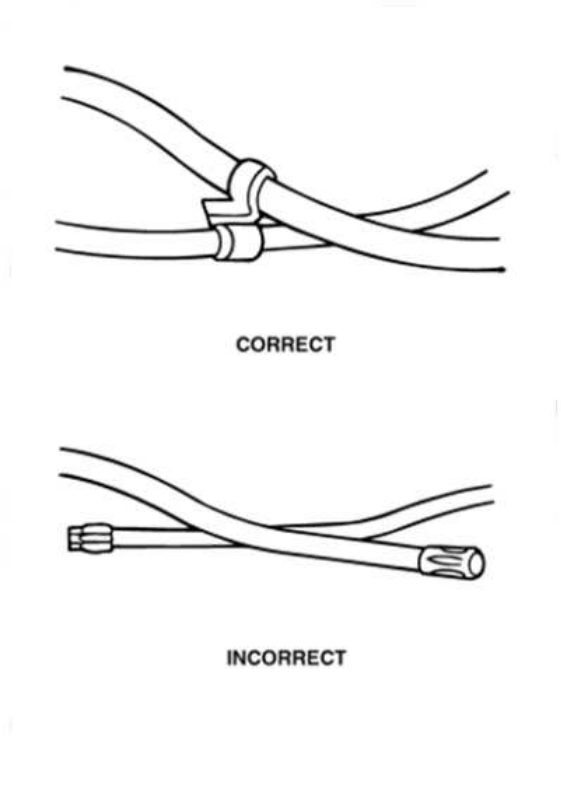

Fig. 20 Properly Clamp Crisscrossed Lines

Notes

When routing a flexible air line between components in relative motion, leaks due to abrasion and/or less than optimal bend radius may occur. To minimize possible air leakage, the following guidelines are recommended:

- Sufficient line length must be provided to allow for movement.
- Fittings must not be part of the flexible portion of the hose assembly. To minimize twisting, the hose should bend in the same plane of motion as the boss to which it is connected.

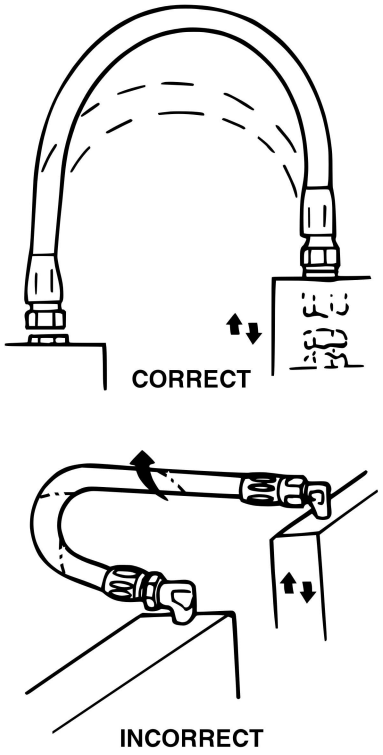

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Fig. 21 Install Line to Bend in Same Plane of Motion

Notes

- Flexible air line that is bent in two planes should be clamped at the point where the line changes planes. In effect, this divides the line into two assemblies. DO NOT use nylon tubing in these types of applications

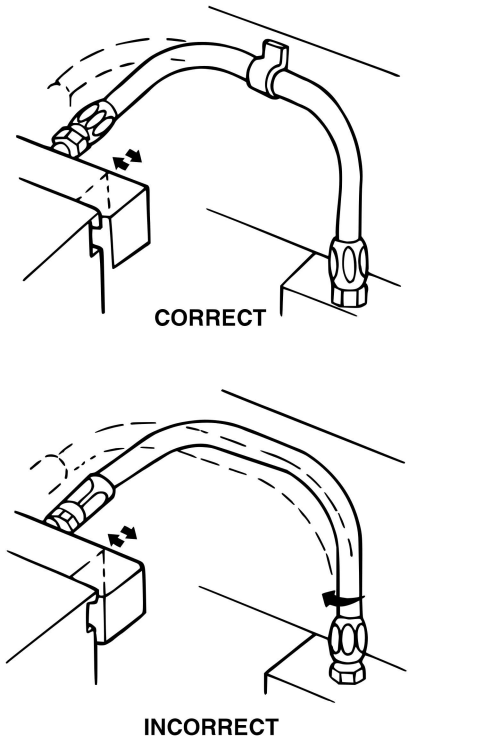

Fig. 22 Clamp Line Where Planes Change

When an air line is routed close to a high heat source (e.g., exhaust pipe, exhaust manifold or radiator), the following minimum clearances must be maintained:

- Braided hose 102 mm (4 in)
- Plastic, nylon or rubber line 152 mm (6 in)

The above clearances may be reduced if an appropriate heat shield is used.

Air Lines Clamping

To minimize the occurrence of air leakage, the following clamp installation procedures are recommended:

- When installing a clamp, install the fastener parallel to the ground with the clamp suspended from the fastener and the clamp well backed.

- DO NOT install the clamp fastener perpendicular to the ground. The weight of the clamped line may cause the clamp to bend and the line to move.

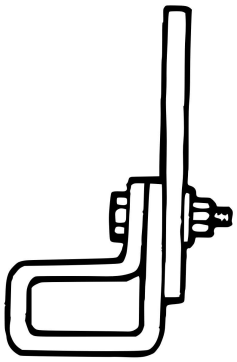

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Fig. 23 Preferred Clamp Installation

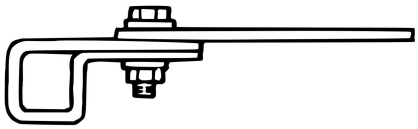

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Fig. 24 Avoid Installation Where Fastener is Perpendicular to Ground

- If the clamp fastener must be installed perpendicular to the ground, provide full-length support for the clamp

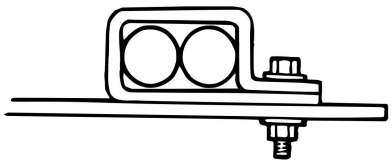

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Fig. 25 Provide Proper Clamp Support

- When installing two clamps on one fastener, install the upper clamp first, then suspend the second clamp.

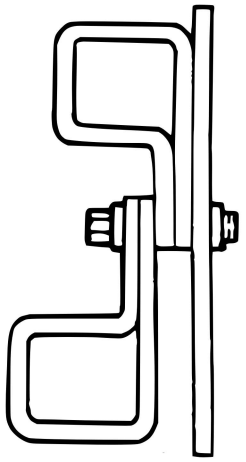

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Fig. 26 Installing Two Clamps on One Fastener

Avoid installations where the clamp will not be adequately supported.

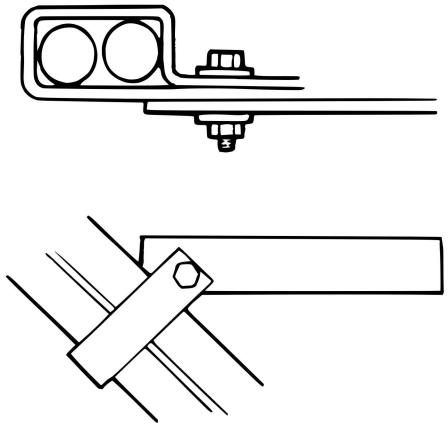

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Fig. 27 Avoid Inadequate Clamp Support

- When clamping multiple hoses, provide a backing of 6.35 mm (0.25 in) minimum past the mounting legs of the clamp

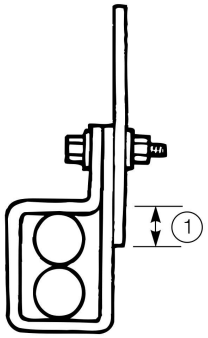

Fig. 28 Proper Backing for Multiple-Hose Clamp Installations

1. 6.35 mm (0.25 in)

- Inverted clamps may be used if the clamp material is of adequate strength to support the load and resist bending.

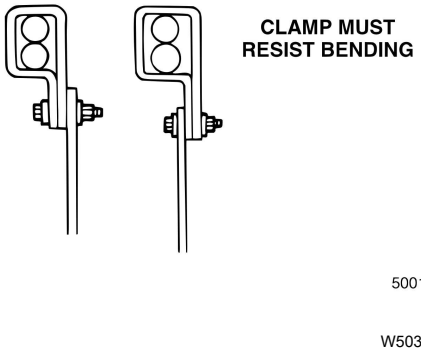

Fig. 29 Inverted Clamp Installation

- If an installation requires that the clamp mounting legs be bent, make sure the clamp material is of adequate strength to support the load and resist further bending.

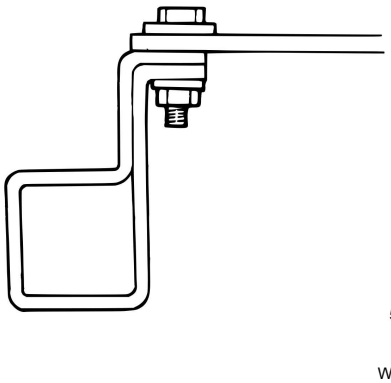

Fig. 30 Bent Clamp Leg Installation

Clamps

Rubber-covered metal-band clamps of suitable size for the hose being clamped should be used for primary support. DO NOT use a clamp that is too large for the diameter of the hose, because the hose may rub against the clamp and result in an air leak.

Tie Wraps

Nylon tie wraps should be used for bundling air lines together, when necessary, between primary supporting clamps. Do not use tie wraps for primary support of hose lines unless button-head tie wraps are used. Additional information concerning button-head tie wraps can be found in the section.

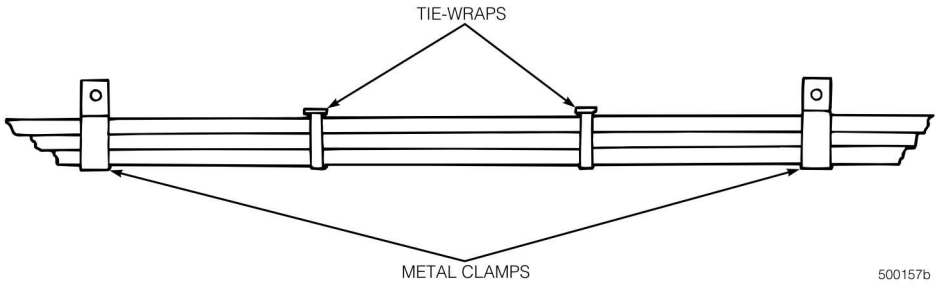

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Fig. 31 Metal Clamps for Primary Support, Tie Wraps for Bundling

Nylon tie wraps may be used for primary support when clamping additional hoses to metal clamped hoses as long as the number and size of the additional hose(s) are not greater than the metal clamped hoses. When installing tie wraps, they should be snug, but not so tight as to collapse or cut the hose. Always trim the ends of the tie wraps.

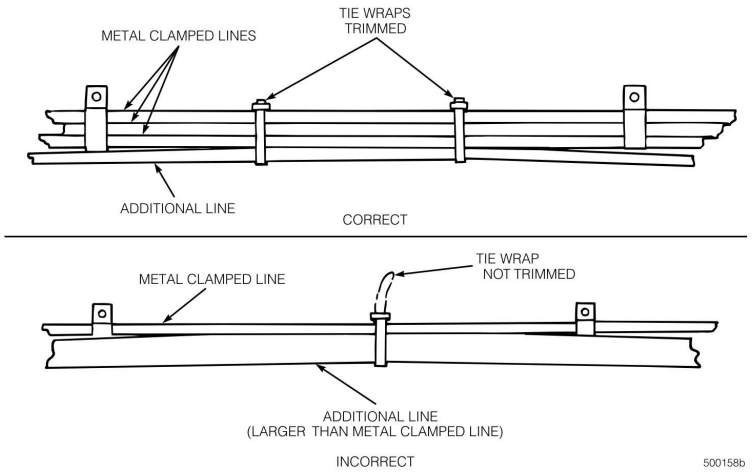

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Fig. 32 Use Tie Wraps for Primary Support of Additional Hose(s)

Button-Head Tie Wraps

Button-head tie wraps were used in certain applications for primary support of air lines at MACK assembly plants. If it becomes necessary to cut this type of tie wrap to install a new air line, install a **new** button-head tie wrap as follows:

- Install the tie wrap through the frame hole and around the air line(s).
- Tighten the wrap by hand until snug, then use Panduit tool No. GS4H or Snap-on tool No. YA317 to properly tension and cut off the excess end of the tie-wrap.
- The cutoff should be flush with the button-head, leaving no burrs or sharp edges. If these special tools are not available, or if the tie wrap was originally installed on a stand-off bracket and clearance for using the tensioning tool is insufficient, tension the tie wrap by hand, then cut off the excess with a diagonal cutter (or similar tool). The tie wrap should be tight, but not so tight that it collapses or pinches the line.
- For bundled air line installations, the lines should be secure within the bundle and without excessive clearance. Refer to the following illustration.

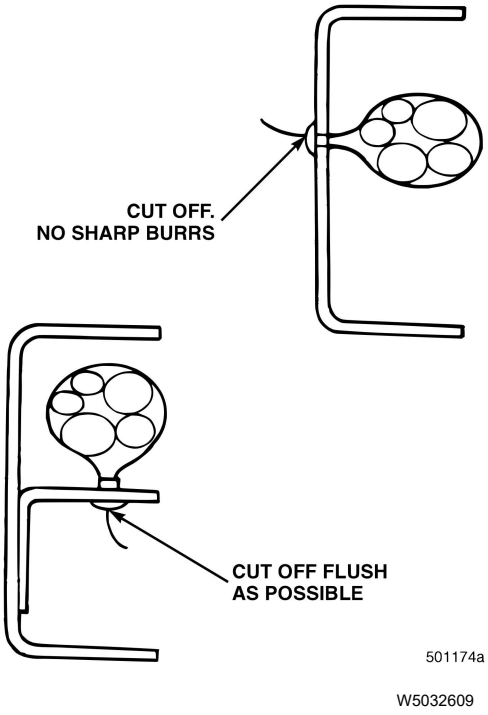

Fig. 33 Installing Button-Head Tie Wraps

Air Lines Minimum Allowable Radius

For rigid air lines, minimum bending radius recommendations are as follows:

Rigid Airlines		
Tubing OD mm (in)	**Bent by Hand mm (in)**	**Bent with Bending Tool mm (in)**
6.35 (1/4)	25.4 (1)	14.3 (9/16)
9.53 (3/8)	50.8 (2)	25.4 (1)
12.70 (1/2)	76.2 (3)	38.1 (1-1/2)
15.88 (5/8)	101.6 (4)	50.8 (2)
19.05 (3/4)	152.4 (6)	63.5 (2-1/2)

For flexible air lines, minimum bending radius recommendations are as follows:

Flexible Air Lines

Flexible Air Lines			
Hose Size	**Hose ID mm (in)**	**Hose OD mm (in)**	**Minimum Bending Radius mm (in)**
No. 4	4.76 (3/16)	13.21 (0.52)	19.05 (3/4)
No. 6	7.94 (5/16)	17.27 (0.68)	31.75 (1-1/4)
No. 8	10.32 (13/32)	19.56 (0.77)	44.45 (1-3/4)
No. 10	12.70 (1/2)	23.37 (0.92)	57.15 (2-1/4)

Notes

Air Tank Fittings

Norgren Push-in

Listed below is a list of the straight threaded O-ring fittings, which are used in the MACK tank setup on the the vehicle. The new fittings will not work with older air tanks due to the new fittings and air tanks being straight threaded and the older fittings and air tanks having pipe threads.

The fittings are supplied by Norgren and are referred to as Norgren Fleetfit Vehicle Push-in Fittings with Hobbs connector.

Note: These parts are available from MACK PDC.

Description	Vendor Part No.	Part No.
Male Elbow 3/8” X PIF X M16 X 1.5	94 4138 55	20999390
Male Elbow 3/4” X PIF X M22 X 1.5	94 4138 98	20462691
Male Elbow 1/2” X PIF X M22 X 1.5	94 4138 68	20462690
Male Elbow 5/8” X PIF X M22 X 1.5	94 4138 75	20378449
Male Elbow with Check Valve	95 4036 01	20560349
Male Elbow 5/8” X PIF X M16 X 1.5	94 4138 79	20469783

Torques

The following table lists the torque measurements to insert the Norgren Air Tank Push-In Fittings into MACK Air Tanks. Use these specifications for any Air Tank Service Procedures performed on all vehicles.

Size	Torque
M16	25 – 29 Nm (18.4 – 21 ft-lb.)
M22	30 – 38 Nm (22 – 28 ft-lb.)

Notes

Brake Literature

Bendix

Copies of service literature for Bendix components can now be accessed directly from the official internet site of the Bendix Corporation.

To review and download Bendix service literature, please visit:

- **http://www.bendix.com**

Eaton

Copies of service literature for Eaton components can now be accessed directly from the official internet site of the Eaton Corporation.

To review and download Eaton service literature, please visit:

- **http://www.roadranger.com/rr/CustomerSupport/Support/LiteratureCenter/index.htm**

Gunite

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To review and download Gunite service literature, please visit:

- **http://www.gunite.com/literature/**

Meritor

Copies of service literature for Meritor components can now be accessed directly from the official internet site of the Arvin Meritor Corporation.

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Norgren

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To review and download Norgren service literature, please visit the following site:

- **www.norgren.com/usa**

MGM

Copies of service literature for MGM components can now be accessed directly from the official internet site of the Indian Head Industries.

To review and download MGM service literature, please visit the following site:

- **http://mgmbrakes.com/**

Chicago Rawhide

Copies of service literature for Chicago Rawhide components can now be accessed directly from the official internet site of the SKF corporation.

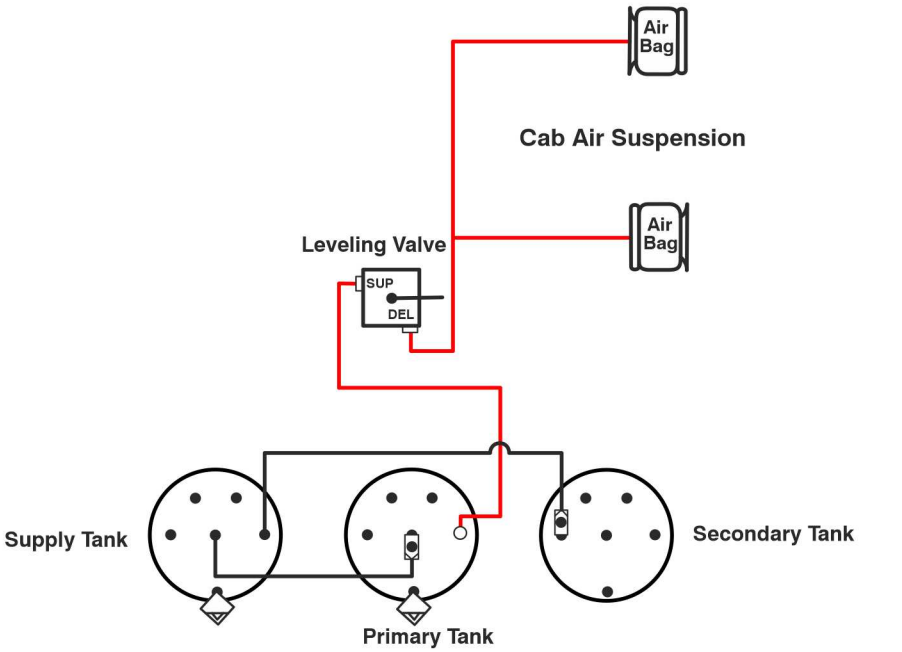
To review and download Chicago Rawhide service literature, please visit the following site:

- **http://www.vsm.skf.com/usa/Heavyduty/index.html**

Notes

Air Brake Routing and Schematics

Cab Air Suspension



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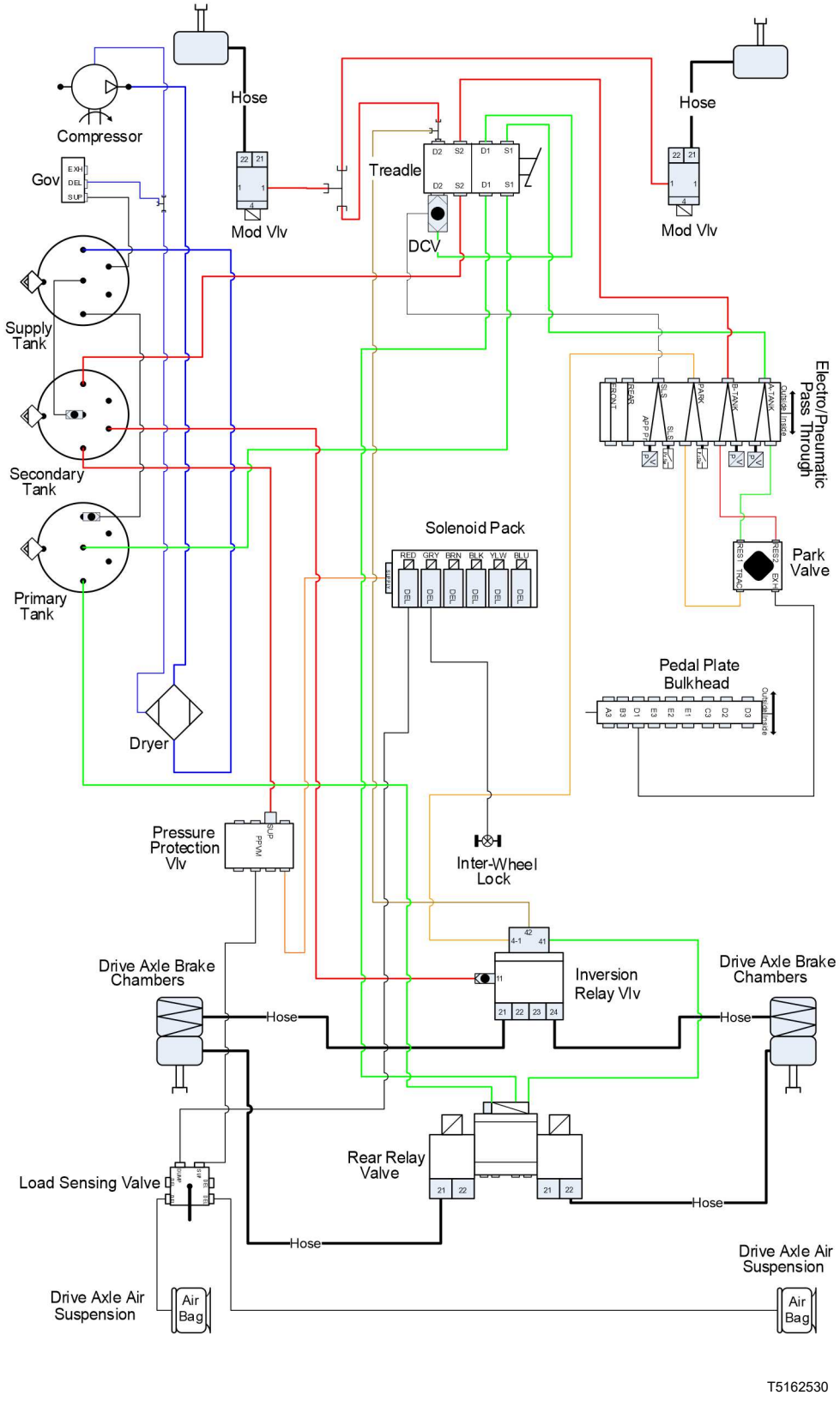
Brake Schematics (Air Suspension)



Brake Schematics (Leaf Suspension)