Freightliner Brake System

Plumbing and ABS Design Guidelines

Chassis Engineering

Freightliner Design Rules for Pneumatic Brake Valves and ABS

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This book defines the current policies of certain aspects of brake system design compatibility at Freightliner. It includes the type of pneumatic brake valves, "hold-off" or "crack pressures", and air circuits, that are compatible with the various brake chamber sizes, foundation brake sizes, suspensions, and axle groups. It also shows which wheel-ends have ABS wheel speed sensors installed and which are modulated when under ABS control. These rules apply to all models of Freightliner vehicles with pneumatic brakes. Since these policies are intended to meet both the requirements of FMVSS-121 and the desire by our customers for optimum brake balance, only those brake system configurations listed in this book are approved by the Chassis Engineering Department. Approval to deviate from these rules must be obtained by one of the Brake Engineering Managers or Project Engineers. As designs change, these pages will be updated and copies sent to the above people on the distribution list.

Approved By:

Tony Moore — 8/5/97
Tony Moore — Date

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Air Circuits:

By law (FMVSS-121) there must be two independent service air systems on every pneumatically braked vehicle. At Freightliner, these are known as the Primary and Secondary air systems. The air lines associated with the circuits are colored as follows:

Primary is Green
Secondary is Red

This book uses these same colors for clarity where applicable. Generally, the front axle(s) are powered and controlled by the secondary air system and the rear axle(s) by the primary system. However, multi-axle vehicles often have several rear axles powered by the secondary air system. This is to balance the total amount of braking power between the two air systems as much as possible since FMVSS-121 requires that vehicles not exceed specific maximum stopping distance limits with any failed (depleted) air system. Some of the 12 x 4 and 12 x 6 vehicles have an axle shown as being supplied/controlled by either the primary or the secondary systems. Which circuit is chosen depends on the GAWR's so that the braking power is most equally distributed between primary and secondary. A method for determining which axles are primary and which are secondary are given in the 12 x 4 section.

Front Axle Plumbing:

Currently, a quick release valve having a 6 psi "sustained" hold-off pressure is standard on single steering axle vehicles with 15" x 4" brakes. The description "sustained" means that the hold-off pressure or crack pressure is maintained during all types of brake pedal usage or modulation. Some former valves were "non-sustained" which meant the hold-off pressure faded away or was reduced during brake applications where the pedal was not modulated.

For vehicles with a single steering axle, a quick release valve will provide sufficient air flow to meet the brake timing requirements of FMVSS-121 when the brake chambers are 24 in^2 or less. However, if the chambers are larger than 24 in^2 then a relay valve is needed since it has a higher flow rate. For vehicles with dual steering axles, a relay valve is mandatory regardless of chamber size.

Field reports have indicated that the 15" x 4" front brake is prone to "chatter" in certain braking conditions. Therefore, on single steering axle vehicles, the 15" x 4" brake should normally be used when the valve hold-off pressures are nearly the same across the vehicle as defined in this book. This applies to any make of 15" x 4" brake (eg. Rockwell, Eaton, Dana, etc.). There is one exception. Some customers are ordering a 0-1 psi steering axle valve with 15" 4" front brakes and a 3-4 psi drive axle valve. We are allowing those customers to have this combination when the sales codes specifically ask for it. Larger front brakes could be used with the equal hold-off pressure valves, however, a lower steering axle hold-off pressure is desired as also shown in this book

A quick release valve should not supply/control more than one axle (2 brakes). A relay valve should not supply/control more than two axles (4 brakes).

Rear Axle Plumbing:

Currently the standard relay valve is the Rockwell/WABCO ABS combo valve. This valve combines the features of a normal relay valve and ABS modulator valve. It may or may not include the Traction Control feature. This valve is normally mounted on the rear suspension cross-member. However, for certain suspensions, this space is unavailable. In those cases, a single separate relay and two independent modulator valves are used. The standard relay valve hold-off pressure is 5.5 psi whether with the Combo valve or the separate relay valve. Sales information may refer to a hold-off pressure range such as 5-8 psi. Note that some Midland relay valves have an approximate 7 psi hold-off pressure.

Previous policy was to equip nearly all tractors with a brake proportioning relay valve (e.g. Bendix BP-R1). This feature reduced drive axle chamber pressures during braking when bobtail in order to reduce the occurrence of wheel lock-up. However, since ABS is mandatory for tractors built after 3-3-97, the WABCO ABS combo valve will become the new standard valve. This valve does not have the bobtail brake proportioning feature. ABS control will modulate drive axle chamber pressures when both bobtail and lightly loaded to limit wheel lock-up.

A relay valve should not control more than 2 rear axles (4 brakes). A quick release valve should not be used on the rear axle(s) of either a truck or tractor with or without ABS.

ABS:

This book illustrates only the standard 4S/4M ABS. That is four wheel speed sensors and four modulator valves. Freightliner may offer the 6S/4M or the 6S/6M as optional systems but those are not detailed here. Although many tandem drive axles have only two modulator valves, all four brakes are modulated. The 4S/4M system controls wheel lock-up on both left side brakes with one modulator valve and both right side brakes with the other modulator.

The wheel speed sensors are installed on one of the rear axles depending on the suspension type. Tests have shown that during heavy braking different suspensions have different or unequal wheel loading. This causes the lightly loaded wheels to tend toward lockup earlier than the heavier loaded wheels. The sensors are installed on the wheels that tend toward lock-up first. For vehicles with twin steering axles only the forward most axle is sensed and modulated. For 6 x 2 vehicles, the sensors are always placed on the driving axle.

ECAS:

There are two kinds of Electronically Controlled Air Suspensions (ECAS):

1. ECAS: Controlled suspension height.
2. ECAS+: Same as ECAS above but also includes "load transfer" feature.

ECAS can be installed on a variety of vehicle types with no compatibility problems with the brake system. However, ECAS+ is currently reserved for a 6 x 2 vehicle. The tag axle is unloaded via suspension air bag pressure when traction control is activated. This causes the driving axle to

increase in load and hence improves traction capability. Hence ABS and ATC are required. Also, the rear wheel speed sensors must be installed on the driving axle. Because the tag axle may lock up and slide during a traction situation, separate relay valves are used to "block off" air to the tag axle brakes when ATC is operational. These relay valves (one for the left side and one for the right) must have the same hold-off pressure as the drive axle relay valve.

Special Configurations:

1. Some Construction Vehicles

Vehicles with a single heavy front axle (e.g. 20,000 lb. GAWR) having large front brakes (e.g. 15" x 6" wedge brakes) and super single 19.5" tires must have a 7 psi hold-off relay valve on the steering axle. If the drive axles also have 19.5" tires, then the rear axle hold-off pressure should be 4.0 psi.

2. Steering axle Ratio and Proportioning Valves

A few customers are receiving the LQ-5 ratio valve (eg. Ryder) and the BP-1 valve (eg. Mobile Oil) on the steering axle. Only these few customers and by written agreement may receive these valves.

3. 0-1 psi Quick Release Valve with 15" x 4" Front Brake

Although there are field reports of excessive front brake chatter and noise with low hold-off valves and 15" x 4" brakes, some customers insist on ordering this combination (eg. Penske). However, this is not recommended as outlined in this book. It should be noted that the 0-1 psi quick release valve will only be offered with a 3-4 psi drive axle relay valve.

This Book Does Not Consider the Following Pneumatic Related Items:

- How to route the air lines
- Air line sizes, types or fittings
- Air tank sizing or quantities
- Air compressor sizing
- Air dryer details
- Treadle valve details
- Parking brake design (spring brake chamber sizes, tire size limitations, lining materials, GVWR limitations, etc.)
- Parking brake circuit design
- Modulated Spring Brakes
- Tractor protection and trailer supply/control circuit design
- ABS Electronic Control Unit (ECU) details
- The Electronic Braking System (EBS)
- Other air activated options