

Notes on Vehicle Brake Testing With Single Car Brake Tester

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Caution	The timings and choke sizes used in the following document are based on New Zealand railway brake systems. (The triple valve choke sizes and bulb size are peculiar to New Zealand.) Operators in other countries should not assume that the tests described will reflect their local practices.
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Introduction

All rail operators doing work on carriage and wagon brakes need some method of testing for correct brake operation after maintenance and at (annual) inspections. The usual apparatus is a single car brake tester designed to test the brakes on one vehicle at a time (hence the name).

Tranz Rail Ltd use a quite elaborate tester designed to test all operations of modern wagon brakes. Most operators use a simpler braking system and can therefore use a simpler tester. This paper discusses the tests that should be made on a rail vehicle brakes and describes two tester designs, a simple one suitable where No 4 locomotive brake systems are used and an improved version for operators using modern self maintaining locomotive brake systems.

The purpose of a brake tester is to simulate the action of a locomotive brake control system. The tests done should be performed on the whole vehicle system, including the headstock cocks, hoses and couplings. (To do this, open all cocks and seal unused hoses with dummy couplings.) The minimum tests required are:-

- Visual - Check for worn brake blocks, missing or damaged rigging, air leaks etc.
- Brake Pipe Leakage - The amount of air leakage in the vehicle brake system must be less than a specified amount.
- Piston Travel - The brake piston travel must be within the prescribed limits for the type of cylinder.
- Pneumatic Automatic Slack Adjuster (when fitted) - This must work correctly.
- Rigging & Handbrake Test - The brake rigging must be correctly set up and the handbrake operating correctly.
- Minimum Reduction Test - The brakes must operate on the minimum reduction in brake pipe pressure that occurs during brake application.
- Slow Release Test - The brakes must correctly release when the train pipe pressure rises slowly (this simulates the case of a vehicle at the rear of a long train).
- Brake Pipe Maintenance and Auxiliary Leakage - The brakes must remain on for a specified period when applied.
- Passenger Emergency Valve Test - The emergency valves (if fitted) must operate correctly.
- Release Valve - The reservoir release cock must work correctly.

Requirements for a single car brake tester. - A suitable tester should be able to:-

- Measure the air pressure in the vehicle brake system. (The gauge should be graduated to 20 kPa divisions or better).
- Supply air to the vehicle brake pipe at 550 kPa (or whatever test pressure is being used). [Charging]
- Isolate the vehicle brake system for leakage tests.
- Exhaust air from the vehicle to atmosphere through a 1.5 mm diameter choke. [Apply]
- Supply air to the vehicle through a No 74 drill (nearest metric equivalent = 0.58 mm) diameter choke. [Sensitive Release]
- If the operator is using modern locomotives which maintains the brake pipe pressure at the applied setting then the brake tester needs to maintain a set pressure (475 kPa) to simulate the locomotive brake system. For older locomotive brake systems (eg No 4 valve) then simply isolating the brake system after application is sufficient.

Other Equipment Required

- Supply of compressed air greater than 550 kPa (or whatever test pressure is being used).
- Dummy hose coupling(s).
- Stop watch (a watch with a second hand or seconds display can be used if a stop watch is not available).

Test Procedures

The pressures and times quoted are Tranz Rail standards for a 550 kPa brake system (Loco-hauled Car and Van Brake Manual. 5 June 1996). If the brake system is operated at a lower pressure (eg 70 psi = 480 kPa) the pressures need to be adjusted accordingly. To allow a margin of error the Taieri Gorge Railway {TGR} has uses more stringent tests than Tranz Rail and this is shown in brackets {}.

When testing carriage and wagon brakes the following tests should be made:-

Visual

- A complete visual and audible inspection should be first made for worn brake blocks, missing or damaged rigging, etc. All faults should be repaired before continuing with testing.
- The triple valve should be checked to ensure the valve size, and its exhaust choke, match the cylinder. (Triple valves get changed between inspections and mistakes get made.)

Charge vehicle

- Test single car tester to daily test code.
- Couple tester to vehicle via a brake hose.
- Open all brake cocks and fit dummy coupling(s) to the unused hose(s). (This allows the brake cocks and hoses to be included in the tests.) Check that cocks move freely.
- Charge brake pipe to 550 kPa. (Allow 10 minutes to charge an uncharged vehicle).
- Check for air leaks in the piping etc.

Brake Pipe Leakage

- Charge brake system to 550 kPa and close off air supply.
- Measure the drop in brake pipe pressure over 1 minute. The total drop should ideally be zero but must be less than 15 kPa over 1 minute.
- If the leakage is too high close the feed valve to the water lifting gear (if fitted). If the leakage decreases the leak is in the lifting apparatus.
- The leakage must be reduced to less than 15 kPa before continuing with the remaining tests.

Piston Travel

- Reduce the train pipe pressure to 400 kPa (150 kPa reduction) by exhausting air via a 1.5 mm diameter choke and observe if the brakes apply.
- The piston travel should be between limits for the cylinder type.
 Eg for standard stroke 8", 10" & 12" cylinders these are

With automatic slack adjuster	165 mm
Without automatic slack adjuster	125 – 200 mm

Possible faults are:-

Fault	Possible Reasons
Brakes do not apply	<ul style="list-style-type: none"> • Faulty triple valve • Faulty automatic release valve diaphragm
Piston travel too short	<ul style="list-style-type: none"> • Hockey stick adjusting nuts at fault
Piston travel too long	<ul style="list-style-type: none"> • Hockey stick adjusting nuts loose • Automatic slack adjuster not working • Automatic slack adjuster at end of travel • Faulty brake rigging (eg pin missing)
Brakes do not release	<ul style="list-style-type: none"> • Faulty triple valve • Faulty release valve • Seized brake rigging

- Check at brake cylinder for audible air leakage.
- [A leakage test during this test is useful as it may reveal triple valve faults.]

Rigging & Handbrake Test

- With the brakes applied (150 kPa reduction) check all rigging and levers to ensure they are at the correct angles and will not foul on any obstructions as the blocks wear. (Pay particular attention to bogie brake levers as their movement can be restricted; the yokes around the bogie centre to ensure they won't hit the centre casting as the blocks wear; and the shoe hangers. On 25140 bogies with small tyres these hangers can foul the frame as the blocks wear.)
- Check the handbrake operation.
 - Carriage handbrakes should apply after 6 - 8 turns.
 - Van handbrakes should apply after 1 - 6 turns.
 - Wagon handbrakes (lever type) should not bottom with weight applied to the lever.

Pneumatic Automatic Slack Adjuster (when fitted)

- When the piston travel is correct (see Piston Travel Test) release the brakes and screw the slack adjuster out, so that the travel will increase.
- Make a 150 kPa reduction and check the piping on the pneumatic adjuster for leaks.
- Release the brakes and check that the adjuster works. (If you can't watch the adjuster use a chalk witness mark.)

Minimum Reduction Test - Test that the brakes will operate on the minimum reduction in brake pipe pressure that occurs during brake application.. The minimum reduction applied by a locomotive brake system (or the driver) should be 50 kPa (7 psi) so the test is done at 40 kPa reduction to allow a safety margin.

- Charge vehicle brake system fully to 550 kPa.
- Make a reduction of 40 kPa. The brakes should apply and remain applied for 1 minute.

Possible faults are:-

Fault	Possible Reasons
Brakes do not apply	<ul style="list-style-type: none"> Faulty triple valve Faulty release valve
Brakes release in less than 1 minute	<ul style="list-style-type: none"> Air leak from auxiliary reservoir (this should have been detected during the Brake Pipe Leakage Test)

- Check for air blow at the triple valve exhaust. Only a slight blow is allowed.
- [A repeat leakage test during this test is useful as it may reveal triple valve faults.]

Slow Release Test - Test that the brakes will correctly release when the train pipe pressure rises slowly (this simulates the case of a vehicle at the rear of a long train).

- Reduce brake pipe pressure to 465-480 kPa.
- When the pressure gauge is steady open the **Slow Release Valve** to supply air at 550 kPa to the brake pipe via a No 74 drill choke (0.58 mm diameter) and note the time until the air starts exhausting from the triple valve. The time must be less than 25 seconds {20 seconds for TGR}. Possible faults are:-

Fault	Possible Reasons
Brakes do not start releasing in 25 seconds	<ul style="list-style-type: none"> Excessive brake pipe leakage Faulty triple valve Leaking automatic release valve diaphragm

- When brakes are fully released, check for air blow at the triple valve exhaust. Only a slight blow is allowed.

Passenger Emergency Valve Test

- Fully charge system to 550 kPa
- Operate each Emergency Valve in turn and check that the brakes apply and the valves move freely. Restore each valve after testing.

Release Valve Test

Manual Type

- Apply the brakes
- Operate the cock and check that air exhausts from the reservoir and the brakes release.
- Release the cock and check that it closes.

Automatic type

- Apply the brakes (150 kPa reduction).
- Operate the cock and check that air exhausts from the reservoir and the brakes release.
- Release the cock and check that it closes.
- Exhaust the brake pipe (reduce the pressure to zero)
- Operate the cock and release it. It should remain open until the reservoir empties.

Final Leakage Test

A repeat of the leakage test on page 2 is advisable, as it will reveal if the emergency valve cocks, relay valve or release valve have increased leakage after operation. (The only time these normally get used is during these brake tests.)

Brake Pipe Maintenance and Auxiliary Leakage (10 Minute Application Test)

- Charge vehicle brake system fully to 550 kPa
- Reduce brake pipe pressure to 475 kPa. (Maintain the brake pipe pressure at this value during the test if using modern braking system). The brakes must apply and remain applied for 10 minutes {TGR 15 minutes}.

Possible faults are:-

Fault	Possible Reasons
Brakes release with no sound of escaping air from triple valve	<ul style="list-style-type: none">• Severe brake cylinder leakage
Brakes release due to triple valve releasing (sound of air escaping from triple valve)	Air leak from auxiliary reservoir from:- <ul style="list-style-type: none">• triple valve mounting gasket• release valve and its piping

Simple Brake Tester

While commercial brake testers can be purchased these may need modifications to suit New Zealand conditions. (Eg the SMC tester available from Australia needs the choke sizes changed and a larger pressure gauge fitted.)

It is quite practical to build a simple brake tester using commercial products and a bit of ingenuity. A plan is attached along with the test procedures.

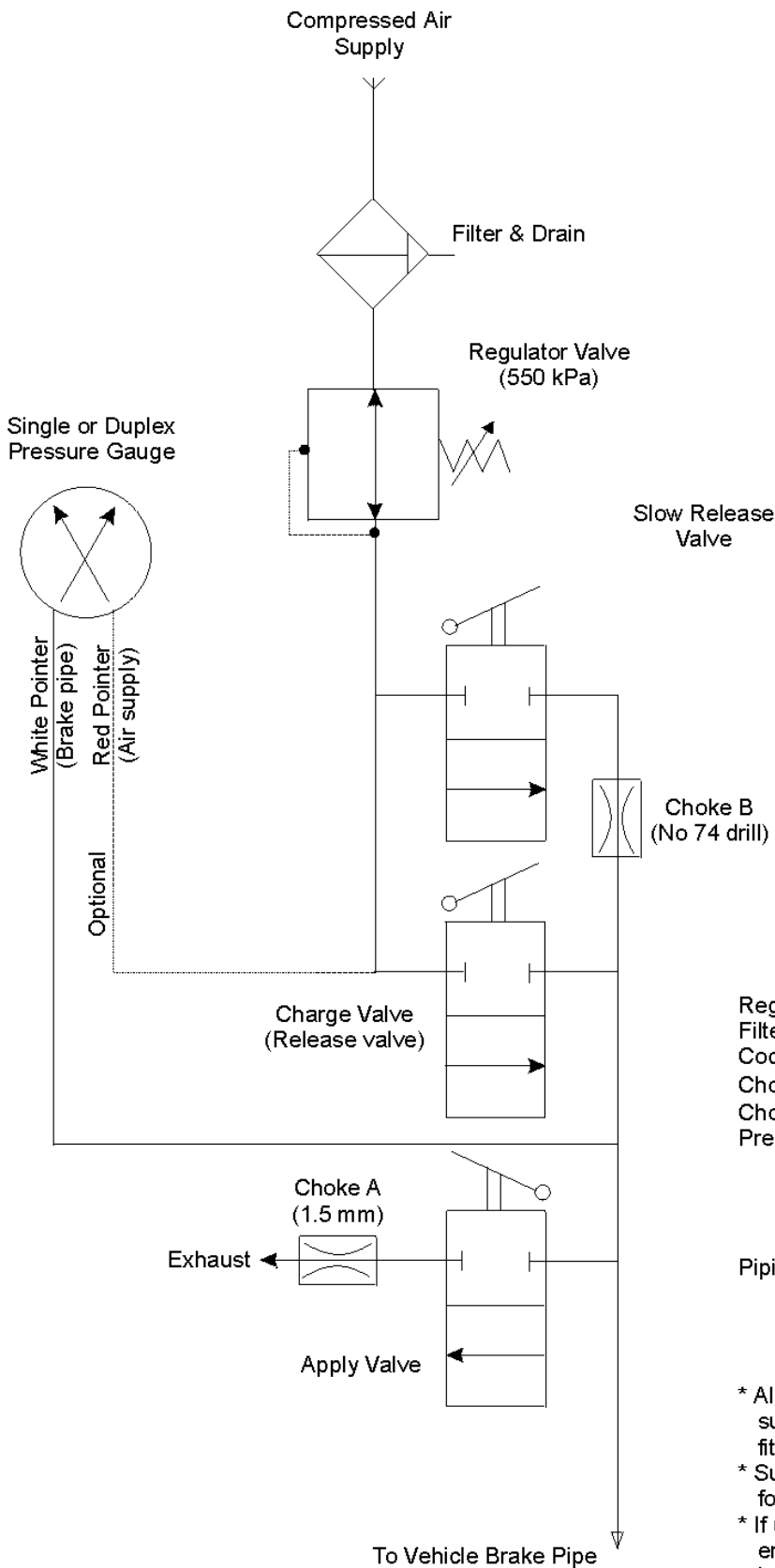
SMC Single Car Brake Tester

The Taieri Gorge Railway uses a modified SMC manufactured single car brake tester. This tester is a compact unit with most of the controls mounted on or in an aluminium monoblock supported by a frame. However this particular tester needs modifying before use.

- Exhaust chokes - The SMC tester comes with 3 interchangeable chokes. The larger sizes apply the brakes too rapidly to allow accurate pressure setting. The only useful choke is the smallest and this should be drilled out to 1.5 mm (standard).
- Sensitive release choke - this is .035" in diameter (0.89 mm) and needs to be replaced with a 0.58 mm choke.
- Pressure gauge - the supplied gauge is far too small for accurate pressure settings. This needs to be replaced. While not essential using a locomotive duplex pressure gauge allows for easier setting of pressure reductions as one needle can be compared with the other.
- Maintaining feature - because of the modern locomotive braking systems used the brake tester needs to maintain a set reduction (475 kPa) for the 10 minute test. As the SMC tester doesn't have this feature it had to be added externally to the tester using standard air components.

In hindsight it would have been simpler to build a tester from scratch using standard components. The only real advantage of the SMC tester is the reduction in joints (and potential leaks) by using a monoblock housing.

**Simple Single Car Brake Tester
Schematic**



Components

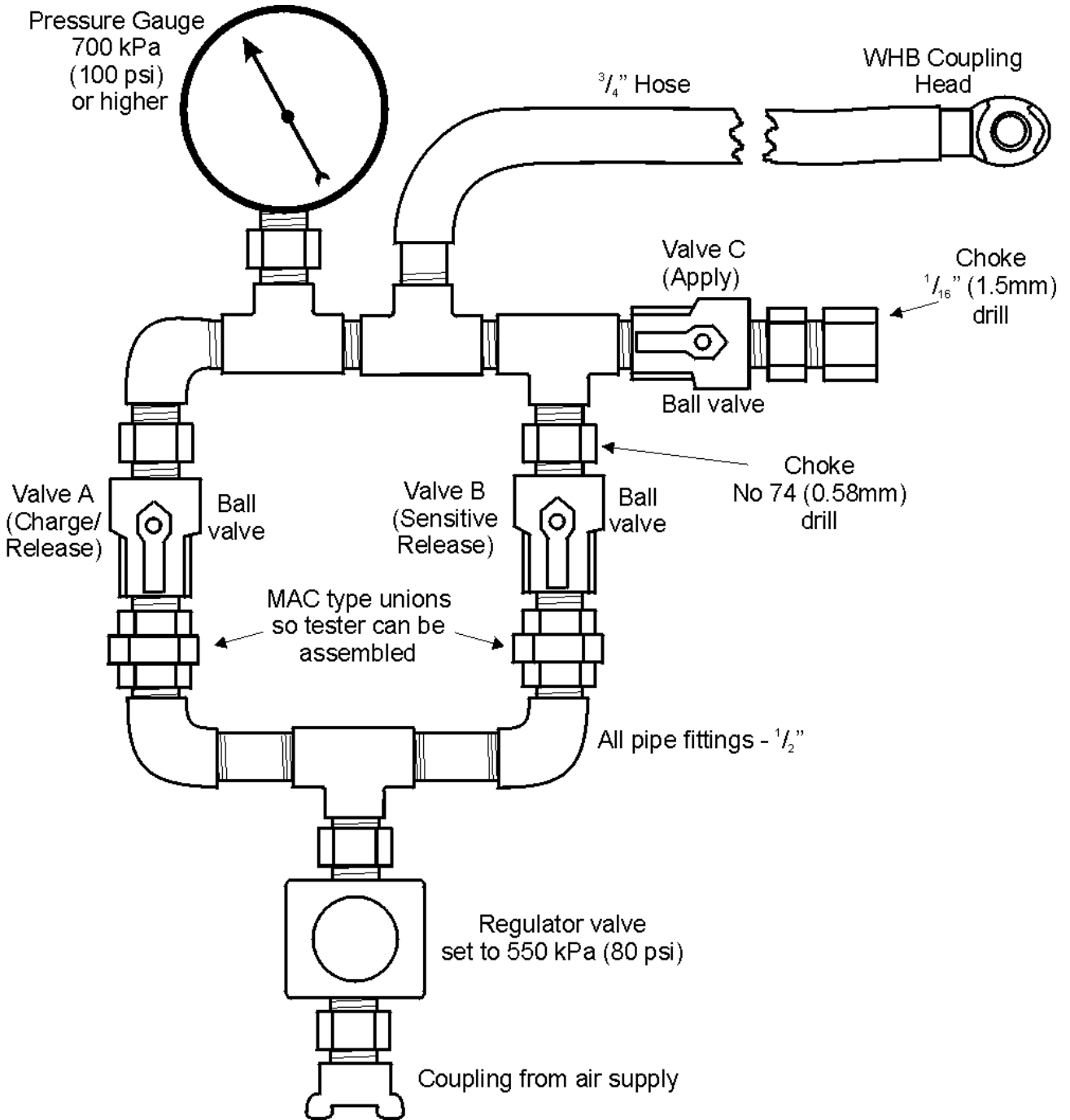
- Regulator valve - 1/2" (eg SMC IR402-04)
- Filter/Water Trap - 1/2" (eg SMC AF4000-04)
- Cocks - 1/2" ball type
- Choke A - 1.5 mm \varnothing
- Choke B - No 74 drill or 0.58 mm \varnothing
- Pressure gauge - Single or duplex;
100 mm or larger;
Max pressure 700kPa or higher;
25 kPa scale divisions or finer
(eg locomotive duplex gauge)
- Piping - all 1/2"

Notes

- * All hose connections should be well supported to avoid putting stress on fittings and connections.
- * Suggest that the tester be fitted to a frame for protection and ease of carrying.
- * If using a second hand pressure gauge ensure that it has reasonable accuracy and is not worn (needle moves smoothly and readings are repeatable). A sloppy or sticking movement will make accurate leakage tests impossible.

Mechanical Construction

Ted Pointon (the Federation's Mechanical Convenor) suggests this construction for a car tester.



Single Car Tester

Rubber hose to be long enough to couple to car brake pipe hose with car tester opposite car brake cylinder so that brake cylinder can be observed and release wire can be used to release brakes etc.

[Editors Note:- This length of hose is not recommended. For a 1" car brake pipe a half car length of 3/4" hose will increase the total volume by more than 25% and affect timings, especially the Sensitive Release test. In practise it is not necessary to observe the brake cylinder operating.]

Improved Car Brake Tester

One drawback of the simple tester described above is that brake pipe pressure is not maintained during the Brake Pipe Maintenance and Auxiliary Leakage test (10 Minute Application Test). Any leakage in the brake system during this test will reduce the brake pipe pressure and effect the result of the test.

An improved tester can be made by replacing the basic regulator valve in the simple regulator with a relay valve fed by a sensitive regulator valve. A 1.5 mm choke should be fitted to the exhaust port on the relay valve (see schematic below) and the pressure gauge needs to be the duplex type (or two single gauges fitted).

Set the regulated pressure set to 550 kPa to perform all tests except the Brake Pipe Maintenance and Auxiliary Leakage test.

For the Brake Pipe Maintenance and Auxiliary Leakage test:-

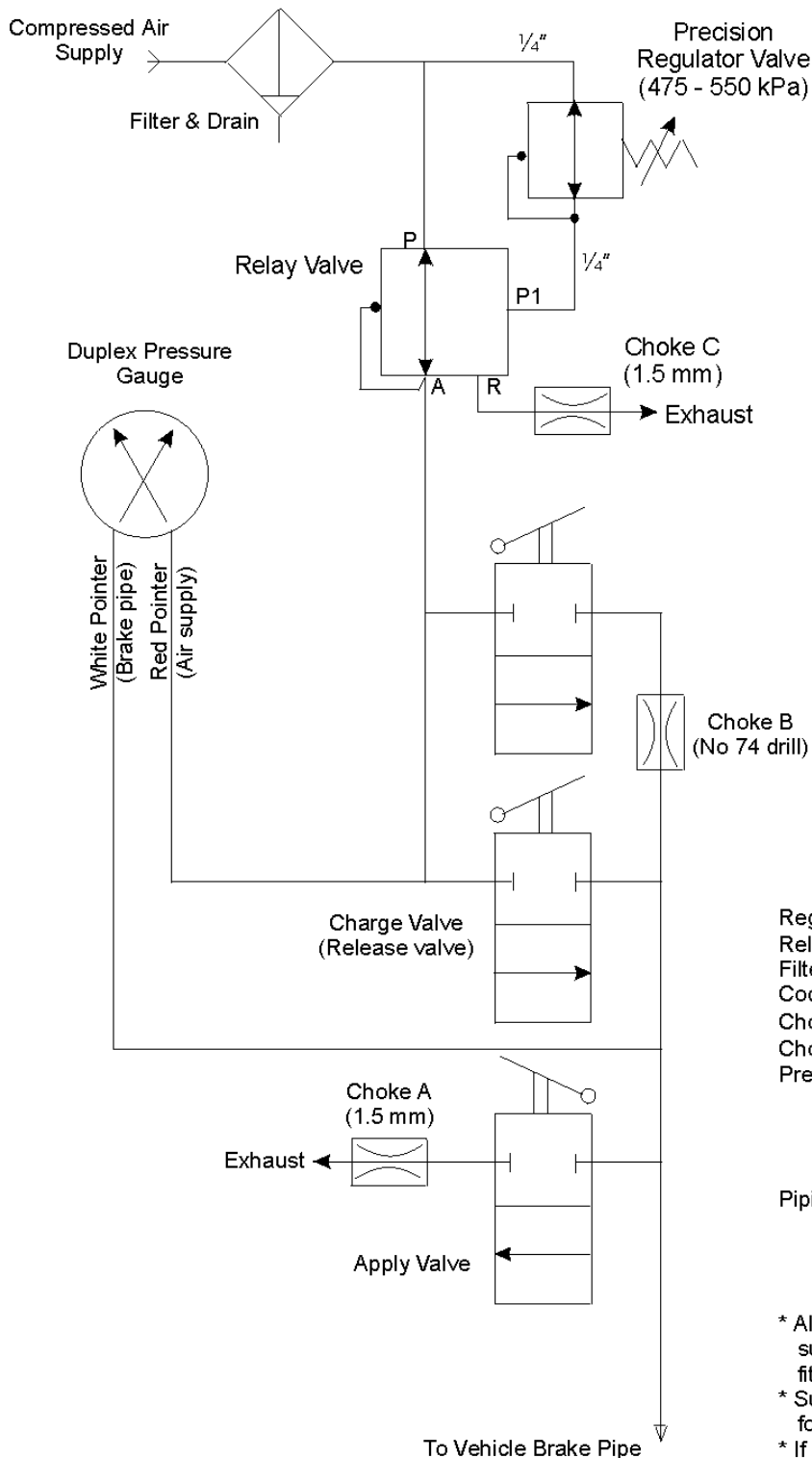
- Close all the valves.
- Reduce the regulated pressure to 475 kPa (red needle).
- Open the Charge Valve. The brake pipe pressure will drop to 475 kPa (white needle) and maintain at this pressure. The brakes must remain operated for a minimum of 10 minutes.
- After the test close the Charge Valve and restore the pressure to 550 kPa.

Using the Tester

Having built a tester the rail operator should then:-

- Prepare an instruction sheet setting out the test procedures to be used (including how to test the tester). This can be laminated and should be kept with the brake tester.
- Prepare a check sheet which records
 - Date of test
 - Vehicle tested
 - Details of the vehicle brake system (eg triple valve type, date overhauled, cylinder size, etc).
 - Details of the tests carried out (eg pass/fail, leakage in kPa, time in seconds).
 - Other work carried out (eg cylinder cleaned & greased, water trap cleaned, brake blocks renewed.)
 - Repairs done during test.
 - Name and signature of person carrying out tests.
- Train staff in use of the tester.

Improved Single Car Brake Tester Schematic



Components

- Regulator valve - 1/4" (eg SMC IR2020-02)
- Relay Valve - 1/2" (eg SMC VEX1300-04)
- Filter/Water Trap - 1/2" (eg SMC AF4000-04)
- Cocks - 1/2" ball type
- Chokes A & C - 1.5 mm \varnothing
- Choke B - No 74 drill or 0.58 mm \varnothing
- Pressure gauge - Duplex;
100 mm or larger;
Max pressure 700kPa or higher;
25 kPa scale divisions or finer
(eg locomotive duplex gauge)
- Piping - all 1/2" unless shown otherwise.

Notes

- * All hose connections should be well supported to avoid putting stress on fittings and connections.
- * Suggest that the tester be fitted to a frame for protection and ease of carrying.
- * If using a second hand pressure gauge ensure that it has reasonable accuracy and is not worn (needle moves smoothly and readings are repeatable). A sloppy or sticking movement will make accurate leakage tests impossible.

Testing The Tester

Daily Test

Before any brake testing is done the tester should be tested as follows:

- Connect an air supply.
- Connect a dummy hose coupling to the end of the hose.
- Open the Charge Valve and observe that the pressure gauge reads 550 kPa (or the specified test pressure).
- Observe that the pressure does not vary over 1 minute (tests the pressure regulating valve).
- Close the Charge Valve and observe that the pressure does not fall or rise over 1 minute (leakage test).

Possible faults

Fault	Reason
Pressure varies with Charge Valve open.	Faulty pressure regulator.
Pressure falls with Charge Valve closed.	Leakage through the Apply Valve, from pipe fittings or the dummy coupling connection.
Pressure rises with Charge Valve closed.	Leakage through the Charge Valve or Sensitive Release Valve.

A faulty tester should not be used until repaired.

Annual Test

The annual test should consist of

- Daily test as above
 - Pressure gauge – this should be tested against a known quality pressure gauge at 400 kPa and 550 kPa. Absolute accuracy is not essential but the readings should be repeatable and the needle must move smoothly without sticking.
 - Timing test. The recommended method is:-
 - When the tester is first constructed use a known dummy volume (e.g. old equalising reservoir or auxiliary reservoir) connected to the hose and :-
 - Open Charge Valve and charge reservoir to 550 kPa.
 - Close Charge Valve and open Apply Valve. Record the time taken for the pressure to fall from 550 kPa to 400 kPa. Close the Apply Valve.
 - Open the Sensitive Release Valve and record the time taken for the pressure to rise from 400 kPa to 500 kPa.
 - Retain the recorded times and the dummy volume and repeat the tests yearly. An increase in timings indicates blocked chokes. A decrease in times indicates worn (oversize) chokes.
- If the above tests cannot be done then the alternative is to dismantle the tester and check that the choke valves are not obstructed or damaged.
- Visual inspection of the tester's condition including the hose, coupling head rubber, support brackets, etc.
 - Soap test – test all connections, valve handles etc for leaks with a soap solution.

More Improvements

The standard Tranz Rail tester uses an equalising reservoir to control a relay valve which in turn supplies the train pipe (similar in principle to a No 4 brake valve). Various dummy volumes are used provide reference pressures for the Minimum Reduction test and various functions of the WF (freight) triple valve.

The author is researching this to design a simplified version and will publish details at a later date.
