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Translation

ORI

Brakes - A study of minimum standards for maintenance of goods wagon brakes

Frein - Contrôle d'un standard minimal dans la maintenance du frein équipant les wagons
Bremse - Überprüfung eines Mindeststandards der Instandhaltung der Bremse für Güterwagen

UNION INTERNATIONALE DES CHEMINS DE FER
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Contents

Summary

This leaflet deals in point 1 with a "minimum test procedure" and in point 2 with the "technical requirements for brake testing equipment".

The "minimum test procedure" describes minimum standards for technical inspections carried out in repairing faulty air brakes on rolling stock used in international traffic.

The "technical requirements for brake testing equipment" set out basic requirements for brake testing equipment so that the "minimum test procedure" can be carried out. These technical requirements could form part of a specification sheet.

1 - Minimum test procedure

1.1 - Preconditions

1.1.1 - Preambule

These minimum tests are intended to form part of a standard for examinations that can be used in contracted repair of faulty brakes on rolling stock for Railway Undertaking (RU) that do not own or keep rolling stock. The results serve as a declaration and documentation of a fault or damage and as proof for the owner/keeper or their repair workshop.

Each step of the minimum tests sets reference values and permissible variations. These are based on the guidelines of *UIC Leaflets 540 and 547* (see Bibliography - page 29) (see the notes to the leaflets for an understanding of each test), but are identical in every case. This is because the aim of the minimum tests is to review the minimum requirements for safe brake operation of a wagon used in train formation.

R

1.1.2 - Initial inspection of brake operation

- Fill automatic brake train pipe level to 5,0 bar,
- Reduce automatic brake train pipe level to 3,5 bar: the brake must apply,
- Fill automatic brake train pipe level to 5,0 bar: the brake must release.

The initial inspection should detect faults that are not connected to faulty distributor operation and do not therefore require the use of the brake test equipment.

O

1.1.3 - Connecting the automatic brake train pipe to the testing equipment

Before beginning the tests the following connections need to be made between the wagon and the testing equipment. The guidelines set out in Appendix A - page 17 are to be followed when choosing a connecting pipe for the automatic train pipe and the measuring line:

- Automatic brake train pipe,
- Control reservoir (A) (see point 1.2.2.5 - page 7),
- Pilot pressure (C_v) (recommended for brakes where $C_{empty} = C_{loaded}$, obligatory where $C_{empty} < C_{loaded}$),
- R-additional reservoir,
- Brake cylinder (C) (all separately piloted C pressure values are to be measured),
- Pilot line T (all separately piloted T pressure values are to be measured) on wagons with automatic mechanical or two-level pneumatic empty-loaded devices or with automatic load braking.

It is necessary to equip:

- all goods wagons with a testing lead for measuring the brake cylinder pressure C,

- and wagons with automatic mechanical or two-level pneumatic empty-loaded devices, or with automatic load braking (pneumatic piloting) with a control lead T,

as described in Appendix A - page 17.

It is recommended that C and T pressures, and all brake piston travel values that are specific to the vehicle should be inscribed on the wagon.

1.1.4 - Brake test equipment requirements

R **1.1.4.1 - Order of test procedure**

For dependability reasons it is recommended that the brake testing equipment carry out the entire test procedure from point 1.2.2.2 - page 5, onwards on a computerised basis as stipulated by point 2 - page 11 (except for any adjustments to be made to the wagon).

O **1.1.4.2 - Variance comparison of the measured values**

Each step of the test procedure and the variance comparison is carried out automatically without the operator's intervention. The variance comparison uses stored or previously entered target values. This presupposes that before each new step of the procedure the testing equipment sets up and checks the initial situation as defined under point 1.1.5 - page 3 and that it does so independently of the operator.

O 1.1.5 - Checking the initial situation before each step of the test

– Stabilising	- pressure values are considered stabilised when they remain stable for at least 60 sec.
– Absolute pressures	- stabilised pressure in the automatic train brake pipe means 5 ± 0,05 bar, - stabilised pressure in the control reservoir (A) means a value within 0,05 bar of the automatic brake pipe value, - stabilised pressure in the auxiliary reservoir means a value over 4,8 bar, - stabilised pressure in the brake cylinder means ≤ 0,05 bar.

1.2 - Procedure for the minimum brake tests

1.2.1 - Checking the mechanical characteristics of the brake components

plus the accesibility and operation of the installations.

All brake components must be correctly installed.

1.2.1.1 - Brake switching devices

Check that the switching devices (on/off switches, brake position switches, empty/loaded device) are in good working order and accessible.

1.2.1.2 - Brake shoes and brake shoe play

The brake shoes must be:

- sufficiently thick,
- not broken,
- not overflowing.

The automatic rigging regulator checks the play and ensures an average brake shoe play of circa 5 mm.

1.2.1.3 - Automatic brake train pipe, cut-off cock, release mechanisms

The automatic brake train pipe and the brake coupling hose must be in working order.

The cut-off cocks must:

- be in useable working order,
- lock securely in the end positions,
- bleed the air from the brake coupling hose when in the "closed" position.

The release mechanisms must be accessible from both sides.

1.2.1.4 - Arresting gear

The arresting gear must be present and correct.

1.2.1.5 - Brake rigging, bolts

Brake rigging and bolts must have free movement (ie not rusted up). Bolts must be secured.

1.2.1.6 - Handbrake

The handbrake must be accessible and in working order.

1.2.2 - Checking the pneumatic characteristics of the brake components

Wagons are classified as follows according to brake type:

Type I a Wagon with two-level mechanical empty/loaded device (manually operated)

$$C_{empty} = C_{loaded}$$

Type I b Wagon with two-level mechanical empty/loaded device (automatically piloted by the cradle device and T-pressure)

$$C_{empty} = C_{loaded}$$

Type II a Wagon with two-level pneumatic empty/loaded device (manually operated)

$$C_{empty} < C_{loaded}$$

Type II b Wagon with two-level pneumatic empty/loaded device (automatically piloted by the cradle device and T-pressure)

$$C_{empty} < C_{loaded}$$

Type III Wagon with automatic load braking (A)

$$T_{empty} : T_{loaded} \approx C_{empty} : C_{loaded}$$

1.2.2.1 - Leak tightness of the brake system

Test organisation:

The distributor is on. All cut-off cocks are open and the unused coupling heads from the brake couplings are sealed with plugs.

Procedure:

- fill the automatic brake pipe to 5,0 bar and check the initial position,
- shut off the automatic brake pipe supply on the brake test equipment,
- measure the automatic brake pipe pressure: maximum permissible pressure decrease without refilling is 0,3 bar in 5 minutes.

1.2.2.2 - Leak tightness of the brake cylinder

Test organisation:

Brake position P, empty/loaded device in loaded position for Type I a and II a. For Types I b, II b & III the T-pressure must be loaded for the mechanical switch to trip or to reach C-pressures from C_{loaded} and/or C_{max}.

Test procedure:

- fill the automatic brake pipe to 5,0 bar and check the initial position,
- reduce automatic brake pipe from 5,0 to 0,0 bar as in rapid application of the brakes,
- wait 60 s for the pressure to stabilise,
- R-pressure must drop no more than $\Delta p \leq 0{,}25$ bar over 180 s.

1.2.2.3 - Brake responsiveness

(*UIC Leaflet 540, point 1.10.2*)

Test organisation:

Brake position P, empty/loaded device in loaded position for Type I a & Type II a. For Types I b, II b & III the T-pressure T_{loaded} must be loaded for the mechanical switch to trip or to reach C-pressures from C_{loaded} to C_{max}.

Test procedure:

- Fill the automatic brake pipe to 5,0 bar and check the initial position,
- Reduce the brake-pipe pressure in linear fashion from 5,0 bar to 4,4 bar over 6 s and then maintain this level,
- After these 6 s C-pressure must maintain $\geq$ 0,2 bar for $\geq$ 10 s.

1.2.2.4 - Insensitivity of released brakes

(*UIC Leaflet 540, point 1.10.1*)

Test organisation:

Brake position P, empty/loaded device in loaded position for Type I a and Type II a. For Types I b, II b and Type III the T-pressure T_{loaded} must be loaded for the mechanical switch to trip or to reach C-pressures from C_{loaded} to C_{max}.

Test procedure:

- Fill the brake-pipe to 5,0 bar and check the initial position,
- Reduce the brake-pipe pressure in linear fashion to 4,4 bar over 120 s,
- C-pressure must remain at 0 bar (< 0,05 bar).

1.2.2.5 - Release characteristics

(*UIC Leaflet 540, point 1.5*)

Test organisation:

Brake position P, empty/loaded device in loaded position for Type I a andType II a. For Types I b, II b and Type III the T-pressure T_{loaded} must be loaded for the mechanical switch to trip or to reach C-pressures from C_{loaded} to C_{max}.

Test procedure **without** A-pressure measurement:

- Raise brake pipe pressure to 5,0 bar and check the initial position,
- Lower brake-pipe pressure to 4,5 bar and maintain this level,
- Let C-pressure stabilise for 10 s and then measure,
- Measure C-pressure again after 180 s. C-pressure[1] may only change by ≤ 0,2 bar,
- Raise brake-pipe pressure to 4,85 bar at a rate of 0,5 to 0,6 bar per minute,
- C-Pressure must show 0 bar (< 0,05 bar) after maximum 60 s.

If any of the target values are not met then the distributor must be immediately replaced, or a second test **with** A-pressure measurement must follow to support the diagnosis:

Test procedure **with** A-pressure measurement:

- Establish test connection to control reservoir A,
- Raise brake-pipe pressure to 5,0 bar and check the initial position,
- Lower brake-pipe pressure to 4,2 bar and maintain for 60 s,
- Measure A-pressure,
- Raise brake-pipe pressure to 4,7 bar (without going beyond this level) and maintain for 60 s. Over this period A-pressure must not fall more than $\Delta_p \leq 0{,}05$ bar and C-pressure[1] must show ≥ 0,3 bar,
- Raise brake-pipe pressure to 4,85 bar at a rate of 0,5 to 0,6 bar per minute,
- C-Pressure must show 0 bar (< 0,05 bar) after maximum 60 s.

1. On systems where the brake power is adjusted using a pneumatically-controlled device (types IIa, IIb and III where $C_{empty} < C_{loaded}$), the pressure of 0,2 or 0,3 bars corresponds to the pilot pressure (C_V)

1.2.2.6 - Application and release times, brake cylinder pressure

The vehicle-specific test values for brake piston travel, C-pressure and T-pressure can be read off the label on the wagon or the brake calculation.

1.2.2.6.1 - Test procedure for Type I a and Type II a

- Raise brake-pipe pressure to 5,0 bar and check the initial position,
- Lower brake-pipe pressure to under 3,4 bar in less than 3 s,
- Measure brake cylinder application time,
- Measure C-pressure,
- Raise brake-pipe pressure to 5,0 bar,
- Measure brake cylinder release time,
- Measure C-pressure.

Test A :	Brake position **G**	Empty/loaded device to **loaded**
Test B :	Brake position **G**	Empty/loaded device to **empty** (Type II a only)
Test C :	Brake position **P**	Empty/loaded device to **loaded**
Test D :	Brake position **P**	Empty/loaded device to **empty** (Type II a only)

1.2.2.6.2 - Test procedure for Type I b, II b & Type III

Proceed as follows to test the **valve actuator** and the **load weigh valve**:

- Raise brake-pipe pressure to 5,0 bar and check the initial position,
- Measure pilot pressure T_{empty} of the load weigh valve/actuator if the target value is known,
- Use lifting gear to load or unload the load weigh valve/actuator, and note the corresponding changes in T-pressure[1].

1. only when the actuators or load weigh valve generate a T-pressure in proportion to the load.

Procedure for tests B, C, D:

- Raise brake-pipe pressure to 5,0 bar and check the initial position,
- Adjust pilot pressure T and feed externally,
- Lower brake-pipe pressure to under 3,4 bar in less than 3 s,
- Measure brake cylinder application time,
- Measure C-pressure,
- Raise brake-pipe pressure to 5,0 bar,
- Measure brake cylinder release time,
- Measure C-pressure.

Test B :	Brake position **G**	Pilot pressure T_{loaded}	(feed T externally - according to vehicle specification)
Test C :	Brake position **P**	Pilot pressure T_{empty}	(feed T externally - according to vehicle specification)
Test D :	Brake position **P**	Pilot pressure T_{loaded}	(feed T externally - according to vehicle specification)

1.2.2.6.3 - Success criteria

An inspection can be considered to have been passed when:

- Final stabilised C-pressure is 3,8 ± 0,2 bar or 3,6 ± 0,2 bar for wagons with this value for nominal pressure (Type I a and I b),
- Final stabilised C-pressure (depending on the system used by the wagon) reaches the target values ± 0,2 bar in the empty and in the loaded position (Type I a, I b and II a),
- T-pressure in the load weigh valve/actuator reaches the target value ± 0,3 bar for empty wagons (Type I b, II b and III, Test A only),
- T-pressure variation in the wagon's load weigh valve/actuator when it is loaded or unloaded is at least ± 0,3 bar (Type I b, II b and III, Test A only), as proof of basic operability[1],
- The brake rigging transmission reaches the empty or loaded position under corresponding pilot pressure T (externally fed). Check by measuring the cylinder piston travel,
- Final stabilised C-pressure reaches the target value ± 0,2 bar under coresponding pilot pressure T (externally fed). Type II b and III only,
- With the brake in position P, C-pressure reaches 95% of the final stabilised value in maximum 5 s for Type I a, Type I b and Type II a; or 7 s for Type II b and Type III,

1. Only when the actuators or load weigh valve generate a T-pressure in proportion to the load.

- With the brake in position G, C-pressure reaches 95% of the final stabilised value in 15 to 38 sec,

- Under C-pressure up to 0,4 bar brake cylinder release times lie between:

  - 36 and 72 s for position G,
  - 12 to 24 s[1] for position P

  but
  for Type I a and Type II a only with the empty loaded device switched to loaded
  for Types I b, II b und III only with pilot pressure T_{loaded},

- After release C-pressure reaches 0 (< 0,0 5 bar).

1.2.2.7 - Final test: check the pipes and hoses for leaks

At the end of the inspection, disconnect the test equipment and check the pipes, hoses and connections for leaks.

1.2.2.8 - Check-list

All checks and steps of the test procedure are listed in Appendix B - page 21.

1. Between 12 and 30 seconds for wagons with a total mass on rail of 70 t or more.

2 - Minimum technical standards for brake testing equipment

2.1 - Scope

These minimum technical standards form the basic guidelines for brake testing equipment that is intended for use in inspection of goods wagon air brakes as laid out in point 1 - page 2. They could be used as part of a specification sheet for development and construction of a brake testing device. The term "individual goods wagon" refers to all vehicles that are fitted with a braking system as described in *UIC Leaflets 540 to 547*, and which are subject to inspection.

Brake testing devices that comply with the requirements of this leaflet (backed up by a conformity certificate) are considered as approved devices for the minimum brake tests described in point 1.

2.2 - Functions and objectives for the use of brake testing equipment

The brake testing device must be deployable in minimum brake tests and their test criteria as set out in point 1. In this respect these are only functional minimum standards and do not claim to be exhaustive. Any further requirements made on such equipment (eg further tests, ease of operation, ergonomics, accident prevention) are to be completed by the operator in a specification sheet.

Thus the functions and objectives can be described as follows:

1. Functions

   - Piloting and supplying air to the vehicle's air brake through the automatic brake train pipe and the T-pressure (pilot pressure);
   - Piloting the brake system (test procedure).

2. Main objectives

   - Measurement, display and storing of parameters (pressure, time and wagon ID number);
   - Testing the correct functioning of the brakesystem and components by comparison with the parameters (pressure changes over time);
   - Appraisal of conformity by automatic procedure (neutral assessment) independent of the operator;
   - Evaluation and documentation of the test results.

3. Secondary objectives

   - Traceability of the test procedures;
   - Carrying out repeat cycles;
   - Effective fault finding;
   - Improved vehicle availability;
   - Creation of databases.

Observance and implementation of the secondary objectives must never interfere with the main objectives.

2.3 - General requirements

The testing equipment must be defined in such a way that it can fulfil the following requirements:

- **Automatic test procedure:**
  It is recommended that the tests should be carried out on an automated basis as stipulated in point 1.1.4.1 - page 3. In isolated cases however, manual intervention must remain possible, but the equipment must be able to record and document any such intervention. Interventions can be regulated by procedures for according authorisation to the operator (test staff). In certain cases it must be possible for changes to be made to the order in which the steps of the test are carried out, or to leave out or repeat certain steps.
  Under point 1.1.4.2 - page 3 each step of the test including variance comparisons must be carried automatically, even when initiated by the operator.

- **Procedure in the case of a fault in the brake system:**
  Faults (incorrect test values, leaks etc.) must be indicated by the equipment during the test. It must be possibe to repeat the test step concerned and then correct the fault without having to interrupt the test procedure. For safety reasons all test results that have been obtained up to that point must be stored.

- **Storing results:**
  Test data must be stored and printed if necessary. The data must be transferable to a PC for analysis and processing.

- **Programming the equipment:**
  The testing equipment must be designed so that where target values are available a wide range of goods wagons can be tested. It must be possible to load the correct test programme by preselection into the operating memory of the device. All relevant target values and permitted tolerances for a particular wagon must be loaded automatically at the same time, so that a variance comparison of the test values can be carried out automatically. The keeper or owner of the vehicle must supply these data. The programme must also allow new target values and tolerances to be entered or modification of existing data.

2.4 - Requirements, functions

2.4.1 - Air supply

The testing equipment must supply air faultlessly at pressures ranging from 6,5 to 10 bar, and be immune to any variations in the pressurised air supply network throughout the duration of the test.

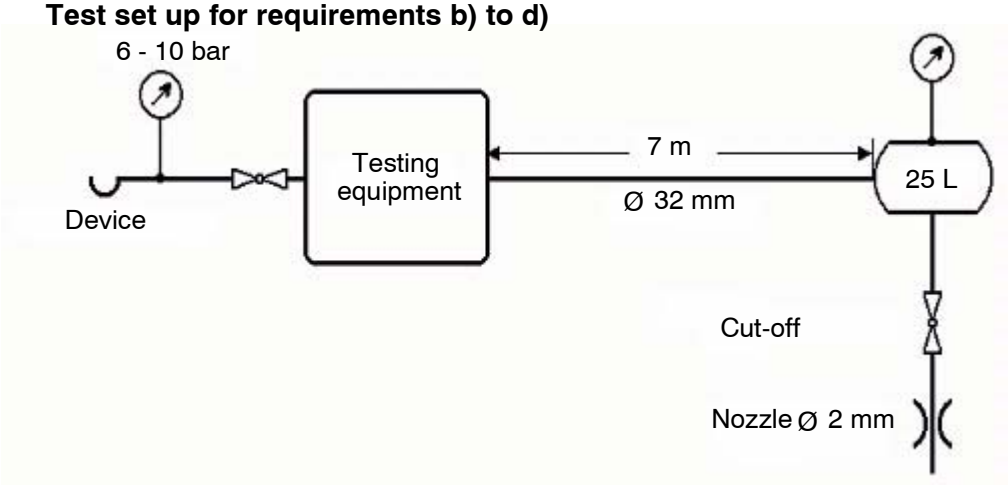
The equipment must be designed with sufficient capacity to enable all steps of the test to be carried out.

Since the equipment is intended for use with a wide range of goods wagons, the following criteria for air capacity and supply must be observed and tested when inspecting the equipment:

Requirement	**Criterion**
Piloting of the automatic brake train pipe:	0 - 6 bar
Brake-pipe capacity of the wagon[a]:	10 to 60 litres according to overall wagon length
Total capacity (brake-pipe plus additional reservoir) of the wagon[a]:	max. 400 litres
Filling capacity:	a) At a feed pressure of 6,5 bar the device must be able to fill a 400 litres reservoir connected to the brake pipe to a pressure of 5,0 bar in 5 minutes maximum.
Feed performance:	b) At a feed pressure of 6,5 to 10 bar, topening of a Ø 2 mm vent hole in a 25 litres reservoir that is connected to the device by a 7 m long pipe of Ø 32 mm interior diameter must lead to a pressure drop of no more than 0,15 bar.
Bleeding capacity:	c) When a 25 litres reservoir is connected to the device's brake-pipe port by a 7 m long pipe of Ø 32 mm interior diameter at an initial pressure of 5,0 bar, rapid application of the brakes must result in 3,5 bar max in the reservoir in 2 s max.
Testing for leaks:	d) After closing the Ø 2 mm nozzle and choosing the procedure for leak testing - see point 1.2.2.1 - page 5 - the pressure in the 25 litres reservoir (to simulate the brake-pipe volume of a wagon) must vary no more than ± 0,1 bar from an initial 5,0 bar over a period of 20 minutes.

a. A wagon is a set of one or more elements (multiple unit, articulated unit) identified by a single registration number unique to that wagon.

Test set up for requirements b) to d)



Accuracy of measuring cycles (Ramps):	As part of the brake test, the test equipment must bring about given changes of pressure in the brake-pipe in a given lapse of time (ramps). The accuracy of the resulting ramps must be checked and recorded with a test programme. Ramp accuracy means +/- 0,02 bar in the given time. Eg: to check brake insensitivity brake-pipe pressure must be lowered by 0,6 bar in 6 s (for brake pipe volumes of 10 to 60 litres). The testing equipment must be able to bring about a pressure change of 0,58 to 0,62 bar in 6 s.

2.4.2 - Electricity supply

The test equipment must function using the electricity supply specified by the operator.

2.4.3 - Measurements: categories, accuracy, range

There are two options for taking measurements:

- Sensors placed directly on the wagon and connected electrically to the testing equipment,
- Air pressure measuring hoses running from the wagon to the testing equipment, where the sensors are sited.

It is up to the operator to choose the method on a case by case basis, but the guidelines of Appendix A - page 17 must be followed, ie.

The following pressure values must be recorded **simultaneously**:

on the wagon :

- Brake cylinder pressure C (at least twice),
- Pre-pilot pressure C_V,
- Control reservoir A,
- load weigh valve pressure / pilot pressure T (at least twice),
- Additional reservoir R.

On the testing equipment:

- Brake-pipe pressure.

For these pressures the whole measurement chain from pressure detection to display and storing of data must fulfil the following criteria:

- Range: 0 - 6 bar,
- Accuracy: at least ± 0,5 % at 10 bar (± 0,05 bar),
- Display: two decimal places.

2.4.4 - Programming

The IT equipment of the brake test station must ensure the following points:

- Exact detection of the pressure range related to "Time" and the "other physical quantities measured",
- Processing of the measurements using algorithms, which are set up and validated by the wagon operator,
- Setting up of a pneumatic and/or electrical (analogue or digital) signal to check the time, pneumatic and electrical requirements, as well as the accuracy, traceability and reliablility specified by the wagon operator for the items under test,
- Display and recording of the measurements and the signals. The recordings must be intact and complete.

2.5 - Equipment calibration and self-testing

The testing equipment must be able to carry out the following internal checks:

Self-testing	The device must self test its functional efficiency every time it is switched on (microprocessor test, sensor availability, benchmarking of the pressure converter); The operator must be informed of any fault.
Calibration	It must also be possible to calibrate the device as and when required. The predefinded calibration values and the actual values must be recordable and printable. The report produced by the device must indicate whether or not the operator has calibrated the measurement connections.

2.6 - Data that must be listed in the test report

The test report must be clearly traceable to the wagon and the workshop. The report must show the following information as a minimum:

- test date,
- operator name or number,
- workshop name or code,
- Wagon number, currently a 12 figure number, 14 figure number in the future.

The report must list all the tests carried out with the pass/fail assessment for each test, so that the result can be clearly identified. The check list in Appendix B - page 21 gives an example of a test report based on the cycles of minimum tests set out in point 1 - page 2. Any changes in the test procedure must be reflected in the report.

The report must clearly state in numerical rather than graphical form the measurements, and the permissible and recognised threshold values defined for this test. This applies in particular to data relating to pneumatic qualities marked with the "☒" symbol.

Furthermore, it must be clear from the report which values fall within the threshold limits and which do not.

Appendix A - Test and measurement connectors

A.1 - Test connectors for brake cylinder pressure C

As per point 1.1.3 - page 2 freight wagons must be equipped with connectors for measuring brake cylinder pressure.

Example:

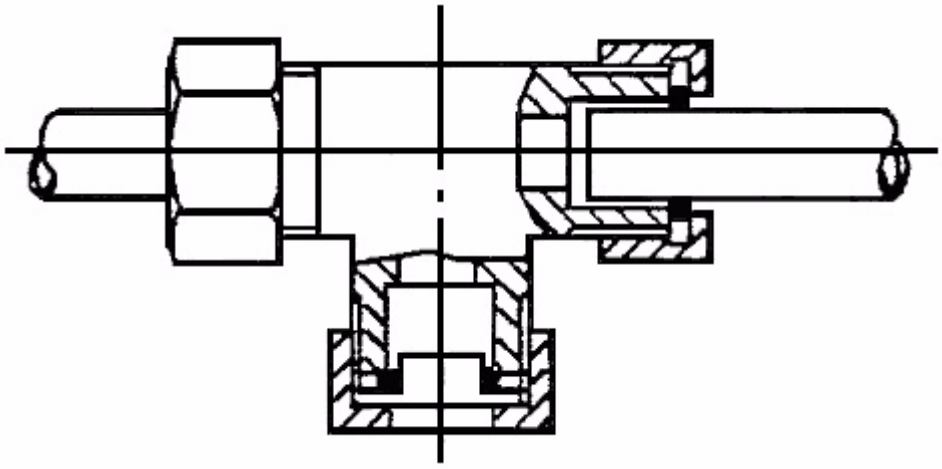


Fig. 1 - Test connectors

A.2 - Control connectors for wagons with automatic mechanical or pneumatic empty-loaded devices or with automatic load braking

As per point 1.1.3 wagons with automatic mechanical or pneumatic empty-loaded devices or with automatic load braking must have a control connection on the pilot line. As in the "Switch Positions" diagram below, this control connector is sited in the pilot line between the cradle/pilot valve (port 1) and the relay valve (port 3). It has three pneumatic switch positions which can be selected automatically by a universal connector when appropriately attached to port 2 (see point A.3 - page 19):

- Position A: universal connector closed. Connection only between cradle/pilot valve and relay valve,
- Position B: connection to cradle /pilot valve closed. Connection only between universal connector and relay valve for external feed of T-pressure from the testing equipment,
- Position C: connection between the universal connector and the open pilot line to allow the testing equipment to measure the T-pressure created by the cradle / pilot valve.

A possible variation is shown by the Fig. 3 of an existing connector. In this case the three switch positions can be selected by the appropriately connected universal connector (see Fig. 4 - page 19) using a pin that can adopt three different lengths.

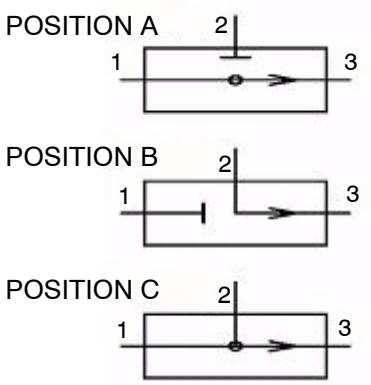


Fig. 2 - Switch positions

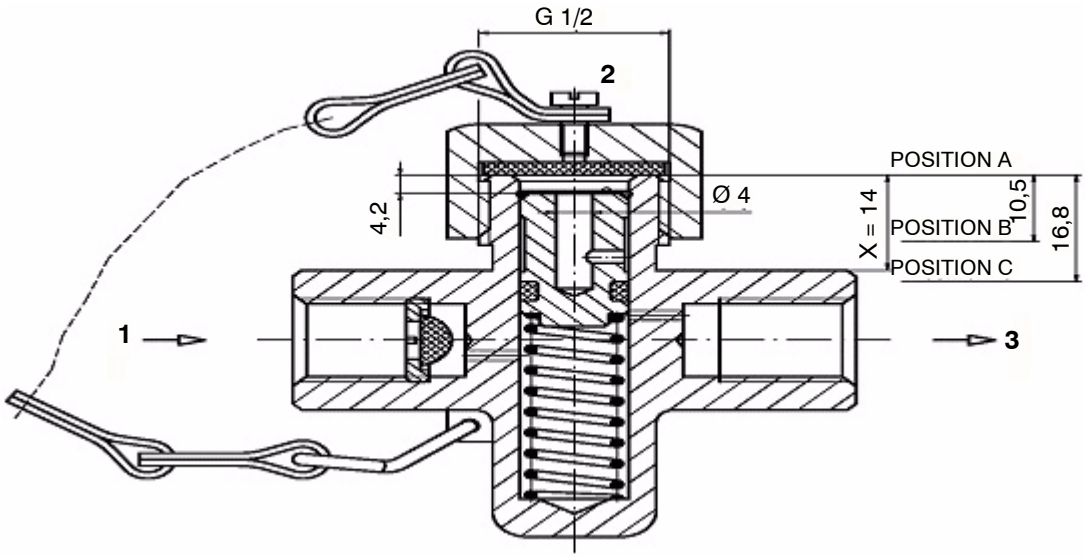


Fig. 3 - Control connector

A.3 - Testing equipment universal connector for wagons with automatic mechanical or pneumatic empty-loaded devices or with automatic load braking

The universal connector creates the pneumatic connection between the control connector sketched in point A.2 - page 17 and the testing equipment. To ensure compatibility with the control connector the universal connector must be of the appropriate dimensions and be able to pilot the three switchpositions A, B and C.

A possible variation is shown by the Fig. 4 which is compatible with the Fig. 3 - page 18. The diagram shows and existing model with the positions indicated. The table below lists the positions of the control connector and the corresponding positions of the universal connector.

Control connector position	Universal connector position	Function
A	K	closed
B	T-1-2	External T-pressure feed
C	T 2	T-pressure measurement

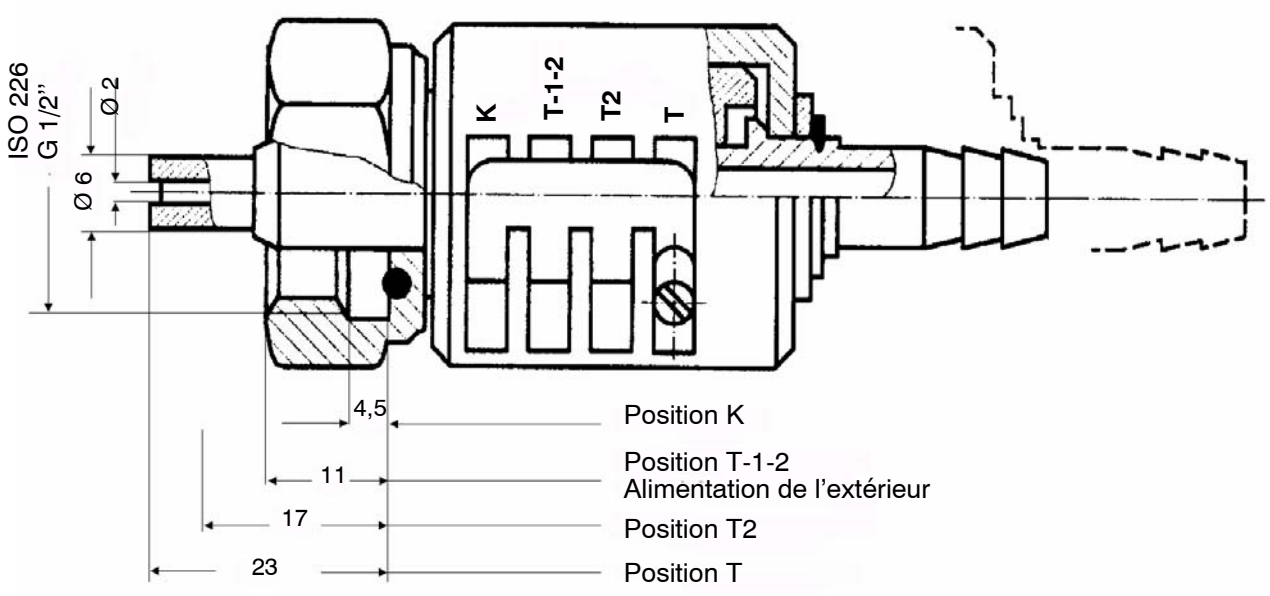


Fig. 4 - Universal connector

A.4 - Arrangement of the connecting lines

To measure:

- Pilot pressure T,
- A-pressure,
- C-pressure,
- C_V-pressure.

On the wagon.

A.4.1 - Pneumatic connections (Pressure measurement converter on the testing equipment)

To ensure accuracy of measurement a maximum test volume for the connections must be defined when using pneumatic connectors.

Use of a 5 mm diameter feed pipe is recommended. The pipe needs to be no longer than a length that will ensure the necessary accuracy of the whole measurement chain, as set out under point 2.4.3 - page 14.

A.4.2 - Electrical connections (Pressure measurement converter directly on the measurement connection)

Measurement converters that are directly attached to the wagon should be connected to the testing equipment by electric cables.

A.4.3 - Arrangement of connection to the automatic brake train pipe (testing equipment to wagon)

Use of a feed pipe with a maximum volume of 5,6 litres is recommended, which for an internal diameter of 32 mm means a maximum length of 7 metres.

Appendix B - Check-list

B.1 - Checking the mechanical characteristics of the brake components

(see point 1.2.1 - page 4)

Repair depot:	.....	Date:	.....
Wagon n°: Owner:	....	Wagon type:	.....
Brake type:	.....		

	(tick)
Does the brake shut off device work?	☐
Does the brake position changer work?	☐
Does the manual mechanic or automatic empty/loaded device work?	☐
Are the brakes shoes of sufficient thickness (min 10 mm) and not broken or overflowing?	☐
Does the automatic rigging regulator function correctly?	☐
Is average brake shoe play (ca. 5 mm) present, and with brake released are the brake shoes not applied to the wheel?	☐
Are the cut-off cocks in working order and operable, do they stop securely in the end positions and is the brake coupling pipe bled when the cock is in the closed position?	☐
Are the release mechanisms accessible and in working order?	☐
Is the arresting mechanism in order?	☐
Are the brake rigging bolts unfrozen?	☐
Is the brake rigging unfrozen?	☐
Are the bolt attachments on the brake hanger in order?	☐
Is the handbrake accessible and in working order?	☐

B.2 - Checking the pneumatic characteristics of the brake components

(see point 1.2.2 - page 5)

B.2.1 - Brake system leak tightness

(see point 1.2.2.1 - page 5)

Target:	Actual:	Result:
Max permissible pressure drop in brake-pipe 0,3 bar/5 minutes	..... bar/5 minutes	OK ☐ Not OK ☐

B.2.2 - Brake cylinder leak tightness

(see point 1.2.2.2 - page 5)

Target:	Actual:	Result:
Max permissible R-pressure drop: ≤ 0,25 bar /180 s	..... bar/180 s	OK ☐ Not OK ☐

B.2.3 - Brake responsiveness

(see point 1.2.2.3 - page 6)

Target:	Actual:	Result:
C-pressure must reach ≥ 0,2 bar after 6 s	C-pressure after 6 s ..... bar	OK ☐ Not OK ☐

B.2.4 - Insensitivity of released brakes

(see point 1.2.2.4 - page 6)

Target:	Actual:	Result:
C-pressure must remain at 0 bar (< 0,05 bar)	C-pressure..... bar	OK ☐ Not OK ☐

B.2.5 - Release characteristics

(see point 1.2.2.5 - page 7)

Test procedure **without** A-pressure measurement

Target:	Actual:	Result:
Brake-pipe pressure 4,5 bar After 180 s: C-pressure change[a] ≤ 0,2 bar	C-pressure change [a] .....bar	OK ☐ Not OK ☐
Brake-pipe pressure 4,85 bar After 60 s: C-pressure < 0,05 bar	C-pressure..... bar	OK ☐ Not OK ☐

a. On systems where the brake power is adjusted using a pneumatically-controlled device (types IIa, IIb and III where $C_{empty} < C_{loaded}$), the pressure of 0,2 or 0,3 bars corresponds to the pilot pressure (C_v).

Test procedure **with** A-pressure measurement

Target:	Actual:	Result:
Brake-pipe pressure 4,7 bar After 60 s: - A-pressure drop < 0,05 bar - C-pressure[a] ≥ 0,3 bar	A-pressure drop.....bar C-pressure[a] ..... bar	OK ☐ Not OK ☐
Brake-pipe pressure 4,85 bar After 60 s: C-pressure < 0,05 bar	C-pressure..... bar	OK ☐ Not OK ☐

a. On systems where the brake power is adjusted using a pneumatically-controlled device (types IIa, IIb and III where $C_{empty} < C_{loaded}$), the pressure of 0,2 or 0,3 bars corresponds to the pilot pressure (C_v).

B.2.6 - Application and release times, brake cylinder pressure

(see point 1.2.2.6 - page 8)

B.2.6.1 - Test procedure for Type I a and II a

(see point 1.2.2.6.1 - page 8)

Test A - Brake position **G** - switched to loaded		
Target:	Actual:	Result:
Brake cylinder application time: 15 to 38 s	Brake cylinder application time: .....s	OK ☐ Not OK ☐
C-pressure from 3,6 ± 0,2 or 3,8 ± 0,2 bar. Or as per wagon's system	C_1-pressure : .....bar C_2-pressure :.....bar	OK ☐ Not OK ☐
Brake cylinder application time: 36 to 72 s (C-pressure 0,4 bar)	Brake cylinder application time: ..... s	OK ☐ Not OK ☐
C-pressure 0 bar (< 0,05 bar)	C_1-pressure: .....bar C_2-pressure: .....bar	OK ☐ Not OK ☐

Test B - Brake position **G** - switched to **empty** only for Type II a		
Target:	Actual:	Result:
Brake cylinder application time: 15 to 38 s	Brake cylinder application time: .....s	OK ☐ Not OK ☐
C-pressure as per wagon's system ± 0,2 bar	C_1-pressure: .....bar C_2-pressure: .....bar	OK ☐ Not OK ☐
C-pressure 0 bar (< 0,05 bar)	C_1-pressure: .....bar C_2-pressure: .....bar	OK ☐ Not OK ☐

Test C - Brake position **P** - switched to **loaded**		
Target:	Actual:	Result:
Brake cylinder application time max. 5 s (Type I a) or 7 s (Type II a)	Brake cylinder application time: .....s	OK ☐ Not OK ☐
C-pressure from 3,6 ± 0,2 or 3,8 ± 0,2 bar. Or as per wagon's system	C_1-pressure: .....bar C_2-pressure: .....bar	OK ☐ Not OK ☐
Brake cylinder application time: 12 to 24 s[a] (C-pressure 0,4 bar)	Brake cylinder application time: ..... s	OK ☐ Not OK ☐
C-pressure 0 bar (< 0,05 bar)	C_1-pressure: .....bar C_2-pressure: .....bar	OK ☐ Not OK ☐

a. Between 12 and 30 seconds for wagons with a total mass on rail of 70 t or more.

Test D - Brake position **G** - switched to **empty** only for type II a		
Target:	Actual:	Result:
Brake cylinder application time max 7 s	Brake cylinder application time: .....s	OK ☐ Not OK ☐
C-pressure as per wagon's system ± 0,2 bar	C_1-pressure: .....bar C_2-pressure: .....bar	OK ☐ Not OK ☐
C-pressure 0 bar (< 0,05 bar)	C_1-pressure: .....bar C_2-pressure: .....bar	OK ☐ Not OK ☐

B.2.6.2 - Test procedure for Type I b, II b und III

(see point 1.2.2.6.2 - page 8)

Test A - T-pressure T_{empty} (from the actuator to the cradle/pilot valve)		
Target:	Actual:	Result:
T-pressure T_{empty} (as per the wagon's system) Target value t ± 0,3 bar	T-pressure.....bar	OK ☐ Not OK ☐
T-pressure variation[a] when loading and unloading ≥ 0,3 bar	T-pressure-variation.....bar	OK ☐ Not OK ☐

a. Only when the actuators or load weigh valve generate a T-pressure in proportion to the load.

Test B - Brake position **G** - T-pressure T_{loaded} (external T-feed - according to vehicle specification)		
Target:	Actual:	Result:
Brake application time 15 to 38 s	Brake application time: .....s	OK ☐ Not OK ☐
C-pressure (loaded) as per the wagon's system ± 0,2 bar	C_1-pressure (loaded): .....bar C_2-pressure (loaded): .....bar	OK ☐ Not OK ☐
Brake cylinder release time: 36 to 72 s (C-pressure 0,4 bar)	Brake cylinder release time: .....s	OK ☐ Not OK ☐
C-pressure 0 bar (< 0,05 bar)	C_1-pressure: .....bar C_2-pressure: .....bar	OK ☐ Not OK ☐

Test C - Brake position **P** - T-pressure $\mathbf{T}_{empty}$ (external T feed - according to vehicle specification)		
Target:	Actual:	Result:
Piston travel corresponding to load position (type Ib only)	Piston travel..... mm	OK ☐ Not OK ☐
Brake application time max 5 s (type I b) or 7 s (Type II b and III)	Brake application time: .....s	OK ☐ Not OK ☐
C-pressure (empty) as per the wagon's system ± 0,2 bar	C_1-pressure (empty): .....bar C_2-pressure (empty): .....bar	OK ☐ Not OK ☐
C-pressure 0 bar (< 0,05 bar)	C_1-pressure: .....bar C_2-pressure: .....bar	OK ☐ Not OK ☐

Test D - Brake position **P** - T-pressure T_{loaded} (external T feed - according to vehicle specification)		
Target:	Actual:	Result:
Piston travel corresponding to load position (type I b only)	Piston travel ..... mm	OK ☐ Not OK ☐
Brake application time max 5 s (type I b) or 7 s (type II b and III)	Brake application time: .....s	OK ☐ Not OK ☐
C-pressure (loaded) as per the wagon's system ± 0,2 bar	C_1-pressure (loaded) : .....bar C_2-pressure (loaded) : .....bar	OK ☐ Not OK ☐
Brake cylinder release time: 12 to 24 s[a] (C-pressure 0,4 bar)	Brake cylinder release time: .....s	OK ☐ Not OK ☐
C-pressure 0 bar (< 0,05 bar)	C_1-pressure: .....bar C_2-pressure: .....bar	OK ☐ Not OK ☐

a. Between 12 and 30 seconds for wagons with a total mass on rail of 70 t or more.

List of abbreviations

A	Control reservoir of the the pilot valve or indication for wagon with load dependent brake
C	Brake cylinder
C-Pressure	Brake cylinder pressure
C_V-Pressure	Pre-pilot pressure, pressure between pilot valve and release valve
G	Brake position "freight train" (G=Güterzug)
LCC	Life cycle cost
m	Metres
P	Brake position "passenger train"
s	Seconds
T-Pressure	Pressure in the pilot line (from the load weigh valve), pilot pressure
UIC	(Union Internationale des Chemins de fer) International Union of Railways

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