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Air brakes

Standard programme of tests

International Union of Railways

Leaflet to be classified in Volume :

V - Transport stock

Amendments

Note

This leaflet forms part of a set which also includes :

Leaflet 520 : Wagons, coaches and vans - drawgear

Leaflet 526-1 : Wagons - Buffers with a stroke of 105 mm

Leaflet 526-2 : Wagons - Buffers with a stroke of 75 mm

Leaflet 540 : Brakes - Air brakes for freight and passenger trains

Leaflet 541-00 : Brakes - Regulations concerning manufacture of the different brake parts (1)

Leaflet 541-03 : Brakes - Regulations concerning manufacture of the different brake parts - Driver's brake valve

Leaflet 541-5 : Brakes - Electropneumatic brakes for passenger trains and freight trains

Leaflet 543 : Brakes - Regulations relative to the equipment and use of vehicles

Leaflet 544-1 : Brakes - Braking power

Leaflet 546 : Brakes - High power brakes for passenger trains

Leaflet 571-1 : Standard wagons - Ordinary two-axle wagons - Characteristics

Leaflet 571-2 : Standard wagons - Ordinary bogie wagons - Characteristics

(1) Leaflet 541-00 is in course of preparation and will replace Leaflet 541-1.

Contents

0 - General

This leaflet contains programmes for implementation of the tests which new air brakes are required to undergo before they can be accepted for use in international traffic. These tests are intended to confirm that the conditions of Leaflet 540 have been met.

The UIC Sub-Committee for Braking is authorised to arrange for any further checks and tests which may be necessary outside the scope of this leaflet.

The leaflet defines the scope of the test report required under point 3 of Leaflet 540, together with the scope of the tests undertaken for presentation purposes.

The railway presenting a new air brake for acceptance shall provide all locomotives, trailing vehicles and other equipment necessary for the presentation of this brake.

Acceptance for use in international traffic, of supplementary equipment belonging to a new air brake, such as :

- quick-release valves,
- automatic control equipment for the "empty/load" changeover,
- automatically variable load braking equipment,
- brake pipe emptying accelerators,

is governed by the provisions of Leaflet 541.00.

See leaflet 546 for high power brakes (R brakes).

1 - Arrangements for carrying out tests

1.1 - Staff

The railway presenting the brake shall provide an engineer to supervise the tests, together with the staff necessary for their performance and for driving the trains.

The Sub-Committee for Braking shall appoint staff to monitor and supervise the tests undertaken on the train, on the locomotive and in the recording cars. The staff shall be selected from member railways of the Sub-Committee, with the exception of the railway presenting the brake for acceptance.

1.2 - Measurements undertaken

Measurements must be undertaken for all tests.

The Sub-Committee for Braking shall specify on which vehicles in the train the following measurements are to be made :

- pressure in the main brake pipe ;
- at least three pressures within the main brake capacities ;
- decelerations (see also point 4.1.1) with a view to detecting longitudinal reactions. These measurements are also made during the running tests.

The measurements must be undertaken at the front and rear of the test train at least and on the vehicles immediately preceding and following the recording car.

The values measured must be transmitted without any undue time lag to the recording car.

The equipment in the recording car shall include, in particular :

a) recording equipment with continuous time-synchronised paper feed, providing an indication of the time and simultaneous recording of :

- marks corresponding to operations of the driver's control valve to apply and release the brakes,
- 1 special mark for the locomotive and for the recording car,
- the values measured in the vehicles specified by the Sub-Committee for Braking,
- train speed as measured in the recording car,
- tracks reference points at intervals of 100 m.

It must be possible to insert reference marks simultaneously on all diagrams produced so that an exact comparison can be made at any given time between the recordings made.

The paper feed mechanism linked to the test equipment in the recording car must be selected with a view to providing good data legibility.

Other methods may also be used for the recording of measurements made and must provide diagrams of an equivalent standard immediately after the tests have been carried out.

b) easily visible equipment to display the values recorded and/or the following braking conditions :

- pressure gauges showing pressures in the main brake pipe at any given time or, where applicable, in the main reservoir pipe, the pressures being shown for a number of brake capacities of the recording car and, at the same time, for a number of brake capacities of the vehicles immediately preceding and following the recording car,
- speed-indicators,
- measuring equipment to record braking distances.

c) equipment enabling propagation time to be measured,

d) falling-ball accelerometer conforming to Appendix 3,

e) telephone link with the locomotive and other observation points.

During the stationary tests, it must also be possible for the pressures in the main brake pipe, in the brake cylinder and in two other capacities of the brake submitted, together with the "brake applied" and "brake released" indications, to be recorded on two additional vehicles specified by the Sub-Committee for Braking. All vehicles must be suitably prepared for this purpose.

It must be possible, by means of a modified driver's control valve or other variable control device, to create a temporary and limited overcharge in the train and subsequently reduce this. The control device must enable a minimum filling pressure of 7 bars at the front of the train to be lowered to 5.2 bars within 1 second and subsequently restored to the rated pressure.

In order to carry out the tests on individual vehicles, a portable control unit will be necessary and will incorporate a variable pressure driver's control valve with a neutral setting. It must be possible to produce clearly defined leakages which must occur when the control valve is in the neutral position.

It must be possible to measure the forces applied to the brake blocks of individual vehicles when these are stationary.

1.3 - Test procedure (presentation tests)

All handling/manipulation of the distributor units on vehicles under test is prohibited during the course of the presentation. The Sub-Committee for Braking reserves the right to prescribe appropriate safety measures.

Each hauled vehicle in the test formation will be numbered on both sides from 1 onwards, from front to rear of train. Members of the Sub-Committee will be provided with a diagram showing all possible formations of the test train. This diagram must show :

- the serial numbers of the hauled vehicles,
- the UIC marking,
- the load,
- the marks used to identify the points at which the train is split to make up formations of differing lengths when the stationary tests are carried out,
- the total length of the trains formed and their main brake pipes, excluding branch pipes.

Unless authorized by the Sub-Committee for Braking, all non-programmed modifications to the test train and all interference with the vehicles, are prohibited.

Before commencing the tests, the Sub-Committee for Braking shall satisfy itself that :

- the formation of the test train is correct,
- the locomotive is in a suitable condition as regards the driver's control valve, the compressor and pneumatic pipes, including air-tightness,
- the transmission equipment relaying the values measured and the recording apparatus itself are functioning correctly.

The railway presenting a brake for acceptance shall distribute to members of the Sub-Committee for Braking bilingual forms (French/German) listing the tests in consecutive order with their serial number, stating the nature of these tests and any special conditions which apply. Before a test is commenced, the engineer supervising the test arrangements shall give all necessary instructions concerning the manner in which it is to be carried out.

The recording equipment shall be switched on suitably in advance of each test.

Each diagram sheet must contain the following particulars, arranged in accordance with the model layout given below :

UIC Sub-Committee for Braking

Date : Time :

Type of brake :

Number of test : Nature of test :

Signature :

The diagram sheets are to be countersigned by an authorised member of the Sub-Committee after each test.

During runs made over level track, the automatic brake on the locomotive shall remain in operation, but must not be released separately. In contrast, the automatic brake on the locomotive will be isolated during all runs made over gradients.

The use of brakes which are operative on the locomotive only, on both level track and on gradients, is prohibited.

Except where certain clauses stipulate other values, the normal rated pressure of 5.0 bars shall, in principle, be maintained in the main brake pipe throughout all of the tests.

2 - Vehicles, test rigs

For the purpose of the tests, the railway presenting the brake must, as far as possible, equip standard UIC 2-axle wagons and bogie wagons fitted with cast iron brake blocks and suitable for running under S conditions with the new compressed air brake. The main brake pipe on these wagons will have an inside diameter of 32 mm and the wagons must have a braking force conforming to point 8 of Leaflet No. 543 for an axle load of 20 t. The wagons must also be fitted with buffers in accordance with Leaflets Nos. 526-1 and 526-2 and with non-continuous drawgear conforming to Leaflet No. 520.

As a general rule, the wagons to be used should be fitted with a manually operated "empty/load" changeover. On wagons fitted with an automatically variable load brake, it must be possible for the latter to be set to a comparable brake ratio position.

A certain number of reserve vehicles should be on hand.

The railway presenting the brake for acceptance must provide the Sub-Committee with outline diagrams of the different series of vehicles and locomotives used for the tests ; the railway concerned must also provide full information on the characteristics of these vehicles and locomotives, such as tare, load, braking, braked mass, brake changeover mass, coupler equipment, buffing- and drawgear equipment, type of driver's control valve, power of compressors, reservoir capacities, etc.

2.1 - Individual vehicles

Standard type bogie wagons, i.e. 4-axle wagons as referred to under point 2 of this leaflet and fitted with a manually-controlled "empty/load" changeover, will be subjected to individual vehicle tests.

In order that the correct functioning of the brake may be verified while continuous refilling of the auxiliary reservoir is in progress, the wagon must be fitted with a main brake pipe.

2.2 - Test trains, recording cars

The composition of trains which are to undergo tests is shown in Appendix 4.

Where the stationary tests are concerned, the train must be formed of a minimum of 75 vehicles with a maximum length of 1,200 m (locomotive excluded).

Where running tests are concerned, the following test trains must be provided :

- *G braking* :
  maximum length of 700 m (including locomotive), minimum number of vehicles 45 and gross hauled weight approximately 1,200 t.
- *P braking* :
  maximum length of 600 m (including locomotive), minimum number of vehicles 40 and gross hauled weight approximately 1,000 t.

Apart from the vehicles specified under point 2 of this leaflet, which will be fitted with the brake being presented for acceptance, the presenting railway shall acquire, for "mixed freight trains", a certain number of wagons fitted with a different brake already accepted for use in international traffic. In accordance with the provisions of point 4.0, the Sub-Committee will itself determine the number and nature of these vehicles, after having taken note of the operational characteristics of the brake presented.

2.3 - Locomotive

The locomotive shall be fitted with an automatic graduated release brake with "passenger" and "goods" positions. This brake can be set for simultaneous operation with the train brakes or be isolated.

The capacity of the main reservoir shall be between 800 and 1,000 litres. A main pipe will be provided. The automatic brake will be activated by means of a driver's control valve complying with the conditions of leaflet No. 541-03.

2.4 - Test rigs

(In reserve).

3 - Stationary tests

The tests will be divided into two sections : tests on individual vehicles and tests with complete trains.

Diagrams will be produced for all of these tests and will show the most significant pressure readings obtained.

3.1 - Tests on individual vehicles

For the purpose of the tests, a wagon with a similar through pipe, or its volumetric equivalent, will be connected to the main brake pipe at the rear of the vehicle under test.

Every effort should be made to obtain a main brake pipe with a length of 31 m or a volume of 25 litres.

Appendix 1 shows the "G/P" changeover and "empty/load" settings to be selected on the vehicles and specifies the additional tests to be undertaken :

- with a rated pressure of 4 bars and 6 bars in the main brake pipe ;
- with continuous filling of the auxiliary reservoir to a pressure of 10 bars from the main pipe.

3.1.1 - Filling tests (leaflet No. 540, point 1.8)

The filling time will be determined for the different brake capacities up to a pressure of 4.8 bars, the driver's control valve being in the running position and the normal rated pressure at 5 bars. The filling time will be measured as from the time when pressure in the main brake pipe begins to rise.

3.1.2 - Tests to verify graduated application and release functions (leaflet 540, points 1.3, 1.6 and 1.13.1)

Graduated service brake applications will be made, followed by a rapid and graduated release. Certain of these release operations will be interrupted by stepped brake applications.

Examination of the resulting diagrams must confirm that the brake is sensitive to minor pressure variations arising in the main brake pipe during application and release.

Pressure in the main brake pipe will be reduced to approximately 3.8 bars and, after measurement of the brake cylinder pressure, will be further reduced by 0.1 bar before being finally restored to 3.8 bars. Restoration of pressure in the main brake pipe to the 3.8 bar level must give rise to a corresponding variation in brake-cylinder pressure. Brake-cylinder pressure must not differ by more than 0.1 bar from the pressure obtained as a result of a brake application.

After raising pressure in the main brake pipe to approximately 4.2 bars, this test will be repeated in the same manner. For this purpose, the stability of the reference pressure must be verified by maintaining one level of braking for a period of at least 1 minute without refilling from the main brake pipe.

3.1.3 - Verification of full application (leaflet No. 540, point 1.7)

A check must be made to verify that the fall in main brake-pipe pressure necessary to obtain maximum pressure in the brake cylinder is effectively between 1.4 and 1.6 bars. The maximum brake-cylinder pressure of 3.8 ± 0.1 bar must be obtained for piston strokes of 50,100 and 150 mm.

3.1.4 - Verification of brake-cylinder filling and emptying times and measurement of forces applied to the brake blocks (Leaflet No. 540, points 1.18 and 1.19.1)

The filling time is measured from the time air begins to flow into the brake cylinder to the time when pressure in the latter attains 95 % of its maximum value. The brake-cylinder emptying time is measured from the time air begins to escape from the brake cylinder until pressure in the latter attains a value of 0.4 bar.

During the course of all these release operations, a note will also be made of the time the force acting on the blocks disappears.

The following times must be achieved :

- G braking : Filling time between 18 and 30 seconds
  Emptying time between 45 and 60 seconds
- P braking : Filling time between 3 and 5 seconds (6 s)
  Emptying time between 15 and 20 seconds (25 s).

When emergency applications and service brake applications are made under G braking conditions, a check must be made to ensure that the force applied to the brake blocks quickly reaches approximately 10 % of its maximum value as braking commences.

After obtaining a fall in pressure of 0.4 bar from the normal rated pressure in the main brake pipe, a certain force must continue to be applied to the blocks and cylinder pressure must be at least 0.5 bar.

During tests involving measurement of forces acting on the blocks, the brake rigging must not be tapped or knocked when the brake is being applied.

3.1.5 - Verification of sensitiveness (Leaflet No. 540, points 1.10.1 and 1.10.2)

With the brake on the vehicle concerned set to the operating position, a simulated leakage will be induced in the main brake pipe in the vicinity of the portable driver's control valve and a check made to ensure that :

- the brake is not activated when this simulated leakage (see point 3.1.6) gives rise to a fall in pressure in the pipe of 0.3 bar in one minute (Insensitiveness). Duration of test : 5 minutes ;
- the brake is activated within 1.2 s in the event of this leakage causing the pressure in the pipe to fall by 0.6 bar in 6 s (Sensitivity).

3.1.6 - Check to verify that the brake is correctly re-established and reset for operation (Leaflet No. 540, point 1.5)

After a full brake application, pressure in the main brake pipe will only be restored to a level 0.15 bar below the normal rated pressure. The brake cylinders must be emptied completely.

This test will be repeated in such a way that, during release, the filling process is interrupted at certain intervals (neutral position) and a simulated leakage induced in the main brake pipe at the same time.

When the brake-cylinder pressure has attained 0.3 bar and a leakage has been induced in the same manner as for the insensitivity test described in point 3.1.5, the brake-cylinder pressure must again increase (reset for operation position not yet reached, insensitivity criterion not in force). It will be necessary to determine as from what brake-cylinder pressure below 0.3 bar and after what interval of time :

- this test ceases to increase brake-cylinder pressure ;
- a simulated leakage, induced in the same manner as for the insensitivity test described in point 3.1.5, activates the brake by producing an initial and rapid fall of pressure in the main brake pipe.

On the basis of the documentation describing the design of the brake presented, the Sub-Committee will decide, during the course of this test, whether a further demonstration, involving measurement of the pressure in other brake capacities, is necessary to provide an even more positive indication that the brake has been correctly re-established and reset for operation.

3.1.7 - Check on effectiveness of protection provided to counteract uneven filling movements during release (Leaflet No. 540, point 1.19.2)

After a full brake application has been made, a minimum pressure of 6 bars shall be maintained in the main brake pipe for a period of at least :

- 40 s under "Goods" braking ;
- 10 s under "Passenger" braking.

No overcharge, such as would be likely to impede subsequent operation of the brake, should be observed afterwards in the different brake capacities.

3.1.8 - Check on effectiveness of protection provided to counteract uneven filling movements occurring with the brake in the release position (Leaflet No. 540, point 1.21)

With the brake released and the normal rated pressure of 5 bars, an uneven filling movement lasting 2 seconds will be initiated at a pressure of at least 6 bars. Using the equipment mentioned under point 1.2, the pressure of the uneven filling movement will be reduced to 5.2 bars in one second and then restored to the rated pressure.

The brake must not be activated during this operation.

3.1.9 - Check to verify maintenance of pressure and sensitiveness to compensation for cylinder leakage (Leaflet 540, point 1.13.2)

During the course of a moderate service, a full service and an emergency brake application, a simulated leak of 1 mm diameter will be induced in the cylinder after the pressure has attained its final level.

Pressure equalisation in the brake cylinder must commence no later than the moment cylinder pressure is reduced by 0.2 bar. Providing sufficient pressure is available from the auxiliary reservoir, the level obtained with an air-tight cylinder must be maintained within a tolerance of ± 0.1 bar.

3.1.10 - Manual release of brake (Leaflet 540, point 1.22)

It must be possible for the brake to be released manually after a service brake application or emergency brake application.

3.2 - Tests on complete trains

After studying the documents to be submitted to it, such as the description of the brake and the results obtained from the stationary tests carried out in accordance with point 3.1, the Sub-Committee for Braking will decide whether the tests on trains can be completely or partially replaced by a full-scale test rig simulation.

The 1,200 m length train will be split and stabled on two parallel tracks. The two sections of the train will be interconnected by means of a loose cable. Appendix 4 shows the various alternative test train formations.

For the tests which follow, Appendix 2 indicates the train lengths to be subjected to the tests given under the various points in this section, together with the train numbers to be used. Unless otherwise stated, the wagons will be braked in the "empty" position.

3.2.1 - Filling test (Leaflet No. 540, point 1.8)

The filling time for the train will be measured with all brake capacities in the fully emptied state. This will be the time elapsing from the moment the stop cocks at the rear of the locomotive in use are opened and that when pressure in the various brake capacities of the last vehicle attains a level of 4.8 bars. The test will be continued until the pressure has reached a level of 5 bars in the aforementioned brake capacities. The brake must not come into application on any of the wagons during this test.

The values measured will be recorded in a continuous manner until a pressure or 5 bars is obtained at the rear of the train.

The method of filling is left to individual choice.

3.2.2 - Verification of the air-tightness of brake components

The object of these tests is to ensure that the general air-tightness of the brake equipment on all vehicles in the prescribed trains is sufficient to allow the brake to function normally and prevent any distortion of the results of subsequent tests.

The Sub-Committee shall select 5 vehicles on each of which 4 pressure gauges will be fitted and connected to the main brake pipe, to the cylinder and to two other brake capacities specified by the Sub-Committee. At the latter's request, these groups of pressure gauges may also be connected to other vehicles during the course of the tests.

The following procedure will apply :

A) The volumetric brake capacities having been filled, the supply from the main brake pipe will be cut between the locomotive and the first vehicle. The pressure gauges on the 5 vehicles selected by the Sub-Committee will then be kept under observation, together with those on the recording car included in the train, and the readings noted after 10 minutes. No fall in pressure exceeding 0.25 bar per minute must be observed and none of the brakes on the train must be applied.

B) The main brake pipe will subsequently be reconnected to the locomotive and the normal rated pressure re-established throughout the entire train. The main pipe will then be completely emptied and the pressure gauges fitted to the brake cylinder and, where applicable, to other brake capacities, kept under observation and the readings noted after a period of 10 minutes. No fall in pressure exceeding 0.1 bar per minute must be observed in any brake cylinder throughout the entire test.

Diagrams need not be produced in respect of these two tests.

3.2.3 - Measurement of the transmission speed (leaflet No. 540, point 1.16)

The transmission speed is the quotient obtained from the length of the main brake pipe of the train as measured – without taking into account its branches – from the driver's control valve to the cut-off cock at the rear of the train, and the period elapsing between the time the driver turns the handle of his valve to the application position and the time air begins to enter the brake cylinder of the last vehicle (transmission time).

The minimum transmission speed for trains conforming to point 1.16 of Leaflet No. 540, must be 250 m/s.

3.2.4 - Sensitivity test (Leaflet No. 540, point 1.17)

When a service brake application is made and is accompanied by a fall in pressure of 0.3 bar in the main brake pipe, the braking effect must be transmitted through to the last vehicle. The drop in pressure obtained in the main brake pipe of the last vehicle must not exceed 0.4 bar.

For the 0.3 bar service brake application, the transmission speed will be measured with the same equipment and to the same requirements as for point 3.2.3.

Finally, the driver's control valve will be set to the running position and must result in the release of all brakes.

3.2.5 - Measuring of the release time (Leaflet No. 540, point 1.20)

After the brake has been reset and restored to a pressure of 5 bars, the driver will reduce pressure in the main brake pipe to 3.5 bars and will then release the brakes as quickly as possible, but without overcharging the brakes on the leading vehicles in the train.

The release time for the complete train is the time elapsing between the moment the driver turns the handle of his control valve to the release position and that when the brake cylinder pressure of the last vehicle reaches 0.4 bar.

It is necessary, in all cases, to establish that there has been no continuous overcharging of the brake capacities of the leading vehicle.

The release times shall not exceed :

a) G braking : 70 s for train No. 1 ;
b) P braking : 25 s for train No. 7.

A check must be made to ensure that these times are obtained with tests during which the full application is preceded by a number of partial applications and release operations enabling a pressure amounting to approximately one third of that produced by a full application to be created in the brake cylinders.

3.2.6 - Reducing overcharge (Leaflet No. 540, points 1.3 and 1.10.1)

Pressure in the main brake pipe will be established at 6 bars. Commencing with the locomotive, the normal rated pressure will be restored at a rate of fall in pressure conforming to Leaflet No. 541-03, point 4.4, either by using the driver's control valve or by means of a special device. None of the brakes must be applied during this test.

3.2.7 - Influence of variations in rated pressure (Leaflet No. 540, point 1.3)

In order to check the operation of the brake at rated pressures of 4 bars and 6 bars in the main brake pipe, the following tests shall be carried out in consecutive order :

Emergency applications, service applications, rapid releases and graduated releases.

Inspection of the resulting diagrams must show that the operation of the brake has not been impaired by the increase or decrease in the rated pressure.

3.2.8 - Verification of the inexhaustibility of the brake (Leaflet No. 540, point 1.12.2)

On 50 % of the wagons, the "empty/load" changeover will be set to the "load" position. The manner in which the brakes are to be distributed will be determined by the Sub-Committee for Braking.

The Sub-Committee will designate 10 vehicles to serve as reference vehicles in each train. In principle, 5 of these vehicles will be set to the "load" and 5 to the "empty" position ; pressure gauges will be fitted to the brake cylinders of the 10 vehicles concerned.

The brakes on the train will be filled at the normal rated pressure, following which an emergency application will be made from the locomotive. Pressures in the cylinders of the aforementioned vehicles will then be noted, together with those in the cylinders of the observation coach and the recording car. The driver will then release the brakes and restore the normal rated pressure throughout the train. A check will be made to verify that all brakes in the train have been released.

The driver will subsequently perform such operations as are indicated to him by the Sub-Committee for the purpose of exhausting the brake. The Sub-Committee is unable to select these operations until it has studied the theoretical principles on which the operation of the brake is based. The operations performed will not include any prolonged use of the driver's valve in the neutral position and must not at any time produce a pressure below 0.3 bar in the brake cylinders. When the appropriate instruction is given by the Sub-Committee, the various operations carried out will end with an emergency brake application.

The new pressures created in this way in the brake cylinders of the reference vehicles will subsequently be noted. The mean value of these pressures must be equal to at least 85 % of the mean level of the cylinder pressures previously obtained.

3.2.9 - Examination of the application and release process (Leaflet 540, points 1.6 and 1.9)

The "empty/load" changeover settings will be those indicated in point 3.2.8.

Emergency applications, service applications and graduated full service applications will be made, followed by rapid and graduated release operations. In certain cases, the release operation will be interrupted by braking steps.

On train No. 6, sections of 60 to 80 m in length will be converted for "through pipe" working and included in the train formation in the three following ways : wagons with through pipe positioned at front, in the centre and at the rear of the train.

Inspection of the resulting diagrams should show that the graduated operation characteristics of the brake presented for acceptance, as initiated during application and release, are maintained throughout the length of the train.

3.2.10 - Check to verify that reference pressure remains constant

With the pipe at the normal rated pressure of 5 bars, the driver will initiate a fall in pressure of 1 bar. Using either his control valve or the supply valve, he will subsequently maintain pressure in the pipe at 4 bars for a period of 30 minutes. He will then restore the pressure to 5 bars in steps of 0.2 bar. The state of application of the brakes will be kept under observation throughout the duration of the test. None of the brakes should be released when the pressure in the main brake pipe is less than 4.8 bars.

3.2.11 - Check on effectiveness of protection provided to counteract uneven filling movements (Leaflet No. 540, point 1.21)

With the brake released and pressure in the main brake pipe at the rated level of 5 bars, an uneven filling movement will be initiated. The duration of this uneven filling movement of 6 bars in the first wagon will be at least 2 seconds. After return to the rated pressure, no premature brake application must take place during the following 30 seconds.

4 - Running tests on the track

4.0 - General

The results of stationary tests (as obtained with a train or using a full-scale test rig) must be verified by running tests.

In the light of good results obtained from stationary tests or with a full-scale test rig, the Sub-Committee lay decide to forego all or part of the running tests. Conversely, it may require tests to be undertaken with a train of empty wagons. In particular, it may stipulate that running tests should provide proof of compatibility with brakes already accepted.

The running tests to be carried out are described below.

The test trains must be completely prepared and ready for the tests half an hour prior to departure, in order that the Sub-Committee may be able to proceed with all observations deemed necessary.

The arrangements made must be such that the running of normal traffic over the test section does not interfere with the planned tests.

4.1 - Tests on level track

For the tests on level track, ease of control of the brake will be demonstrated by controlled stops and by braking to slow but not stop the train (speed at least equal to a given speed).

The tests should also demonstrate that the brakes operate under all conditions without producing dangerous reactions.

This particularly applies with non-uniform load and brake distribution :

- when emergency brake applications are made,
- when a service brake application is followed by an emergency application,
- when the brakes are released during running.

4.1.1 - Train formations

The formation of the test train will be arranged so that groups of empty wagons alternate with groups of partly-loaded wagons. The recording car will be positioned approximately in the centre of the train. The longitudinal deceleration — filtered with approximately 4 Hz — must be measured on the body of the recording car and on the vehicle bodies at the external separation points between empty and loaded wagons. This deceleration must be measured on the empty wagon and on the loaded wagon at the ends of the train.

Appendix 4 shows examples of train formations.

For G braking conditions, a freight train with shoe brakes will be formed of empty wagons and partially-loaded wagons with an overall length (locomotive included) of 700 m and a weight exceeding 1,200 t.

Couplings must be tightened to leave an average clearance of approximately 0 mm between buffer plates (buffers in contact).

For P braking conditions, the train length will be reduced to approximately 600 m (including locomotive) by detaching some of the partially-loaded wagons. The weight of the train must be in excess of 1,000 t. The couplings will be tightened under a force of 10 to 20 kN.

Trains will be hauled by a locomotive on which the automatic brake is in operation, but its dynamic brake inoperative.

4.1.2 - Conditions to be met by the brakes

Empty wagons will be braked under "empty" conditions and loaded wagons under "empty" or "loaded" conditions.

For G and P braking conditions, the following formations conforming to Appendix 4 will be arranged by isolating and restoring to service the brakes on the corresponding wagons :

- all brakes in service with a braked mass percentage of approximately 100 for the train ;
- a braked mass percentage of approximately 60 for the train and a virtually uniform distribution of braked wagons.

4.1.3 - Nature of tests

The tests must be carried out on level track, as far as possible without curves and belonging to the railway presenting the brake for acceptance.

The maximum accelerations and decelerations of vehicles fitted with accelerometers will be noted for each test.

Each train formation must be subjected to emergency stops (ES), graduated stops (GS) and braking to slow the speed of the train (S).

A - Emergency stop (ES)

The driver's valve will be set to the emergency application position when the train passes a pre-determined point and will remain in this position until the entire train has come to a stand.

B - Graduated stop (GS)

The graduated stop entails changing, at a predetermined point, to a speed which is at least equal to a given speed, with all brakes released, and stopping as close as possible to a specified point. Operation of the switchgroup controller and driver's brake valve is left entirely to the driver's discretion. A service brake application must, however, be initiated at the start of the test track section. The distance between the specified stopping point and the position of the driver's cab at the time of stopping will be measured at the lineside.

C - Braking to slow speed of train (S)

The test entails changing, at a predetermined point, to a speed which is at least equal to a prescribed speed, with all brakes released in the case of level track, and subsequently braking in such a manner that the locomotive changes to a speed equal to but not exceeding another prescribed speed at another predetermined point. The train then continues its run without stopping.

The driver has complete freedom as regards the manner in which this test is undertaken (operation of switchgroup controller and driver's control valve).

Table I below shows the planned tests :

Table I - Test runs on level track

Nature of test	Speed at start of test (km/h)	Speed at end of test (km/h)	Stopping distance or braking distance to reduced speed section (m)	Train formations as shown in Appendix 4	Observations
ES	10	0	—	1 to 4	In both directions of running
ES	30	0	—	1 and 2	
ES	60	0	—	1 and 2	
ES	80	0	—	3 and 4	
ES	100	0	—	3 and 4	
ES	30	0	—	1 to 4	After a GS of 0.6 at V > 40 km/h
GS	20	0	300	1 and 2	
GS	30	0	300	1 to 4	
GS	50	0	800	1 to 4	
GS	80	0	800	1 and 2	
GS	100	0	—	3 and 4	
S	30	10	300	1 to 4	
S	50	10	800	1 and 2	
S	70	10	800	3 and 4	

4.2 - Tests on falling gradients

The tests undertaken during the different descents should serve to confirm that the brake submitted is such as to allow the descent of long and severe gradients in complete safety. The line profiles for the proposed test tracks must be submitted for approval to the Sub-Committee.

4.2.1 - Train formations and braking ratios

The same train formations (detailed in Appendix 4) as for the tests on level track must be used for these tests.

4.2.2 - Nature of tests

The test runs will take place in the direction of the falling gradient and may be carried out in two different ways : with or without stops.

The brake-cylinder pressures will be measured on 10 wagons in the train, 5 of these being braked in the "load" position.

The Sub-Committee reserves the right to decide itself which vehicles these shall be.

The cylinder pressures can be determined either by means of externally mounted removable pressure gauges on these vehicles or by electrical transmission to the recording car.

In all cases, regardless of whether the descent is made with or without stops, the driver will make an emergency application prior to departure and this will be recorded by the recording car apparatus. A note will be made of the resulting brake cylinder pressures obtained on the different vehicles fitted with removable pressure gauges.

During the descents, the Sub-Committee Chairman can arrange, at any given moment, for an emergency application to be made in addition to those for which provision is normally made in the programme. This application will be carried out by the driver on instructions from the recording car. The pressures obtained in the brake cylinders of the recording car and vehicles fitted with pressure gauges will be recorded in the same way as for the previous case.

Finally, shortly before the end of the falling gradient, the train will be stopped by an emergency brake application carried out by the driver and the resulting brake cylinder pressures measured as in the previous case.

The sum of the brake cylinder pressures must not be less than 85 % of that obtained during the emergency brake application made prior to departure.

It is necessary for at least the tests shown in the following table II to be undertaken :

Table II - Test runs over falling gradients

Nature of test	Speed at start of test (km/h)	Speed at end of test (km/h)	Stopping distance or braking distance to reduced speed section (m)	Train formations as shown in Appendix 4	Observations
ES	30	0	–	1 and 2	Test carried out after an ES as soon as speed reverts to 20 km/h following release
ES	20	0	–	1 and 2	
ES	60	0	–	1 to 4	
GS	60	0	1500 1)	1 and 2	
S	50	20	1000 1)	1 and 2 and 4	
S	60	30	1000 1)	3 and 4	
S	50	constant	– 2)	1 and 2	
S	70	constant	– 2)	3	

1) These distances relate to a gradient of approximately 25 °/₀₀
2) Over the entire section of line on a falling gradient.

The line on a falling gradient will be subdivided into sections to which the test parameters of table II will be related.

The Sub-Committee will specify, in the final programme, the arrangements and conditions under which the descents are to be made.

The uniform speed stipulated for the line section concerned must be observed to within ± 10 km/h.

5 - Test report

5.1 - Report on the preliminary tests undertaken by the railway requesting acceptance

5.1.1 - When a railway requests acceptance of a new continuous compressed air brake for use in international traffic, it must carry out a number of preliminary braking tests with this air brake. The braking tests must include at least the entire series of stationary tests on individual vehicles and complete trains mentioned under point 3. After prior agreement with the UIC Sub-Committee for Braking, it is possible for the tests on complete trains to be replaced by a full-scale test-rig simulation. Points 1.2 and 1.3 must consequently be observed when carrying out these tests. By derogation from point 1.2, the railway will itself determine for which of the 3 most important brake capacities the pressures are to be measured.

5.1.2 - A report (1) on the tests must be submitted to the UIC Sub-Committee for Braking. The remaining copies shall be held in reserve by the railway concerned. These copies may be requested by other railways not belonging to the UIC Sub-Committee for Braking. The report must contain the following minimum information :

- cover page showing the name of the railway and designation of the compressed air brake,
- index of contents with list of appendices,
- summary,
- description of brake with working diagrams and, where relevant, sectional drawings,
- information on the measurements undertaken (where applicable, please include appendices with descriptions and diagrams illustrating the transmission of the values measured and the recording apparatus),
- information on driver's control valve(s) used and air-compressor unit(s),
- schematic drawings of the various series of vehicles (with brake calculations) and, where applicable, of the locomotives used for the tests, together with their characteristics (tare, payload, brake ratios, braked mass, system changeover mass, coupling equipment, buffing- and drawgear, type of driver's control valve, power of compressors, capacity of reservoirs, etc.),
- description of full-scale test rig if the tests on complete trains are to be simulated on a rig,
- test programme,

(1) 20 copies in German and 20 copies in French.

- summary of the conditions specified in Appendix 2 of Leaflet No. 540, completed by a column indicating the numbers of the tests by which the corresponding characteristics have been verified,
- test report sheets on which the tests are consecutively numbered and an indication is given of their nature and special features, including the principal test results obtained,
- curves (diagrams) produced by the recording apparatus in respect of tests on individual vehicles carried out in accordance with point 3.1 (except for point 3.1.1 Filling test),
- curves (diagrams) produced by the recording apparatus in respect of tests on complete trains carried out in accordance with point 3.2. The measurements taken should include at least the front and rear of the train, together with the vehicles immediately adjacent to the recording car.

5.2 - Report on the presentation tests undertaken for the requirements of the UIC Sub-Committee for Braking

Unless otherwise indicated by the Sub-Committee, the same vehicles, measuring apparatus and measurement points are to be used as for the tests under point 5.1.

The forms distributed in accordance with point 1.3 by the railway presenting the brake and on which the tests must be listed in consecutive order, together with their special features and the principal test results obtained, will be attached when completed as appendices to the Sub-Committee's minutes. The railway presenting the brake shall also provide, for inclusion with the minutes, a concise description of the new air brake in French and German.

The Sub-Committee shall decide whether the railway presenting the brake must prepare a further report on the presentation tests for the Sub-Committee and will also specify which test curves (diagrams) are to be included in this report. The requirements of point 5.1.2 should likewise be observed in preparing the report.

The following information in respect of the running tests should be included :

- route guide with particulars of distances, gradients, radii, etc. of the lines over which the test runs are made and markers denoting test points,
- complete recordings (report sheets) of the test runs made,
- graphs showing pressure and speed data in respect of test runs,
- recordings of reactions measured,
- any other diagrammatic material or information required by the UIC Sub-Committee for Braking.

5.3 - Report on additional tests undertaken

If the UIC Sub-Committee for Braking asks the railway presenting the brake to undertake certain additional tests, a detailed report must be submitted on these tests. Points 5.1.2 and 5.2 apply by analogy to the preparation of this report. Where certain information is already contained in the test report prepared in accordance with point 5.1, it will suffice to refer to this information.

6 - Acceptance

When all the tests necessary for presentation of the brake to the UIC Sub-Committee for Braking have been completed, all recordings, diagrams and other test results necessary for the assessment of the compressed air brake must be made available to the Sub-Committee. The UIC Sub-Committee for Braking will decide, during an internal consultation meeting :

- whether the air brake satisfies the requirements of Leaflet No. 540 and whether it can be accepted for international traffic ;
- whether it is necessary to undertake further tests with the participation of delegates from the Sub-Committee and whether, after the test results have been made known, a further consultation meeting should take place concerning the acceptance of the air brake ;
- whether the air brake, in the form presented, fails to meet the conditions of Leaflet No. 540 and should not be accepted for international traffic.

The decisions made by the UIC Sub-Committee for Braking will be made known after the consultation to the railway requesting acceptance of the brake. The decisions will be published in the Conclusions of the meeting.

APPENDIX 1

Brake position for individual vehicles during the tests undertaken in accordance with point 3.1.

Wagon suitable for S running	Position of "empty/load" changeover	Tests under "Goods" (G) and "Passenger" (P) braking in accordance with point : 3.1.1	3.1.2	3.1.3	3.1.4	3.1.5	3.1.6	3.1.7	3.1.8	3.1.9	3.1.10
Without main pipe	Empty	G	G/P	G/P	G/P	G	G	G/P	G		G/P
At rated pressure of 5 bars	Load		G/P	G/P	G/P			G/P		G/P	
Rated pressure of 4 and 6 bars	Load		G para. 1 + 2	G[2]	G[1]	G	G para. 1	G			G
With main pipe	Empty				G/P			G			
	Load		P	P	G/P					G/P	G
Nos. of conditions in Leaflet No. 540		1.8	1.3 1.6 1.13.1	1.7	1.18 1.19.1	1.10.1 1.10.2	1.5	1.18.2	1.21	1.13.2	1.22

1) It is not necessary to meet the conditions.
2) For the rated pressure of 4 bars, non-respect of the maximum cylinder pressure of 3.6 bars is acceptable.

APPENDIX 2

Composition of test trains and distribution of brakes for the stationary tests in accordance with point 3.2.

Train No.	Length of train	Number of wagons	Brake position	Proportion of braked wagons	Stationary tests in accordance with point: 3.2.1	3.2.2	3.2.3	3.2.4	3.2.5	3.2.6	3.2.7	3.2.8	3.2.9	3.2.10	3.2.11
1	750 m	≥ 50	G	100 %	X		X		X	X	X	X[1]	X[1]	X[1]	X
2	750 m	≥ 60	G	50 %			X								
3	750 m	≥ 50	G	33 %				X			X				
4	1200 m	≥ 75	G	75 %		X	X	X							
5	1200 m	≥ 75	G	50 %			X	X							
6	500 m	≥ 33	P	100 %	X	X	X	X		X		X[1]	X[2]		
7	400 m	–	P	100 %					X						
Conditions as in Leaflet No. 540					1.8	–	1.16	1.17	1.20	1.3 1.10.1	1.3	1.12.2	1.6 1.9	–	1.21

1) 50 % of the wagons have the changeover set to the "load" position.
2) 3 different train formations in which a 60 to 80 m group of wagons fitted with the through pipe are positioned at the front, in the centre and at the rear of the train.
Unless otherwise stated, wagons will be braked in the "empty" position.

APPENDIX 3

Calibration table for

Scale M 2:1

Static calibration table

Balls	Gradient of inclined plane	Acceleration in m/sec²	Acceleration in g	Balls	Gradient of inclined plane	Acceleration in m/sec²	Acceleration in g
1	25 °/₀₀	0.245	0.025	9	600 °/₀₀	5.886	0.6
2	50 °/₀₀	0.491	0.05	10	800 °/₀₀	7.848	0.8
3	75 °/₀₀	0.736	0.075	11	1000 °/₀₀	9.81	1.0
4	100 °/₀₀	0.981	0.1	12	1200 °/₀₀	11.772	1.2
5	150 °/₀₀	1.472	0.15	13	1400 °/₀₀	13.734	1.4
6	200 °/₀₀	1.962	0.2	14	1600 °/₀₀	15.696	1.6
7	300 °/₀₀	2.943	0.3	15	1800 °/₀₀	17.658	1.8
8	400 °/₀₀	3.924	0.4				

APPENDIX 3

falling-ball accelerometer

Falling-ball accelerometers have 15 differently inclined planes for each of the two directions of travel. Each inclined plane has a steel ball. These balls leave their guide surface as soon as the acceleration of the unit exceeds $g.tg.\alpha$.

The number of balls which have fallen indicates, in accordance with the accompanying table, the maximum acceleration to which the instrument has been subjected during the reaction process under examination.

The instrument has a resetting device enabling the balls to be returned to their original position after the test. The unit must be fitted to the floor in a manner which prevents it from sliding and must be adjusted in its horizontal track by means of the inbuilt spirit-level.

Accuracy of the measurement method

The values shown in the calibration table are only valid for reactions of a certain duration. Where impulses are of very brief duration, the balls only react to substantially greater accelerations. The correlation between time and the acceleration necessary to eject the balls from their guide surface is shown in the accompanying diagram in which ball No. 6 is taken as an example.

This correlation is expressed as follows :

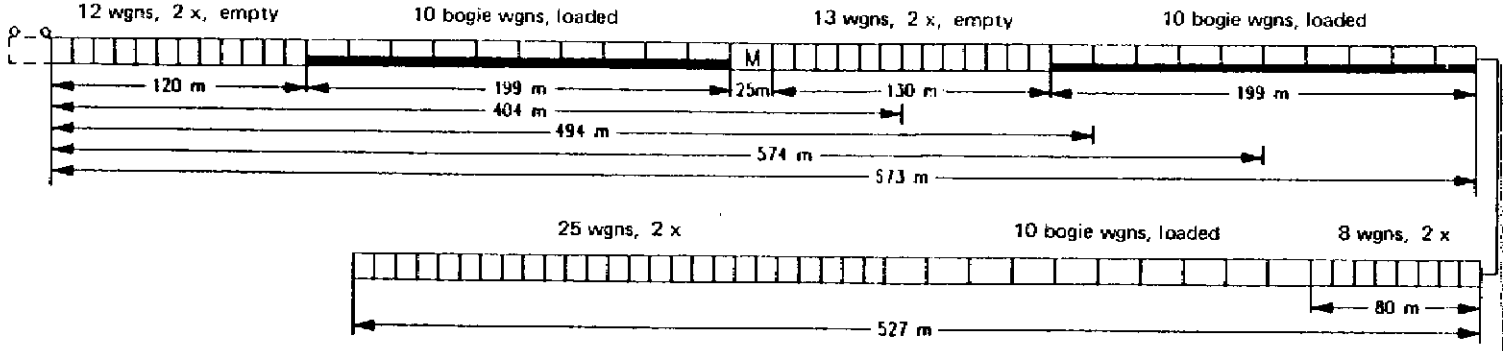
$$\text{travel s of ball} = \frac{\text{acceleration b} - g.tg\alpha}{2}\ t^2$$

Since accelerations of very brief duration are not harmful to the load, falling-ball accelerometers, despite this element of imprecision, do enable useful comparisons to be made.

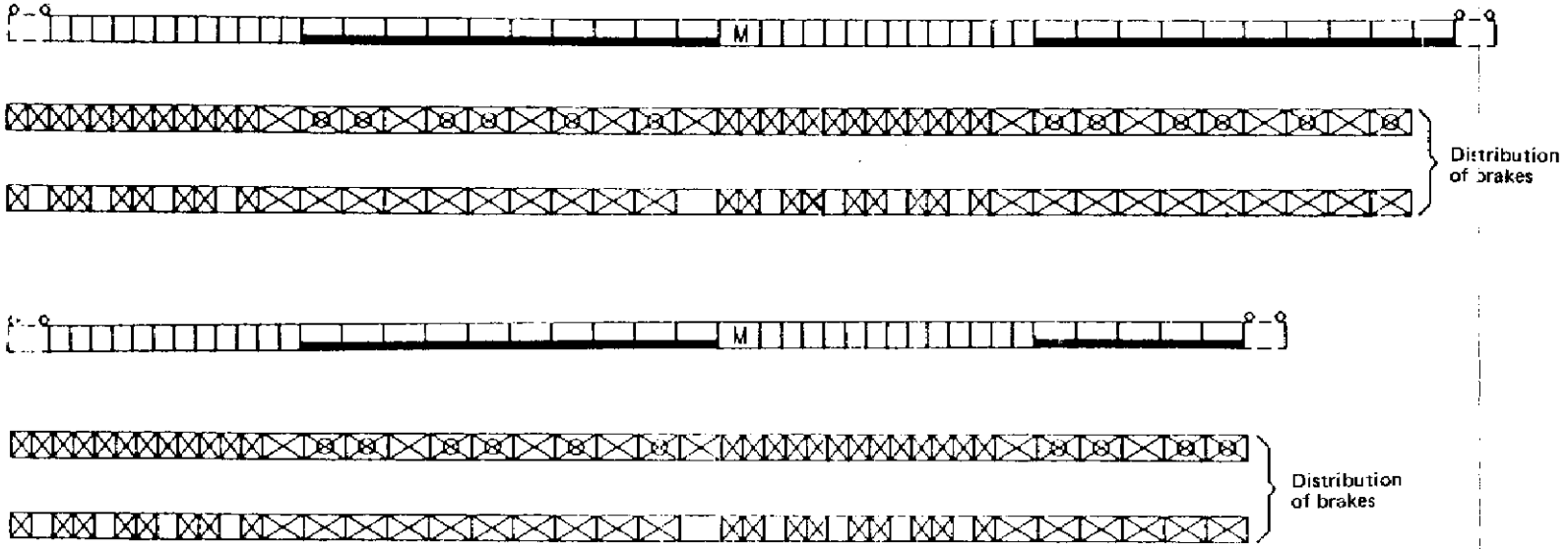
Source : ORE B 36, RP3 – Appendix 2.3/1, dated 1962, completed by the UIC Sub-Committee for Braking in January, 1989.

Composition of test trains

TRAIN FORMATION DIAGRAMS FOR STATIONARY TESTS



TRAIN FORMATION DIAGRAMS FOR TESTS ON LEVEL TRACK AND ON FALLING GRADIENTS



G and P braking

Train lengths possible	Number of wagons
404 m	29
494 m	37
753 m	54
1200 m	89

Train formation diagrams for G braking :
673 m, 1230 t

1st diagram : $\lambda \approx 100\ \%$

2nd diagram : $\lambda \approx 60\ \%$

Train formation diagrams for P braking :
574 m, 1010 t

3rd diagram : $\lambda \approx 100\ \%$

4th diagram : $\lambda \approx 60\ \%$

Standard UIC 2-axle wagon (Es), length over buffers 10.00 m, empty

Standard UIC 4-axle wagon (Rs/Res), length over buffers 19.90 m, empty

As previous vehicle, but laden-up to weight of "empty/load" changeover

M Recording car weighing approximately 60 t, $\lambda \approx 100\ \%$

Distribution of brakes :

Wagon brake isolated

Wagon braked, "empty/load" changeover in "empty" position

Wagon braked, "empty/load" changeover in "load" position

Application

With effect from 1st July, 1989.

All railways in the Union.

Record References

This leaflet, coded in 1952 under the No. 547, corresponds to previous Leaflet No. 204.

Latest headings under which the question has been studied :

— *Question 5/T/FIC* - Revision of UIC leaflets.
(Sub-Committee for Braking : Paris, January 1989).