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REDLINE VERSION

INTERNATIONAL STANDARD

colour inside

Railway applications – Rolling stock – Testing of rolling stock on completion of construction and before entry into service

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ELECTROTECHNICAL
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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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RAILWAY APPLICATIONS – ROLLING STOCK – TESTING OF ROLLING STOCK ON COMPLETION OF CONSTRUCTION AND BEFORE ENTRY INTO SERVICE

FOREWORD

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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

International Standard IEC 61133 has been prepared by IEC technical committee 9: Electrical equipment and systems for railways.

This standard is derived from EN 50215.

This third edition cancels and replaces the second edition, published in 2006; it constitutes a technical revision.

The main technical changes with regard to the previous edition are as follows:

- References to standards other than international have been removed from the main text so the notes refer solely to Annex B;
- Annex B has been updated with the latest European information, and cross-references between the TSIs and ENs and the clauses of IEC 61133 have been added.

The text of this standard is based on the the second edition and the following documents:

FDIS	Report on voting
9/2096/FDIS	9/2132/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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RAILWAY APPLICATIONS – ROLLING STOCK – TESTING OF ROLLING STOCK ON COMPLETION OF CONSTRUCTION AND BEFORE ENTRY INTO SERVICE

1 Scope

This International Standard specifies general criteria to demonstrate by testing that newly constructed complete railway vehicles conform with standards or other normative documents.

This International Standard, as a whole or in part, applies to all railway vehicles except special purpose vehicles such as track-laying machines, ballast cleaners and personnel carriers. The extent of application of the standard for particular vehicles will be specifically mentioned in the contract, to take account, where necessary, of any legislative requirements.

NOTE 1 The parts of the standard which are applicable will depend on the type of vehicle (e.g. passenger, freight, powered trailer, etc.).

NOTE 2 The scope of this standard excludes railbound and road/rail vehicles for construction and maintenance of railway infrastructure.

NOTE 3 This standard does not deal with tests carried out on components or equipment before fitting to the vehicle.

In so far as this International Standard is applicable, it may be used for the following:

– generator sets mounted on a vehicle provided for auxiliary purposes;
– electrical transmission used on trolley buses or similar vehicles;
– control and auxiliary equipment of vehicles with non-electrical propulsion systems;
– vehicles guided, supported or electrically propelled by systems which do not use the adhesion between wheel and rail.

NOTE 4 Specific technical requirements apply to vehicles which operate on the railways in the European Union. The source of those requirements is given in Annex B. Where a European requirement applies to a given clause, a note has been inserted at the end of the clause.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60077 (all parts), *Railway applications – Electric equipment for rolling stock*

IEC 60310:~~2004~~ 2015, *Railway applications – Traction transformers and inductors on board rolling stock*

IEC 60322:2001, *Railway applications – Electric equipment for rolling stock – Rules for power resistors of open construction*

IEC 60349 (all parts), *Electric traction – Rotating electrical machines for rail and road*

~~IEC 60349-1:2002, *Electric traction – Rotating electrical machines for rail and road vehicles – Part 1: Machines other than electronic convertor-fed alternating current motors*~~

~~IEC 60349-2:2002, *Electric traction – Rotating electrical machines for rail and road vehicles – Part 2: Electronic convertor-fed alternating current motors*~~

IEC 60494-1:~~2002~~ 2013, *Railway applications – Rolling stock – Pantographs – Characteristics and tests – Part 1: Pantographs for main line vehicles*

IEC 60494-2:~~2002~~ 2013, *Railway applications – Rolling stock – Pantographs – Characteristics and tests – Part 2: Pantographs for metros and light rail vehicles*

IEC 60529:~~2001~~ 1989, *Degrees of protection provided by enclosures (IP Code)*

IEC 60571:~~1998~~ 2012, *Railway applications – Electronic equipment used on ~~rail vehicles~~ rolling stock*

IEC 60850:~~2000~~ 2014, *Railway applications – Supply voltages of traction systems*

IEC 61287 (all parts), *Railway applications – Power convertors installed on board rolling stock*

~~IEC 61287-1:2005, *Railway applications – Power convertors installed on board rolling stock – Part 1: Characteristics and test methods*~~

IEC 61377-1~~:2006~~, *Railway applications – Rolling stock – Part 1: Combined testing of inverter-fed alternating current motors and their control system*

IEC 61377-2~~:2002~~, *Railway applications – Rolling stock – Combined testing – Part 2: Chopper-fed direct current traction motors and their control*

IEC 61377-3~~:2002~~, *Railway applications – Rolling stock – Part 3: Combined testing of alternating current motors, fed by an indirect converter, and their control system*

IEC 61991:2000, *Railway applications – Rolling stock – Protective provisions against electrical hazards*

IEC 62236-3-1:~~2003~~ 2008, *Railway applications – Electromagnetic compatibility – Part 3-1: Rolling stock – Train and complete vehicle*

IEC 62236-3-2:~~2003~~ 2008, *Railway applications – Electromagnetic compatibility – Part 3-2: Rolling stock – Apparatus*

IEC 62278:2002, *Railway applications – Specification and demonstration of reliability, availability, maintainability and safety (RAMS)*

IEC 62313:2009, *Railway applications – Power supply and rolling stock – Technical criteria for the coordination between power supply (substation) and rolling stock*

IEC 62425, *Railway applications – Communication, signalling and processing systems – Safety related electronic systems for signalling* ~~[1]~~

IEC 62427:2007, *Railway applications – Compatibility between rolling stock and train detection systems*

IEC 62845, *Railway applications – Radio remote control system of traction vehicles for shunting application*

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~~[1] To be published.~~

IEC 62846, *Railway applications – Current collection systems – Requirements for and validation of measurements of the dynamic interaction between pantograph and overhead contact line*[2]

ISO/IEC 17025~~:2005~~, *General requirements for the competence of testing and calibration laboratories*

ISO 3095~~:2005~~, *Acoustics – Railway applications – Measurement of noise emitted by railbound vehicles*

ISO 3381~~:2005~~, *Railway applications – Acoustics – Measurement of noise inside ~~rail~~ railbound vehicles*

ISO 9001:2015, *Quality management systems – Requirements*

NOTE For applications in the European Union, see also the references in Annex B.

~~UIC Leaflet 623-1: 3rd Edition, 2005, *Approval procedures for the diesel engines of motive power units*~~

~~UIC Leaflet 623-2: 3rd Edition, 2005, *Approval tests for the diesel engines of motive power units*~~

~~UIC Leaflet 623-3: 3rd Edition, 2003, *Series test and acceptance conditions for diesel engines of motive power units*~~

3 Terms, definitions and abbreviations

For the purposes of this document, the following terms, definitions and abbreviations apply:

3.1
a.c.
alternating current

3.2
approval authority
any body other than the purchaser with the legal right to require tests to be performed on vehicles within the scope of this standard and to whom compliance verification ~~must~~ is demonstrated

Note 1 to entry: These bodies ~~may~~ can be different in each country and ~~may~~ can include national or international regulatory bodies, national safety authorities, infrastructure ~~controllers~~ managers, and, in Europe, Notified Bodies (see Annex B).

3.3
contract
all the component parts of the technical specifications agreed between manufacturer and purchaser, consisting of purchaser's technical specifications, manufacturer's technical responses, minutes of meetings, and any other formal contract documents

3.4
d.c.
direct current

[2] To be published.

3.5
EMC
electromagnetic compatibility

3.6
infrastructure ~~controller~~ manager
organisation which ~~controls~~ manages the railway infrastructure, including, for example, track, signalling, communications and structures

3.7
IP
ingress Protection

3.8
manufacturer
organisation which has the technical responsibility for the supply of the vehicle system.

Note 1 to entry: There ~~may~~ can be more than one manufacturer where the contract for the vehicle is split in two or more parts.

3.9
manufacturer's works
location where the assembly of the vehicles is completed and where static tests are generally performed

3.10
modification level
definition of equipment modification status for which the test results are valid

3.11
purchaser
organisation which orders and will own the vehicle

Note 1 to entry: The purchaser ~~may~~ can have the responsibility for direct negotiations with the manufacturer, unless that responsibility is delegated to the user, a main contractor or a consultant.

3.12
quality plan
document specifying which procedures and associated resources ~~shall be~~ are applied by whom and when to a specific project, product, process or contract (ISO 9000)

3.13
routine test
test to which each vehicle is subjected to during or after manufacture to ascertain whether it complies with the specified criteria

3.14
safety-related
carries responsibility for safety

3.15
supplier
organisation which has the responsibility for the supply of individual items of equipment or groups of equipment to the manufacturer

3.16
supplier's works
location where individual items of equipment or groups of equipment are manufactured

3.17
test plan
plan of the tests to be undertaken by the manufacturer as presented within its quality plan, including all supporting information on the conduct of the tests

Note 1 to entry: In the context of this standard, the test plan includes all subordinate test specifications.

3.18
type test
test of one or more devices, system or complete vehicle to show that the design meets the required specifications and the relevant standards

3.19
UIC
Union Internationale des Chemins de Fer (International Union of Railways)

3.20
user
organisation which will use the vehicle

Note 1 to entry: The user will be a train operator and ~~may~~ can be the purchaser, or another party who uses the vehicle on behalf of the purchaser through, for example, a leasing arrangement.

3.21
validation documentation
documented evidence that a product, process or service is in conformance with specified requirements or other normative documents

3.22
voluntary test
any additional test (either type or routine) added to the Test Plan by agreement between the manufacturer and the purchaser

3.23
WSP
wheelslide protection

4 Requirements

4.1 General

The manufacturer shall exercise control over all activities affecting the quality of the products to ensure that the requirements of the standards or other normative documents to which the declaration refers are met.

For this purpose the manufacturer shall have at his disposal all necessary means for carrying out this control at all levels (for example raw materials, supplies, production, finished products or packing). Information on the manufacturer's quality system and the results of tests as appropriate shall be available.

The manufacturer shall establish and maintain a quality system. This shall include auditable procedures covering the final inspection and test operations, including workmanship standards, test specifications, test records, calibration of test instruments and equipment, document control, control of non-conforming products and personnel training.

~~NOTE~~ It is recommended that manufacturers operate a quality system in accordance with ISO 9001.

The quality plan for the design, production, inspection and testing of the product shall include a test plan defining how the manufacturer will demonstrate conformance to the specified requirements.

The configuration (type numbers, serial numbers, modification status) of key components, including revisions of software, shall be recorded as a “quality” record.

The contract shall define the various tests to be undertaken on completed vehicles and before entry into service to assure the purchaser that:

– the vehicles comply with the technical requirements of the contract (type tests, 3.18, see also 5.3.1);
– every vehicle conforms to the design standard proved in the type tests (routine tests, 3.13, see also 5.3.2);
– the vehicles comply with the appropriate legislation (national or regional);
– the vehicles are compatible with the railway system on which they are intended to run as defined in writing by the infrastructure manager.

Inspection of the vehicle, including equipment installation, piping and wiring, and all component type and routine tests shall be successfully completed according to the relevant standards and specifications, except as permitted by 6.1, before the tests within the scope of this standard are commenced. The tests covered by this standard are to demonstrate correct interfacing with the functions of the vehicle.

This standard does not cover the following types of testing:

– endurance and reliability,
– development,
– investigative (except for guidance only),
– system test, such as subassembly or system combined test.

NOTE The European requirements for product verification and tests are specified in Annex B.

4.2 Third party test facilities

If it is intended to use third party test facilities this shall be declared and agreed ~~at the time of contract~~ with details ~~of the third party, its~~, the test facilities required and the accreditation expected included in the test plan (see 4.3).

This shall of necessity apply to:

– static tests necessitating the vehicle to be moved to a specialised test centre not belonging to either the manufacturer or the purchaser;
– dynamic tests on another system not belonging to either the manufacturer or the user.

It is recommended that third party test facilities are accredited to ISO/IEC 17025.

~~NOTE 1~~ The purchaser or the approval authority of the country concerned may require tests to be carried out by an accredited test facility independent of the manufacturer.

~~NOTE 2 The European requirements for tests are specified in the technical specifications for interoperability as identified in Annex B.~~

4.3 Test plan

The various tests to be undertaken ~~by the manufacturer~~ shall be presented by the manufacturer within its quality plan as a test plan which shall detail the following:

a) the test programme;

b) the component and equipment type tests to be completed before undertaking each vehicle test;

c) the test facilities to be used, including, as appropriate, their accreditation and competence details, and their level of independence from the manufacturer;

d) the test methods;

e) the vehicle loading conditions for each test;

f) the environmental conditions for each test;

g) the limits and tolerances of any test measuring methods;

h) the success criteria for each test;

~~i) the corrective action process;~~

i) the validation documentation.

The test plan may include referenced test specifications to include some of the details above.

Where the contract requires validation of certain tests or documents by the purchaser or any approval authorities, these shall be identified in the test plan. In the case where the contract or the approval authorities require evidence to be kept, the requirement shall be included in the test plan and the purchaser shall agree the test specification.

Where the contract requires safety to be demonstrated by a series of tests derived from a safety or risk assessment performed in accordance with IEC 62278, or as required by an external Approval Authority, then these tests shall be included in the test programme and identified as such in the test plan. The term “safety-related” is used (see definition 3.14, derived from IEC 62425) in this standard to identify those tests which might be in this category. The final decision on whether a test is safety-related rests with those who determine the contribution made by the test to the responsibility for safety.

The auditable process used to derive the information for the test plan shall ensure that the list of tests produced to support the validation documentation is comprehensive.

~~The configuration (type numbers, serial numbers, modification status) of key components, including revisions of software, shall be recorded as a “quality” record.~~

On successful completion of each test the validation documentation shall be prepared by the manufacturer.

5 Categories of tests

5.1 General

The test plan shall present the tests to be carried out in the following categories:

a) preliminary adjustment tests (see 5.2);

b) acceptance tests, which include:

- type tests, see 5.3.1;
- routine tests, see 5.3.2;
- tests required by the Approval Authority, see 5.3.3;

c) investigation tests (see 5.4).

The tests may be simplified or omitted by agreement between purchaser and manufacturer:

1) if the vehicles concerned are demonstrated to be identical to vehicles previously constructed and for which experience is available, or if the vehicles are equipped with motors or other important components stipulated by the purchaser;
2) if it can be shown by documentary proof that equivalent tests have been performed under representative conditions.
3) by agreement with relevant approval authorities, where specified in the contract. The information required may be provided by reference to other standards.

5.2 Preliminary adjustment tests

Before submitting the vehicle to the acceptance tests, the manufacturer may require to carry out preliminary adjustment tests which cannot be made in manufacturer's works and which may involve test runs on the user's lines with or without load. In this event, at least the minimum amount of testing required for safe running (see 6.2) shall be completed to the satisfaction of the user and the infrastructure ~~controller~~ manager.

The maximum total distance of the trial runs to obtain necessary adjustments should be agreed in the contract and shall take into account the type of vehicle, more especially its maximum speed and the new devices which are incorporated. Failing a specified value in the contract, a maximum run not exceeding 5 000 km should be adopted for vehicles which are to be subjected to the type tests.

~~Test runs may only be undertaken under the supervision and with the participation of a qualified agent appointed by the user. The user shall also appoint the driver of the vehicle.~~

5.3 Acceptance tests

5.3.1 Type tests

These tests shall be performed over an agreed duration to demonstrate that the vehicle design complies with the performance requirements specified in the contract. They are listed in Tables A.1 and A.2 in Annex A and described in Clauses 8 and 9 ~~(see Clause 6)~~.

The tests shall be undertaken on the first vehicles built to the design unless otherwise agreed at the time of contract and included in the test plan.

If the type tests are performed on a prototype or pre-production vehicle, then the manufacturer shall agree with the purchaser those additional tests which are necessary on the first production built vehicle to be included in the test plan.

The tests shall be performed under the appropriate test conditions as explained in Clause 6.

Voluntary type tests may be required only if they are specified in the test plan.

5.3.2 Routine tests

These tests shall be carried out on each vehicle to be delivered. They are listed in Tables A.1 and A.2 in Annex A and described in Clauses 8 and 9 ~~(see Clause 6)~~.

Specific parameters used in the type test should be selected as the test criteria for compliance of each vehicle. The routine tests shall include sufficient measurements and checks to confirm compliance with the selected test criteria.

The tests shall be performed under the appropriate test conditions as explained in Clause 6.

The results obtained in the routine tests shall, taking into account acceptable tolerances, not be less satisfactory than those obtained for the type tests.

In cases where observations made during the corresponding type tests make it unnecessary for the routine test to be repeated in its entirety, a limited range or sample of routine tests, or a simplified form of those tests stated in the summary tables, or declarations of conformity may be accepted by agreement in the contract.

Any necessary additional routine tests shall be agreed in the contract and included in the Test Plan.

5.3.3 Tests required by Approval Authority

Tests required by Approval Authorities and those tests demonstrating safety (see 4.3) shall be clearly identified in the test plan. Tests regarded as in this category are shown in Tables A.1 and A.2 in Annex A.

5.4 Investigation tests

Investigation tests are special tests of an optional character and are carried out in order to obtain additional information. They shall be carried out only if they are specified in the contract.

These tests may be arranged by agreement between purchaser and manufacturer. In each particular case, the purchaser and manufacturer shall agree on the operating method and the programme for these tests.

The results of investigation tests shall not be used as a reason for refusing to accept the vehicle.

6 Test conditions

6.1 General

Tests shall be performed under the prevailing ambient conditions unless otherwise specified.

The test plan shall take account of the nature and site of each test and should cover:

a) type and routine test programmes, especially in those cases where this standard allows the parties a freedom of choice;

b) static tests (see 6.2);

c) dynamic tests (see 6.3);

d) methods for testing for environmental conditions, e.g. snow, rain, dust, temperature, etc. where these conditions are seasonal;

e) factory tests on components which, due to shortage of suitable test facilities at the supplier's works, are required to be carried out on the completed vehicle either statically or dynamically;

f) test requirements for any equipment supplied by the user or purchaser and installed in the vehicle; such requirements being agreed in advance among the parties concerned, including the manufacturer of the relevant equipment.

6.2 Static tests

These tests should normally take place at the manufacturer’s works and are described in Clause 8.

These tests shall include checks that the vehicle is sufficiently safe to undertake the dynamic tests.

The test facilities shall be appropriate and sufficient to ensure the tests are performed consistently; otherwise, the manufacturer shall inform the purchaser of any limitations of their test facilities with respect to these tests.

Where tests are performed at a third-party facility (see 4.2) which involves ~~movement~~ transportation of the vehicle to or from that facility, sufficient tests shall be undertaken by the manufacturer to ensure that the ~~movement~~ transportation can be completed safely.

6.3 Dynamic tests

The dynamic tests ~~are normally undertaken on the lines over which the vehicle is intended to operate or, if not available, over lines with similar characteristics as specified in the contract, and~~ are described in Clause 9.

~~The purchaser shall arrange access to the lines as appropriate and the necessary crew under the conditions specified in the contract.~~

~~Operation of the test trains shall comply with all regulations of the infrastructure controller.~~

~~The purchaser shall provide all the necessary facilities for any preparation for dynamic tests (including preliminary test running) under the conditions specified in the contract.~~

The tests may be undertaken on the lines over which the vehicle is intended to operate or, if not available, over lines with similar characteristics or on specialised dedicated test facilities. The test locations and arrangements shall be specified in the contract.

Arrangements for access to the lines and the provision of traincrew as appropriate should be included in the conditions specified in the contract.

The requirement to perform a test should not take precedence over the regulations of the relevant infrastructure managers or test facility manager.

Provision of all the necessary facilities by the purchaser or the provider of the test facilities for any preparation for dynamic tests (including preliminary test running) should be included in the conditions specified in the contract.

Where it is necessary to undertake the dynamic tests on the track of another infrastructure ~~controller~~ manager, the selected route, its characteristics and conditions of operation shall be agreed at the time of contract.

~~It is permitted to perform some or all of the dynamic tests at a dedicated facility by agreement.~~

~~NOTE 1~~ Attention is drawn to the need to ensure that the responsibilities of all parties involved in performing the dynamic tests are clearly defined.

~~NOTE 2~~ Attention is also drawn to the need to complete all the necessary preliminaries such as the relevant parts of the reliability, availability and maintenance case and the safety case before undertaking the dynamic tests.

7 Validation documentation

The validation documentation shall contain sufficient information to identify the vehicle and all its major components and enable these to be traced through the test records. As a minimum the following shall be provided:

a) the name and address of the organisation which produced the documentation;

b) the name and address of the manufacturer;

c) the identification of the vehicle and its major components by name, type, model number and any relevant supplementary information such as lot number, batch or serial number and modification level;

d) the standards or normative documents referenced in the contract or test plan in a clear and concise way;

e) all supplementary information such as grade or category of the vehicle components;

f) the date of the documentation;

g) the signature and title or an equivalent marking of the authorised signatory.

8 Schedule of static tests

8.1 General

The manufacturer shall undertake the schedule of static tests as defined in the test plan. Table A.1 gives a representative list of static tests which may be included in the schedule. The list shall not be taken as exhaustive but may be used as a guideline in the process used by the manufacturer to produce his test plan.

In the absence of specific requirements in the contract, the following tests shall be included in the test plan as appropriate for the type of vehicle covered in the contract.

Unless otherwise stated in the subclause heading, the following requirements are for both the type and routine tests. Where different requirements are specified for these tests, they are detailed in separate subclauses for type and routine tests.

8.2 Dimensional tests

8.2.1 Objective

To verify that the outside dimensions of the vehicle, any clearances and flexible connections when completely assembled and in working order, comply with the limits set out in the contract.

8.2.2 Type tests

8.2.2.1 Outside dimensions (safety-related test)

For each type of vehicle the outside dimensions of the vehicle (including, for example, car height, coupler height, bogie height) shall be measured and checked against the limits set out in the contract, which may include the following conditions:

a) the range of adjustment of all appropriate components (for example air suspension);

b) the range of tolerances for wear and tear (for example wheel wear);

c) the range of loading conditions (see 8.5.2);

d) the range of movement in case of failure or damage (for example suspension components);

e) the worst case combinations of the above a) to d).

Clearances of items that may intrude into limiting dimensions, for example doors which open outwards, shall be taken into account and checked under working conditions if required by the contract.

Where dimensions are determined by calculation, suitable dimensions shall be identified to be checked and included in the test plan.

NOTE European requirements for measuring freight wagons are given in ~~European Standard EN 13775, Parts 1 to 6 (see~~ Annex B~~)~~.

Where the contract does not specify a static loading gauge for the vehicle, the manufacturer shall declare a kinematic or swept envelope in accordance with rules agreed in the contract. The tests required to justify the kinematic or swept envelope shall be included in the test plan. The conditions a) to e) above, and the intrusion of items into the limiting dimensions, shall be taken into account in the determination of the envelope (see 8.3).

~~NOTE 2 European requirements are given in European Standard EN 14363, in the course of preparation (see Annex B).~~

8.2.2.2 Clearance tests (safety-related test)

Tests shall be carried out to determine whether the specified clearances are achieved during relative movements for the load conditions and track geometry specified in the contract as follows:

a) between vehicle bodies and bogies;

b) between adjacent coupled vehicles.

See the note after 8.2.2.3 below.

8.2.2.3 Hose and cable length tests

Tests shall be carried out to determine the appropriate length for bogie and inter-car hoses and cables resulting from the relative movements specified in 8.2.2.2 for the load conditions and track geometry specified in the contract.

NOTE The clearances and lengths determined by tests 8.2.2.2 and 8.2.2.3 can be calculated, and verified by test, which can be carried out statically, using a bogie rotation table and traverser, or during the dynamic tests.

8.2.2.4 Current collector static tests (safety-related test)

It shall be ascertained statically that the operation of current collectors is satisfactory within the limits of movement and static contact force specified in the contract.

Tests shall be made on pantographs, including the limiting dimensions of lateral displacement, as specified in IEC 60494-1 or IEC 60494-2.

NOTE Requirements for gauging are given in UIC Leaflet No. 505-1. European requirements are given in Annex B.

8.2.3 Routine tests

Outside dimension tests (8.2.2.1) and clearance tests (8.2.2.2) shall be carried out in one load condition only (see 8.5.2), and confined to key dimensions determined from the type test.

Parts with provision for adjustment according to the wear of the wheels (such as stone guards, lifeguards, snowploughs, sanding pipes and antennae) shall be checked for correct adjustment.

8.3 Gauging test

8.3.1 Objective

To verify that the envelope of the vehicle is in accordance with the design.

8.3.2 General (type and safety-related test)

The contract may specify the size of the vehicle in a number of alternative ways, requiring different tests for verification, for example:

Build gauge – if the dimensions of the vehicle are specified, the dimensional checks in 8.2 are sufficient verification.

Kinematic envelope – if a kinematic envelope is specified, the dimensional checks in 8.2 and an analysis of the dynamic movements of the vehicle are required, supported by the coefficient of flexibility (sway) test (8.3.3) to validate the calculations used in the analysis.

Swept envelope – if the vehicle is being run on a line where clearances are less than the normal clearances specified by the infrastructure ~~controller~~ manager, a swept envelope, taking account of centre throw and end throw on curves may be required, supported by the coefficient of flexibility (sway) test (8.3.3) to validate the swept envelope calculations.

NOTE European requirements are given in Annex B.

8.3.3 Coefficient of flexibility test (type test and safety-related test, voluntary or obligatory)

~~If required to verify the calculation of a kinematic or swept envelope, then this test shall be a mandatory type test for each vehicle type.~~

This test is voluntary, unless required to verify the calculation of a kinematic or swept envelope; if so it shall be an obligatory type test for each relevant vehicle type, where the relevant type has characteristics representative of a number of vehicle types.

NOTE UIC Leaflet No. 505-5 defines the coefficient of flexibility. European requirements are given in ~~European Standard EN 14363 is in the course of preparation (see~~ Annex B~~)~~.

~~If required by the contract,~~ The manufacturer shall supply the calculated values of the coefficient of flexibility in both minimum and ~~crush~~ exceptional load states (see 8.5.2).

The coefficient of flexibility shall be determined by static direct measurement (sway test) unless the method of determination of the vehicle envelope permits a dynamic roll test.

~~NOTE 2 European requirements are given in UIC Leaflet No. 505-5 which defines the coefficient of flexibility. This definition is summarised as follows:~~

~~– when an empty or loaded vehicle is placed, when stationary, on a canted track D, the running level of which forms an angle δ with the horizontal, its body leans on its springs and forms an angle η with the perpendicular to the rail level;~~

~~– the ratio δ/η calculated or measured after eliminating the influence of dissymmetries and that of the friction of springs and shock absorbers is called the coefficient of flexibility of the vehicle and is designated by the letter "s".~~

8.3.4 Routine test or equivalent (safety-related test)

The geometry of each vehicle shall be verified by suitable means such as a routine test using a template or a controlled production process.

8.4 Lifting ability test (type and safety-related test)

8.4.1 Objective

To verify the ability of the vehicle to be lifted under conditions as specified in the contract.

8.4.2 Type test

The test consists of lifting the vehicle at the designed lifting points using either overhead cranes or jacks. It shall be checked that the vehicle mechanical interfaces, attachments, deflections, etc., are within the tolerances specified in the contract. As a minimum the tests shall demonstrate that the vehicle can be lifted without permanent deformation occurring.

NOTE European requirements for lifting tests for re-railing and recovery are given in Annex B.

8.5 Weighing tests

8.5.1 Objective

To verify that the vehicle mass and distribution complies with the limits set out in the contract.

This normally includes, for each type of vehicle, tests for the following parameters:

a) the vehicle mass;

b) the measured load per axle;

c) the measured load per wheel ~~(if specified)~~.

8.5.2 Load cases

The load cases shall be specified in the contract. The recommended load cases are given in Table 1:

Table 1 – Recommended load cases

	Minimum load	**Normal load**	**Exceptional ~~/crush~~ load**
Passenger/freight loads	0	See following text	
Tooling	Complete		
Crew	0	Full complement	
Level of sand	0	2/3	Full
Water for heating, toilets, catering, etc.	0	2/3	Full
Fuel	0	2/3	Full
Thermal engine coolants and lubricants	Normal	Normal	Normal
Other fluids and lubricants	Normal	Normal	Normal

For vehicles intended to carry passengers or freight loads, in the absence of other information from the purchaser the loads shall be determined as follows:

– Minimum load: Loading state of the vehicle specified in the contract in which the vehicle is complete and which will enable the vehicle to be moved or towed.

– Normal load: Load as specified in the contract for the performance tests, for example motoring or braking.

– Exceptional ~~/crush~~ load: Maximum load that can be operated safely under conditions specified in the contract and used for specific performance tests, for example, emergency braking.

For vehicles not intended to carry passenger or freight loads, for example locomotives, the normal and exceptional ~~/crush~~ passenger/freight load is assumed to be zero, i.e. the same as minimum load.

In order to reduce to a minimum the handling of additional loads, dimensional tests and weighing operations may be:

– carried out in the same loading state;

– executed in loading states other than those specified in the contract, provided suitable corrections are applied to the recorded values.

NOTE European requirements for load cases are given in Annex B.

8.5.3 Type tests (safety-related test)

The weight of the vehicle and the vertical load exerted by each wheel on the track shall be measured and shall be accompanied by a statement as to the accuracy of the measuring equipment. The weighing tests are normally carried out at the manufacturer's works, but may be done at the purchaser's or user's facility by prior arrangement. If the measuring equipment is used in the open air (outside a building), the effects of the prevailing environmental conditions (for example wind and rain) shall be recorded and taken into account.

Unless stated otherwise in the contract, the loading state of the vehicle during the weighing operations shall be minimum load and ~~crush~~ exceptional load. Tests at normal load may be carried out as investigative or voluntary tests.

Weighing tests may be preceded by adjustment of the suspension, carried out by means which, in principle, do not require the measurement of loads but only checks of a dimensional character.

Immediately before the test, a means shall be employed to activate the primary and secondary suspension systems (for example by running the vehicle over a section of track with level differences) to reduce the likelihood of excessive locked-in forces and the vehicle being off-centre.

The vehicle shall be run at reduced speed on to the weighing site, with frictional dampers disconnected and bogie inter-couplers loosened (if fitted). After activation of the suspension system and during weighing, no alteration or adjustment shall be made to the vehicle. No artificial alteration shall be made by means of blows, shaking or other procedure to the state of the body and the suspension produced by the previous activation of the suspension system and arising from friction between the several parts of the suspension.

Four successive and complete weighing operations shall be carried out, the vehicle being moved and measured twice in both directions, so as to eliminate as far as possible the errors resulting from balance inaccuracies and friction.

The value of the measurements shall be taken as the arithmetic mean of the values noted during the weighing operations.

Alternative weighing methods may be used as appropriate to the vehicle suspension system (e.g. spring or air suspension) or the weighing equipment available (e.g. running the vehicle over the weighing site, then lowering the vehicle vertically onto the weighing machine). In this case, the conditions and number of weighing operations shall be defined in the contract.

The mass of the vehicle and the load on the individual axles and wheels on the vehicle shall meet the requirements of the contract, taking into account the following:

– the maximum and minimum mass, and allowable tolerance on the overall mass of the vehicle;
– the maximum load and allowable tolerance on the load of each axle on the vehicle;
– the difference in load from one side of the vehicle to the other.

The following measurements when defined in the contract shall be tested:

– the excess mass of the vehicle in running order over that stated in the contract;
– for motive power units, the static adhesive load;
– for motive power units, the load on each driving axle compared to the average value of the loads on driving axles intended to exert the same tractive effort;
– the load per axle compared to the figure permissible on the lines on which the vehicle is to run; this figure shall be specified in the contract;

– the load on the line of the wheels on one side compared to the average of the loads on both lines of wheels and for a given axle, the load per wheel compared to the average load per wheel of this axle.

NOTE The European requirements for axle load tolerances are specified in the Technical Specifications for Interoperability as identified in Annex B.

8.5.4 Routine tests (safety-related test)

The weighing tests defined in 8.5.3 shall be carried out except as indicated below.

The loading state of the vehicle shall be minimum load.

Two successive weighing operations shall be carried out.

For wagons and non-powered carriages, a declaration of conformity is acceptable if agreed in the contract.

8.6 Sealing tests

8.6.1 Objective

To verify that the sealing (e.g. the IP rating according to IEC 60529) employed on the vehicle and any filters, separators or similar devices comply with the performance specified in the contract.

8.6.2 Type tests

The test plan shall include tests of the vehicle body and equipment cases and cupboards to verify that the contract requirements are met. The vehicle shall be complete with all relevant interior fittings, equipment and covers. The tests shall take account of the factors in the following subclauses, as appropriate:

a) Where the contract includes air-conditioning or pressure ventilation equipment, the parts of the vehicle or equipment covered by that equipment shall be tested in accordance with 8.15.5.

b) The water tightness of the body and electrical equipment boxes mounted outside the body, including all openings, doors, covers, cover strips or crevices which might allow penetration of water or snow, shall be tested.

   The validation of water tightness shall be conducted in conditions representative of the climate in which the vehicles are to operate. The regime of representative testing shall be agreed in the contract and included in the test plan.

   A distinction shall be made between the water-tightness of the openings (air inlets, etc.) which depends essentially on design and the water-tightness of covers (doors, windows, bonnets, etc.) which depends primarily on installation and the condition of the joints.

   The tightness of openings and covers as well as the effectiveness of the arrangements provided for the evacuation of water from certain compartments shall be such that the observed water penetration is not liable to have an adverse effect on cabling, electrical equipment or any other equipment necessary for maintaining the vehicle in proper working order.

c) The effectiveness of blinds, louvres, filters, dust separators and in general all devices for cleaning the air drawn into the equipment boxes shall be verified to ensure the safety of cabling, switchgear, or any other apparatus necessary for the satisfactory operation of the vehicle.

d) The proper mounting of the louvres, filters, dust separators, etc., shall be verified.

e) Arrangements to prevent ingress of other contaminants such as snow or sand shall be tested to ensure proper operation of equipment, as appropriate.

Further guidance on tests for sealing of enclosures is given in IEC 60529.

8.6.3 Routine tests (voluntary test)

A simplified water test and other specific tests shall be carried out as specified in the test plan.

8.7 Electrical insulation tests (routine tests)

8.7.1 General

Objective: To test the insulation integrity of the vehicle electrical circuits.

These tests are routine tests which may be carried out on the completed vehicle. They may also be carried out on an incomplete vehicle, in the manufacturer's works upon completion of the cabling, after mounting but before connection of items of electrical equipment already tested individually for dielectric strength. In the latter case, a check of the insulation impedance of each of the circuits shall be carried out once the vehicle has been entirely completed.

Equipment such as rotating machines, which has previously passed insulation tests to an agreed standard (IEC) may also be disconnected before the vehicle insulation test.

Where the contract calls for double insulation of the electrical equipment from the car body, for example, trolley bus systems, then it shall be verified that such insulation exists and that each part of the insulation system can withstand the requirements of the insulation tests in this subclause.

NOTE Further European requirements for insulation tests are given in Annex B.

8.7.2 Voltage withstand test

Most frequently, the equipment is composed of several circuits with different insulation levels; each one shall be separately tested to earth, all other circuits being in principle earthed.

As necessary, contactors and switchgear should be closed or short circuited to ensure that all parts of the circuit are connected. All precautions shall be taken in order to avoid possible appearance of abnormal voltages due to capacitive or inductive effects.

Equipment likely to suffer during the tests, e.g. electronic components, shall be disconnected or short circuited. Such equipment shall have previously passed an insulation test to an agreed standard.

The withstand test voltage shall be applied for 1 min between each of the various cable circuits and earth. Its value shall be equal to 85 % of the test voltage of single pieces of apparatus defined by IEC standards in force (for example, IEC 60077 (all parts), IEC 60310, IEC 60322, IEC 60349 (all parts), IEC 61287 (all parts)), for the component of the circuit having the lowest test voltage.

8.7.3 Insulation impedance test

In the absence of values specified in the contract, the test voltage shall be at least 500 V and the minimum insulation impedance values measured shall not be less than those given below:

– 5 MΩ for circuits having a rated voltage equal to or greater than 300 V d.c. or 100 V a.c.;

– 1 MΩ for circuits having a rated voltage less than 300 V d.c. or 100 V a.c.

A value of less than 1 MΩ may be agreed in the contract to take account of known conditions, such as high humidity, use of armoured cables, etc.

Alternatively, the manufacturer shall propose the insulation impedance values to be used, for approval by the purchaser.

Such conditions, and ambient conditions (temperature and relative humidity), shall be recorded.

If an insulation impedance test is carried out both before and after the voltage withstand test, the test conditions shall be the same for both tests and the impedance value measured by the test following the voltage withstand test shall not be lower by more than 10 % than that measured in the initial test.

8.8 Protective bonding and return circuits tests (routine and safety-related test)

Objective: To verify that the protective bonding and return circuits on the vehicle meet the requirement of the contract.

Electrical connections are required on the vehicle:

a) to fix the electrical potential of various circuits and the vehicle's mechanical parts to protect against the risk of electric shock;

b) to protect bearings from damage resulting from the effects of stray currents;

c) to ensure a return path for certain circuits (e.g. traction current return, auxiliary (including train heating circuit) return).

Tests shall be done to ensure that protective bonding and return circuits meet the requirements of IEC 61991.

It shall be checked that the flexible connections are made to a suitable length for accommodating the maximum relative movements of the points connected.

It shall be checked that the earth and return terminals are easily accessible and visible for checking.

8.9 Air system tests

8.9.1 General

Objective: To establish that all pneumatic components operate as specified in the contract, when installed on the vehicle and connected within the air system and to determine whether the air-tightness of the pneumatic equipment complies with the limits set out in the contract.

If the braking system does not use air, then the tests in this subclause shall apply as far as appropriate. Any amendment to the test criteria shall be agreed in the contract and included in the test plan.

8.9.2 Air tightness of main reservoirs and other air equipment (routine and safety-related test)

8.9.2.1 General

With the vehicle in normal operating conditions, the main air reservoirs shall be filled to maximum working pressure and then isolated from the compressors.

8.9.2.2 Main reservoirs and associated devices

With the various items of compressed air equipment (braking circuits, doors, suspension, electropneumatic devices, etc.) isolated and not under pressure, it shall be checked that after

the time specified in the contract the reduction of the pressure in the main reservoirs is not greater than that specified in the contract.

In the absence of values specified in the contract, the pressure shall not fall by more than 20 kPa (0,2 bar) after 5 min from an initial pressure between the maximum and minimum settings at which the main reservoir pressure is regulated.

8.9.2.3 Main reservoirs and associated devices combined with other pneumatic equipments

With the various items of compressed air equipment under pressure (except those intentionally designed to have certain inherent leaks), but not in operation, it shall be checked that the pressure in the main reservoirs has not fallen by a value and during a time period specified in the contract.

In the absence of specified values, the pressure shall not fall in 20 min to a value less than the minimum value compatible with the proper functioning of all the equipment from an initial pressure between the maximum and minimum settings at which the main reservoir pressure is regulated.

When a motor coach or locomotive is intended to be coupled with trailers not fitted with main reservoirs and forming part of the same fixed train set or multiple unit, the tests of 8.9.2.2 and 8.9.2.3 shall be repeated on the complete fixed train set. The time limits and allowable leakage in this case shall be agreed in the contract depending on the composition of the fixed train set or multiple unit.

Depending on the type of brakes used, the procedure for testing the air-tightness of the main brake pipes shall be agreed in the contract and included in the test plan.

8.9.3 Air tightness of brake cylinders and auxiliary reservoirs (routine and safety-related test)

By using the drivers brake handle or other means, maximum working pressure shall be applied to the brake cylinders and associated auxiliary reservoirs. The air supplies shall then be isolated.

In the absence of values specified in the contract, the pressure in the brake cylinders shall not fall by more than 10 kPa (0,1 bar) after 3 min.

8.9.4 Checking operation of compressed air equipment (type and safety-related test where appropriate)

The correct operation of all compressed air equipment shall be checked, for example:

– safety and protective devices;
– pressure regulating device;
– isolating cocks (shut-off valves);
– drain valves;
– pressure transducers and switches;
– compressor duty cycle, if tested by static simulation (see also 9.18);
– warning horns;
– air driers.

Where the contract covers a fixed train set or multiple unit, the operation shall be checked on the complete train set or multiple unit.

8.10 Hydraulic system tests (type, routine and safety-related test where appropriate)

Objective: To determine whether the oil-tightness of the hydraulic equipment complies with the limits set out in the contract and to establish that all hydraulic components operate as specified in the contract, when installed and connected to the hydraulic system.

As a type test, the correct operation of all hydraulic equipment shall be checked, for example:

– hydraulic pumps;
– hydraulic motors (e.g. cooling group, radiator fan, etc.);
– safety and protective devices;
– pressure limiters;
– non-return valves;
– shut-off valves;
– drain valves.

As a routine test, with the vehicle in normal operating conditions, the hydraulic system shall be filled to maximum working pressure and then isolated from the pump. It shall be checked that after the time specified in the contract the reduction of the pressure in the system is not greater than that specified in the contract and that there are no visible signs of hydraulic fluid leakage.

8.11 Friction brake system tests

8.11.1 General

Objective: To verify that the brake system operates in accordance with the design, to give sufficient confidence that the dynamic tests may take place, and that all production vehicles are to the same standard.

The following systems shall be functionally checked statically:

a) emergency brake;
b) service brake;
c) interface between the friction and the electric brake, where fitted (if done by simulation in place of a dynamic test, see 9.4);
d) interface with other systems such as wheelslide control, load weighing, traction control (where fitted);
e) mobility of brake rigging.

8.11.2 Pneumatically applied brake systems

8.11.2.1 Type tests (safety-related tests)

The purpose of these tests is to verify, in conjunction with dynamic braking tests, that the operation of the brake system and the application of force at the brake shoes or linings complies with the contract.

These tests shall be carried out after completion of the air system tests specified in 8.9. A check shall be made that the brake rigging is correctly adjusted. Tests shall be made at static for the service brake in order to check the characteristics specified in the contract for the complete pneumatic brake system, in particular, time of application and release of the brakes and maximum pressures at the brake cylinders under different operating conditions.

The measurements of brake cylinder pressure and timings shall be repeated for the emergency brake and a number of intermediate positions of the service brake controller.

Where applicable, the operation of the wheelslide dump valves or other anti-skid devices should be checked, for example, blow down time, application time and release time. The operation of the dump valves appropriate to the wheelslide signal should also be checked.

When the vehicle is equipped with a load weighing system, the brake cylinder pressures shall be measured with the vehicle in the minimum, normal and exceptional ~~/crush~~ load conditions. This test may be carried out using simulated loads, provided that the load detection devices are tested during other tests being carried in each of the loading states of the vehicles.

NOTE The European requirements for static brake test procedures ~~in preparation by CEN/TC256 as~~ are identified in Annex B.

8.11.2.2 Routine tests (safety-related test)

A simplified form of test, to avoid loading the vehicle, shall be carried out. This test shall demonstrate that all braking systems are equivalent to those type tested.

8.11.3 Other systems (type, routine and safety-related as appropriate)

Where vehicles are fitted with other braking systems designed to slow or stop the train, such as spring or hydraulically applied brakes, electrically or mechanically actuated brakes, mechanical or magnetic track brakes or any other systems, type and routine tests shall be carried out to achieve the same objective as defined in 8.11.1, following the same principles as defined in 8.11.2.

8.11.4 Sanding systems (type, routine and safety-related test)

Where sanding is employed to assist braking, the tests shall demonstrate that the ~~required braking performance is~~ requirements of the sanding system are met without interference with either infrastructure systems such as points and crossings and train detection or train systems such as braking, electrical or air supplies. The test criteria shall be included in the test plan. If dynamic tests are required by the contract, they can be combined with the braking tests (see 9.4).

For a type test, the following shall be checked as appropriate against the contract:

- correct activation of sanding in braking mode (and traction mode if fitted),
- correct operation of interface with wheelslide detection system,
- means of isolation of sanding function, and associated indications,
- manual control (if provided),
- the effect of sander operation on auxiliary supplies (including electrical and pneumatic),
- sand capacity, delivery rate and usage monitoring, as appropriate,
- sand specification,
- sand deposition and spread.

For a routine test, a simplified function test which demonstrates delivery rate shall be carried out. If a manual test function is fitted, it may be sufficient for the routine test.

8.12 Parking brake type tests (safety-related test)

Objective: To verify that the parking brake system satisfies the requirements of the contract.

The test criteria to demonstrate the effectiveness of the parking brake system (operating conditions and measurement of applied forces) shall be included in the test plan.

If the train is maintained stopped for a limited period by a parking brake subject to leaks (e.g. hydraulic or air brake) the brake shall be applied with maximum force and it shall be verified during a period specified in the contract that there is no significant fall-off in the force applied.

NOTE The duration of the parking brake test depends on the operating conditions.

8.13 Auxiliary power supply system tests

8.13.1 Objective

To verify that the auxiliary power supply systems operate as specified in the contract when installed on the vehicle and connected to their proper loads, including battery charging.

8.13.2 Type tests (safety-related tests where appropriate)

The tests shall check the performance of the auxiliary power supply system connected to its loads over the range of loads defined in the specification.

It shall be checked that the input and output of the auxiliary power supply system is kept within the continuous rating or other ratings, these ratings being in accordance with those given in the relevant standards, as specified in the contract.

If the auxiliary power supply system components have not been fully tested at the supplier's works, owing to, for example, lack of suitable facilities, then additional tests can be included in the test plan by agreement between the manufacturer and the purchaser.

The test plan shall include test criteria for the following:

– power up;
– starting of the loads, including time delays where necessary;
– battery charging;
– cooling arrangements;
– load-shedding;
– cross-feed arrangements (where one or more vehicles are fed from an alternative power supply on another vehicle), including changeover switching.

Where appropriate (for example where rotating machines or external cooling form part of the system), the tests specified in 8.15.2 shall also apply to the auxiliary power supply system.

Where the power supply feeds functions essential for the safety of the train, such as magnetic track brakes, the type tests shall be identified as safety-related in the test plan.

8.13.3 Routine tests

Functional and operating tests at nominal voltage shall be carried out. The characteristics of the auxiliary power supply system at nominal voltage shall be verified against the contract requirements and the type test results.

8.14 Battery charging tests

8.14.1 Objective

To verify that the battery and its charging system meet the requirements of the contract.

8.14.2 Type test

The following tests shall be made on the vehicle's battery and battery charger to verify:

a) that the battery charging equipment is capable of furnishing a sufficient but not excessive charge to the battery, as required in the contract;

b) that the supply is capable of charging the battery under all load conditions within the contract for the vehicle, e.g. maximum and minimum supply voltages, thermal engine operating speeds, ambient temperature limits, etc.;

c) except for chargers supplied only for standby use, that the charger is capable of supplying all the load assigned to the battery and other loads as appropriate when the vehicle is in operation including the effect of any load shedding;

d) that the ~~capacity exists for~~ charging regime ~~the battery in a time period allowing full charge to the battery~~ in a normal operating duty cycle during a 24 h period allows the battery to be fully charged;

e) that the ventilation of battery boxes is sufficient to ensure no dangerous build-up of gases during charging periods;

f) that the off-charge battery is capable of maintaining operation of the vehicle during the time period specified in the contract and under the conditions specified in the contract, especially taking into account essential supplies such as emergency lighting (see also 8.15);

NOTE Restriction of operations, e.g. reduced lighting or disconnection of non-essential systems, is possible (load-shedding).

g) that the voltage ripple level is within the maximum level specified in the contract when the battery charger is operated with a disconnected battery.

In order that the battery circuit parameters ~~comply~~ shown above can be verified as compliant with the contract requirements for the conditions specified in the contract, the following parameters shall be measured as appropriate:

1) the maximum charging current;
2) the maximum voltage or charging voltage over the specified temperature range as appropriate;
3) the floating voltage;
4) the floating current;
5) the discharging current;
6) the discharging time.

The test criteria shall be included in the test plan.

These tests can be carried out during the auxiliary power system type tests.

8.14.3 Routine test

For a routine test on a battery and charger it is sufficient to check:

a) maximum charging current with its limitation value;
b) maximum voltage;
c) steady state floating voltage;
d) steady state floating current.

8.15 Auxiliary and control system tests

8.15.1 Objective

To verify that the auxiliary and control systems operate as specified in the contract when installed on the vehicle and connected to the correct auxiliary power supply and other interface loads.

8.15.2 General tests

8.15.2.1 Type tests

For each system defined in 8.15.3 to 8.15.8, it shall be checked, during static sequence tests, that the individual and sequential operation of all items of equipment, in the various circuits, including, for example, air-operated switchgear, is correct and has not been impaired during final installation.

Any interfaces that exist between the systems shall be included in the tests.

Electrical clearances of the assembled equipment shall be checked, especially at connections.

Where required by the contract, the functional operation of overload protection devices shall be checked (using simulated signals where necessary). It shall be checked that the settings of adjustable protective devices and relays, etc., are correct.

A check shall be made that the operation of air-operated switchgear is not hindered by too small a cross-section of their supply pipes or lack of reservoir capacity.

In the case of forced cooling of auxiliary electrical equipment and auxiliary power supplies, if the equipment concerned has not been tested on the test bed with the same cooling units and with cooling ducts of the same size as those of the vehicle, a check shall be made on the vehicle that the volume of cooling air complies with that designed or specified. This may be checked by measuring the difference in static pressure across the auxiliary equipment, providing a table showing the relationship between static pressure difference and air volume is available for equipment under test. The ducts shall be checked for air-tightness.

A check shall be made on the direction of rotation of auxiliary machines and the phase rotation of a.c. supplies.

Starting tests on the auxiliary machines shall be made taking account of the machine duty cycle and range of operation, and starting conditions specified in the contract.

8.15.2.2 Routine tests

For all systems defined in 8.15.3 to 8.15.8, functional and operating tests at nominal voltage shall be carried out. The tests shall include more than one start of auxiliary machines.

In order to avoid setting up interface tests for each vehicle, a simplified set of functional tests, derived from the type test, using set values or simulations where appropriate, may be carried out to verify that each vehicle meets the test criteria, provided that all the equipment on the vehicle under test is exercised. Further suggestions are given in 8.15.3 to 8.15.8.

8.15.3 Train control (safety-related tests where appropriate)

8.15.3.1 Single unit operation

All control functions shall be tested from their controllers, switches and pushbuttons in the cab and any other appropriate location on the vehicle, to ensure that the correct sequence of events occurs so far as is possible statically (see also 8.17).

This test shall be performed for all normal, emergency and default operating modes specified in the contract.

If appropriate, these tests may be combined with individual system tests (see 8.15.4 to 8.15.8).

8.15.3.2 Interfacing between systems

All interfaces between systems shall be tested for correct operation and sequence in all modes specified in the contract. If appropriate, these tests may be combined with individual system tests (see 8.15.4 to 8.15.8).

8.15.3.3 Multiple operation

If the vehicle or multiple unit trainset is intended to operate coupled to other vehicles or trainsets controlled from a single driving cab, type tests shall be made to prove the functions that are required to operate in multiple, for example:

– traction and braking circuits;
– fault indications and signals;
– compressor interlocks;
– parallelling or transfer of auxiliary supplies or batteries;
– door operation;
– safety loops for the control of brakes or doors;
– control of lights, heaters and other auxiliaries;
– passenger emergency systems;
– passenger information.

Where train wires are crossed, for example to ensure correct identification of the direction of motion or the opening side for doors, then these functions shall be checked for all practical combinations of vehicles in multiple normally found in service.

These functions shall also be checked at all operating or driving positions.

For a routine test it is permitted that multiple operation be checked by simulation of other vehicles.

8.15.4 Door control systems (safety-related test)

It shall be checked that external and internal power operated doors, steps and remotely controlled door locking systems function correctly as specified in the contract.

The checks shall include all door indicators, safety loop circuits and operating systems for normal and emergency access and egress under all operating conditions as specified in the contract.

8.15.5 Heating, ventilation and air-conditioning system tests (safety-related test where appropriate)

The type tests shall check the correct operation of comfort and environmental control systems for both passenger and traincrew areas, including the adequacy of sealing of the car body, including doors and windows against draughts.

It shall be checked in particular that the heating equipment and air conditioning or pressure ventilation equipment as appropriate are capable of maintaining the temperatures and airflows under the conditions specified in the contract.

If required in the contract, the equipment used to protect the vehicle against pressure shocks shall be checked (see also 9.14).

The tightness of air ducts used on the vehicle, for passenger/crew air-conditioning should be checked as a routine test, for example with a smoke producing device.

Specific tests may be required for traincrew areas to satisfy the relevant safety authorities.

NOTE European requirements for testing of air-conditioning systems are set out in ~~EN 13129-2 and other European Standards in the course of preparation by CEN/TC256 (see~~ Annex B~~)~~.

8.15.6 Lighting system (interior)

8.15.6.1 Type tests (emergency lighting tests are safety-related tests)

A meter shall be used to measure the illuminance level at the reading level at seat positions and floor level in the vestibules and gangways to check that the required level is achieved for both full and emergency lighting.

NOTE The European requirements for lighting are specified ~~in EN 13272 and the technical specification for interoperability, rolling stock as identified~~ in Annex B.

8.15.6.2 Routine test (safety-related test where appropriate)

The test shall ensure that all lights work and that the switching of lights (e.g. normal and emergency, separate circuits, etc.) is correct, including any default conditions, as specified in the contract.

8.15.7 Other systems (type, routine and safety-related tests where appropriate)

It shall be checked that under all specified test conditions, all other systems, where fitted, function correctly in their operating environment, in accordance with the contract.

Where fitted, the following systems shall be tested. These system tests may be classed as safety-related or be required by Approval Authorities, depending on their use:

– passenger information;
– public address;
– communication;
– radio;
– fire detection and extinguishing.

Where fitted, systems to be tested shall include, for example:

– train management;
– diagnostic systems;
– data transmission;
– video;
– television;
– toilet;
– water systems;
– catering equipment.

For catering equipment, the tests shall ensure correct operation in accordance with the contract, especially in respect of operating and surface temperatures, and safety in use.

The closing and locking systems of all internal and external equipment and panel hatches, doors and covers intended for access shall be checked for correct operation.

8.15.8 Software controlled systems (safety-related test where appropriate)

It shall be verified that the software used in vehicle systems has been tested and validated in accordance with the requirements of IEC 60571 as ~~amended~~ appropriate to the proper application of IEC 62278.

On each vehicle, it shall be checked that the software fitted is the same validated version.

8.16 Tests on thermal engine and associated generating sets or transmission

8.16.1 General

Objective: To verify that the thermal engine and generating set or transmission (hereinafter referred to as the power unit assembly) operates as specified in the contract, when installed on the vehicle and connected to its proper loads and protective equipment.

Where the engine and generators are not tested together before assembly on the vehicle (see UIC 623), the test procedure for the complete engine and generator on the vehicle shall be as defined in the contract.

Before undertaking any of the following tests, the manufacturer shall ensure that the alignment of the coupling between the engine and the generators has been checked to ensure that it is in accordance with the design.

Where appropriate the subclauses below shall be applicable to thermal engine driven generator sets used for supplying auxiliary power to a train separately from the traction power unit.

8.16.2 Operating speed tests of the thermal engine (type tests)

The no-load speed (r/min) of the engine at idling, maximum speed, and all intermediate speed positions of the speed controller (when applicable), shall be measured to check the correct operation of the speed control system.

~~The loaded speed (rpm) of the engine at all load settings specified as normal operating points shall be measured. The test shall be performed on a static load bank.~~

At the regular operation point of the engine, the loaded speed (r/min) shall be measured at each specified load. The permissible range of loaded speed shall be specified in the contract. Speed tolerances shall be in accordance with the contract.

Depending on the type of power unit assembly, the loaded speed tests shall be carried out by the following methods:

a) for a power unit assembly with a generator, a load resistor or static load bank shall connected to the generator output;

b) for a power unit assembly with a mechanical/hydraulic transmission (including a reverser), stall load tests shall be carried out with the brakes applied on the vehicle and the output axis of the torque converter bound.

8.16.3 Thermal engine protective devices (type test)

The correct operation of protective devices of the thermal engine such as thermostats, pressure gauges, overspeed, fire detectors, emergency stop, etc., shall be checked.

The operation of sensors other than overspeed can be simulated by external means, provided that sensors have been calibrated by their suppliers.

8.16.4 Thermal engine fluid, air and exhaust circuits (routine test, safety-related test where appropriate)

The tightness of all reservoirs, pipes and ducts of the thermal equipment (fuel, oil, cooling fluid, exhaust, compressed air cranking) shall be checked.

The operation of the fuel supply, the pre-heating, pre-lubricating and cold cranking devices shall be checked.

8.16.5 Engine driven auxiliaries

8.16.5.1 Type test

The correct operation of the engine driven auxiliary systems shall be demonstrated with regard to:

– the intended performance;
– the ~~operating~~ ambient temperature and altitude range;
– the engine speed range.

8.16.5.2 Routine test

As a minimum the following shall be checked:

– the rotational speed and directions of the various auxiliaries driven by the thermal engine;
– the correct tension of the driving belts, or
– operation of the transmission;

and, if compressor accessories are fitted:

– the build-up of the pressure in the main reservoir;
– the setting of the unloading valve and of the safety valve.

8.16.6 Cranking of the thermal engine (type test)

The cranking of the engine (cold or pre-heated if necessary) at ambient temperature shall be checked having regard to the details necessary for minimum temperatures specified in the contract. These details and the number of successive cranking operations to be made by the battery or other means of cranking (e.g. compressed air) shall be as agreed in the contract.

8.16.7 Operation of the thermal engine

8.16.7.1 Type test

~~The thermal engine shall be connected to a static load bank.~~

The method of loading shall be in accordance with either a) or b) in 8.16.2.

Test conditions shall be maintained for ~~a reasonable~~ sufficient time to allow engine temperature to reach its final steady state value.

The following shall be checked:

a) that the anti-vibration mounts are effective at all conditions of engine speed and load. ~~If contract values have been given,~~ The vibration level of the engine generator assembly shall be measured and shall comply with the values specified in the contract, if applicable;
b) that the torsional dampers are effective if the calculation of the torsional critical speeds shows that resonances could be excited from the engine;

c) that the cooling system has a inbuilt heat dissipation capability sufficient to meet the agreed cooling margin and to maintain the cooling fluid temperature at the design level in the whole range of the operating ambient conditions;

d) that air management within the cooler group and for engine room scavenging meets the declared performance;

e) the tightness of all pipes and ducts of the thermal equipment and of the aspirated air ducting of the engine;

f) that heat sensitive equipment and parts, such as electronics, cabling, plastic pipes and tubing, rubber details, etc., are not subjected to excessive temperature;

g) the operation of the regulating equipment;

h) that temperature and pressure values of the fluids used in cooling and lubricating systems are in agreement with the contract specifications;

i) that inlet pressure and exhaust pressure and temperature are in agreement with the contract specifications;

j) the manufacturer's stated turbo-charger surge margin shall be verified by test if required by the contract;

k) the diesel engine exhaust composition shall be checked if required by the contract;

l) that the fuel consumption at various conditions of engine speed and load meets the agreed performance.

8.16.7.2 Routine test

The thermal engine shall be connected to a static load bank.

With the engine and generators at normal working temperature and excitation conditions set to conform with those specified in the contract, the manufacturers declared curves for generator losses shall be used to check the gross supply to the electrical equipment at full power and agreed intermediate power settings. The checks listed in 8.16.7.1 e) to k) should also be carried out against the nominal values confirmed by the type tests.

8.17 Traction system tests (type, routine and safety-related tests where appropriate)

Objective: To verify that the traction system responds correctly to its control signals in order to demonstrate its fitness for dynamic tests.

All sequencing and built-in test programmes shall be tested before the vehicle is moved.

In particular, the selection of forward and reverse, initiation of motoring and electric braking functions and removal of traction power shall be checked for correct operation with both valid and invalid control inputs.

Where the traction system is force-cooled, the operation of the cooling systems shall be checked, including airflow and air speed, correct starting sequence of cooling fans, and time delays, if any, before stopping cooling fans. Other tests on the cooling system shall be in accordance with 8.15.2.

Where sanding is employed to assist traction, the tests shall demonstrate that the required performance is met without interference with infrastructure systems such as points and crossings and train detection (see 8.11.4). The test criteria shall be included in the test plan.

8.18 Operability and maintainability (type test)

8.18.1 General

Objective: To verify that the vehicle meets the requirements of the contract for safety and ease of operation and maintenance.

All areas where staff have access in the normal course of their duties, for operation, maintenance and overhaul shall be checked for compliance to the requirements of the contract and the relevant safety authorities, both for operation and safety.

These checks should include and take account of the following:

– accessibility to mechanical parts, including**:**
  - protection against the possibility of contact with moving parts such as blowers, couplings, belts, sharp edges, etc.;
  - protection against risks from air intakes;
– accessibility to electrical parts, including:
  - safety clearances from fixed or movable live equipment;
  - prevention of accidental contact with live electrical parts taking into account the difference between:
    a) compartments containing apparatus liable to be subjected to a high voltage by an external supply source (coupled vehicle, station or depot supply) for which access involves a prior disconnection and/or earthing of certain points of the circuits, and:
    b) compartments containing only equipment of the vehicle traction circuit for which a single electric safety device (e.g. opening of the main contactor) is sufficient;
  - protection against electrical arcing from circuit-breaking devices such as high-speed circuit-breakers or contactors;
  - protective bonding for the electrical equipment and for parts of the vehicle which may accidentally be made alive (see 8.8);
– dismounting (doors, steps, ladders);
– access for and ease of cleaning;
– conformance with standards;
– interchangeability, where specified;
– access for testing;
– discharge time of power capacitors, including warning labels;
– protection against fire (type and accessibility of extinguishers, operation of fire protection systems, see also 8.20);
– protection of parts with a risk of harmful temperatures (e.g. exhaust systems);
– provision of necessary warning signs as required in the contract (in particular, hot surfaces, high voltage conditions or moving parts).

If required by the contract, maintainability shall be tested by a demonstration.

8.18.2 Cabs and traincrew areas (safety-related test)

Checks on working conditions of traincrew areas shall be carried out as far as possible during static tests and shall be completed during dynamic tests. For driving cabs, reference may be made to the appropriate standard.

NOTE Requirements are ~~currently specified~~ set out in UIC ~~Leaflet~~ 651 ~~(a European Standard is in the course of preparation by CEN/TC256, see Annex B)~~. European requirements are specified in Annex B.

The test criteria shall be included in the Test Plan and should take into account:

– dimensions and layout, including protection from injury, exits and evacuation, and provision and access to emergency equipment;
– driver sightlines and the effect of reflections in the windscreen, including performance of windscreen wipers, windscreen washers, windscreen de-misters and windscreen de-frosters (if any);

– visibility of controls, instruments (especially when illuminated) and indicator lamps both in sunlight and at night without detrimental effect from direct or reflected light so as to cause any optical illusion;

– ergonomic design of controls and seats to minimise inaccuracy in operation or undue physical tiredness, and risk of inadvertent operation.

8.18.3 Passenger areas (safety-related test where appropriate)

Facilities for evacuation, including walkways and emergency exit doors, windows and associated facilities, shall be checked against the contract.

Facilities for ~~disabled people~~ persons of reduced mobility, such as accessible areas including toilets, mechanical aids to accessibility and aids for the mobility, visual and hearing impaired shall be checked against the contract.

NOTE European requirements for facilities for ~~disabled people~~ persons of reduced mobility are defined in ~~the course of preparation, see~~ Annex B.

8.18.4 Rescue (safety-related test where required)

Facilities for rescuing the vehicles, including the use of special or adaptor couplers, shall be checked against the contract.

NOTE European requirements for ~~high speed trains~~ rescue are defined in ~~the rolling stock TSI, see~~ Annex B.

8.19 Noise and vibration tests (type test, safety-related test where appropriate)

Objective: To verify that the noise and vibration emitted by the vehicles when stationary comply with the contract.

Tests shall be performed on a completed vehicle or vehicles as appropriate to demonstrate that the noise levels in the passenger and crew areas and outside the vehicle are compliant with the values specified in the contract.

The noise level tests shall be performed in accordance with ISO 3095 and ISO 3381, for stationary vehicle type tests, for test procedures specified in the contract.

NOTE 1 European requirements for noise tests are defined in ~~course of preparation by CEN (see~~ Annex B~~)~~.

Tests shall be performed on a completed vehicle or vehicles as appropriate to demonstrate that vibration caused by the operation of the apparatus or machines on the vehicle (compressor set, blower, electromagnetic equipment, circuit breakers, thermal engines, etc.) is not a source of discomfort to the passengers or traincrew.

NOTE 2 European requirements for vibration tests, where necessary, are given in ~~EN 12663 (see~~ Annex B~~)~~.

8.20 Safety-related system tests (routine tests)

Objective: To verify that all safety-related systems not covered by the specific requirements elsewhere in Clause 8 perform in accordance with the requirements of the contract after they have been installed to the vehicle.

For example, the following shall be tested where applicable;

– automatic emergency brake;

– automatic vigilance equipment;

– drivers safety device or equipment;

– automatic train protection equipment, or any equivalent speed regulating and on-board signalling equipment;

– vehicle speedometers;
– event or data recording equipment;
– fire detection and extinguishing devices;
– passenger emergency equipment;
– safety-related circuits in other subsystems (e.g. brakes, doors);
– head, marker and tail lamps;
– bells, whistle, horns.

This list is not exhaustive, and shall be amended as appropriate in accordance with the contract.

The tests of the systems and equipment above shall include functional interfaces and performance not measurable unless the system or equipment is installed in the vehicle.

NOTE European requirements for testing of some of the systems listed above are given in Annex B.

9 Schedule of dynamic tests

9.1 General

The manufacturer shall undertake the schedule of dynamic tests as defined in the test plan. Table A.2 gives a representative list of dynamic tests which may be included in the schedule. The list is not exhaustive but shall be used as a guideline in the process used by the manufacturer to produce his test plan.

In the absence of specific requirements in the purchaser's specification, the following tests (9.2 to 9.20) shall be included in the test plan as appropriate for the type of vehicle covered in the contract. For vehicles intended to operate in fixed formation trainsets, the tests shall be conducted in train configurations representative of those in which the vehicles may normally operate.

Unless otherwise stated, the following requirements are for both the type and routine tests. Where different requirements are specified for these tests, they are detailed in separate subclauses for type and routine tests.

9.2 Traction performance (tractive effort/speed characteristics)

9.2.1 Type test

Objective: To verify that the traction performance meets the specified criteria. The tests are restricted to checking the starting and acceleration performance up to the maximum specified speed.

The vehicle, unit or train shall be taken through the starting and acceleration cycles specified at the time of the contract, up to the required speeds at all the specified load conditions (to include at least the minimum and ~~crush~~ exceptional loaded conditions). The tests shall be made under good adhesion conditions and, when specified, under adverse adhesion conditions.

The tests shall demonstrate that the tractive effort/speed characteristics comply with the requirements specified in the contract. The values can be deduced from starting and acceleration tests under known conditions by measurement of vehicle speed against time.

Alternative methods of demonstrating the vehicle performance may be proposed by the manufacturer or requested by the purchaser and included in the contract.

It shall be checked that acceleration is achieved smoothly throughout the control sequence without jerks in excess of the value specified in the contract.

9.2.2 Routine test

Each vehicle shall be taken through the starting and acceleration cycles at the specified load case agreed in the test plan.

It shall be checked that the acceleration is as specified. The values can be deduced from the tests defined in the test plan by measurement of the vehicle speed against time. It should be checked qualitatively that any transitions occur without abnormal jerks.

9.3 Traction performance (journey time check) (voluntary type test)

Objective: To verify the ability of the vehicle to meet the specified running schedules and energy consumption.

The tests shall check that the times for either the individual distances or the total distance are in accordance with those specified in the contract and that the energy consumption is within the tolerance specified in the contract.

If the purchaser intends to carry out tests to check a "typical run" schedule, he shall supply the manufacturer, before placing the contract, with all the particulars relating to the "typical run" and to the "typical train" to be used, under the same conditions as those appearing below:

For the test run:

– maximum times to be observed for running the whole distance or various parts thereof;

For the test route:

a) lengths, gradients and curvature details of the lines;
b) stopping or dwell times;
c) maximum speeds allowable on the various sections;
d) an estimate of the service line voltage over the test route;
e) the suitability of the line for regenerative braking (if applicable);
f) load conditions.

The test shall be performed on vehicles which have completed the agreed period of running-in and in accordance with the following conditions specified in the contract:

– load conditions;
– dry adhesion;
– calm weather;
– temperature range;

and, if required for confirmation of energy consumption:

g) the vehicle's load or the hauled load;
h) number of axles or train length;
i) weight multiplication factor to be used to allow for the inertia of the rotating masses, including any trailing vehicles not under test;
j) resistance to motion curve at different speeds for the vehicles, including any trailing vehicles not under test;

k) the braking effort curve for the vehicles at various speeds, including any trailing vehicles not under test;

l) the maximum acceleration and the maximum variation in acceleration allowable;

m) the maximum braking deceleration allowable;

n) the driving mode - manual or automatic.

For a vehicle with a thermal engine, the characteristics of the fuel and lubricating oil shall comply with those specified by the thermal engine manufacturers and accepted by the user.

As an alternative test, vehicles with thermal engines may have energy consumption tests carried out on a stationary vehicle using a duty cycle agreed in the contract.

The test shall be carried out on rolling stock which has already had a period of running, in calm weather and in temperature conditions agreed in the contract.

The electrical energy consumption (active or reactive) may be deduced by calculation after measurement of line voltage and current values with instruments placed either on the vehicle itself or on a vehicle coupled to it (e.g. a dynamometer car). In addition, the line voltage may be checked by means of a recording voltmeter. The line receptivity for regenerative braking may be monitored.

The mean values of the fuel consumption obtained for a thermal engine during the successive runs shall be measured.

The electrical or fuel energy consumption measured may depend on certain uncontrolled variables which can be introduced: for example, operating conditions, speed differences and in particular the receptivity of the line where regenerative braking is specified. Following the tests, the manufacturer may recalculate the predicted values of energy consumption as a result of any changes to the testing conditions.

9.4 Braking tests

9.4.1 Type test (safety-related tests)

9.4.1.1 Objective

To verify that the vehicle braking systems meet the performance requirements of the contract.

9.4.1.2 General

The dynamic tests of the braking systems on the vehicle shall include either measurement of distance against speed during deceleration between agreed speeds (for example, stopping distances), including the maximum specified speed, or measurement of deceleration over the specified speed range up to maximum specified speed. The tests shall also check that the braking is achieved smoothly and without jerks, particularly where the system involves blending of one braking method to another.

The tests shall demonstrate the performance of all braking systems of the vehicle (for example, emergency and service, pure air brake or blended air and electric brake or hydraulic retarder).

Tests of other braking systems (for example, magnetic track brake) shall be carried out as agreed in the contract.

All relevant standards shall be taken into account for the braking tests.

~~NOTE~~ UIC Leaflets 540, 541-03, 541-05, 541-3, 541-4, 541-5, 543, 544-1, 544-2, 546, 547 and 660 should be taken into account for these braking tests (see Bibliography).

NOTE European requirements for braking tests ~~for high speed trains are given in the TSI rolling stock, and for braking tests for mass transit systems are given in EN 13452-2~~, calculation methods for stopping distances and other requirements are defined in Annex B. ~~Other European Standards (prEN 14531-6 and CEN WI 00256142) are in the course of preparation by CEN/TC256 (see Annex B).~~

9.4.1.3 Vehicle conditions

For vehicles designed to carry passengers or goods, these type tests shall be carried out in the load conditions specified in the contract or, if not specified, in the minimum load condition (tare) and the exceptional ~~/crush~~ load condition. Further tests may be required to verify that the required stopping distance is met over the whole load range, to cater for non-linearities in the characteristics of the friction materials, and the use of load-weighing systems which vary the brake force applied.

For motive power units, the tests shall be carried out at normal load.

The tests shall be performed with all systems in working order and, when specified in the contract, with some brake devices or bogies isolated.

For friction brake systems, the brake shoes, pads or linings shall have been bedded-in (sufficient brake applications made to ensure a good fit between the block and wheel or pad and disc).

For vehicles provided with slack adjusters, type tests shall be carried out with new brake shoes, pads or linings; for vehicles without slack adjusters, type tests shall be carried out with brake shoes, pads or linings worn to their wear limits.

9.4.1.4 Route conditions

The tests shall be carried out on a well-bedded track.

Unless otherwise specified, tests shall be carried out on dry track. If tests are carried out in the prevailing atmospheric conditions (i.e. with the rails wet or dry), the conditions shall be recorded with the results.

By agreement between the purchaser, user and manufacturer, tests can be carried out on track where adhesion conditions have been artificially degraded to simulate actual conditions to be found in service (see also 9.4.1.6).

9.4.1.5 Methods of measuring stopping distances

The method of measuring stopping distances may vary between contracts to take account of conditions prevailing in different countries but the method used shall ensure that the objective of the test is met. This subclause describes one method for measuring stopping distances but other methods, for example using on-board speed and distance measuring equipment and graphical presentation, may be used.

NOTE 1 For trains approved by UIC in international traffic, the test requirements are specified in UIC Leaflet 544-1.

NOTE 2 European requirements for braking tests ~~for high speed trains are given in the TSI rolling stock, and for braking tests for mass transit systems are given in EN 13452-2~~, calculation methods for stopping distances and other requirements are defined in Annex B. ~~European Standards (prEN 14531-6 and CEN WI 00256142) are in the course of preparation by CEN/TC256 (see Annex B).~~

Stopping distances are measured on straight level track with the vehicle running either by itself, or with other vehicles in the case of multiple unit trains, or with the number of trailing coaches required in the contract.

At least three checks shall be made for each setting or each type of brake (emergency, service and, if needed, blended electric). The actual number of tests shall depend on the variation of results obtained in each check and shall be carried out as shown in a) to d) below:

a) before passing the brake application marker, motoring power shall be cut off, the speed of the vehicle being close to the reference speed for the test. When passing the marker, the required brake setting is applied;

b) accurate measurement shall be taken of:
   - the measured stopping distance L in metres, recorded during each test;
   - the speed V km/h at the application of braking (this speed shall be uniform and should not differ from the reference speed V_0 by more than ±3 km/h);

c) the curve of speed variation with time during the braking period should also be recorded, together with the necessary additional parameters (pressures, currents, etc.) in order to determine graphically the deceleration rate where this is required. The deceleration rate shall comply with the service or emergency braking rate as required in the contract;

d) a check shall be made where applicable that the pressure in the brake pipe returns to normal between tests.

If the measurement of stopping distance cannot be carried out on an absolutely level stretch of track, the level of the straight stretch chosen shall not vary by more than ±4 mm/m. For any divergence from the level track or the value of V, the measuring stopping distance L shall be corrected by the following formula:

~~$$L_1 = L \times \frac{3{,}92\times(1+R_0)\times V_0^2}{[3{,}92\times(1+R_0)\times V^2]\pm i\times L}$$~~

$$L_1 = \frac{V_0 t_0}{3{,}6} + \left(L - \frac{V t_0}{3{,}6}\right) \times \frac{3{,}933\times(1+R_0)\times V_0^2}{\left[3{,}933\times(1+R_0)\times V^2\right] \pm i\times\left(L - \frac{V t_0}{3{,}6}\right)}$$

or:

$$L_1 = \frac{V_0 t_0}{3{,}6} + \frac{(1+R_0)\times V_0^2}{\left[\frac{(1+R_0)\times V^2}{\left(L - \frac{V t_0}{3{,}6}\right)}\right] \pm 0{,}254\times i}$$

where:

L_1 is the corrected stopping distance, in metres;

L is the measured stopping distance, in metres;

V_0 is the initial reference speed, in kilometres per hour;

V is the actual initial speed, in kilometres per hour;

t_0 is the response time (dead or idle running time), in seconds;

i is the gradient, in millimetres per metre ‰;

R_0 is the factor for rotational inertia.

In the absence of a specified figure for R_0 in the contract, the value of 0,08 may be used.

In the formula, before i, the + sign is used for a downgrade and the – sign for an upgrade.

The corrected stopping distance L_1, so determined, shall not be longer than that specified in the contract for each setting or each type of brake.

9.4.1.6 Frequency of brake tests

The frequency of braking tests repeated one after the other, shall be arranged to check that during the most severe specified conditions the energy required by the braking system (air, oil, battery, etc.) does not exceed the capacity of the energy source.

9.4.1.7 Wheel-slide protection

Where the braking system includes a wheel-slide protection (WSP) system/s the braking tests shall include checks that the system/s perform as specified. See also 8.15.8. Reference to UIC Leaflet 541-05 is recommended. Where sanding is employed to assist braking, the dynamic tests shall verify that the vehicle and sanding equipment meet the criteria given in 8.11.4.

NOTE European requirements are specified in Annex B.

9.4.1.8 Emergency braking

Tests shall be carried out to check the brake performance with the brake controller or the automatic devices for driving in the emergency position. Further tests to check conformance of additional brakes such as magnetic track or eddy-current systems shall be performed as agreed in the contract. These tests may be carried out as part of the tests specified in 9.4.1.4 above. These tests may be required by Approval Authorities as part of the acceptance criteria for the vehicles.

9.4.1.9 Electrical braking tests

For vehicles equipped with electrical braking, the following checks shall be made for all levels of service brake and for braking applied, either manually or automatically:

a) that, in the case of electrical holding braking on a downhill grade, the actual braking fully complies with the performance specified in the contract;

b) that the voltage appearing at the terminals of the motors and regulating equipment does not exceed the designed value or the value specified in the contract;

c) that the current in the traction motors does not exceed the designed value or the value specified in the contract;

d) that there is no abnormal self-excitation of the traction motors either when braking or when hauled dead;

e) that, in the case of regenerative braking on a.c. supply lines, the power factor is within the figures specified in the contract;

f) that, in the case of regenerative braking and in the event of loss of the power supply, external short circuit of the power supply, pantograph bounce, lack of receptivity of the power supply, line gaps or neutral sections, transition takes place to an alternative braking system as specified in the contract;

g) that, in the case where a composite braking system is incorporated, e.g. blended braking or substitutional braking, a smooth transition occurs without significant jerk, underbraking or overbraking between the different braking systems e.g. air brake, rheostatic electric brake and regenerative electric brake;

h) that the electric braking builds up and releases steadily without significant jerk. Unless otherwise specified in the contract, a jerk rate of 1 m/s^3 should not be exceeded, except under emergency braking conditions.

Some of the measurements above (e.g. b), c) and d)) may be omitted if electric braking verification tests have been performed on a combined test rig.

9.4.2 Routine tests (safety-related tests)

Unless otherwise specified in the contract, each vehicle built shall be subject to line braking tests (including the requirements of 9.4.1.7) at a single load condition (e.g. minimum or normal load) on dry track. Any variation in these conditions shall be noted with the results.

The braking stops shall be made from the maximum speed specified in the contract and the stopping distances measured as shown in 9.4.1 or permitted alternative as specified in the contract. These tests can be combined with other commissioning tests. Some of these tests may be required by Approval Authorities as part of the acceptance criteria for the vehicles.

A simplified check of the operation of the wheelslide protection system (if fitted) shall be performed on each vehicle. This check may be performed during or derived from other routine dynamic tests using appropriate measuring equipment.

A simplified check of the operation of the dynamic brake (if fitted), to check transition, blending and application/release (generally as described in 9.4.1.9 f), g) and h)) shall be performed on each vehicle. This check may be performed during or derived from other routine dynamic tests.

If agreed in the contract, routine tests for wagons and trailer coaches can be covered either by the static tests (see 8.11), provided that they provide sufficient demonstration that the vehicle conforms to the type tested vehicle, or by a declaration of conformity.

9.5 Traction and braking thermal capacity tests (type test, safety-related test where appropriate)

Objective: To verify that the traction and braking equipment can operate the specified duty cycles within specified temperature limits.

NOTE These tests may be combined with those covered in 9.3, and some items may be covered by a combined test of traction equipment before installation in the vehicle. Some of these tests (particularly braking tests) may be required by Approval Authorities as part of the acceptance criteria for the vehicles.

It shall be checked that when operated at the specified duty cycles, the temperature rises of the equipment are within the design limits for the particular equipment.

Measurements shall be made to check that the following equipment operates within specified temperature ranges (see also paragraph below):

– rotating electrical machines;
– cooling fluids (e.g. for main transformer, inverter);
– electrical resistors, starting and braking;
– reactors;
– power semi-conductors;
– cable insulation;
– cable ducts and conduits;
– auxiliary machines;
– control switchgear;
– capacitors;
– equipment compartments and equipment cases;
– cooling air;

– transmission links between traction motor and wheels;
– mechanical brake elements;
– axle boxes;
– wheelsets;
– friction brake components.

~~NOTE~~ This list is not exhaustive; the actual list should be as agreed in the contract.

The operating conditions of the thermal engine shall be checked, in particular temperatures and pressures of the various fluids used in its operation, and temperatures in the engine compartment. The integrity and efficiency of the thermal engine exhaust system shall be checked to ensure that no harmful gases can enter the engine compartment, driving cab or passenger compartments with all doors and windows closed.

The above tests shall be repeated with the vehicle operating with parts of the equipment (e.g. traction motors) isolated in the conditions required in the contract.

When the vehicle is required to carry out emergency duties to assist other vehicles, it is recommended that the above tests are repeated in the conditions required by the emergency duties as specified in the contract.

9.6 Resistance to motion (voluntary type test)

Objective: To verify the vehicle's resistance to motion and where applicable the rotational inertia.

This test should be carried out under dry adhesion conditions and calm weather.

The vehicle shall be set in motion at the maximum speed specified in the contract on a line of known gradient, without curves as far as possible, and the speed shall be allowed to decrease without the action of the brakes. The variations in speed, time and the distance run shall be recorded by suitable means from which a curve of resistance to motion can be derived, taking into account the line gradient and the influence of the rotating masses.

Tests for resistance to motion may be carried out by using a dynamometer car or an instrument for measuring deceleration.

For electrically powered vehicles, resistance to motion may also be deduced from the electrical power consumed by the traction circuits, taking into account the efficiency of the traction motors and all power losses in the traction system.

In the case of trains with variable compositions, it may be necessary to carry out these tests with each alternative composition.

The method of calculating the resistance to motion shall be agreed in the contract.

9.7 Speed regulating system tests (type and routine tests, safety-related where appropriate)

Objective: To verify the operation of speed regulating systems.

Where applicable, vehicles equipped with speed regulating systems shall be type tested to verify:

– that the vehicle speed is controlled in a smooth manner, without significant jerks or oscillations between braking, coasting and acceleration;

– that the traction and braking equipment is not subject to an excessive number of operations or frequency of operation (to minimise component wear compared to a manually driven vehicle);
– that the acceleration and braking rates in response to changed commands are within the limits specified in the contract;
– that the vehicle speeds resulting from the speed regulating systems are as specified in the contract and do not exceed any tolerances on the set speeds;
– that the stopping position accuracy at platforms and other stopping locations (e.g. stop signals) is as specified in the contract.

For a routine test, a simplified test of the functions of the speed regulating system shall be carried out.

Some of these tests may be required by Approval Authorities as part of the acceptance criteria for the vehicles.

9.8 Automatic train protection systems (type, routine and safety-related tests)

The proper functioning of vehicles equipped with an automatic train protection system shall be checked according to the procedures agreed in the contract and included in the test plan.

In particular, the following shall be checked:

a) the protection system operates at the speeds and in response to signals, either external (lineside) or internal (trainborne, such as display of recommended speed in cab), specified in the contract, either to apply the emergency brakes or otherwise alert the driver that the vehicle speed has to be reduced;
b) in the case that the emergency brakes are applied, the motoring power is automatically cut off and the braking rate specified in the contract is applied. Depending on the type of system installed, the vehicle or train shall stop within the braking distance specified in the contract or reduce speed below the automatic train protection permitted speed as required by the contract;
c) there is no inadvertent action during the tests and that the protection system does not operate without cause unless actual overspeed or failure to stop has occurred.

The automatic train protection system shall be tested over the full operating conditions to check correct operation.

For a routine test, a simplified test of the functions of the automatic train protection system shall be carried out.

These tests are likely to be required by Approval Authorities as part of the acceptance criteria for the vehicles.

9.9 Vehicle/track interaction

9.9.1 Safety of running

9.9.1.1 Objective

To verify the safety in operation of the vehicle in the following areas:

a) safety against derailment;
b) safety against shifting of the track;
c) safety against excessive mechanical stresses on the rails and their means of fixation, on wheels, axles and certain parts of the bogies;

d) safety against the consequences of a suspension fault (deflated air suspension, for example);

e) safety systems to prevent wheels locking.

9.9.1.2 Type test (safety-related test)

The vehicle shall, if possible, be run on lines on which it is intended to work including tunnels, both at speeds within the range demanded by the timetable and at the maximum speeds specified in the contract.

Running tests may also be made on other tracks in average conditions selected by agreement between purchaser and manufacturers.

NOTE International requirements on items a) to d) are given in UIC Leaflet 518. European ~~Standard EN 14363 is in the course of preparation by CEN/TC256, see~~ requirements are defined in Annex B.

9.9.1.3 Routine test (safety-related test)

The parameters used to assess conformance shall be based on data generated by the type test performed in accordance with 9.9.1.2. The parameters selected and the limit values to check conformance shall be agreed in the contract and included in the test plan.

9.9.2 Suspension clearances, inter-vehicle clearances (voluntary type and safety-related test where appropriate)

Objective: To verify that adequate clearances are provided for operation of the vehicle on the specified limiting cases of radius of curvature, applied cant, etc., in all loading conditions of the vehicle.

The operation of the vehicle on curved track shall be checked by running the vehicle over a curve of minimum specified radius at the speed specified in the contract, while a check is made that there is no restriction of movement or binding, that jumper cables, pneumatic couplings, connections to motors and current return connections are of sufficient length, that the motor ventilating bellows and the drives operated from an axle of the vehicle (e.g. speed recorder drive) are so designed as to avoid damage.

The vehicle shall be coupled to another similar vehicle, or to a vehicle of another type as required in the contract, to run in service coupled with the first named. The vehicle shall be run over reverse curves and it shall be checked that the vehicle behaves in a satisfactory manner, i.e. that there is neither binding nor overriding of the drawgear or corridor connections, if these are provided. The test shall be effected with the coupling gear fully under tension.

In the case of vehicles provided with automatic coupling, the possibility of coupling on curves of a radius, as specified in the contract shall be verified.

A check shall be made that the running over curves and point work takes place without binding and without permanent deformation of the track.

The tests required on curved track shall be repeated where appropriate on straight track with the maximum changes of gradient specified in the contract.

Where the contract calls for operation on curved track with changes of gradient and cant, this shall be checked (e.g. ferry-boat services, tram systems).

Consideration should be given to wheel wear and the effect of incorrect operation or damage to the suspension (i.e. deflated air suspension or broken springs) causing the vehicle's body to be in contact with the bogie or wheels at one or more places.

Whilst these tests can be carried out on the relevant infrastructure ~~controller's~~ manager's tracks, some may be carried out on prepared track in a depot or the manufacturer's works, provided that the track is in a proper state of maintenance.

The movement of the vehicle on curved track can be checked statically by means of a traverser or turntable, turning one bogie with respect to the car body (see 8.2.2.2 and 8.2.2.3).

9.10 Ride comfort quality (voluntary tests)

9.10.1 Objective

To verify that the ride comfort quality meets the requirements specified in the contract.

9.10.2 Type test

The vehicle shall be run on lines agreed with the purchaser as representative of the track over which it is intended to operate. The track quality, permitted operating speeds, population of curves, installed cant and cant deficiency shall be representative of that specified in the contract. The methods of evaluation and test conditions shall be defined in the test plan.

NOTE ~~Guidance on methods of evaluation and test conditions is given in European pre-standard ENV 12299.~~ European guidance on methods of evaluation and test conditions is given in Annex B.

9.10.3 Routine test (voluntary test)

The parameters used to assess the conformance of each vehicle built shall be based on data generated by the type test (9.10.2). The parameters selected and the limit values shall be agreed between the manufacturer and the purchaser and included in the test plan.

9.11 Kinematic ~~gauging~~ envelope

9.11.1 Type test (safety-related test)

Objective: To verify that the vehicle complies with the kinematic ~~gauging~~ envelope requirements specified in the contract.

These tests may be combined with the ride comfort quality tests covered at 9.10.2 using data computed from the suspension displacements to check the motion of the vehicle body. The same data may be used to check the pantograph sway motion (where fitted) to check conformance with pantograph gauge limits.

If agreed in the contract, calculation supported by static tests may be used to compute the kinematic or swept envelope (see 8.3).

9.11.2 Routine test (voluntary)

The parameters used to assess the conformance of each vehicle built shall be based on data generated by the type test, see 9.11.1. The parameters selected and the limit values shall be agreed in the contract.

These tests may be combined with the ride comfort quality tests, see 9.10.3.

9.12 Operation of wheel flange lubricators (safety-related routine test only)

Objective: To verify that wheel flange lubricators provide lubrication as specified in the contract without contamination of wheel tread or rail head.

Where fitted to the vehicle these units shall be tested in accordance with the supplier's instructions and their performance verified against the contract.

NOTE European requirements for flange lubrication are defined in Annex B.

9.13 Current collector and power supply contact system compatibility tests (safety-related type test only)

Objective: To verify that current collectors perform as specified in the contract.

Before performing these tests the static type and routine tests (see 8.7 and 8.8) shall be completed.

The vehicle shall be run at the maximum speed specified in the contract on lines over which it is to operate. If the vehicle is required to run in a train with more than one pantograph raised or collector shoe in contact (e.g. locomotives or motor coaches in multiple unit trains), then the current collection shall be checked in the operating conditions specified in the contract (e.g. speed, distance between current collectors). Tests shall be performed in each direction of motion.

The quality of the supply system, over which the tests shall be run, shall be agreed in the contract and included in the test plan.

A check shall be made that satisfactory current collection takes place, without damage, abnormal wear or vibration of either the collector or the supply (in the case of pantographs, in accordance with IEC 60494-1 or IEC 60494-2).

The weather at the time of the test should be noted.

The electrical and mechanical operation of the current collector and associated electrical circuits over neutral sections and gaps in the third-rail shall be checked.

In the case of a pantograph, a check shall be made with the pantograph raised, in both directions of travel and up to the maximum speed specified in the contract, that the aerodynamic effect does not cause forces which, in addition to the static forces, exceed the upper and lower limits specified in the contract. This check shall be repeated with vehicles in multiple if specified in the contract (for example, in the case of a vehicle with a short distance between the two pantographs).

A check shall also be made that the aerodynamic effect is not such as to produce an unauthorised raising of the lowered pantograph and has no adverse influence on the proper execution of raising or lowering movements at speed.

~~NOTE European requirements for testing of the dynamic interaction between the pantograph and the overhead line are given in European Standard EN 50317 (see Annex B).~~

Tests and test methodology for compatibility are defined in IEC 62313. Requirements for testing of the dynamic interaction between the pantograph and the overhead line are given in future IEC 62846.

It shall be verified by measurement that the calculated maximum pantograph sway is not exceeded taking into account the worst dynamic movement of the vehicle (see also 9.10.2 and 9.11.1). Reference may be made to UIC leaflet 505-1, IEC 60494-1 or IEC 60494-2. This test may be carried out statically (see 8.2.2.4).

9.14 Aerodynamic effects (type tests only, safety-related where appropriate)

Objective: To verify that the aerodynamic characteristics of the vehicle conform to the requirements specified in the contract.

Special tests shall be made as specified in the contract to cover aerodynamic effects as follows:

a) to check the resistance of the mechanical parts of the vehicle to aerodynamic shock waves. The tests may cover the effects due to trains passing at speed on the adjacent track and passage through tunnels;

b) to check the pressure tightness of the vehicle structure;

c) to check there are no adverse effects on air intakes to systems such as cooling, air conditioning, etc.;

d) to check for slipstream effects and the effects of cross-winds.

NOTE 1 European requirements for test procedures for aerodynamic requirements of rolling stock are given in ~~European Standard EN 14067, parts 4 and 5, in the course of preparation by CEN/TC256 (see~~ Annex B~~)~~.

NOTE 2 European requirements permitting tests on reduced-scale models or numerical simulations are given in Annex B.

9.15 Electromagnetic compatibility (type tests only)

9.15.1 Internal interference within the vehicle (safety-related where appropriate)

Objective: To verify that all equipment functions correctly after installation, without interference effects.

Where equipment tests in accordance with IEC 62236-3-2 confirm that there is sufficient margin between the electromagnetic emissions and the immunity levels of the equipment within the vehicle, further testing of that equipment is not required.

The vehicle test shall be executed as follows:

All contactors, relays and other possible sources of noise of the electrical circuits on the vehicle, shall be operated in sequence, to ensure there is no harmful electrical interference with the vehicle circuits, due to electromagnetic radiated or conducted signals.

Reference should be made to IEC 62236-3-2 for detailed methods of checking the immunity of control equipment from electromagnetic emissions.

9.15.2 External interference produced by the vehicle (safety-related where appropriate)

Objective: To verify that the interference spectrum (amplitudes, frequencies, psophometric currents, etc.) produced by the vehicle under ~~all loading~~ normal operating conditions and reasonable degraded conditions complies with the ~~values~~ requirements specified both in IEC 62236-3-1~~, or~~ and in the contract for compatibility with trackside systems.

The set of normal operating conditions and reasonable degraded conditions to be used for the tests shall be agreed between the purchaser and manufacturer and included in the contract.

IEC 62236-3-1:2008, Clause 6 sets out the parameters for testing the complete vehicle to account for various operating environments.

Tests shall be conducted in accordance with IEC 62236-3-1, unless otherwise agreed in the contract, to determine that no adverse effects occur, under ~~all~~ normal conditions that prevail on the railway over which the vehicles are intended to operate, for example:

– at different distances from the sub-station;

– at different speeds and accelerations, in motoring and braking.

~~NOTE European requirements for the tests are set out in EN 50238, including specific requirements for testing of rolling stock to establish train characteristics affecting train detection systems (see Annex B).~~

IEC 62427 defines a process to obtain the assurance that specific rolling stock operating on a specific route does not interfere with train detection systems installed on that route.

The individual compatibility requirements and test conditions for rolling stock referring to this are given by the infrastructure manager and/or Approval Authority of the respective country and should be included within the contract.

Where applicable, it shall be checked that the detection devices or monitoring systems, which are fitted for monitoring critical frequencies, operate as specified in the contract.

Test reports shall be produced and submitted in accordance with the requirements of the infrastructure ~~controller~~ manager over whose lines the vehicles are intended to operate.

9.15.3 Radio frequency interference ~~(safety-related)~~

Objective: To verify that the vehicle does not produce excessive electromagnetic interference at radio frequencies.

The test shall be conducted in accordance with IEC 62236-3-1 unless otherwise agreed in the contract, at the critical frequencies and maximum levels defined therein.

9.15.4 External interference to the vehicle ~~(safety-related)~~

Objective: To verify that the vehicle can operate satisfactorily when subject to externally radiated interference levels as specified in the contract.

IEC 62236-3-1:2008, Clause 5 states that no tests are performed on a complete vehicle. Compliance shall be proved by immunity tests in accordance with IEC 62236-3-2, in conjunction with an EMC test plan.

It shall be the responsibility of the purchaser to communicate to the manufacturer at the time of the contract any potential source of interference for the vehicle which might not be considered as part of a normal railway system.

9.15.5 Electrostatic discharges (voluntary test)

Objective: To verify that the vehicle operates satisfactorily when subject to electrostatic discharges at the levels specified.

When specified in the contract the manufacturer shall carry out electrostatic discharge tests in accordance with IEC 62236-3-2.

9.16 Interruption and voltage/jump and short circuit test (voluntary type test only)

9.16.1 General

Objective: To verify that voltage changes in the external supply do not adversely affect the performance of the vehicle.

These tests shall only be undertaken on the complete vehicle when the type test specified in IEC 61377-1, IEC 61377-2 or IEC 61377-3 has not been performed on a test bed subject to agreement between the purchaser and manufacturer.

NOTE A new edition of IEC 61377 is going to be published combining the three parts of the current edition.

Tests shall be made under different line conditions (e.g. voltage, line inductance) to be found in service, for example either at the substation or at the furthest distance from the substation.

In the case of equipment with the final drive consisting of a.c. or d.c. commutator motors directly connected to the power supply via passive units (transformers, tapchangers, rheostats, diodes, etc.) the tests shall be made in the following three different conditions:

– minimum field on the traction motors (if applicable);
– maximum speed of the vehicle;
– one hour current rating of traction motors.

In the case of equipment with converters and in the absence of information specified in the contract, the tests shall be made in the following three different conditions:

– maximum current in the power circuit;
– maximum output voltage of the converters;
– maximum speed of the vehicle.

9.16.2 Voltage jump tests

The supply voltage shall be increased suddenly from approximately the nominal supply voltage. The increase shall be based on the requirements of IEC 60850.

Various methods can be employed to carry out the tests, in particular it may be possible:

– to operate on the controls of the supply substations; or
– to short-circuit suddenly a resistor located on the vehicle itself or on another vehicle coupled to it; or
– to disconnect suddenly a heavy load connected in parallel with the vehicle on test; or
– to switch in a supply substation previously out of service.

In the case of a vehicle provided with regenerative braking, a test with a sudden drop in voltage (of the order of 10 %) shall be carried out at maximum speed and at the maximum regenerated current obtainable at this speed (and also at the maximum speed obtainable with the maximum regenerated current specified in the contract). These tests can be carried out by suddenly connecting a heavy load in parallel with the vehicle on test.

The tests shall not adversely affect the equipment. The equipment shall continue to deliver the same performance without permanent damage, even in the most severe operating conditions (after reconnection, if the protective equipment disconnected the propulsion equipment when the voltage jump was applied).

9.16.3 Interruption tests

For traction and regenerative braking, the external supply voltage shall be disconnected and reconnected with the total time of interruption being in the range from 10 ms to 10 s, as agreed in the contract. All protective devices, including no-voltage protection devices, shall be in operation for these tests.

A number of tests shall be carried out to ensure that the specified range of intervals between interruptions is fully covered. The tests can be carried out by disconnecting and reconnecting the circuit by means of a circuit-breaker.

The tests shall not adversely affect the equipment. The equipment shall continue to deliver the same performance without permanent damage, even in the most severe operating conditions (after reconnection, if the protective equipment disconnected the propulsion equipment during the interruption).

9.16.4 Voltage variation testing

All the equipment on the vehicle, particularly the auxiliary equipment, shall be tested for correct operation over the full range of the line voltage specified in the contract.

A number of tests shall be carried out to ensure that the range of voltage is covered (e.g. maximum, minimum and nominal line voltage).

9.16.5 Short circuit test

For traction and regenerative braking the external supply voltage shall be short circuited for unlimited time. All protective devices shall be in operation for these tests.

The tests shall not adversely affect the equipment, and the line current shall not exceed the values specified in the contract. After reconnection, the equipment shall be able to continue to deliver the performance specified in the contract without any permanent damage, even in the operating conditions as specified.

9.17 Noise tests

9.17.1 Type test

Objective: To verify that the internal noise and noise emitted by the vehicles complies with the specification.

External noise tests shall be performed in accordance with ISO 3095; internal noise tests in accordance with ISO 3381. In each case, the tests shall be those identified as type tests using the measurements and in the conditions specified in the standard. The test procedures to be used shall be specified in the contract.

NOTE European requirements for noise tests for ~~high speed~~ trains are given in ~~the TSI rolling stock (see~~ Annex B~~)~~.

9.17.2 Routine test (voluntary test)

If required by the contract, measurements performed to check that sample vehicles conform to the standard demonstrated by the type test above shall be in accordance with the monitoring tests defined in ISO 3095 and ISO 3381.

9.18 Air systems – compressor duty cycle (type test, safety-related where appropriate)

Objective: To verify that the installed compressor/s can deliver the required amount of air to meet all system requirements.

Tests shall be undertaken representative of the most demanding duty cycle for the air system when operating specified services, including, for example, operation of any air-activated door systems, warning horns, etc.

Locomotives shall be tested hauling the maximum load specified in the contract.

Multiple units shall be tested in the ~~crush laden~~ exceptional load condition.

The tests shall include the following measurements:

– main reservoir pressure;
– main reservoir pipe pressure;
– air suspension pressure (where applicable);
– time taken to fully charge the system (see also static test in 8.9);

– duration of compressor operations;
– air dew point downstream of the air drier.

The tests shall demonstrate the following:

– charge time from a completely empty system is within the time specified in the contract (normally not greater than 15 min), except for locomotives hauling freight wagons;
– the system is maintained at its working pressure when operating in normal service with all air operated equipment in use;
– when specified in the contract that the vehicle is capable of operating the air system of itself and a disabled unit/vehicle/s.

NOTE This test can be carried out during other dynamic tests (for example, the traction performance test, see 9.3). Alternatively, the test can be carried out with defined leakage, provided that it can be demonstrated that the air consumption is representative of the specified duty.

9.19 Windscreen wipers (type test)

Objective: To verify that the windscreen wipers and washers and demisters give the specified clear area of the windscreen at all operating speeds and weather conditions.

The test shall cover all operating speeds up to the maximum specified in the contract. The tests shall be performed preferably in adverse weather conditions.

The wipers shall clean a specified area and not be adversely affected by aerodynamic effects.

The windscreen washer shall operate as specified in the contract.

9.20 Train control system (type test, safety-related where appropriate)

Objective: To check that all train control systems function correctly in the dynamic environment.

Some of these tests can be combined with other dynamic tests: for example, motoring control tests can be done during traction performance tests (9.2).

During dynamic testing, all train control systems and circuits shall be checked to ensure that they are operating correctly as specified in the contract. In particular, the following shall be checked:

– sequence of control;
– operation of time delays;
– operation of interlocks;
– operation from valid coded signals;
– interface between different systems.

Where appropriate, the vehicle auxiliary systems tested statically in accordance with 8.15 shall be checked to ensure that they operate correctly in dynamic conditions, without any adverse effects from the operation of the traction and braking systems or any other effects from the movement of the vehicle.

In particular the following shall be checked:

– public address system audibility;
– radio operation on the intended infrastructure;
– track-to-train data links including closed circuit television;

– data transmissions in the dynamic environment;
– train management systems, including diagnostic systems, using inputs from the operating vehicle in real time;
– internal closed circuit television or video systems.

Where specified in the contract, degraded modes shall be tested and verified.

Where a freight traction vehicle is fitted with a radio remote control system to provide remote control by an external operator, requirements are defined by IEC 62845.

Annex A
(informative)

List of tests

In Tables A.1 and A.2, the symbols in the columns have the following meanings:

MU	Multiple Unit
O	Obligatory
V	Voluntary
D of C	Declaration of conformity
T	Type test
R	Routine test
C	Calculation
S	Safety-related
A	may be required by Approval Authorities
n/a	not applicable
*	See Annex B or Bibliography.

Where a symbol appears in brackets (e.g. (O), (V), (R)), the test applies where the equipment is fitted or if the test is appropriate. Refer to the relevant subclause for further details.

Tests may be waived if the conditions of 5.1 are met.

Table A.1 – List of static tests *(1 of 4)*

Clause/ subclause	Test	Type of test	Loco	Freight	Pass-enger	Freight MU	MU	Refer to
8.2	Dimensional tests							
8.2.2	Type tests							
8.2.2.1	Outside dimensions	C, T, S	O	O	O	O	O	EN 13775* ~~EN 14363*~~
8.2.2.2 a	Clearance tests (car body to bogie)	C, T, S	O	O	O	O	O	
8.2.2.2 b	Clearance tests (vehicle to vehicle)	C, T, S	O	O	O	O	O	
8.2.2.3	Hose and cable length tests	C, T	O	O	O	O	O	
8.2.2.4	Current collection	T, S	(O)	n/a	n/a	(O)	(O)	IEC 60494-1 IEC 60494-2
8.2.3	Routine tests	R	O or D of C	O or D of C	O or D of C	O or D of C	O or D of C	
8.3	Gauging test							
8.3.2	General	T, S	O	O	O	O	O	EN 15273*
8.3.3	Coefficient of flexibility test	T, S	(O or V)	(O or V)	(O or V)	(O or V)	(O or V)	UIC 505-5* EN 14363*
8.3.4	Routine tests	R, S	O	O	O	O	O	
8.4	Lifting ability test	T, S	O	O	O	O	O	EN 16404*
8.5	Weighing tests							
8.5.3	Type tests	T, S	O	O	O	O	O	EN 15663*

Table A.1 *(2 of 4)*

Clause/ subclause	Test	Type of test	Loco	Freight	Pass-enger	Freight MU	MU	Refer to
8.5.4	Routine tests	R, S	O	O or D of C	O or D of C	O	O	
8.6	Sealing tests							
8.6.2	Type tests	T	O	O	O	O	O	IEC 60529
8.6.3	Routine tests	R	V	V	V	V	V	
8.7	Electrical insulation tests							
8.7.2	Voltage withstand test	R	O	O	O	O	O	EN 50343*
8.7.3	Insulation impedance test	R	O	O	O	O	O	EN 50343*
8.8	Protective bonding and return circuits tests	R, S	O	O	O	O	O	IEC 61991
8.9	Air system test							
8.9.2 8.9.3	Air tightness test	R, S	O	O	O	O	O	
8.9.4	Functional test	T, (S)	O	O	O	O	O	
8.10	Hydraulic system tests (tightness)	R, (S)	(O)	(O)	(O)	(O)	(O)	
8.10	Hydraulic system tests (functional)	T, (S)	(O)	(O)	(O)	(O)	(O)	
8.11	Friction brake system tests							
8.11.2	Pneumatically applied brake systems							
8.11.2.1	Type tests	T, S	O	O	O	O	O	EN13452-1* EN 15734-2* EN 15806* EN 16185-2*
8.11.2.2	Routine tests	R, S	O	O	O	O	O	
8.11.3	Other systems	T, R, S	(O)	(O)	(O)	(O)	(O)	
8.11.4	Sanding system	T, R, S	(O)	(O)	(O)	(O)	(O)	
8.12	Parking brake type tests	T, S	O	O	O	O	O	
8.13	Auxiliary power supply system tests							
8.13.2	Type tests	T, (S)	O	O	O	O	O	
8.13.3	Routine tests	R	O	O	O	O	O	
8.14	Battery charging tests							
8.14.2	Type tests	T	O	O	O	O	O	
8.14.3	Routine tests	R	O	O	O	O	O	
8.15	Auxiliary and control system tests							
8.15.2	General tests							
8.15.2.1	Type tests	T	O	O	O	O	O	
8.15.2.2	Routine tests	R	O	O	O	O	O	
8.15.3	Train control static functions							
8.15.3.1	Single unit operation	T, R, (S)	O	(O)	O	O	O	
8.15.3.2	Interfacing between systems	T, R, (S)	O	(O)	O	O	O	
8.15.3.3	Multiple operation	T, R, (S)	(O)	(O)	(O)	O	O	

Table A.1 *(3 of 4)*

Clause/ subclause	Test	Type of test	Loco	Freight	Pass-enger	Freight MU	MU	Refer to
8.15.4	Door control systems	T, R, S	O	(O)	O	(O)	O	EN 14752*
8.15.5	Heating, ventilation and air-conditioning system tests							
	Traincrew areas	T, R, S	O	n/a	O	O	O	EN ~~13129~~ 14813-2*
	Passenger areas	T, R	n/a	n/a	V	n/a	V	EN 13129* EN 14750-2*
	Freight wagons	T, R	n/a	(O)	n/a	(O)	n/a	
8.15.6	Lighting system tests							
	Type tests	T, (S)	O	V	O	V	O	EN 13272*
	Routine tests	R, (S)	O	V	O	V	O	EN 13272*
8.15.7	Other systems							
	Safety-related	T, R, S, (A)	(O)	n/a	(O)	(O)	(O)	
	Not safety-related	T, R	(V)	n/a	(V)	(V)	(V)	
8.15.8	Software controlled systems							
	Safety-related	T, (S)	O	(O)	O	(O)	O	IEC 60571
	Not safety-related	T	V	n/a	V	(V)	V	
	Software version	R, S	O or D of C	(O or D of C)	O or D of C	(O or D of C)	O or D of C	
8.16	Tests on thermal engine and associated generating sets and transmission							
8.16.2	Operating speeds of the thermal engine	T	V or D of C	(V or D of C)	(V or D of C)	V or D of C	V or D of C	
8.16.3	Thermal engine protective devices	T	O or D of C	(O or D of C)	(O or D of C)	O or D of C	O or D of C	
8.16.4	Thermal engine fluid, air and exhaust circuits	R, (S)	O	(O)	(O)	O	O	
8.16.5	Engine-driven auxiliaries							
8.16.5.1	Type tests	T	V or D of C	(V or D of C)	(V or D of C)	V or D of C	V or D of C	
8.16.5.2	Routine tests	R	V or D of C	(V or D of C)	(V or D of C)	V or D of C	V or D of C	
8.16.6	Cranking of the thermal engine	T	V or D of C	(V or D of C)	(V or D of C)	V or D of C	V or D of C	
8.16.7	Operation of the thermal engine							
8.16.7.1	Type tests	T	V or D of C	(V or D of C)	(V or D of C)	V or D of C	V or D of C	
8.16.7.2	Routine tests	R	O or D of C	(O or D of C)	(O or D of C)	O or D of C	O or D of C	
8.17	Traction system tests	T, R, (S)	O	n/a	n/a	O	O	
8.18	Operability and maintainability							
8.18.1	General	T	V	V	V	V	V	
8.18.2	Cabs and traincrew areas	T, S	O	n/a	O	O	O	UIC 651*
8.18.3	Passenger areas	T, (S)	n/a	n/a	V, (O)	n/a	V, (O)	

Table A.1 *(4 of 4)*

Clause/ subclause	Test	Type of test	Loco	Freight	Pass-enger	Freight MU	MU	Refer to
8.18.4	Rescue	T, (S)	V, (O)	V, (O)	V, (O)	V, (O)	V, (O)	
8.19	Noise and vibration tests	T, (S)	V, (O)	V, (O)	V, (O)	V, (O)	V, (O)	ISO 3095 ISO 3381 EN 12663* EN15892*
8.20	Safety-related system tests	R, S	O	(O)	(O)	O	O	EN15153*

Table A.2 – List of dynamic tests *(1 of 2)*

Clause/ subclause	Test	Type of test	Loco	Freight	Pass-enger	Freight MU	MU	Refer to
9.2	Traction performance (tractive effort/speed characteristics)							
	Type tests	T	V	n/a	n/a	V	V	
	Routine tests	R	V or D of C	n/a	n/a	V or D of C	V or D of C	
9.3	Journey time check	T	V	n/a	n/a	V	V	
9.4	Braking tests							
9.4.1	Type test (all) (emergency braking)	T, S, (A)	O	O	O	O	O	UIC 540 series* EN 14531* EN 13452-2* EN 15734-2* EN 15595* EN 16185-2*
9.4.2	Routine tests	R, S, (A)	O	O or D of C	O or D of C	O	O	
9.5	Traction and braking thermal capacity tests							
	Traction thermal capacity tests	T	V or D of C	n/a	n/a	V or D of C	V or D of C	
	Braking thermal capacity tests	T, S, (A)	O	O	O	O	O	
9.6	Resistance to motion	T	V	V	V	V	V	
9.7	Speed regulating system tests	T, R, (S) (A)	V, (O)	n/a	n/a	V, (O)	V, (O)	
9.8	Automatic train protection systems	T, R, S, (A)	O	n/a	n/a	O	O	
9.9	Vehicle/track interaction							
9.9.1	Safety of running	T, R, S	O	O or D of C	O	O	O	UIC 518 ~~EN14363~~* EN 14363* EN 15686* EN 15687* EN 15839* EN 16235*
9.9.2	Suspension clearances, inter-vehicle clearances	T, (S)	V	V	V	V	V	
9.10	Ride comfort quality							
9.10.2	Type test	T	V	V	V	V	V	EN~~V~~ 12299*

Table A.2 *(2 of 2)*

Clause/ subclause	Test	Type of test	Loco	Freight	Pass-enger	Freight MU	MU	Refer to
9.10.3	Routine tests	R	V	V	V	V	V	
9.11	Kinematic gauging							
9.11.1	Type test	T, S	O or C	O or C	O or C	O or C	O or C	
9.11.2	Routine tests	R	V	V	V	V	V	
9.12	The operation of wheel flange lubricators	R, S	(O)	(O)	(O)	(O)	(O)	EN 15427*
9.13	Current collector and power supply contact system compatibility tests	T, S	O	n/a	n/a	O	O	IEC 60494 ~~EN 50317*~~ UIC 505-1* IEC 62313 Future IEC 62846
9.14	Aerodynamic effects	T, (S)	O	O	O	O	O	EN 14067*
9.15	Electromagnetic compatibility							
9.15.1	Internal interference within the vehicle	T, (S)	V, (O)	(V)	V, (O)	V, (O)	V, (O)	IEC 62236
9.15.2	External interference produced by the vehicle	T, S	O	(O)	O	O	O	IEC 62236 ~~EN 50238*~~ IEC 62427
9.15.3	Radio frequency interference	T, S	O	(O)	O	O	O	IEC 62236 ~~EN 50238*~~ IEC 62427
9.15.4	External interference to the vehicle	T, S	O	(O)	O	O	O	IEC 62236 ~~EN 50238*~~ IEC 62427
9.15.5	Electrostatic discharges	T	V	(V)	V	n/a	n/a	
9.16	Interruption & voltage/ jump and short circuit test	T	V	n/a	n/a	V	V	IEC 60850
9.17	Noise tests							
9.17.1	Type test	T	O	O	O	O	O	ISO 3095 ISO 3381 EN 15892*
9.17.2	Routine test	R	V	V	V	V	V	ISO 3095 ISO 3381
9.18	Air systems – compressor duty cycle	T, (S)	V or (O)	n/a	n/a	V or (O)	V or (O)	
9.19	Windscreen wipers	T	O	n/a	n/a	O	O	
9.20	Train control system	T, (S)	V, (O)	(V)	V, (O)	V, (O)	V, (O)	IEC 62845

Annex B
(informative)

Requirements for the European Community – Legal requirement in accordance with ~~IEC Administrative Circular~~ AC/135/2002

B.1 ~~Introduction~~ General

This annex is to identify the European requirements resulting from the Interoperability Directives of the Council of the European Union. The Interoperability Directives cover the mainline networks of the European member states but not urban rail as defined by those states.

To support the Directives, the European Commission has published a number of Technical Specifications for Interoperability (TSI), as shown below.

Further information can be obtained from the Guides for the Application of the ~~High Speed~~ TSIs ~~of Council Directive 96/48/EC~~ produced from time to time and published by the European Rail Agency.

The information given below is correct at the time of the vote on the FDIS (see Foreword). Further directives, decisions, regulations and other documents, including revisions, will be published during the currency of this standard. It is the responsibility of the users of this standard to ensure that they are aware and make use of the correct documents.

Only the principal documents are listed below. Other directives and decisions may apply to rolling stock being supplied to member states of the EU. It is the responsibility of the person supplying to such member states to ensure that all relevant requirements are met.

B.2 Legal references

B.2.1 Directives

The following are the principal Directives currently in force~~, with the relevant TSIs~~:

~~COUNCIL DIRECTIVE 96/48/EC of 23 July 1996 on the interoperability of the trans-European high-speed rail system,~~

~~COUNCIL DIRECTIVE 2001/16/EC of 19 March 2001 on the interoperability of the trans-European conventional rail system.~~

DIRECTIVE 2008/57/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 17 June 2008 on the interoperability of the rail system within the Community as amended by 2009/131/EC of 16 October 2009 and 2011/18/EU of 1 March 2011 (Recast Interoperability Directive).

COUNCIL DIRECTIVE 2004/49/EC of 29 April 2004 on safety on the Community's railways and amending Council Directive 95/18/EC on the licensing of railway undertakings and Directive 2001/14/EC on the allocation of railway infrastructure capacity and the levying of charges for the use of railway infrastructure and safety certification as amended by 2008/57/EC of 17 June 2008 and 2008/110/EC of 16 December 2008 (Railway Safety Directive).

~~COUNCIL DIRECTIVE 2004/50/EC of 29 April 2004 amending Council Directive 96/48/EC on the interoperability of the trans-European high-speed rail system and Directive 2001/16/EC of the European Parliament and of the Council on the interoperability of the trans-European conventional rail system.~~

B.2.2 Technical specifications for interoperability

The following are the principal TSIs related to rolling stock currently in force, together with the clauses in IEC 61133 to which they apply:

~~Commission Decision 2002/735/EC, TSI (High Speed) Rolling Stock (C(2002)1952),~~

~~Commission Decision 2002/733/EC, TSI (High Speed) Energy (C(2002)1949),~~

~~Commission Decision 2002/731/EC, TSI (High Speed) Control, Command and Signalling (C(2002)1947).~~

~~(The high speed TSIs have been revised; the new editions are expected to be available during 2006).~~

~~Commission Decision 2006/66/EC, TSI Noise (C(2005)5666).~~

~~(Conventional Rail TSIs for Freight Wagons, Locomotives and Traction Units, Passenger Carriages and others are in preparation).~~

~~The following Directive is currently in preparation and consultation:~~

~~Draft proposal for a Directive on the approximation of the laws, regulations and administrative provisions of the Member States relating to Rail Mass Transit installations (RMT installations)~~

COMMISSION DECISION 2008/232/EC of 21 February 2008 concerning a technical specification for interoperability relating to the 'rolling stock' sub-system of the trans-European high-speed rail system as amended by 2012/464/EU of 23 July 2012 (4.1, 8.15.6.1, 8.18.4, 8.19, 9.4.1.2, 9.4.1.5, 9.9.1.2, 9.17.1).

COMMISSION DECISION 2011/291/EU of 26 April 2011 concerning a technical specification for interoperability relating to the rolling stock subsystem — 'Locomotives and passenger rolling stock' of the trans-European conventional rail system, as amended by 2012/464/EU of 23 July 2012 (4.1, 8.15.6.1, 8.18.4, 9.4.1.2, 9.4.1.5, 9.9.1.2).

COMMISSION REGULATION (EU) 321/2013 of 13 March 2013 concerning the technical specification for interoperability relating to the subsystem 'rolling stock — freight wagons' of the rail system in the European Union (4.1, 9.4.1.2, 9.4.1.5, 9.9.1.2).

COMMISSION DECISION 2011/229/EU of 4 April 2011 concerning the technical specifications of interoperability relating to the subsystem 'rolling stock – noise' of the trans-European conventional rail system, as amended by 2012/464/EU of 23 July 2012 (8.19, 9.17.1).

COMMISSION DECISION 2008/164/EU of 21 December 2007 concerning the technical specification of interoperability relating to 'persons with reduced mobility' in the trans-European conventional and high-speed rail system, as amended by 2012/464/EU of 23 July 2012 (4.1, 8.18.3).

COMMISSION DECISION 2008/163/EU of 20 December 2007 concerning the technical specification of interoperability relating to 'safety in railway tunnels' in the trans-European conventional and high speed rail system, as amended by 2012/464/EU of 23 July 2012 (4.1, 8.15.5, 8.15.6.1).

COMMISSION DECISION 2012/88/EU of 25 January 2012 on the technical specification for interoperability relating to the control-command and signalling subsystem of the trans-European rail system, as amended by 2012/696/EU of 6 November 2012 (8.20).

COMMISSION DECISION 2010/713/EU of 9 November 2010 on modules for the procedures for assessment of conformity, suitability for use and EC verification to be used in the technical specifications for interoperability adopted under Directive 2008/57/EC of the European Parliament and of the Council (4.1).

B.3 European Standards relevant to Clauses in IEC 61133

The following European standards are ~~referred to in this international standard~~ relevant to the IEC 61133 clauses/subclauses listed against them and define European requirements:

ENV 12299:~~1999~~ 2009, *Railway applications – Ride Comfort for Passengers, Measurement and Evaluation* (9.10.2)

~~EN 12663:2000, *Railway applications – Structural requirements of railway vehicle bodies*~~

EN 13129-2:2004, *Railway applications – Air conditioning for main line rolling stock – Part 2: Type tests* (8.15.5)

EN 13272:~~2001~~ 2012, *Railway applications – Electrical lighting for rolling stock in public transport systems* (8.15.6.1)

EN 13452-2:2003, *Railway applications – Braking – Mass transit brake systems – Part 2: Methods of test* (8.11.2.1, 9.4.1.2, 9.4.1.5)

EN 13775-1-6:2003-2004, *Railway applications – Measuring of new and modified freight wagons* (6 parts) (8.2.2.1)

~~EN 14033-1, *Railway Applications – Track – Technical requirements for railbound construction and maintenance machines – Part 1: Running of railbound machines* (under approval, expected available 2006)~~

~~EN 14033-2, *Railway applications – Track – Technical requirements for railbound construction and maintenance machines – Part 2: Specific railway requirements for the working railbound machines* (in preparation, expected available 2007)~~

EN 14067-4:2005 + A1:2009, *Railway applications – Aerodynamics – Part 4: Requirements and test procedures for aerodynamics on open track* (9.14)

EN 14067-5:2006 + A1:2010, *Railway applications – Aerodynamics – Part 5: Requirements and test procedures for aerodynamics in tunnels* (9.14)

EN 14067-6:2010, *Railway applications – Aerodynamics – Part 6: Requirements and test procedures for cross wind assessment* (9.14)

EN 14363:2005, *Railway applications – Testing for the acceptance of running characteristics of railway vehicles – testing of running behaviour and stationary tests* (8.3.3, 9.9.1.2)

EN 14531-1:2005, *Railway applications – Braking – Methods for calculation of stopping distances, slowing distances and immobilisation braking – Part 1: General algorithms* (9.4.1.2, 9.4.1.5)

EN 14531-6:2009, *Railway applications – Methods for calculation of stopping and slowing distances and immobilization braking – Part 6: Step by step calculations for train sets or single vehicles* (9.4.1.2, 9.4.1.5)

EN 14750-2:2006, *Railway applications – Air conditioning for urban and suburban rolling stock – Part 2: Type tests* (8.15.5)

EN 14752:2005, *Railway applications – Body entrance systems* (8.15.4)

EN 14813-2:2006 + A1:2010, *Railway applications – Air conditioning for driving cabs – Part 2: Type tests* (8.15.5, 8.18.2)

EN 15153-1:2013, *Railway applications – External visible and audible warnings for trains – Part 1: Head, marker and tail lamps* (8.20)

EN 15153-2:2013, *Railway applications – External visible and audible warnings for trains – Part 2: Warning horns* (8.20)

EN 15273:2013, *Railway applications – Gauges – Part 2: Rolling stock gauge* (8.3.2)

EN 15427:2008 + A1:2010, *Railway applications – Wheel/rail friction management– Flange lubrication* (9.12)

EN 15595:2009 + A1:2011, *Railway applications – Braking – Wheel slide protection* (9.4.1.7)

EN 15663:2009 + AC:2010, *Railway applications – Definition of vehicle reference masses* (8.5.2 – see note below)

EN 15686:2010, *Railway applications – Testing for the acceptance of running characteristics of railway vehicles with cant deficiency compensation system and/or vehicles intended to operate with higher cant deficiency than stated in EN 14363:2005, Annex G* (9.9.1.2)

EN 15687:2010, *Railway applications – Testing for the acceptance of running characteristics of freight vehicles with static axle loads higher than 225 kN and up to 250 kN* (9.9.1.2)

EN 15734-2:2010, *Railway applications – Braking systems of high speed trains – Part 2: Test methods* (8.11.2.1, 9.4.1.2, 9.4.1.5)

EN 15806:2010, *Railway applications – Braking – Static brake testing* (8.11.2.1)

EN 15839:2012, *Railway applications – Testing for the acceptance of running characteristics of railway vehicles – Freight wagons – Testing of running safety under longitudinal compressive forces* (9.9.1.2)

EN 15892:2011, *Railway applications – Noise Emission – Measurement of noise inside driver's cabs* (8.19, 9.17.1)

EN 16185-2, *Railway applications – Braking systems of multiple unit trains – Part 2: Test methods* (in preparation) (8.11.2.1, 9.4.1.2, 9.4.1.5)

EN 16235, *Railway applications – Testing for the acceptance of running characteristics of railway vehicles – Freight wagons – Conditions for dispensation of freight wagons with defined characteristics from on-track tests according to EN 14363* (9.9.1.2)

EN 16404:2014, *Railway applications – Re-railing and recovery requirements for railway vehicles* (8.4)

~~EN 50238:2003, *Railway applications – Communication, signalling and processing systems – Compatibility between rolling stock and train detection systems*~~

~~EN 50317:2002, *Railway applications – Current collection systems – Requirements for and validation of measurements of the dynamic interaction between pantograph and overhead contact line*~~

EN 50343:2003, *Railway applications – Rolling stock. Rules for installation of cabling* (8.7.1)

Other standards are in preparation.

NOTE regarding EN 15663:

The nearest equivalent load cases from EN 15663 to those stated in IEC 61133 are as follows:

IEC 61133	EN 15663
Minimum load	Dead mass
Normal load	Operational mass under normal payload
Exceptional load	Design mass under exceptional payload.

Bibliography

~~ISO 9000:2005, *Quality management systems – Fundamentals and vocabulary*~~

~~ISO 9001:2000, *Quality Management Systems – Requirements*~~

UIC Leaflet 505-1: 10th Edition, 2006, *Railway transport stock – Rolling stock construction gauge*

UIC Leaflet 505-5: ~~2nd~~ 3rd Edition, ~~1977 and 4 amendments~~ 2010, ~~*Basic conditions common to leaflets 505-1 to 505-4 - Notes on the preparation and provisions of these leaflets*~~ *History, justification and commentaries on the elaboration and development of UIC leaflets of the series 505 and 506 on gauges*

UIC Leaflet 518: ~~3rd~~ 4th Edition, ~~2005~~ 2009, *Testing and approval of railway vehicles from the point of view of their dynamic behaviour – Safety – Track fatigue – Ride quality*

UIC Leaflet 540: ~~4~~ 5th Edition, ~~2002~~ 2006, *Brakes – Air Brakes for freight trains and passenger trains*

UIC Leaflet 541-03: 1st Edition, 1984, *Brakes – Regulations concerning manufacture of the different brake parts – Driver's brake valve*

UIC Leaflet 541-05: 2nd Edition, 2005, *Brakes – Regulations concerning the construction of various brake components – Wheel slip prevention device (WSP)*

UIC Leaflet 541-3: ~~5~~ 7th Edition, ~~2004~~ 2010, *Brakes –Disc brakes and disc brake pads – General conditions governing bench tests*

UIC Leaflet 541-4: ~~2nd~~ 4th Edition, ~~1990 and 3 amendments~~ 2010, *Brakes –Brakes with composition brake blocks*

UIC Leaflet 541-5: ~~2nd~~ 4th Edition, ~~2005~~ 2006, *Brakes – Electropneumatic brake (ep brake) – Electropneumatic emergency brake override (EBO)* (new edition in course of publication)

UIC Leaflet 543: ~~12~~ 13th Edition, ~~2003~~ 2007, *Brakes – Regulations governing the equipment of trailing stock*

UIC Leaflet 544-1: ~~4~~ 5th Edition, ~~2004~~ 2013, *Brakes – Braking Power*

UIC Leaflet 544-2: 2nd Edition, 1983, *Conditions to be observed by the dynamic brake of locomotives and motor coaches so that the extra braking effort produced can be taken into account for the calculation of the braked-weight*

UIC Leaflet 546: 5th Edition, 1967 and 5 amendments, *Brakes – High power brakes for passenger trains*

UIC Leaflet 547: 4th Edition, 1989, *Brakes – Air brake – Standard programme of tests*

UIC Leaflet 623-1: 5th Edition, 2008, *Approval procedures for the diesel engines of motive power units*

UIC Leaflet 623-2: 6th Edition, 2010, *Approval tests for the diesel engines of motive power units*

UIC Leaflet 623-3: 3rd Edition, 2003, *Series test and acceptance conditions for diesel engines of motive power units*

UIC Leaflet 651: 4th Edition, 2002, *Layout of drivers' cabs in locomotives, railcars, multiple-unit trains and driving trailers*

UIC Leaflet 660: 2nd edition, 2002, *Measures to ensure the technical compatibility of high-speed trains*

IEC 61133

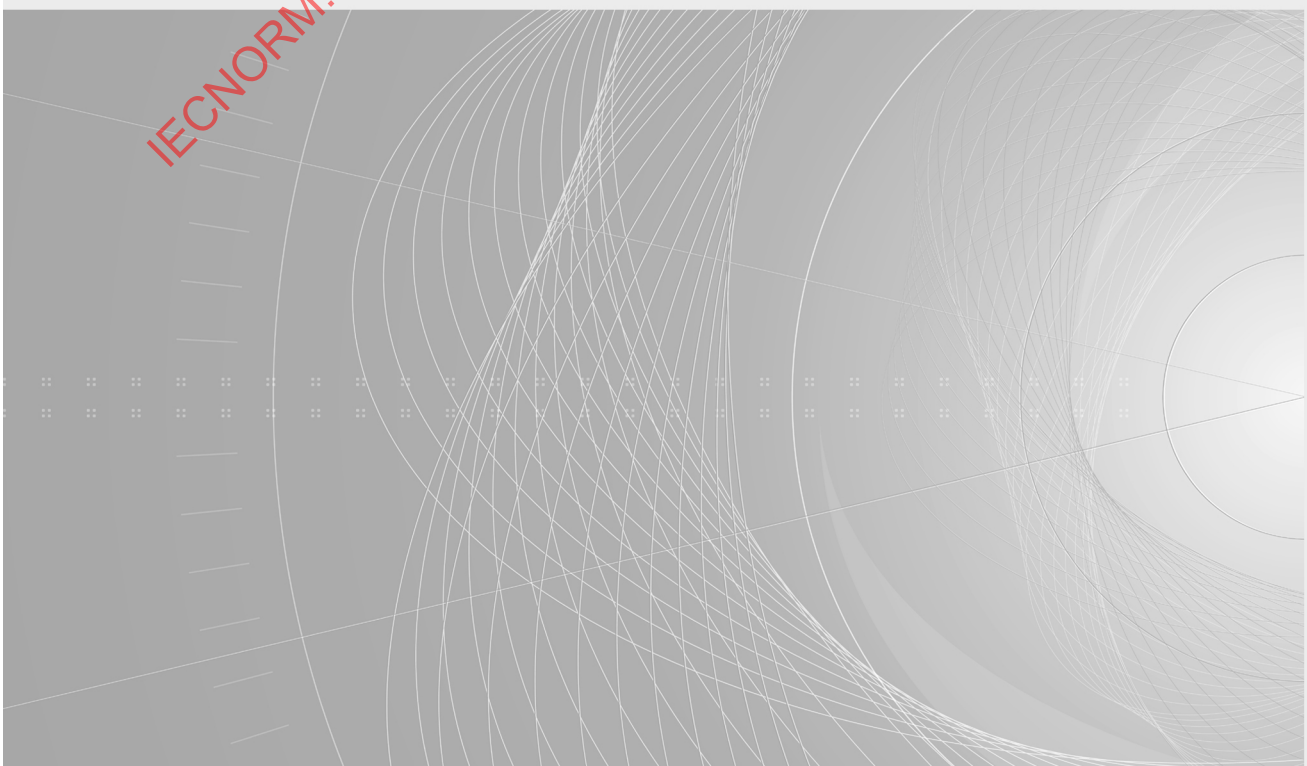
Edition 3.0 2016-02

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Railway applications – Rolling stock – Testing of rolling stock on completion of construction and before entry into service

Applications ferroviaires – Matériel roulant – Essais de matériel roulant après achèvement et avant mise en service



IEC 61133:2016-02(en-fr)

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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RAILWAY APPLICATIONS – ROLLING STOCK – TESTING OF ROLLING STOCK ON COMPLETION OF CONSTRUCTION AND BEFORE ENTRY INTO SERVICE

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 61133 has been prepared by IEC technical committee 9: Electrical equipment and systems for railways.

This standard is derived from EN 50215.

This third edition cancels and replaces the second edition, published in 2006; it constitutes a technical revision.

The main technical changes with regard to the previous edition are as follows:

- References to standards other than international have been removed from the main text so the notes refer solely to Annex B;
- Annex B has been updated with the latest European information, and cross-references between the TSIs and ENs and the clauses of IEC 61133 have been added.

The text of this standard is based on the the second edition and the following documents:

FDIS	Report on voting
9/2096/FDIS	9/2132/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

RAILWAY APPLICATIONS – ROLLING STOCK – TESTING OF ROLLING STOCK ON COMPLETION OF CONSTRUCTION AND BEFORE ENTRY INTO SERVICE

1 Scope

This International Standard specifies general criteria to demonstrate by testing that newly constructed complete railway vehicles conform with standards or other normative documents.

This International Standard, as a whole or in part, applies to all railway vehicles except special purpose vehicles such as track-laying machines, ballast cleaners and personnel carriers. The extent of application of the standard for particular vehicles will be specifically mentioned in the contract, to take account, where necessary, of any legislative requirements.

NOTE 1 The parts of the standard which are applicable will depend on the type of vehicle (e.g. passenger, freight, powered trailer, etc.).

NOTE 2 The scope of this standard excludes railbound and road/rail vehicles for construction and maintenance of railway infrastructure.

NOTE 3 This standard does not deal with tests carried out on components or equipment before fitting to the vehicle.

In so far as this International Standard is applicable, it may be used for the following:

– generator sets mounted on a vehicle provided for auxiliary purposes;
– electrical transmission used on trolley buses or similar vehicles;
– control and auxiliary equipment of vehicles with non-electrical propulsion systems;
– vehicles guided, supported or electrically propelled by systems which do not use the adhesion between wheel and rail.

NOTE 4 Specific technical requirements apply to vehicles which operate on the railways in the European Union. The source of those requirements is given in Annex B. Where a European requirement applies to a given clause, a note has been inserted at the end of the clause.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60077 (all parts), *Railway applications – Electric equipment for rolling stock*

IEC 60310:2015, *Railway applications – Traction transformers and inductors on board rolling stock*

IEC 60322:2001, *Railway applications – Electric equipment for rolling stock – Rules for power resistors of open construction*

IEC 60349 (all parts), *Electric traction – Rotating electrical machines for rail and road*

IEC 60494-1:2013, *Railway applications – Rolling stock – Pantographs – Characteristics and tests – Part 1: Pantographs for main line vehicles*

IEC 60494-2:2013, *Railway applications – Rolling stock – Pantographs – Characteristics and tests – Part 2: Pantographs for metros and light rail vehicles*

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*

IEC 60571:2012, *Railway applications – Electronic equipment used on rolling stock*

IEC 60850:2014, *Railway applications – Supply voltages of traction systems*

IEC 61287 (all parts), *Railway applications – Power convertors installed on board rolling stock*

IEC 61377-1, *Railway applications – Rolling stock – Part 1: Combined testing of inverter-fed alternating current motors and their control system*

IEC 61377-2, *Railway applications – Rolling stock – Combined testing – Part 2: Chopper-fed direct current traction motors and their control*

IEC 61377-3, *Railway applications – Rolling stock – Part 3: Combined testing of alternating current motors, fed by an indirect converter, and their control system*

IEC 61991:2000, *Railway applications – Rolling stock – Protective provisions against electrical hazards*

IEC 62236-3-1:2008, *Railway applications – Electromagnetic compatibility – Part 3-1: Rolling stock – Train and complete vehicle*

IEC 62236-3-2:2008, *Railway applications – Electromagnetic compatibility – Part 3-2: Rolling stock – Apparatus*

IEC 62278:2002, *Railway applications – Specification and demonstration of reliability, availability, maintainability and safety (RAMS)*

IEC 62313:2009, *Railway applications – Power supply and rolling stock – Technical criteria for the coordination between power supply (substation) and rolling stock*

IEC 62425, *Railway applications – Communication, signalling and processing systems – Safety related electronic systems for signalling*

IEC 62427:2007, *Railway applications – Compatibility between rolling stock and train detection systems*

IEC 62845, *Railway applications – Radio remote control system of traction vehicles for shunting application*

IEC 62846, *Railway applications – Current collection systems – Requirements for and validation of measurements of the dynamic interaction between pantograph and overhead contact line*[1]

ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

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1 To be published.

ISO 3095, *Acoustics – Railway applications – Measurement of noise emitted by railbound vehicles*

ISO 3381, *Railway applications – Acoustics – Measurement of noise inside railbound vehicles*

ISO 9001:2015, *Quality management systems – Requirements*

NOTE For applications in the European Union, see also the references in Annex B.

3 Terms, definitions and abbreviations

For the purposes of this document, the following terms, definitions and abbreviations apply:

3.1
a.c.
alternating current

3.2
approval authority
any body other than the purchaser with the legal right to require tests to be performed on vehicles within the scope of this standard and to whom compliance verification is demonstrated

Note 1 to entry: These bodies can be different in each country and can include national or international regulatory bodies, national safety authorities, infrastructure managers, and, in Europe, Notified Bodies (see Annex B).

3.3
contract
all the component parts of the technical specifications agreed between manufacturer and purchaser, consisting of purchaser's technical specifications, manufacturer's technical responses, minutes of meetings, and any other formal contract documents

3.4
d.c.
direct current

3.5
EMC
electromagnetic compatibility

3.6
infrastructure manager
organisation which manages the railway infrastructure, including, for example, track, signalling, communications and structures

3.7
IP
ingress Protection

3.8
manufacturer
organisation which has the technical responsibility for the supply of the vehicle system

Note 1 to entry: There can be more than one manufacturer where the contract for the vehicle is split in two or more parts.

3.9
manufacturer's works
location where the assembly of the vehicles is completed and where static tests are generally performed

3.10
modification level
definition of equipment modification status for which the test results are valid

3.11
purchaser
organisation which orders and will own the vehicle

Note 1 to entry: The purchaser can have the responsibility for direct negotiations with the manufacturer, unless that responsibility is delegated to the user, a main contractor or a consultant.

3.12
quality plan
document specifying which procedures and associated resources are applied by whom and when to a specific project, product, process or contract (ISO 9000)

3.13
routine test
test to which each vehicle is subjected to during or after manufacture to ascertain whether it complies with the specified criteria

3.14
safety-related
carries responsibility for safety

3.15
supplier
organisation which has the responsibility for the supply of individual items of equipment or groups of equipment to the manufacturer

3.16
supplier's works
location where individual items of equipment or groups of equipment are manufactured

3.17
test plan
plan of the tests to be undertaken by the manufacturer as presented within its quality plan, including all supporting information on the conduct of the tests

Note 1 to entry: In the context of this standard, the test plan includes all subordinate test specifications.

3.18
type test
test of one or more devices, system or complete vehicle to show that the design meets the required specifications and the relevant standards

3.19
UIC
Union Internationale des Chemins de Fer (International Union of Railways)

3.20
user
organisation which will use the vehicle

Note 1 to entry: The user will be a train operator and can be the purchaser, or another party who uses the vehicle on behalf of the purchaser through, for example, a leasing arrangement.

3.21
validation documentation
documented evidence that a product, process or service is in conformance with specified requirements or other normative documents

3.22
voluntary test
any additional test (either type or routine) added to the test plan by agreement between the manufacturer and the purchaser

3.23
WSP
wheelslide protection

4 Requirements

4.1 General

The manufacturer shall exercise control over all activities affecting the quality of the products to ensure that the requirements of the standards or other normative documents to which the declaration refers are met.

For this purpose the manufacturer shall have at his disposal all necessary means for carrying out this control at all levels (for example raw materials, supplies, production, finished products or packing). Information on the manufacturer's quality system and the results of tests as appropriate shall be available.

The manufacturer shall establish and maintain a quality system. This shall include auditable procedures covering the final inspection and test operations, including workmanship standards, test specifications, test records, calibration of test instruments and equipment, document control, control of non-conforming products and personnel training.

It is recommended that manufacturers operate a quality system in accordance with ISO 9001.

The quality plan for the design, production, inspection and testing of the product shall include a test plan defining how the manufacturer will demonstrate conformance to the specified requirements.

The configuration (type numbers, serial numbers, modification status) of key components, including revisions of software, shall be recorded as a “quality” record.

The contract shall define the various tests to be undertaken on completed vehicles and before entry into service to assure the purchaser that:

– the vehicles comply with the technical requirements of the contract (type tests, 3.18, see also 5.3.1);
– every vehicle conforms to the design standard proved in the type tests (routine tests, 3.13, see also 5.3.2);
– the vehicles comply with the appropriate legislation (national or regional);
– the vehicles are compatible with the railway system on which they are intended to run as defined in writing by the infrastructure manager.

Inspection of the vehicle, including equipment installation, piping and wiring, and all component type and routine tests shall be successfully completed according to the relevant standards and specifications, except as permitted by 6.1, before the tests within the scope of

this standard are commenced. The tests covered by this standard are to demonstrate correct interfacing with the functions of the vehicle.

This standard does not cover the following types of testing:

– endurance and reliability,
– development,
– investigative (except for guidance only),
– system test, such as subassembly or system combined test.

NOTE The European requirements for product verification and tests are specified in Annex B.

4.2 Third party test facilities

If it is intended to use third party test facilities this shall be declared and agreed with details, the test facilities required and the accreditation expected included in the test plan (see 4.3).

This shall of necessity apply to:

– static tests necessitating the vehicle to be moved to a specialised test centre not belonging to either the manufacturer or the purchaser;
– dynamic tests on another system not belonging to either the manufacturer or the user.

It is recommended that third party test facilities are accredited to ISO/IEC 17025.

The purchaser or the approval authority of the country concerned may require tests to be carried out by an accredited test facility independent of the manufacturer.

4.3 Test plan

The various tests to be undertaken shall be presented by the manufacturer within its quality plan as a test plan which shall detail the following:

a) the test programme;
b) the component and equipment type tests to be completed before undertaking each vehicle test;
c) the test facilities to be used, including, as appropriate, their accreditation and competence details, and their level of independence from the manufacturer;
d) the test methods;
e) the vehicle loading conditions for each test;
f) the environmental conditions for each test;
g) the limits and tolerances of any test measuring methods;
h) the success criteria for each test;
i) the validation documentation.

The test plan may include referenced test specifications to include some of the details above.

Where the contract requires validation of certain tests or documents by the purchaser or any approval authorities, these shall be identified in the test plan. In the case where the contract or the approval authorities require evidence to be kept, the requirement shall be included in the test plan and the purchaser shall agree the test specification.

Where the contract requires safety to be demonstrated by a series of tests derived from a safety or risk assessment performed in accordance with IEC 62278, or as required by an external Approval Authority, then these tests shall be included in the test programme and

identified as such in the test plan. The term “safety-related” is used (see definition 3.14, derived from IEC 62425) in this standard to identify those tests which might be in this category. The final decision on whether a test is safety-related rests with those who determine the contribution made by the test to the responsibility for safety.

The auditable process used to derive the information for the test plan shall ensure that the list of tests produced to support the validation documentation is comprehensive.

On successful completion of each test the validation documentation shall be prepared by the manufacturer.

5 Categories of tests

5.1 General

The test plan shall present the tests to be carried out in the following categories:

a) preliminary adjustment tests (see 5.2);

b) acceptance tests, which include:

- type tests, see 5.3.1;
- routine tests, see 5.3.2;
- tests required by the Approval Authority, see 5.3.3;

c) investigation tests (see 5.4).

The tests may be simplified or omitted by agreement between purchaser and manufacturer:

1) if the vehicles concerned are demonstrated to be identical to vehicles previously constructed and for which experience is available, or if the vehicles are equipped with motors or other important components stipulated by the purchaser;

2) if it can be shown by documentary proof that equivalent tests have been performed under representative conditions.

3) by agreement with relevant approval authorities, where specified in the contract. The information required may be provided by reference to other standards.

5.2 Preliminary adjustment tests

Before submitting the vehicle to the acceptance tests, the manufacturer may require to carry out preliminary adjustment tests which cannot be made in manufacturer’s works and which may involve test runs on the user's lines with or without load. In this event, at least the minimum amount of testing required for safe running (see 6.2) shall be completed to the satisfaction of the user and the infrastructure manager.

The maximum total distance of the trial runs to obtain necessary adjustments should be agreed in the contract and shall take into account the type of vehicle, more especially its maximum speed and the new devices which are incorporated. Failing a specified value in the contract, a maximum run not exceeding 5 000 km should be adopted for vehicles which are to be subjected to the type tests.

5.3 Acceptance tests

5.3.1 Type tests

These tests shall be performed over an agreed duration to demonstrate that the vehicle design complies with the performance requirements specified in the contract. They are listed in Tables A.1 and A.2 in Annex A and described in Clauses 8 and 9.

The tests shall be undertaken on the first vehicles built to the design unless otherwise agreed at the time of contract and included in the test plan.

If the type tests are performed on a prototype or pre-production vehicle, then the manufacturer shall agree with the purchaser those additional tests which are necessary on the first production built vehicle to be included in the test plan.

The tests shall be performed under the appropriate test conditions as explained in Clause 6.

Voluntary type tests may be required only if they are specified in the test plan.

5.3.2 Routine tests

These tests shall be carried out on each vehicle to be delivered. They are listed in Tables A.1 and A.2 in Annex A and described in Clauses 8 and 9.

Specific parameters used in the type test should be selected as the test criteria for compliance of each vehicle. The routine tests shall include sufficient measurements and checks to confirm compliance with the selected test criteria.

The tests shall be performed under the appropriate test conditions as explained in Clause 6.

The results obtained in the routine tests shall, taking into account acceptable tolerances, not be less satisfactory than those obtained for the type tests.

In cases where observations made during the corresponding type tests make it unnecessary for the routine test to be repeated in its entirety, a limited range or sample of routine tests, or a simplified form of those tests stated in the summary tables, or declarations of conformity may be accepted by agreement in the contract.

Any necessary additional routine tests shall be agreed in the contract and included in the Test Plan.

5.3.3 Tests required by Approval Authority

Tests required by Approval Authorities and those tests demonstrating safety (see 4.3) shall be clearly identified in the test plan. Tests regarded as in this category are shown in Tables A.1 and A.2 in Annex A.

5.4 Investigation tests

Investigation tests are special tests of an optional character and are carried out in order to obtain additional information. They shall be carried out only if they are specified in the contract.

These tests may be arranged by agreement between purchaser and manufacturer. In each particular case, the purchaser and manufacturer shall agree on the operating method and the programme for these tests.

The results of investigation tests shall not be used as a reason for refusing to accept the vehicle.

6 Test conditions

6.1 General

Tests shall be performed under the prevailing ambient conditions unless otherwise specified.

The test plan shall take account of the nature and site of each test and should cover:

a) type and routine test programmes, especially in those cases where this standard allows the parties a freedom of choice;

b) static tests (see 6.2);

c) dynamic tests (see 6.3);

d) methods for testing for environmental conditions, e.g. snow, rain, dust, temperature, etc. where these conditions are seasonal;

e) factory tests on components which, due to shortage of suitable test facilities at the supplier's works, are required to be carried out on the completed vehicle either statically or dynamically;

f) test requirements for any equipment supplied by the user or purchaser and installed in the vehicle; such requirements being agreed in advance among the parties concerned, including the manufacturer of the relevant equipment.

6.2 Static tests

These tests should normally take place at the manufacturer’s works and are described in Clause 8.

These tests shall include checks that the vehicle is sufficiently safe to undertake the dynamic tests.

The test facilities shall be appropriate and sufficient to ensure the tests are performed consistently; otherwise, the manufacturer shall inform the purchaser of any limitations of their test facilities with respect to these tests.

Where tests are performed at a third-party facility (see 4.2) which involves transportation of the vehicle to or from that facility, sufficient tests shall be undertaken by the manufacturer to ensure that the transportation can be completed safely.

6.3 Dynamic tests

The dynamic tests are described in Clause 9.

The tests may be undertaken on the lines over which the vehicle is intended to operate or, if not available, over lines with similar characteristics or on specialised dedicated test facilities. The test locations and arrangements shall be specified in the contract.

Arrangements for access to the lines and the provision of traincrew as appropriate should be included in the conditions specified in the contract.

The requirement to perform a test should not take precedence over the regulations of the relevant infrastructure managers or test facility manager.

Provision of all the necessary facilities by the purchaser or the provider of the test facilities for any preparation for dynamic tests (including preliminary test running) should be included in the conditions specified in the contract.

Where it is necessary to undertake the dynamic tests on the track of another infrastructure manager, the selected route, its characteristics and conditions of operation shall be agreed at the time of contract.

Attention is drawn to the need to ensure that the responsibilities of all parties involved in performing the dynamic tests are clearly defined.

Attention is also drawn to the need to complete all the necessary preliminaries such as the relevant parts of the reliability, availability and maintenance case and the safety case before undertaking the dynamic tests.

7 Validation documentation

The validation documentation shall contain sufficient information to identify the vehicle and all its major components and enable these to be traced through the test records. As a minimum the following shall be provided:

a) the name and address of the organisation which produced the documentation;

b) the name and address of the manufacturer;

c) the identification of the vehicle and its major components by name, type, model number and any relevant supplementary information such as lot number, batch or serial number and modification level;

d) the standards or normative documents referenced in the contract or test plan in a clear and concise way;

e) all supplementary information such as grade or category of the vehicle components;

f) the date of the documentation;

g) the signature and title or an equivalent marking of the authorised signatory.

8 Schedule of static tests

8.1 General

The manufacturer shall undertake the schedule of static tests as defined in the test plan. Table A.1 gives a representative list of static tests which may be included in the schedule. The list shall not be taken as exhaustive but may be used as a guideline in the process used by the manufacturer to produce his test plan.

In the absence of specific requirements in the contract, the following tests shall be included in the test plan as appropriate for the type of vehicle covered in the contract.

Unless otherwise stated in the subclause heading, the following requirements are for both the type and routine tests. Where different requirements are specified for these tests, they are detailed in separate subclauses for type and routine tests.

8.2 Dimensional tests

8.2.1 Objective

To verify that the outside dimensions of the vehicle, any clearances and flexible connections when completely assembled and in working order, comply with the limits set out in the contract.

8.2.2 Type tests

8.2.2.1 Outside dimensions (safety-related test)

For each type of vehicle the outside dimensions of the vehicle (including, for example, car height, coupler height, bogie height) shall be measured and checked against the limits set out in the contract, which may include the following conditions:

a) the range of adjustment of all appropriate components (for example air suspension);

b) the range of tolerances for wear and tear (for example wheel wear);

c) the range of loading conditions (see 8.5.2);

d) the range of movement in case of failure or damage (for example suspension components);

e) the worst case combinations of the above a) to d).

Clearances of items that may intrude into limiting dimensions, for example doors which open outwards, shall be taken into account and checked under working conditions if required by the contract.

Where dimensions are determined by calculation, suitable dimensions shall be identified to be checked and included in the test plan.

NOTE European requirements for measuring freight wagons are given in Annex B.

Where the contract does not specify a static loading gauge for the vehicle, the manufacturer shall declare a kinematic or swept envelope in accordance with rules agreed in the contract. The tests required to justify the kinematic or swept envelope shall be included in the test plan. The conditions a) to e) above, and the intrusion of items into the limiting dimensions, shall be taken into account in the determination of the envelope (see 8.3).

8.2.2.2 Clearance tests (safety-related test)

Tests shall be carried out to determine whether the specified clearances are achieved during relative movements for the load conditions and track geometry specified in the contract as follows:

a) between vehicle bodies and bogies;

b) between adjacent coupled vehicles.

See the note after 8.2.2.3 below.

8.2.2.3 Hose and cable length tests

Tests shall be carried out to determine the appropriate length for bogie and inter-car hoses and cables resulting from the relative movements specified in 8.2.2.2 for the load conditions and track geometry specified in the contract.

NOTE The clearances and lengths determined by tests 8.2.2.2 and 8.2.2.3 can be calculated, and verified by test, which can be carried out statically, using a bogie rotation table and traverser, or during the dynamic tests.

8.2.2.4 Current collector static tests (safety-related test)

It shall be ascertained statically that the operation of current collectors is satisfactory within the limits of movement and static contact force specified in the contract.

Tests shall be made on pantographs, including the limiting dimensions of lateral displacement, as specified in IEC 60494-1 or IEC 60494-2.

NOTE Requirements for gauging are given in UIC Leaflet No. 505-1. European requirements are given in Annex B.

8.2.3 Routine tests

Outside dimension tests (8.2.2.1) and clearance tests (8.2.2.2) shall be carried out in one load condition only (see 8.5.2), and confined to key dimensions determined from the type test.

Parts with provision for adjustment according to the wear of the wheels (such as stone guards, lifeguards, snowploughs, sanding pipes and antennae) shall be checked for correct adjustment.

8.3 Gauging test

8.3.1 Objective

To verify that the envelope of the vehicle is in accordance with the design.

8.3.2 General (type and safety-related test)

The contract may specify the size of the vehicle in a number of alternative ways, requiring different tests for verification, for example:

Build gauge – if the dimensions of the vehicle are specified, the dimensional checks in 8.2 are sufficient verification.

Kinematic envelope – if a kinematic envelope is specified, the dimensional checks in 8.2 and an analysis of the dynamic movements of the vehicle are required, supported by the coefficient of flexibility (sway) test (8.3.3) to validate the calculations used in the analysis.

Swept envelope – if the vehicle is being run on a line where clearances are less than the normal clearances specified by the infrastructure manager, a swept envelope, taking account of centre throw and end throw on curves may be required, supported by the coefficient of flexibility (sway) test (8.3.3) to validate the swept envelope calculations.

NOTE European requirements are given in Annex B.

8.3.3 Coefficient of flexibility test (type test and safety-related test, voluntary or obligatory)

This test is voluntary, unless required to verify the calculation of a kinematic or swept envelope; if so it shall be an obligatory type test for each relevant vehicle type, where the relevant type has characteristics representative of a number of vehicle types.

NOTE UIC Leaflet No. 505-5 defines the coefficient of flexibility. European requirements are given in Annex B.

The manufacturer shall supply the calculated values of the coefficient of flexibility in both minimum and exceptional load states (see 8.5.2).

The coefficient of flexibility shall be determined by static direct measurement (sway test), unless the method of determination of the vehicle envelope permits a dynamic roll test.

8.3.4 Routine test or equivalent (safety-related test)

The geometry of each vehicle shall be verified by suitable means such as a routine test using a template or a controlled production process.

8.4 Lifting ability test (type and safety-related test)

8.4.1 Objective

To verify the ability of the vehicle to be lifted under conditions as specified in the contract.

8.4.2 Type test

The test consists of lifting the vehicle at the designed lifting points using either overhead cranes or jacks. It shall be checked that the vehicle mechanical interfaces, attachments, deflections, etc., are within the tolerances specified in the contract. As a minimum the tests shall demonstrate that the vehicle can be lifted without permanent deformation occurring.

NOTE European requirements for lifting tests for re-railing and recovery are given in Annex B.

8.5 Weighing tests

8.5.1 Objective

To verify that the vehicle mass and distribution complies with the limits set out in the contract.

This normally includes, for each type of vehicle, tests for the following parameters:

a) the vehicle mass;

b) the measured load per axle;

c) the measured load per wheel.

8.5.2 Load cases

The load cases shall be specified in the contract. The recommended load cases are given in Table 1:

Table 1 – Recommended load cases

	Minimum load	Normal load	Exceptional load
Passenger/freight loads	0	See following text	
Tooling	Complete		
Crew	0	Full complement	
Level of sand	0	2/3	Full
Water for heating, toilets, catering, etc.	0	2/3	Full
Fuel	0	2/3	Full
Thermal engine coolants and lubricants	Normal	Normal	Normal
Other fluids and lubricants	Normal	Normal	Normal

For vehicles intended to carry passengers or freight loads, in the absence of other information from the purchaser the loads shall be determined as follows:

– Minimum load: Loading state of the vehicle specified in the contract in which the vehicle is complete and which will enable the vehicle to be moved or towed.

– Normal load: Load as specified in the contract for the performance tests, for example motoring or braking.

– Exceptional load: Maximum load that can be operated safely under conditions specified in the contract and used for specific performance tests, for example, emergency braking.

For vehicles not intended to carry passenger or freight loads, for example locomotives, the normal and exceptional passenger/freight load is assumed to be zero, i.e. the same as minimum load.

In order to reduce to a minimum the handling of additional loads, dimensional tests and weighing operations may be:

– carried out in the same loading state;
– executed in loading states other than those specified in the contract, provided suitable corrections are applied to the recorded values.

NOTE European requirements for load cases are given in Annex B.

8.5.3 Type tests (safety-related test)

The weight of the vehicle and the vertical load exerted by each wheel on the track shall be measured and shall be accompanied by a statement as to the accuracy of the measuring equipment. The weighing tests are normally carried out at the manufacturer's works, but may be done at the purchaser's or user's facility by prior arrangement. If the measuring equipment is used in the open air (outside a building), the effects of the prevailing environmental conditions (for example wind and rain) shall be recorded and taken into account.

Unless stated otherwise in the contract, the loading state of the vehicle during the weighing operations shall be minimum load and exceptional load. Tests at normal load may be carried out as investigative or voluntary tests.

Weighing tests may be preceded by adjustment of the suspension, carried out by means which, in principle, do not require the measurement of loads but only checks of a dimensional character.

Immediately before the test, a means shall be employed to activate the primary and secondary suspension systems (for example by running the vehicle over a section of track with level differences) to reduce the likelihood of excessive locked-in forces and the vehicle being off-centre.

The vehicle shall be run at reduced speed on to the weighing site, with frictional dampers disconnected and bogie inter-couplers loosened (if fitted). After activation of the suspension system and during weighing, no alteration or adjustment shall be made to the vehicle. No artificial alteration shall be made by means of blows, shaking or other procedure to the state of the body and the suspension produced by the previous activation of the suspension system and arising from friction between the several parts of the suspension.

Four successive and complete weighing operations shall be carried out, the vehicle being moved and measured twice in both directions, so as to eliminate as far as possible the errors resulting from balance inaccuracies and friction.

The value of the measurements shall be taken as the arithmetic mean of the values noted during the weighing operations.

Alternative weighing methods may be used as appropriate to the vehicle suspension system (e.g. spring or air suspension) or the weighing equipment available (e.g. running the vehicle over the weighing site, then lowering the vehicle vertically onto the weighing machine). In this case, the conditions and number of weighing operations shall be defined in the contract.

The mass of the vehicle and the load on the individual axles and wheels on the vehicle shall meet the requirements of the contract, taking into account the following:

– the maximum and minimum mass, and allowable tolerance on the overall mass of the vehicle;
– the maximum load and allowable tolerance on the load of each axle on the vehicle;
– the difference in load from one side of the vehicle to the other.

The following measurements when defined in the contract shall be tested:

– the excess mass of the vehicle in running order over that stated in the contract;

– for motive power units, the static adhesive load;
– for motive power units, the load on each driving axle compared to the average value of the loads on driving axles intended to exert the same tractive effort;
– the load per axle compared to the figure permissible on the lines on which the vehicle is to run; this figure shall be specified in the contract;
– the load on the line of the wheels on one side compared to the average of the loads on both lines of wheels and for a given axle, the load per wheel compared to the average load per wheel of this axle.

NOTE The European requirements for axle load tolerances are specified in the Technical Specifications for Interoperability as identified in Annex B.

8.5.4 Routine tests (safety-related test)

The weighing tests defined in 8.5.3 shall be carried out except as indicated below.

The loading state of the vehicle shall be minimum load.

Two successive weighing operations shall be carried out.

For wagons and non-powered carriages, a declaration of conformity is acceptable if agreed in the contract.

8.6 Sealing tests

8.6.1 Objective

To verify that the sealing (e.g. the IP rating according to IEC 60529) employed on the vehicle and any filters, separators or similar devices comply with the performance specified in the contract.

8.6.2 Type tests

The test plan shall include tests of the vehicle body and equipment cases and cupboards to verify that the contract requirements are met. The vehicle shall be complete with all relevant interior fittings, equipment and covers. The tests shall take account of the factors in the following subclauses, as appropriate:

a) Where the contract includes air-conditioning or pressure ventilation equipment, the parts of the vehicle or equipment covered by that equipment shall be tested in accordance with 8.15.5.

b) The water-tightness of the body and electrical equipment boxes mounted outside the body, including all openings, doors, covers, cover strips or crevices which might allow penetration of water or snow, shall be tested.

   The validation of water tightness shall be conducted in conditions representative of the climate in which the vehicles are to operate. The regime of representative testing shall be agreed in the contract and included in the test plan.

   A distinction shall be made between the water-tightness of the openings (air inlets, etc.) which depends essentially on design and the water-tightness of covers (doors, windows, bonnets, etc.) which depends primarily on installation and the condition of the joints.

   The tightness of openings and covers as well as the effectiveness of the arrangements provided for the evacuation of water from certain compartments shall be such that the observed water penetration is not liable to have an adverse effect on cabling, electrical equipment or any other equipment necessary for maintaining the vehicle in proper working order.

c) The effectiveness of blinds, louvres, filters, dust separators and in general all devices for cleaning the air drawn into the equipment boxes shall be verified to ensure the safety of

cabling, switchgear, or any other apparatus necessary for the satisfactory operation of the vehicle.

d) The proper mounting of the louvres, filters, dust separators, etc., shall be verified.

e) Arrangements to prevent ingress of other contaminants such as snow or sand shall be tested to ensure proper operation of equipment, as appropriate.

Further guidance on tests for sealing of enclosures is given in IEC 60529.

8.6.3 Routine tests (voluntary test)

A simplified water test and other specific tests shall be carried out as specified in the test plan.

8.7 Electrical insulation tests (routine tests)

8.7.1 General

Objective: To test the insulation integrity of the vehicle electrical circuits.

These tests are routine tests which may be carried out on the completed vehicle. They may also be carried out on an incomplete vehicle, in the manufacturer's works upon completion of the cabling, after mounting but before connection of items of electrical equipment already tested individually for dielectric strength. In the latter case, a check of the insulation impedance of each of the circuits shall be carried out once the vehicle has been entirely completed.

Equipment such as rotating machines, which has previously passed insulation tests to an agreed standard (IEC) may also be disconnected before the vehicle insulation test.

Where the contract calls for double insulation of the electrical equipment from the car body, for example, trolley bus systems, then it shall be verified that such insulation exists and that each part of the insulation system can withstand the requirements of the insulation tests in this subclause.

NOTE Further European requirements for insulation tests are given in Annex B.

8.7.2 Voltage withstand test

Most frequently, the equipment is composed of several circuits with different insulation levels; each one shall be separately tested to earth, all other circuits being in principle earthed.

As necessary, contactors and switchgear should be closed or short circuited to ensure that all parts of the circuit are connected. All precautions shall be taken in order to avoid possible appearance of abnormal voltages due to capacitive or inductive effects.

Equipment likely to suffer during the tests, e.g. electronic components, shall be disconnected or short circuited. Such equipment shall have previously passed an insulation test to an agreed standard.

The withstand test voltage shall be applied for 1 min between each of the various cable circuits and earth. Its value shall be equal to 85 % of the test voltage of single pieces of apparatus defined by IEC standards in force (for example, IEC 60077 (all parts), IEC 60310, IEC 60322, IEC 60349 (all parts), IEC 61287 (all parts)), for the component of the circuit having the lowest test voltage.

8.7.3 Insulation impedance test

In the absence of values specified in the contract, the test voltage shall be at least 500 V and the minimum insulation impedance values measured shall not be less than those given below:

– 5 MΩ for circuits having a rated voltage equal to or greater than 300 V d.c. or 100 V a.c.;

– 1 MΩ for circuits having a rated voltage less than 300 V d.c. or 100 V a.c.

A value of less than 1 MΩ may be agreed in the contract to take account of known conditions, such as high humidity, use of armoured cables, etc.

Alternatively, the manufacturer shall propose the insulation impedance values to be used, for approval by the purchaser.

Such conditions, and ambient conditions (temperature and relative humidity), shall be recorded.

If an insulation impedance test is carried out both before and after the voltage withstand test, the test conditions shall be the same for both tests and the impedance value measured by the test following the voltage withstand test shall not be lower by more than 10 % than that measured in the initial test.

8.8 Protective bonding and return circuits tests (routine and safety-related test)

Objective: To verify that the protective bonding and return circuits on the vehicle meet the requirement of the contract.

Electrical connections are required on the vehicle:

a) to fix the electrical potential of various circuits and the vehicle's mechanical parts to protect against the risk of electric shock;

b) to protect bearings from damage resulting from the effects of stray currents;

c) to ensure a return path for certain circuits (e.g. traction current return, auxiliary (including train heating circuit) return).

Tests shall be done to ensure that protective bonding and return circuits meet the requirements of IEC 61991.

It shall be checked that the flexible connections are made to a suitable length for accommodating the maximum relative movements of the points connected.

It shall be checked that the earth and return terminals are easily accessible and visible for checking.

8.9 Air system tests

8.9.1 General

Objective: To establish that all pneumatic components operate as specified in the contract, when installed on the vehicle and connected within the air system and to determine whether the air-tightness of the pneumatic equipment complies with the limits set out in the contract.

If the braking system does not use air, then the tests in this subclause shall apply as far as appropriate. Any amendment to the test criteria shall be agreed in the contract and included in the test plan.

8.9.2 Air tightness of main reservoirs and other air equipment (routine and safety-related test)

8.9.2.1 General

With the vehicle in normal operating conditions, the main air reservoirs shall be filled to maximum working pressure and then isolated from the compressors.

8.9.2.2 Main reservoirs and associated devices

With the various items of compressed air equipment (braking circuits, doors, suspension, electropneumatic devices, etc.) isolated and not under pressure, it shall be checked that after the time specified in the contract the reduction of the pressure in the main reservoirs is not greater than that specified in the contract.

In the absence of values specified in the contract, the pressure shall not fall by more than 20 kPa (0,2 bar) after 5 min from an initial pressure between the maximum and minimum settings at which the main reservoir pressure is regulated.

8.9.2.3 Main reservoirs and associated devices combined with other pneumatic equipments

With the various items of compressed air equipment under pressure (except those intentionally designed to have certain inherent leaks), but not in operation, it shall be checked that the pressure in the main reservoirs has not fallen by a value and during a time period specified in the contract.

In the absence of specified values, the pressure shall not fall in 20 min to a value less than the minimum value compatible with the proper functioning of all the equipment from an initial pressure between the maximum and minimum settings at which the main reservoir pressure is regulated.

When a motor coach or locomotive is intended to be coupled with trailers not fitted with main reservoirs and forming part of the same fixed train set or multiple unit, the tests of 8.9.2.2 and 8.9.2.3 shall be repeated on the complete fixed train set. The time limits and allowable leakage in this case shall be agreed in the contract depending on the composition of the fixed train set or multiple unit.

Depending on the type of brakes used, the procedure for testing the air-tightness of the main brake pipes shall be agreed in the contract and included in the test plan.

8.9.3 Air tightness of brake cylinders and auxiliary reservoirs (routine and safety-related test)

By using the drivers brake handle or other means, maximum working pressure shall be applied to the brake cylinders and associated auxiliary reservoirs. The air supplies shall then be isolated.

In the absence of values specified in the contract, the pressure in the brake cylinders shall not fall by more than 10 kPa (0,1 bar) after 3 min.

8.9.4 Checking operation of compressed air equipment (type and safety-related test where appropriate)

The correct operation of all compressed air equipment shall be checked, for example:

– safety and protective devices;

– pressure regulating device;

– isolating cocks (shut-off valves);
– drain valves;
– pressure transducers and switches;
– compressor duty cycle, if tested by static simulation (see also 9.18);
– warning horns;
– air driers.

Where the contract covers a fixed train set or multiple unit, the operation shall be checked on the complete train set or multiple unit.

8.10 Hydraulic system tests (type, routine and safety-related test where appropriate)

Objective: To determine whether the oil-tightness of the hydraulic equipment complies with the limits set out in the contract and to establish that all hydraulic components operate as specified in the contract, when installed and connected to the hydraulic system.

As a type test, the correct operation of all hydraulic equipment shall be checked, for example:

– hydraulic pumps;
– hydraulic motors (e.g. cooling group, radiator fan, etc.);
– safety and protective devices;
– pressure limiters;
– non-return valves;
– shut-off valves;
– drain valves.

As a routine test, with the vehicle in normal operating conditions, the hydraulic system shall be filled to maximum working pressure and then isolated from the pump. It shall be checked that after the time specified in the contract the reduction of the pressure in the system is not greater than that specified in the contract and that there are no visible signs of hydraulic fluid leakage.

8.11 Friction brake system tests

8.11.1 General

Objective: To verify that the brake system operates in accordance with the design, to give sufficient confidence that the dynamic tests may take place, and that all production vehicles are to the same standard.

The following systems shall be functionally checked statically:

a) emergency brake;
b) service brake;
c) interface between the friction and the electric brake, where fitted (if done by simulation in place of a dynamic test, see 9.4);
d) interface with other systems such as wheelslide control, load weighing, traction control (where fitted);
e) mobility of brake rigging.

8.11.2 Pneumatically applied brake systems

8.11.2.1 Type tests (safety-related tests)

The purpose of these tests is to verify, in conjunction with dynamic braking tests, that the operation of the brake system and the application of force at the brake shoes or linings complies with the contract.

These tests shall be carried out after completion of the air system tests specified in 8.9. A check shall be made that the brake rigging is correctly adjusted. Tests shall be made at static for the service brake in order to check the characteristics specified in the contract for the complete pneumatic brake system, in particular, time of application and release of the brakes and maximum pressures at the brake cylinders under different operating conditions.

The measurements of brake cylinder pressure and timings shall be repeated for the emergency brake and a number of intermediate positions of the service brake controller.

Where applicable, the operation of the wheelslide dump valves or other anti-skid devices should be checked, for example, blow down time, application time and release time. The operation of the dump valves appropriate to the wheelslide signal should also be checked.

When the vehicle is equipped with a load weighing system, the brake cylinder pressures shall be measured with the vehicle in the minimum, normal and exceptional load conditions. This test may be carried out using simulated loads, provided that the load detection devices are tested during other tests being carried in each of the loading states of the vehicles.

NOTE The European requirements for static brake test procedures are identified in Annex B.

8.11.2.2 Routine tests (safety-related test)

A simplified form of test, to avoid loading the vehicle, shall be carried out. This test shall demonstrate that all braking systems are equivalent to those type tested.

8.11.3 Other systems (type, routine and safety-related as appropriate)

Where vehicles are fitted with other braking systems designed to slow or stop the train, such as spring or hydraulically applied brakes, electrically or mechanically actuated brakes, mechanical or magnetic track brakes or any other systems, type and routine tests shall be carried out to achieve the same objective as defined in 8.11.1, following the same principles as defined in 8.11.2.

8.11.4 Sanding systems (type, routine and safety-related test)

Where sanding is employed to assist braking, the tests shall demonstrate that the requirements of the sanding system are met without interference with either infrastructure systems such as points and crossings and train detection or train systems such as braking, electrical or air supplies. The test criteria shall be included in the test plan. If dynamic tests are required by the contract, they can be combined with the braking tests (see 9.4).

For a type test, the following shall be checked as appropriate against the contract:

- correct activation of sanding in braking mode (and traction mode if fitted),
- correct operation of interface with wheelslide detection system,
- means of isolation of sanding function, and associated indications,
- manual control (if provided),
- the effect of sander operation on auxiliary supplies (including electrical and pneumatic),
- sand capacity, delivery rate and usage monitoring, as appropriate,

- sand specification,
- sand deposition and spread.

For a routine test, a simplified function test which demonstrates delivery rate shall be carried out. If a manual test function is fitted, it may be sufficient for the routine test.

8.12 Parking brake type tests (safety-related test)

Objective: To verify that the parking brake system satisfies the requirements of the contract.

The test criteria to demonstrate the effectiveness of the parking brake system (operating conditions and measurement of applied forces) shall be included in the test plan.

If the train is maintained stopped for a limited period by a parking brake subject to leaks (e.g. hydraulic or air brake) the brake shall be applied with maximum force and it shall be verified during a period specified in the contract that there is no significant fall-off in the force applied.

NOTE The duration of the parking brake test depends on the operating conditions.

8.13 Auxiliary power supply system tests

8.13.1 Objective

To verify that the auxiliary power supply systems operate as specified in the contract when installed on the vehicle and connected to their proper loads, including battery charging.

8.13.2 Type tests (safety-related tests where appropriate)

The tests shall check the performance of the auxiliary power supply system connected to its loads over the range of loads defined in the specification.

It shall be checked that the input and output of the auxiliary power supply system is kept within the continuous rating or other ratings, these ratings being in accordance with those given in the relevant standards, as specified in the contract.

If the auxiliary power supply system components have not been fully tested at the supplier's works, owing to, for example, lack of suitable facilities, then additional tests can be included in the test plan by agreement between the manufacturer and the purchaser.

The test plan shall include test criteria for the following:

– power up;
– starting of the loads, including time delays where necessary;
– battery charging;
– cooling arrangements;
– load-shedding;
– cross-feed arrangements (where one or more vehicles are fed from an alternative power supply on another vehicle), including changeover switching.

Where appropriate (for example where rotating machines or external cooling form part of the system), the tests specified in 8.15.2 shall also apply to the auxiliary power supply system.

Where the power supply feeds functions essential for the safety of the train, such as magnetic track brakes, the type tests shall be identified as safety-related in the test plan.

8.13.3 Routine tests

Functional and operating tests at nominal voltage shall be carried out. The characteristics of the auxiliary power supply system at nominal voltage shall be verified against the contract requirements and the type test results.

8.14 Battery charging tests

8.14.1 Objective

To verify that the battery and its charging system meet the requirements of the contract.

8.14.2 Type test

The following tests shall be made on the vehicle's battery and battery charger to verify:

a) that the battery charging equipment is capable of furnishing a sufficient but not excessive charge to the battery, as required in the contract;

b) that the supply is capable of charging the battery under all load conditions within the contract for the vehicle, e.g. maximum and minimum supply voltages, thermal engine operating speeds, ambient temperature limits, etc.;

c) except for chargers supplied only for standby use, that the charger is capable of supplying all the load assigned to the battery and other loads as appropriate when the vehicle is in operation including the effect of any load shedding;

d) that the charging regime in a normal operating duty cycle during a 24 h period allows the battery to be fully charged;

e) that the ventilation of battery boxes is sufficient to ensure no dangerous build-up of gases during charging periods;

f) that the off-charge battery is capable of maintaining operation of the vehicle during the time period specified in the contract and under the conditions specified in the contract, especially taking into account essential supplies such as emergency lighting (see also 8.15);

NOTE Restriction of operations, e.g. reduced lighting or disconnection of non-essential systems, is possible (load-shedding).

g) that the voltage ripple level is within the maximum level specified in the contract when the battery charger is operated with a disconnected battery.

In order that the battery circuit parameters shown above can be verified as compliant with the contract requirements for the conditions specified in the contract, the following parameters shall be measured as appropriate:

1) the maximum charging current;
2) the maximum voltage or charging voltage over the specified temperature range as appropriate;
3) the floating voltage;
4) the floating current;
5) the discharging current;
6) the discharging time.

The test criteria shall be included in the test plan.

These tests can be carried out during the auxiliary power system type tests.

8.14.3 Routine test

For a routine test on a battery and charger it is sufficient to check:

a) maximum charging current with its limitation value;

b) maximum voltage;

c) steady state floating voltage;

d) steady state floating current.

8.15 Auxiliary and control system tests

8.15.1 Objective

To verify that the auxiliary and control systems operate as specified in the contract when installed on the vehicle and connected to the correct auxiliary power supply and other interface loads.

8.15.2 General tests

8.15.2.1 Type tests

For each system defined in 8.15.3 to 8.15.8, it shall be checked, during static sequence tests, that the individual and sequential operation of all items of equipment, in the various circuits, including, for example, air-operated switchgear, is correct and has not been impaired during final installation.

Any interfaces that exist between the systems shall be included in the tests.

Electrical clearances of the assembled equipment shall be checked, especially at connections.

Where required by the contract, the functional operation of overload protection devices shall be checked (using simulated signals where necessary). It shall be checked that the settings of adjustable protective devices and relays, etc., are correct.

A check shall be made that the operation of air-operated switchgear is not hindered by too small a cross-section of their supply pipes or lack of reservoir capacity.

In the case of forced cooling of auxiliary electrical equipment and auxiliary power supplies, if the equipment concerned has not been tested on the test bed with the same cooling units and with cooling ducts of the same size as those of the vehicle, a check shall be made on the vehicle that the volume of cooling air complies with that designed or specified. This may be checked by measuring the difference in static pressure across the auxiliary equipment, providing a table showing the relationship between static pressure difference and air volume is available for equipment under test. The ducts shall be checked for air-tightness.

A check shall be made on the direction of rotation of auxiliary machines and the phase rotation of a.c. supplies.

Starting tests on the auxiliary machines shall be made taking account of the machine duty cycle and range of operation, and starting conditions specified in the contract.

8.15.2.2 Routine tests

For all systems defined in 8.15.3 to 8.15.8, functional and operating tests at nominal voltage shall be carried out. The tests shall include more than one start of auxiliary machines.

In order to avoid setting up interface tests for each vehicle, a simplified set of functional tests, derived from the type test, using set values or simulations where appropriate, may be carried out to verify that each vehicle meets the test criteria, provided that all the equipment on the vehicle under test is exercised. Further suggestions are given in 8.15.3 to 8.15.8.

8.15.3 Train control (safety-related tests where appropriate)

8.15.3.1 Single unit operation

All control functions shall be tested from their controllers, switches and pushbuttons in the cab and any other appropriate location on the vehicle, to ensure that the correct sequence of events occurs so far as is possible statically (see also 8.17).

This test shall be performed for all normal, emergency and default operating modes specified in the contract.

If appropriate, these tests may be combined with individual system tests (see 8.15.4 to 8.15.8).

8.15.3.2 Interfacing between systems

All interfaces between systems shall be tested for correct operation and sequence in all modes specified in the contract. If appropriate, these tests may be combined with individual system tests (see 8.15.4 to 8.15.8).

8.15.3.3 Multiple operation

If the vehicle or multiple unit trainset is intended to operate coupled to other vehicles or trainsets controlled from a single driving cab, type tests shall be made to prove the functions that are required to operate in multiple, for example:

– traction and braking circuits;
– fault indications and signals;
– compressor interlocks;
– parallelling or transfer of auxiliary supplies or batteries;
– door operation;
– safety loops for the control of brakes or doors;
– control of lights, heaters and other auxiliaries;
– passenger emergency systems;
– passenger information.

Where train wires are crossed, for example to ensure correct identification of the direction of motion or the opening side for doors, then these functions shall be checked for all practical combinations of vehicles in multiple normally found in service.

These functions shall also be checked at all operating or driving positions.

For a routine test it is permitted that multiple operation be checked by simulation of other vehicles.

8.15.4 Door control systems (safety-related test)

It shall be checked that external and internal power operated doors, steps and remotely controlled door locking systems function correctly as specified in the contract.

The checks shall include all door indicators, safety loop circuits and operating systems for normal and emergency access and egress under all operating conditions as specified in the contract.

8.15.5 Heating, ventilation and air-conditioning system tests (safety-related test where appropriate)

The type tests shall check the correct operation of comfort and environmental control systems for both passenger and traincrew areas, including the adequacy of sealing of the car body, including doors and windows against draughts.

It shall be checked in particular that the heating equipment and air conditioning or pressure ventilation equipment as appropriate are capable of maintaining the temperatures and airflows under the conditions specified in the contract.

If required in the contract, the equipment used to protect the vehicle against pressure shocks shall be checked (see also 9.14).

The tightness of air ducts used on the vehicle, for passenger/crew air-conditioning should be checked as a routine test, for example with a smoke producing device.

Specific tests may be required for traincrew areas to satisfy the relevant safety authorities.

NOTE European requirements for testing of air-conditioning systems are set out in Annex B.

8.15.6 Lighting system (interior)

8.15.6.1 Type tests (emergency lighting tests are safety-related tests)

A meter shall be used to measure the illuminance level at the reading level at seat positions and floor level in the vestibules and gangways to check that the required level is achieved for both full and emergency lighting.

NOTE The European requirements for lighting are specified in Annex B.

8.15.6.2 Routine test (safety-related test where appropriate)

The test shall ensure that all lights work and that the switching of lights (e.g. normal and emergency, separate circuits, etc.) is correct, including any default conditions, as specified in the contract.

8.15.7 Other systems (type, routine and safety-related tests where appropriate)

It shall be checked that under all specified test conditions, all other systems, where fitted, function correctly in their operating environment, in accordance with the contract.

Where fitted, the following systems shall be tested. These system tests may be classed as safety-related or be required by Approval Authorities, depending on their use:

– passenger information;
– public address;
– communication;
– radio;
– fire detection and extinguishing.

Where fitted, systems to be tested shall include, for example:

– train management;
– diagnostic systems;
– data transmission;
– video;

– television;
– toilet;
– water systems;
– catering equipment.

For catering equipment, the tests shall ensure correct operation in accordance with the contract, especially in respect of operating and surface temperatures, and safety in use.

The closing and locking systems of all internal and external equipment and panel hatches, doors and covers intended for access shall be checked for correct operation.

8.15.8 Software controlled systems (safety-related test where appropriate)

It shall be verified that the software used in vehicle systems has been tested and validated in accordance with the requirements of IEC 60571 as appropriate to the proper application of IEC 62278.

On each vehicle, it shall be checked that the software fitted is the same validated version.

8.16 Tests on thermal engine and associated generating sets or transmission

8.16.1 General

Objective: To verify that the thermal engine and generating set or transmission (hereinafter referred to as the power unit assembly) operates as specified in the contract, when installed on the vehicle and connected to its proper loads and protective equipment.

Where the engine and generators are not tested together before assembly on the vehicle (see UIC 623), the test procedure for the complete engine and generator on the vehicle shall be as defined in the contract.

Before undertaking any of the following tests, the manufacturer shall ensure that the alignment of the coupling between the engine and the generators has been checked to ensure that it is in accordance with the design.

Where appropriate the subclauses below shall be applicable to thermal engine driven generator sets used for supplying auxiliary power to a train separately from the traction power unit.

8.16.2 Operating speed tests of the thermal engine (type tests)

The no-load speed (r/min) of the engine at idling, maximum speed, and all intermediate speed positions of the speed controller (when applicable), shall be measured to check the correct operation of the speed control system.

At the regular operation point of the engine, the loaded speed (r/min) shall be measured at each specified load. The permissible range of loaded speed shall be specified in the contract. Speed tolerances shall be in accordance with the contract.

Depending on the type of power unit assembly, the loaded speed tests shall be carried out by the following methods:

a) for a power unit assembly with a generator, a load resistor or static load bank shall connected to the generator output;
b) for a power unit assembly with a mechanical/hydraulic transmission (including a reverser), stall load tests shall be carried out with the brakes applied on the vehicle and the output axis of the torque converter bound.

8.16.3 Thermal engine protective devices (type test)

The correct operation of protective devices of the thermal engine such as thermostats, pressure gauges, overspeed, fire detectors, emergency stop, etc., shall be checked.

The operation of sensors other than overspeed can be simulated by external means, provided that sensors have been calibrated by their suppliers.

8.16.4 Thermal engine fluid, air and exhaust circuits (routine test, safety-related test where appropriate)

The tightness of all reservoirs, pipes and ducts of the thermal equipment (fuel, oil, cooling fluid, exhaust, compressed air cranking) shall be checked.

The operation of the fuel supply, the pre-heating, pre-lubricating and cold cranking devices shall be checked.

8.16.5 Engine driven auxiliaries

8.16.5.1 Type test

The correct operation of the engine driven auxiliary systems shall be demonstrated with regard to:

– the intended performance;
– the ambient temperature and altitude range;
– the engine speed range.

8.16.5.2 Routine test

As a minimum the following shall be checked:

– the rotational speed and directions of the various auxiliaries driven by the thermal engine;
– the correct tension of the driving belts, or
– operation of the transmission;

and, if compressor accessories are fitted:

– the build-up of the pressure in the main reservoir;
– the setting of the unloading valve and of the safety valve.

8.16.6 Cranking of the thermal engine (type test)

The cranking of the engine (cold or pre-heated if necessary) at ambient temperature shall be checked having regard to the details necessary for minimum temperatures specified in the contract. These details and the number of successive cranking operations to be made by the battery or other means of cranking (e.g. compressed air) shall be as agreed in the contract.

8.16.7 Operation of the thermal engine

8.16.7.1 Type test

The method of loading shall be in accordance with either a) or b) in 8.16.2.

Test conditions shall be maintained for sufficient time to allow engine temperature to reach its final steady state value.

The following shall be checked:

a) that the anti-vibration mounts are effective at all conditions of engine speed and load. The vibration level of the engine generator assembly shall be measured and shall comply with the values specified in the contract, if applicable;

b) that the torsional dampers are effective if the calculation of the torsional critical speeds shows that resonances could be excited from the engine;

c) that the cooling system has a inbuilt heat dissipation capability sufficient to meet the agreed cooling margin and to maintain the cooling fluid temperature at the design level in the whole range of the operating ambient conditions;

d) that air management within the cooler group and for engine room scavenging meets the declared performance;

e) the tightness of all pipes and ducts of the thermal equipment and of the aspirated air ducting of the engine;

f) that heat sensitive equipment and parts, such as electronics, cabling, plastic pipes and tubing, rubber details, etc., are not subjected to excessive temperature;

g) the operation of the regulating equipment;

h) that temperature and pressure values of the fluids used in cooling and lubricating systems are in agreement with the contract specifications;

i) that inlet pressure and exhaust pressure and temperature are in agreement with the contract specifications;

j) the manufacturer's stated turbo-charger surge margin shall be verified by test if required by the contract;

k) the diesel engine exhaust composition shall be checked if required by the contract;

l) that the fuel consumption at various conditions of engine speed and load meets the agreed performance.

8.16.7.2 Routine test

The thermal engine shall be connected to a static load bank.

With the engine and generators at normal working temperature and excitation conditions set to conform with those specified in the contract, the manufacturers declared curves for generator losses shall be used to check the gross supply to the electrical equipment at full power and agreed intermediate power settings. The checks listed in 8.16.7.1 e) to k) should also be carried out against the nominal values confirmed by the type tests.

8.17 Traction system tests (type, routine and safety-related tests where appropriate)

Objective: To verify that the traction system responds correctly to its control signals in order to demonstrate its fitness for dynamic tests.

All sequencing and built-in test programmes shall be tested before the vehicle is moved.

In particular, the selection of forward and reverse, initiation of motoring and electric braking functions and removal of traction power shall be checked for correct operation with both valid and invalid control inputs.

Where the traction system is force-cooled, the operation of the cooling systems shall be checked, including airflow and air speed, correct starting sequence of cooling fans, and time delays, if any, before stopping cooling fans. Other tests on the cooling system shall be in accordance with 8.15.2.

Where sanding is employed to assist traction, the tests shall demonstrate that the required performance is met without interference with infrastructure systems such as points and crossings and train detection (see 8.11.4). The test criteria shall be included in the test plan.

8.18 Operability and maintainability (type test)

8.18.1 General

Objective: To verify that the vehicle meets the requirements of the contract for safety and ease of operation and maintenance.

All areas where staff have access in the normal course of their duties, for operation, maintenance and overhaul shall be checked for compliance to the requirements of the contract and the relevant safety authorities, both for operation and safety.

These checks should include and take account of the following:

– accessibility to mechanical parts, including:
  - protection against the possibility of contact with moving parts such as blowers, couplings, belts, sharp edges, etc.;
  - protection against risks from air intakes;
– accessibility to electrical parts, including:
  - safety clearances from fixed or movable live equipment;
  - prevention of accidental contact with live electrical parts taking into account the difference between:
    a) compartments containing apparatus liable to be subjected to a high voltage by an external supply source (coupled vehicle, station or depot supply) for which access involves a prior disconnection and/or earthing of certain points of the circuits, and:
    b) compartments containing only equipment of the vehicle traction circuit for which a single electric safety device (e.g. opening of the main contactor) is sufficient;
  - protection against electrical arcing from circuit-breaking devices such as high-speed circuit-breakers or contactors;
  - protective bonding for the electrical equipment and for parts of the vehicle which may accidentally be made alive (see 8.8);
– dismounting (doors, steps, ladders);
– access for and ease of cleaning;
– conformance with standards;
– interchangeability, where specified;
– access for testing;
– discharge time of power capacitors, including warning labels;
– protection against fire (type and accessibility of extinguishers, operation of fire protection systems, see also 8.20);
– protection of parts with a risk of harmful temperatures (e.g. exhaust systems);
– provision of necessary warning signs as required in the contract (in particular, hot surfaces, high voltage conditions or moving parts).

If required by the contract, maintainability shall be tested by a demonstration.

8.18.2 Cabs and traincrew areas (safety-related test)

Checks on working conditions of traincrew areas shall be carried out as far as possible during static tests and shall be completed during dynamic tests. For driving cabs, reference may be made to the appropriate standard.

NOTE Requirements are set out in UIC 651. European requirements are specified in Annex B.

The test criteria shall be included in the Test Plan and should take into account:

– dimensions and layout, including protection from injury, exits and evacuation, and provision and access to emergency equipment;
– driver sightlines and the effect of reflections in the windscreen, including performance of windscreen wipers, windscreen washers, windscreen de-misters and windscreen de-frosters (if any);
– visibility of controls, instruments (especially when illuminated) and indicator lamps both in sunlight and at night without detrimental effect from direct or reflected light so as to cause any optical illusion;
– ergonomic design of controls and seats to minimise inaccuracy in operation or undue physical tiredness, and risk of inadvertent operation.

8.18.3 Passenger areas (safety-related test where appropriate)

Facilities for evacuation, including walkways and emergency exit doors, windows and associated facilities, shall be checked against the contract.

Facilities for persons of reduced mobility, such as accessible areas including toilets, mechanical aids to accessibility and aids for the mobility, visual and hearing impaired shall be checked against the contract.

NOTE European requirements for facilities for persons of reduced mobility are defined in Annex B.

8.18.4 Rescue (safety-related test where required)

Facilities for rescuing the vehicles, including the use of special or adaptor couplers, shall be checked against the contract.

NOTE European requirements for rescue are defined in Annex B.

8.19 Noise and vibration tests (type test, safety-related test where appropriate)

Objective: To verify that the noise and vibration emitted by the vehicles when stationary comply with the contract.

Tests shall be performed on a completed vehicle or vehicles as appropriate to demonstrate that the noise levels in the passenger and crew areas and outside the vehicle are compliant with the values specified in the contract.

The noise level tests shall be performed in accordance with ISO 3095 and ISO 3381, for stationary vehicle type tests, for test procedures specified in the contract.

NOTE 1 European requirements for noise tests are defined in Annex B.

Tests shall be performed on a completed vehicle or vehicles as appropriate to demonstrate that vibration caused by the operation of the apparatus or machines on the vehicle (compressor set, blower, electromagnetic equipment, circuit breakers, thermal engines, etc.) is not a source of discomfort to the passengers or traincrew.

NOTE 2 European requirements for vibration tests, where necessary, are given in Annex B.

8.20 Safety-related system tests (routine tests)

Objective: To verify that all safety-related systems not covered by the specific requirements elsewhere in Clause 8 perform in accordance with the requirements of the contract after they have been installed to the vehicle.

For example, the following shall be tested where applicable;

– automatic emergency brake;

- automatic vigilance equipment;
- drivers safety device or equipment;
- automatic train protection equipment, or any equivalent speed regulating and on-board signalling equipment;
- vehicle speedometers;
- event or data recording equipment;
- fire detection and extinguishing devices;
- passenger emergency equipment;
- safety-related circuits in other subsystems (e.g. brakes, doors);
- head, marker and tail lamps;
- bells, whistle, horns.

This list is not exhaustive, and shall be amended as appropriate in accordance with the contract.

The tests of the systems and equipment above shall include functional interfaces and performance not measurable unless the system or equipment is installed in the vehicle.

NOTE European requirements for testing of some of the systems listed above are given in Annex B.

9 Schedule of dynamic tests

9.1 General

The manufacturer shall undertake the schedule of dynamic tests as defined in the test plan. Table A.2 gives a representative list of dynamic tests which may be included in the schedule. The list is not exhaustive but shall be used as a guideline in the process used by the manufacturer to produce his test plan.

In the absence of specific requirements in the purchaser's specification, the following tests (9.2 to 9.20) shall be included in the test plan as appropriate for the type of vehicle covered in the contract. For vehicles intended to operate in fixed formation trainsets, the tests shall be conducted in train configurations representative of those in which the vehicles may normally operate.

Unless otherwise stated, the following requirements are for both the type and routine tests. Where different requirements are specified for these tests, they are detailed in separate subclauses for type and routine tests.

9.2 Traction performance (tractive effort/speed characteristics)

9.2.1 Type test

Objective: To verify that the traction performance meets the specified criteria. The tests are restricted to checking the starting and acceleration performance up to the maximum specified speed.

The vehicle, unit or train shall be taken through the starting and acceleration cycles specified at the time of the contract, up to the required speeds at all the specified load conditions (to include at least the minimum and exceptional loaded conditions). The tests shall be made under good adhesion conditions and, when specified, under adverse adhesion conditions.

The tests shall demonstrate that the tractive effort/speed characteristics comply with the requirements specified in the contract. The values can be deduced from starting and acceleration tests under known conditions by measurement of vehicle speed against time.

Alternative methods of demonstrating the vehicle performance may be proposed by the manufacturer or requested by the purchaser and included in the contract.

It shall be checked that acceleration is achieved smoothly throughout the control sequence without jerks in excess of the value specified in the contract.

9.2.2 Routine test

Each vehicle shall be taken through the starting and acceleration cycles at the specified load case agreed in the test plan.

It shall be checked that the acceleration is as specified. The values can be deduced from the tests defined in the test plan by measurement of the vehicle speed against time. It should be checked qualitatively that any transitions occur without abnormal jerks.

9.3 Traction performance (journey time check) (voluntary type test)

Objective: To verify the ability of the vehicle to meet the specified running schedules and energy consumption.

The tests shall check that the times for either the individual distances or the total distance are in accordance with those specified in the contract and that the energy consumption is within the tolerance specified in the contract.

If the purchaser intends to carry out tests to check a "typical run" schedule, he shall supply the manufacturer, before placing the contract, with all the particulars relating to the "typical run" and to the "typical train" to be used, under the same conditions as those appearing below:

For the test run:

– maximum times to be observed for running the whole distance or various parts thereof;

For the test route:

a) lengths, gradients and curvature details of the lines;
b) stopping or dwell times;
c) maximum speeds allowable on the various sections;
d) an estimate of the service line voltage over the test route;
e) the suitability of the line for regenerative braking (if applicable);
f) load conditions.

The test shall be performed on vehicles which have completed the agreed period of running-in and in accordance with the following conditions specified in the contract:

– load conditions;
– dry adhesion;
– calm weather;
– temperature range;

and, if required for confirmation of energy consumption:

g) the vehicle's load or the hauled load;
h) number of axles or train length;
i) weight multiplication factor to be used to allow for the inertia of the rotating masses, including any trailing vehicles not under test;

j) resistance to motion curve at different speeds for the vehicles, including any trailing vehicles not under test;

k) the braking effort curve for the vehicles at various speeds, including any trailing vehicles not under test;

l) the maximum acceleration and the maximum variation in acceleration allowable;

m) the maximum braking deceleration allowable;

n) the driving mode - manual or automatic.

For a vehicle with a thermal engine, the characteristics of the fuel and lubricating oil shall comply with those specified by the thermal engine manufacturers and accepted by the user.

As an alternative test, vehicles with thermal engines may have energy consumption tests carried out on a stationary vehicle using a duty cycle agreed in the contract.

The test shall be carried out on rolling stock which has already had a period of running, in calm weather and in temperature conditions agreed in the contract.

The electrical energy consumption (active or reactive) may be deduced by calculation after measurement of line voltage and current values with instruments placed either on the vehicle itself or on a vehicle coupled to it (e.g. a dynamometer car). In addition, the line voltage may be checked by means of a recording voltmeter. The line receptivity for regenerative braking may be monitored.

The mean values of the fuel consumption obtained for a thermal engine during the successive runs shall be measured.

The electrical or fuel energy consumption measured may depend on certain uncontrolled variables which can be introduced: for example, operating conditions, speed differences and in particular the receptivity of the line where regenerative braking is specified. Following the tests, the manufacturer may recalculate the predicted values of energy consumption as a result of any changes to the testing conditions.

9.4 Braking tests

9.4.1 Type test (safety-related tests)

9.4.1.1 Objective

To verify that the vehicle braking systems meet the performance requirements of the contract.

9.4.1.2 General

The dynamic tests of the braking systems on the vehicle shall include either measurement of distance against speed during deceleration between agreed speeds (for example, stopping distances), including the maximum specified speed, or measurement of deceleration over the specified speed range up to maximum specified speed. The tests shall also check that the braking is achieved smoothly and without jerks, particularly where the system involves blending of one braking method to another.

The tests shall demonstrate the performance of all braking systems of the vehicle (for example, emergency and service, pure air brake or blended air and electric brake or hydraulic retarder).

Tests of other braking systems (for example, magnetic track brake) shall be carried out as agreed in the contract.

All relevant standards shall be taken into account for the braking tests.

UIC Leaflets 540, 541-03, 541-05, 541-3, 541-4, 541-5, 543, 544-1, 544-2, 546, 547 and 660 should be taken into account for these braking tests (see Bibliography).

NOTE European requirements for braking tests, calculation methods for stopping distances and other requirements are defined in Annex B.

9.4.1.3 Vehicle conditions

For vehicles designed to carry passengers or goods, these type tests shall be carried out in the load conditions specified in the contract or, if not specified, in the minimum load condition (tare) and the exceptional load condition. Further tests may be required to verify that the required stopping distance is met over the whole load range, to cater for non-linearities in the characteristics of the friction materials, and the use of load-weighing systems which vary the brake force applied.

For motive power units, the tests shall be carried out at normal load.

The tests shall be performed with all systems in working order and, when specified in the contract, with some brake devices or bogies isolated.

For friction brake systems, the brake shoes, pads or linings shall have been bedded-in (sufficient brake applications made to ensure a good fit between the block and wheel or pad and disc).

For vehicles provided with slack adjusters, type tests shall be carried out with new brake shoes, pads or linings; for vehicles without slack adjusters, type tests shall be carried out with brake shoes, pads or linings worn to their wear limits.

9.4.1.4 Route conditions

The tests shall be carried out on a well-bedded track.

Unless otherwise specified, tests shall be carried out on dry track. If tests are carried out in the prevailing atmospheric conditions (i.e. with the rails wet or dry), the conditions shall be recorded with the results.

By agreement between the purchaser, user and manufacturer, tests can be carried out on track where adhesion conditions have been artificially degraded to simulate actual conditions to be found in service (see also 9.4.1.6).

9.4.1.5 Methods of measuring stopping distances

The method of measuring stopping distances may vary between contracts to take account of conditions prevailing in different countries but the method used shall ensure that the objective of the test is met. This subclause describes one method for measuring stopping distances but other methods, for example using on-board speed and distance measuring equipment and graphical presentation, may be used.

NOTE 1 For trains approved by UIC in international traffic, the test requirements are specified in UIC Leaflet 544-1.

NOTE 2 European requirements for braking tests, calculation methods for stopping distances and other requirements are defined in Annex B.

Stopping distances are measured on straight level track with the vehicle running either by itself, or with other vehicles in the case of multiple unit trains, or with the number of trailing coaches required in the contract.

At least three checks shall be made for each setting or each type of brake (emergency, service and, if needed, blended electric). The actual number of tests shall depend on the variation of results obtained in each check and shall be carried out as shown in a) to d) below:

a) before passing the brake application marker, motoring power shall be cut off, the speed of the vehicle being close to the reference speed for the test. When passing the marker, the required brake setting is applied;

b) accurate measurement shall be taken of:
   - the measured stopping distance L in metres, recorded during each test;
   - the speed V km/h at the application of braking (this speed shall be uniform and should not differ from the reference speed V_0 by more than ±3 km/h);

c) the curve of speed variation with time during the braking period should also be recorded, together with the necessary additional parameters (pressures, currents, etc.) in order to determine graphically the deceleration rate where this is required. The deceleration rate shall comply with the service or emergency braking rate as required in the contract;

d) a check shall be made where applicable that the pressure in the brake pipe returns to normal between tests.

If the measurement of stopping distance cannot be carried out on an absolutely level stretch of track, the level of the straight stretch chosen shall not vary by more than ±4 mm/m. For any divergence from the level track or the value of V, the measuring stopping distance L shall be corrected by the following formula:

$$L_1 = \frac{V_0 t_0}{3{,}6} + \left(L - \frac{V t_0}{3{,}6}\right) \times \frac{3{,}933 \times (1 + R_0) \times V_0^2}{\left[3{,}933 \times (1 + R_0) \times V^2\right] \pm i \times \left(L - \frac{V t_0}{3{,}6}\right)}$$

or:

$$L_1 = \frac{V_0 t_0}{3{,}6} + \frac{(1 + R_0) \times V_0^2}{\left[\frac{(1 + R_0) \times V^2}{\left(L - \frac{V t_0}{3{,}6}\right)}\right] \pm 0{,}254 \times i}$$

where:

L_1 is the corrected stopping distance, in metres;

L is the measured stopping distance, in metres;

V_0 is the initial reference speed, in kilometres per hour;

V is the actual initial speed, in kilometres per hour;

t_0 is the response time (dead or idle running time), in seconds;

i is the gradient, in millimetres per metre ‰;

R_0 is the factor for rotational inertia.

In the absence of a specified figure for R_0 in the contract, the value of 0,08 may be used.

In the formula, before i, the + sign is used for a downgrade and the – sign for an upgrade.

The corrected stopping distance L_1, so determined, shall not be longer than that specified in the contract for each setting or each type of brake.

9.4.1.6 Frequency of brake tests

The frequency of braking tests repeated one after the other, shall be arranged to check that during the most severe specified conditions the energy required by the braking system (air, oil, battery, etc.) does not exceed the capacity of the energy source.

9.4.1.7 Wheel-slide protection

Where the braking system includes a wheel-slide protection (WSP) system/s the braking tests shall include checks that the system/s perform as specified. See also 8.15.8. Reference to UIC Leaflet 541-05 is recommended. Where sanding is employed to assist braking, the dynamic tests shall verify that the vehicle and sanding equipment meet the criteria given in 8.11.4.

NOTE European requirements are specified in Annex B.

9.4.1.8 Emergency braking

Tests shall be carried out to check the brake performance with the brake controller or the automatic devices for driving in the emergency position. Further tests to check conformance of additional brakes such as magnetic track or eddy-current systems shall be performed as agreed in the contract. These tests may be carried out as part of the tests specified in 9.4.1.4 above. These tests may be required by Approval Authorities as part of the acceptance criteria for the vehicles.

9.4.1.9 Electrical braking tests

For vehicles equipped with electrical braking, the following checks shall be made for all levels of service brake and for braking applied, either manually or automatically:

a) that, in the case of electrical holding braking on a downhill grade, the actual braking fully complies with the performance specified in the contract;

b) that the voltage appearing at the terminals of the motors and regulating equipment does not exceed the designed value or the value specified in the contract;

c) that the current in the traction motors does not exceed the designed value or the value specified in the contract;

d) that there is no abnormal self-excitation of the traction motors either when braking or when hauled dead;

e) that, in the case of regenerative braking on a.c. supply lines, the power factor is within the figures specified in the contract;

f) that, in the case of regenerative braking and in the event of loss of the power supply, external short circuit of the power supply, pantograph bounce, lack of receptivity of the power supply, line gaps or neutral sections, transition takes place to an alternative braking system as specified in the contract;

g) that, in the case where a composite braking system is incorporated, e.g. blended braking or substitutional braking, a smooth transition occurs without significant jerk, underbraking or overbraking between the different braking systems e.g. air brake, rheostatic electric brake and regenerative electric brake;

h) that the electric braking builds up and releases steadily without significant jerk. Unless otherwise specified in the contract, a jerk rate of 1 m/s^3 should not be exceeded, except under emergency braking conditions.

Some of the measurements above (e.g. b), c) and d)) may be omitted if electric braking verification tests have been performed on a combined test rig.

9.4.2 Routine tests (safety-related tests)

Unless otherwise specified in the contract, each vehicle built shall be subject to line braking tests (including the requirements of 9.4.1.7) at a single load condition (e.g. minimum or normal load) on dry track. Any variation in these conditions shall be noted with the results.

The braking stops shall be made from the maximum speed specified in the contract and the stopping distances measured as shown in 9.4.1 or permitted alternative as specified in the contract. These tests can be combined with other commissioning tests. Some of these tests may be required by Approval Authorities as part of the acceptance criteria for the vehicles.

A simplified check of the operation of the wheelslide protection system (if fitted) shall be performed on each vehicle. This check may be performed during or derived from other routine dynamic tests using appropriate measuring equipment.

A simplified check of the operation of the dynamic brake (if fitted), to check transition, blending and application/release (generally as described in 9.4.1.9 f), g) and h)) shall be performed on each vehicle. This check may be performed during or derived from other routine dynamic tests.

If agreed in the contract, routine tests for wagons and trailer coaches can be covered either by the static tests (see 8.11), provided that they provide sufficient demonstration that the vehicle conforms to the type tested vehicle, or by a declaration of conformity.

9.5 Traction and braking thermal capacity tests (type test, safety-related test where appropriate)

Objective: To verify that the traction and braking equipment can operate the specified duty cycles within specified temperature limits.

NOTE These tests may be combined with those covered in 9.3, and some items may be covered by a combined test of traction equipment before installation in the vehicle. Some of these tests (particularly braking tests) may be required by Approval Authorities as part of the acceptance criteria for the vehicles.

It shall be checked that when operated at the specified duty cycles, the temperature rises of the equipment are within the design limits for the particular equipment.

Measurements shall be made to check that the following equipment operates within specified temperature ranges (see also paragraph below):

– rotating electrical machines;
– cooling fluids (e.g. for main transformer, inverter);
– electrical resistors, starting and braking;
– reactors;
– power semi-conductors;
– cable insulation;
– cable ducts and conduits;
– auxiliary machines;
– control switchgear;
– capacitors;
– equipment compartments and equipment cases;
– cooling air;
– transmission links between traction motor and wheels;
– mechanical brake elements;
– axle boxes;

– wheelsets;
– friction brake components.

This list is not exhaustive; the actual list should be as agreed in the contract.

The operating conditions of the thermal engine shall be checked, in particular temperatures and pressures of the various fluids used in its operation, and temperatures in the engine compartment. The integrity and efficiency of the thermal engine exhaust system shall be checked to ensure that no harmful gases can enter the engine compartment, driving cab or passenger compartments with all doors and windows closed.

The above tests shall be repeated with the vehicle operating with parts of the equipment (e.g. traction motors) isolated in the conditions required in the contract.

When the vehicle is required to carry out emergency duties to assist other vehicles, it is recommended that the above tests are repeated in the conditions required by the emergency duties as specified in the contract.

9.6 Resistance to motion (voluntary type test)

Objective: To verify the vehicle's resistance to motion and where applicable the rotational inertia.

This test should be carried out under dry adhesion conditions and calm weather.

The vehicle shall be set in motion at the maximum speed specified in the contract on a line of known gradient, without curves as far as possible, and the speed shall be allowed to decrease without the action of the brakes. The variations in speed, time and the distance run shall be recorded by suitable means from which a curve of resistance to motion can be derived, taking into account the line gradient and the influence of the rotating masses.

Tests for resistance to motion may be carried out by using a dynamometer car or an instrument for measuring deceleration.

For electrically powered vehicles, resistance to motion may also be deduced from the electrical power consumed by the traction circuits, taking into account the efficiency of the traction motors and all power losses in the traction system.

In the case of trains with variable compositions, it may be necessary to carry out these tests with each alternative composition.

The method of calculating the resistance to motion shall be agreed in the contract.

9.7 Speed regulating system tests (type and routine tests, safety-related where appropriate)

Objective: To verify the operation of speed regulating systems.

Where applicable, vehicles equipped with speed regulating systems shall be type tested to verify:

– that the vehicle speed is controlled in a smooth manner, without significant jerks or oscillations between braking, coasting and acceleration;
– that the traction and braking equipment is not subject to an excessive number of operations or frequency of operation (to minimise component wear compared to a manually driven vehicle);

– that the acceleration and braking rates in response to changed commands are within the limits specified in the contract;

– that the vehicle speeds resulting from the speed regulating systems are as specified in the contract and do not exceed any tolerances on the set speeds;

– that the stopping position accuracy at platforms and other stopping locations (e.g. stop signals) is as specified in the contract.

For a routine test, a simplified test of the functions of the speed regulating system shall be carried out.

Some of these tests may be required by Approval Authorities as part of the acceptance criteria for the vehicles.

9.8 Automatic train protection systems (type, routine and safety-related tests)

The proper functioning of vehicles equipped with an automatic train protection system shall be checked according to the procedures agreed in the contract and included in the test plan.

In particular, the following shall be checked:

a) the protection system operates at the speeds and in response to signals, either external (lineside) or internal (trainborne, such as display of recommended speed in cab), specified in the contract, either to apply the emergency brakes or otherwise alert the driver that the vehicle speed has to be reduced;

b) in the case that the emergency brakes are applied, the motoring power is automatically cut off and the braking rate specified in the contract is applied. Depending on the type of system installed, the vehicle or train shall stop within the braking distance specified in the contract or reduce speed below the automatic train protection permitted speed as required by the contract;

c) there is no inadvertent action during the tests and that the protection system does not operate without cause unless actual overspeed or failure to stop has occurred.

The automatic train protection system shall be tested over the full operating conditions to check correct operation.

For a routine test, a simplified test of the functions of the automatic train protection system shall be carried out.

These tests are likely to be required by Approval Authorities as part of the acceptance criteria for the vehicles.

9.9 Vehicle/track interaction

9.9.1 Safety of running

9.9.1.1 Objective

To verify the safety in operation of the vehicle in the following areas:

a) safety against derailment;

b) safety against shifting of the track;

c) safety against excessive mechanical stresses on the rails and their means of fixation, on wheels, axles and certain parts of the bogies;

d) safety against the consequences of a suspension fault (deflated air suspension, for example);

e) safety systems to prevent wheels locking.

9.9.1.2 Type test (safety-related test)

The vehicle shall, if possible, be run on lines on which it is intended to work including tunnels, both at speeds within the range demanded by the timetable and at the maximum speeds specified in the contract.

Running tests may also be made on other tracks in average conditions selected by agreement between purchaser and manufacturers.

NOTE International requirements on items a) to d) are given in UIC Leaflet 518. European requirements are defined in Annex B.

9.9.1.3 Routine test (safety-related test)

The parameters used to assess conformance shall be based on data generated by the type test performed in accordance with 9.9.1.2. The parameters selected and the limit values to check conformance shall be agreed in the contract and included in the test plan.

9.9.2 Suspension clearances, inter-vehicle clearances (voluntary type and safety-related test where appropriate)

Objective: To verify that adequate clearances are provided for operation of the vehicle on the specified limiting cases of radius of curvature, applied cant, etc., in all loading conditions of the vehicle.

The operation of the vehicle on curved track shall be checked by running the vehicle over a curve of minimum specified radius at the speed specified in the contract, while a check is made that there is no restriction of movement or binding, that jumper cables, pneumatic couplings, connections to motors and current return connections are of sufficient length, that the motor ventilating bellows and the drives operated from an axle of the vehicle (e.g. speed recorder drive) are so designed as to avoid damage.

The vehicle shall be coupled to another similar vehicle, or to a vehicle of another type as required in the contract, to run in service coupled with the first named. The vehicle shall be run over reverse curves and it shall be checked that the vehicle behaves in a satisfactory manner, i.e. that there is neither binding nor overriding of the drawgear or corridor connections, if these are provided. The test shall be effected with the coupling gear fully under tension.

In the case of vehicles provided with automatic coupling, the possibility of coupling on curves of a radius, as specified in the contract shall be verified.

A check shall be made that the running over curves and point work takes place without binding and without permanent deformation of the track.

The tests required on curved track shall be repeated where appropriate on straight track with the maximum changes of gradient specified in the contract.

Where the contract calls for operation on curved track with changes of gradient and cant, this shall be checked (e.g. ferry-boat services, tram systems).

Consideration should be given to wheel wear and the effect of incorrect operation or damage to the suspension (i.e. deflated air suspension or broken springs) causing the vehicle's body to be in contact with the bogie or wheels at one or more places.

Whilst these tests can be carried out on the relevant infrastructure manager’s tracks, some may be carried out on prepared track in a depot or the manufacturer’s works, provided that the track is in a proper state of maintenance.

The movement of the vehicle on curved track can be checked statically by means of a traverser or turntable, turning one bogie with respect to the car body (see 8.2.2.2 and 8.2.2.3).

9.10 Ride comfort quality (voluntary tests)

9.10.1 Objective

To verify that the ride comfort quality meets the requirements specified in the contract.

9.10.2 Type test

The vehicle shall be run on lines agreed with the purchaser as representative of the track over which it is intended to operate. The track quality, permitted operating speeds, population of curves, installed cant and cant deficiency shall be representative of that specified in the contract. The methods of evaluation and test conditions shall be defined in the test plan.

NOTE European guidance on methods of evaluation and test conditions is given in Annex B.

9.10.3 Routine test (voluntary test)

The parameters used to assess the conformance of each vehicle built shall be based on data generated by the type test (9.10.2). The parameters selected and the limit values shall be agreed between the manufacturer and the purchaser and included in the test plan.

9.11 Kinematic envelope

9.11.1 Type test (safety-related test)

Objective: To verify that the vehicle complies with the kinematic envelope requirements specified in the contract.

These tests may be combined with the ride comfort quality tests covered at 9.10.2 using data computed from the suspension displacements to check the motion of the vehicle body. The same data may be used to check the pantograph sway motion (where fitted) to check conformance with pantograph gauge limits.

If agreed in the contract, calculation supported by static tests may be used to compute the kinematic or swept envelope (see 8.3).

9.11.2 Routine test (voluntary)

The parameters used to assess the conformance of each vehicle built shall be based on data generated by the type test, see 9.11.1. The parameters selected and the limit values shall be agreed in the contract.

These tests may be combined with the ride comfort quality tests, see 9.10.3.

9.12 Operation of wheel flange lubricators (safety-related routine test only)

Objective: To verify that wheel flange lubricators provide lubrication as specified in the contract without contamination of wheel tread or rail head.

Where fitted to the vehicle these units shall be tested in accordance with the supplier's instructions and their performance verified against the contract.

NOTE European requirements for flange lubrication are defined in Annex B.

9.13 Current collector and power supply contact system compatibility tests (safety-related type test only)

Objective: To verify that current collectors perform as specified in the contract.

Before performing these tests the static type and routine tests (see 8.7 and 8.8) shall be completed.

The vehicle shall be run at the maximum speed specified in the contract on lines over which it is to operate. If the vehicle is required to run in a train with more than one pantograph raised or collector shoe in contact (e.g. locomotives or motor coaches in multiple unit trains), then the current collection shall be checked in the operating conditions specified in the contract (e.g. speed, distance between current collectors). Tests shall be performed in each direction of motion.

The quality of the supply system, over which the tests shall be run, shall be agreed in the contract and included in the test plan.

A check shall be made that satisfactory current collection takes place, without damage, abnormal wear or vibration of either the collector or the supply (in the case of pantographs, in accordance with IEC 60494-1 or IEC 60494-2).

The weather at the time of the test should be noted.

The electrical and mechanical operation of the current collector and associated electrical circuits over neutral sections and gaps in the third-rail shall be checked.

In the case of a pantograph, a check shall be made with the pantograph raised, in both directions of travel and up to the maximum speed specified in the contract, that the aerodynamic effect does not cause forces which, in addition to the static forces, exceed the upper and lower limits specified in the contract. This check shall be repeated with vehicles in multiple if specified in the contract (for example, in the case of a vehicle with a short distance between the two pantographs).

A check shall also be made that the aerodynamic effect is not such as to produce an unauthorised raising of the lowered pantograph and has no adverse influence on the proper execution of raising or lowering movements at speed.

Tests and test methodology for compatibility are defined in IEC 62313. Requirements for testing of the dynamic interaction between the pantograph and the overhead line are given in future IEC 62846.

It shall be verified by measurement that the calculated maximum pantograph sway is not exceeded taking into account the worst dynamic movement of the vehicle (see also 9.10.2 and 9.11.1). Reference may be made to UIC leaflet 505-1, IEC 60494-1 or IEC 60494-2. This test may be carried out statically (see 8.2.2.4).

9.14 Aerodynamic effects (type tests only, safety-related where appropriate)

Objective: To verify that the aerodynamic characteristics of the vehicle conform to the requirements specified in the contract.

Special tests shall be made as specified in the contract to cover aerodynamic effects as follows:

a) to check the resistance of the mechanical parts of the vehicle to aerodynamic shock waves. The tests may cover the effects due to trains passing at speed on the adjacent track and passage through tunnels;

b) to check the pressure tightness of the vehicle structure;

c) to check there are no adverse effects on air intakes to systems such as cooling, air conditioning, etc.;

d) to check for slipstream effects and the effects of cross-winds.

NOTE 1 European requirements for test procedures for aerodynamic requirements of rolling stock are given in Annex B.

NOTE 2 European requirements permitting tests on reduced-scale models or numerical simulations are given in Annex B.

9.15 Electromagnetic compatibility (type tests only)

9.15.1 Internal interference within the vehicle (safety-related where appropriate)

Objective: To verify that all equipment functions correctly after installation, without interference effects.

Where equipment tests in accordance with IEC 62236-3-2 confirm that there is sufficient margin between the electromagnetic emissions and the immunity levels of the equipment within the vehicle, further testing of that equipment is not required.

The vehicle test shall be executed as follows:

All contactors, relays and other possible sources of noise of the electrical circuits on the vehicle, shall be operated in sequence, to ensure there is no harmful electrical interference with the vehicle circuits, due to electromagnetic radiated or conducted signals.

Reference should be made to IEC 62236-3-2 for detailed methods of checking the immunity of control equipment from electromagnetic emissions.

9.15.2 External interference produced by the vehicle (safety-related where appropriate)

Objective: To verify that the interference spectrum (amplitudes, frequencies, psophometric currents, etc.) produced by the vehicle under normal operating conditions and reasonable degraded conditions complies with the requirements specified both in IEC 62236-3-1 and in the contract for compatibility with trackside systems.

The set of normal operating conditions and reasonable degraded conditions to be used for the tests shall be agreed between the purchaser and manufacturer and included in the contract.

IEC 62236-3-1:2008, Clause 6 sets out the parameters for testing the complete vehicle to account for various operating environments.

Tests shall be conducted in accordance with IEC 62236-3-1, unless otherwise agreed in the contract, to determine that no adverse effects occur, under normal conditions that prevail on the railway over which the vehicles are intended to operate, for example:

– at different distances from the sub-station;

– at different speeds and accelerations, in motoring and braking.

IEC 62427 defines a process to obtain the assurance that specific rolling stock operating on a specific route does not interfere with train detection systems installed on that route.

The individual compatibility requirements and test conditions for rolling stock referring to this are given by the infrastructure manager and/or Approval Authority of the respective country and should be included within the contract.

Where applicable, it shall be checked that the detection devices or monitoring systems, which are fitted for monitoring critical frequencies, operate as specified in the contract.

Test reports shall be produced and submitted in accordance with the requirements of the infrastructure manager over whose lines the vehicles are intended to operate.

9.15.3 Radio frequency interference

Objective: To verify that the vehicle does not produce excessive electromagnetic interference at radio frequencies.

The test shall be conducted in accordance with IEC 62236-3-1 unless otherwise agreed in the contract, at the critical frequencies and maximum levels defined therein.

9.15.4 External interference to the vehicle

Objective: To verify that the vehicle can operate satisfactorily when subject to externally radiated interference levels as specified in the contract.

IEC 62236-3-1:2008, Clause 5 states that no tests are performed on a complete vehicle. Compliance shall be proved by immunity tests in accordance with IEC 62236-3-2, in conjunction with an EMC test plan.

It shall be the responsibility of the purchaser to communicate to the manufacturer at the time of the contract any potential source of interference for the vehicle which might not be considered as part of a normal railway system.

9.15.5 Electrostatic discharges (voluntary test)

Objective: To verify that the vehicle operates satisfactorily when subject to electrostatic discharges at the levels specified.

When specified in the contract the manufacturer shall carry out electrostatic discharge tests in accordance with IEC 62236-3-2.

9.16 Interruption and voltage/jump and short circuit test (voluntary type test only)

9.16.1 General

Objective: To verify that voltage changes in the external supply do not adversely affect the performance of the vehicle.

These tests shall only be undertaken on the complete vehicle when the type test specified in IEC 61377-1, IEC 61377-2 or IEC 61377-3 has not been performed on a test bed subject to agreement between the purchaser and manufacturer.

NOTE A new edition of IEC 61377 is going to be published combining the three parts of the current edition.

Tests shall be made under different line conditions (e.g. voltage, line inductance) to be found in service, for example either at the substation or at the furthest distance from the substation.

In the case of equipment with the final drive consisting of a.c. or d.c. commutator motors directly connected to the power supply via passive units (transformers, tapchangers, rheostats, diodes, etc.) the tests shall be made in the following three different conditions:

– minimum field on the traction motors (if applicable);
– maximum speed of the vehicle;
– one hour current rating of traction motors.

In the case of equipment with converters and in the absence of information specified in the contract, the tests shall be made in the following three different conditions:

– maximum current in the power circuit;
– maximum output voltage of the converters;
– maximum speed of the vehicle.

9.16.2 Voltage jump tests

The supply voltage shall be increased suddenly from approximately the nominal supply voltage. The increase shall be based on the requirements of IEC 60850.

Various methods can be employed to carry out the tests, in particular it may be possible:

– to operate on the controls of the supply substations; or
– to short-circuit suddenly a resistor located on the vehicle itself or on another vehicle coupled to it; or
– to disconnect suddenly a heavy load connected in parallel with the vehicle on test; or
– to switch in a supply substation previously out of service.

In the case of a vehicle provided with regenerative braking, a test with a sudden drop in voltage (of the order of 10 %) shall be carried out at maximum speed and at the maximum regenerated current obtainable at this speed (and also at the maximum speed obtainable with the maximum regenerated current specified in the contract). These tests can be carried out by suddenly connecting a heavy load in parallel with the vehicle on test.

The tests shall not adversely affect the equipment. The equipment shall continue to deliver the same performance without permanent damage, even in the most severe operating conditions (after reconnection, if the protective equipment disconnected the propulsion equipment when the voltage jump was applied).

9.16.3 Interruption tests

For traction and regenerative braking, the external supply voltage shall be disconnected and reconnected with the total time of interruption being in the range from 10 ms to 10 s, as agreed in the contract. All protective devices, including no-voltage protection devices, shall be in operation for these tests.

A number of tests shall be carried out to ensure that the specified range of intervals between interruptions is fully covered. The tests can be carried out by disconnecting and reconnecting the circuit by means of a circuit-breaker.

The tests shall not adversely affect the equipment. The equipment shall continue to deliver the same performance without permanent damage, even in the most severe operating conditions (after reconnection, if the protective equipment disconnected the propulsion equipment during the interruption).

9.16.4 Voltage variation testing

All the equipment on the vehicle, particularly the auxiliary equipment, shall be tested for correct operation over the full range of the line voltage specified in the contract.

A number of tests shall be carried out to ensure that the range of voltage is covered (e.g. maximum, minimum and nominal line voltage).

9.16.5 Short circuit test

For traction and regenerative braking the external supply voltage shall be short circuited for unlimited time. All protective devices shall be in operation for these tests.

The tests shall not adversely affect the equipment, and the line current shall not exceed the values specified in the contract. After reconnection, the equipment shall be able to continue to deliver the performance specified in the contract without any permanent damage, even in the operating conditions as specified.

9.17 Noise tests

9.17.1 Type test

Objective: To verify that the internal noise and noise emitted by the vehicles complies with the specification.

External noise tests shall be performed in accordance with ISO 3095; internal noise tests in accordance with ISO 3381. In each case, the tests shall be those identified as type tests using the measurements and in the conditions specified in the standard. The test procedures to be used shall be specified in the contract.

NOTE European requirements for noise tests for trains are given in Annex B.

9.17.2 Routine test (voluntary test)

If required by the contract, measurements performed to check that sample vehicles conform to the standard demonstrated by the type test above shall be in accordance with the monitoring tests defined in ISO 3095 and ISO 3381.

9.18 Air systems – compressor duty cycle (type test, safety-related where appropriate)

Objective: To verify that the installed compressor/s can deliver the required amount of air to meet all system requirements.

Tests shall be undertaken representative of the most demanding duty cycle for the air system when operating specified services, including, for example, operation of any air-activated door systems, warning horns, etc.

Locomotives shall be tested hauling the maximum load specified in the contract.

Multiple units shall be tested in the exceptional load condition.

The tests shall include the following measurements:

– main reservoir pressure;
– main reservoir pipe pressure;
– air suspension pressure (where applicable);
– time taken to fully charge the system (see also static test in 8.9);
– duration of compressor operations;
– air dew point downstream of the air drier.

The tests shall demonstrate the following:

– charge time from a completely empty system is within the time specified in the contract (normally not greater than 15 min), except for locomotives hauling freight wagons;

– the system is maintained at its working pressure when operating in normal service with all air operated equipment in use;

– when specified in the contract that the vehicle is capable of operating the air system of itself and a disabled unit/vehicle/s.

NOTE This test can be carried out during other dynamic tests (for example, the traction performance test, see 9.3). Alternatively, the test can be carried out with defined leakage, provided that it can be demonstrated that the air consumption is representative of the specified duty.

9.19 Windscreen wipers (type test)

Objective: To verify that the windscreen wipers and washers and demisters give the specified clear area of the windscreen at all operating speeds and weather conditions.

The test shall cover all operating speeds up to the maximum specified in the contract. The tests shall be performed preferably in adverse weather conditions.

The wipers shall clean a specified area and not be adversely affected by aerodynamic effects.

The windscreen washer shall operate as specified in the contract.

9.20 Train control system (type test, safety-related where appropriate)

Objective: To check that all train control systems function correctly in the dynamic environment.

Some of these tests can be combined with other dynamic tests: for example, motoring control tests can be done during traction performance tests (9.2).

During dynamic testing, all train control systems and circuits shall be checked to ensure that they are operating correctly as specified in the contract. In particular, the following shall be checked:

– sequence of control;

– operation of time delays;

– operation of interlocks;

– operation from valid coded signals;

– interface between different systems.

Where appropriate, the vehicle auxiliary systems tested statically in accordance with 8.15 shall be checked to ensure that they operate correctly in dynamic conditions, without any adverse effects from the operation of the traction and braking systems or any other effects from the movement of the vehicle.

In particular the following shall be checked:

– public address system audibility;

– radio operation on the intended infrastructure;

– track-to-train data links including closed circuit television;

– data transmissions in the dynamic environment;

– train management systems, including diagnostic systems, using inputs from the operating vehicle in real time;

– internal closed circuit television or video systems.

Where specified in the contract, degraded modes shall be tested and verified.

Where a freight traction vehicle is fitted with a radio remote control system to provide remote control by an external operator, requirements are defined by IEC 62845.

Annex A
(informative)

List of tests

In Tables A.1 and A.2, the symbols in the columns have the following meanings:

MU	Multiple Unit
O	Obligatory
V	Voluntary
D of C	Declaration of conformity
T	Type test
R	Routine test
C	Calculation
S	Safety-related
A	may be required by Approval Authorities
n/a	not applicable
*	See Annex B or Bibliography.

Where a symbol appears in brackets (e.g. (O), (V), (R)), the test applies where the equipment is fitted or if the test is appropriate. Refer to the relevant subclause for further details.

Tests may be waived if the conditions of 5.1 are met.

Table A.1 – List of static tests *(1 of 4)*

Clause/ subclause	Test	Type of test	Loco	Freight	Pass-enger	Freight MU	MU	Refer to
8.2	Dimensional tests							
8.2.2	Type tests							
8.2.2.1	Outside dimensions	C, T, S	O	O	O	O	O	EN 13775*
8.2.2.2 a	Clearance tests (car body to bogie)	C, T, S	O	O	O	O	O	
8.2.2.2 b	Clearance tests (vehicle to vehicle)	C, T, S	O	O	O	O	O	
8.2.2.3	Hose and cable length tests	C, T	O	O	O	O	O	
8.2.2.4	Current collection	T, S	(O)	n/a	n/a	(O)	(O)	IEC 60494-1 IEC 60494-2
8.2.3	Routine tests	R	O or D of C	O or D of C	O or D of C	O or D of C	O or D of C	
8.3	Gauging test							
8.3.2	General	T, S	O	O	O	O	O	EN 15273*
8.3.3	Coefficient of flexibility test	T, S	(O or V)	(O or V)	(O or V)	(O or V)	(O or V)	UIC 505-5* EN 14363*
8.3.4	Routine tests	R, S	O	O	O	O	O	
8.4	Lifting ability test	T, S	O	O	O	O	O	EN 16404*
8.5	Weighing tests							
8.5.3	Type tests	T, S	O	O	O	O	O	EN 15663*

Table A.1 *(2 of 4)*

Clause/ subclause	Test	Type of test	Loco	Freight	Pass-enger	Freight MU	MU	Refer to
8.5.4	Routine tests	R, S	O	O or D of C	O or D of C	O	O	
8.6	Sealing tests							
8.6.2	Type tests	T	O	O	O	O	O	IEC 60529
8.6.3	Routine tests	R	V	V	V	V	V	
8.7	Electrical insulation tests							
8.7.2	Voltage withstand test	R	O	O	O	O	O	EN 50343*
8.7.3	Insulation impedance test	R	O	O	O	O	O	EN 50343*
8.8	Protective bonding and return circuits tests	R, S	O	O	O	O	O	IEC 61991
8.9	Air system test							
8.9.2 8.9.3	Air tightness test	R, S	O	O	O	O	O	
8.9.4	Functional test	T, (S)	O	O	O	O	O	
8.10	Hydraulic system tests (tightness)	R, (S)	(O)	(O)	(O)	(O)	(O)	
8.10	Hydraulic system tests (functional)	T, (S)	(O)	(O)	(O)	(O)	(O)	
8.11	Friction brake system tests							
8.11.2	Pneumatically applied brake systems							
8.11.2.1	Type tests	T, S	O	O	O	O	O	EN13452-1* EN 15734-2* EN 15806* EN 16185-2*
8.11.2.2	Routine tests	R, S	O	O	O	O	O	
8.11.3	Other systems	T, R, S	(O)	(O)	(O)	(O)	(O)	
8.11.4	Sanding system	T, R, S	(O)	(O)	(O)	(O)	(O)	
8.12	Parking brake type tests	T, S	O	O	O	O	O	
8.13	Auxiliary power supply system tests							
8.13.2	Type tests	T, (S)	O	O	O	O	O	
8.13.3	Routine tests	R	O	O	O	O	O	
8.14	Battery charging tests							
8.14.2	Type tests	T	O	O	O	O	O	
8.14.3	Routine tests	R	O	O	O	O	O	
8.15	Auxiliary and control system tests							
8.15.2	General tests							
8.15.2.1	Type tests	T	O	O	O	O	O	
8.15.2.2	Routine tests	R	O	O	O	O	O	
8.15.3	Train control static functions							
8.15.3.1	Single unit operation	T, R, (S)	O	(O)	O	O	O	
8.15.3.2	Interfacing between systems	T, R, (S)	O	(O)	O	O	O	
8.15.3.3	Multiple operation	T, R, (S)	(O)	(O)	(O)	O	O	

Table A.1 *(3 of 4)*

Clause/ subclause	Test	Type of test	Loco	Freight	Pass-enger	Freight MU	MU	Refer to
8.15.4	Door control systems	T, R, S	O	(O)	O	(O)	O	EN 14752*
8.15.5	Heating, ventilation and air-conditioning system tests							
	Traincrew areas	T, R, S	O	n/a	O	O	O	EN 14813-2*
	Passenger areas	T, R	n/a	n/a	V	n/a	V	EN 13129* EN 14750-2*
	Freight wagons	T, R	n/a	(O)	n/a	(O)	n/a	
8.15.6	Lighting system tests							
	Type tests	T, (S)	O	V	O	V	O	EN 13272*
	Routine tests	R, (S)	O	V	O	V	O	EN 13272*
8.15.7	Other systems							
	Safety-related	T, R, S, (A)	(O)	n/a	(O)	(O)	(O)	
	Not safety-related	T, R	(V)	n/a	(V)	(V)	(V)	
8.15.8	Software controlled systems							
	Safety-related	T, (S)	O	(O)	O	(O)	O	IEC 60571
	Not safety-related	T	V	n/a	V	(V)	V	
	Software version	R, S	O or D of C	(O or D of C)	O or D of C	(O or D of C)	O or D of C	
8.16	Tests on thermal engine and associated generating sets and transmission							
8.16.2	Operating speeds of the thermal engine	T	V or D of C	(V or D of C)	(V or D of C)	V or D of C	V or D of C	
8.16.3	Thermal engine protective devices	T	O or D of C	(O or D of C)	(O or D of C)	O or D of C	O or D of C	
8.16.4	Thermal engine fluid, air and exhaust circuits	R, (S)	O	(O)	(O)	O	O	
8.16.5	Engine-driven auxiliaries							
8.16.5.1	Type tests	T	V or D of C	(V or D of C)	(V or D of C)	V or D of C	V or D of C	
8.16.5.2	Routine tests	R	V or D of C	(V or D of C)	(V or D of C)	V or D of C	V or D of C	
8.16.6	Cranking of the thermal engine	T	V or D of C	(V or D of C)	(V or D of C)	V or D of C	V or D of C	
8.16.7	Operation of the thermal engine							
8.16.7.1	Type tests	T	V or D of C	(V or D of C)	(V or D of C)	V or D of C	V or D of C	
8.16.7.2	Routine tests	R	O or D of C	(O or D of C)	(O or D of C)	O or D of C	O or D of C	
8.17	Traction system tests	T, R, (S)	O	n/a	n/a	O	O	
8.18	Operability and maintainability							
8.18.1	General	T	V	V	V	V	V	
8.18.2	Cabs and traincrew areas	T, S	O	n/a	O	O	O	UIC 651*
8.18.3	Passenger areas	T, (S)	n/a	n/a	V, (O)	n/a	V, (O)	

Table A.1 *(4 of 4)*

Clause/ subclause	Test	Type of test	Loco	Freight	Pass-enger	Freight MU	MU	Refer to
8.18.4	Rescue	T, (S)	V, (O)	V, (O)	V, (O)	V, (O)	V, (O)	
8.19	Noise and vibration tests	T, (S)	V, (O)	V, (O)	V, (O)	V, (O)	V, (O)	ISO 3095 ISO 3381 EN 12663* EN15892*
8.20	Safety-related system tests	R, S	O	(O)	(O)	O	O	EN15153*

Table A.2 – List of dynamic tests *(1 of 2)*

Clause/ subclause	Test	Type of test	Loco	Freight	Pass-enger	Freight MU	MU	Refer to
9.2	Traction performance (tractive effort/speed characteristics)							
	Type tests	T	V	n/a	n/a	V	V	
	Routine tests	R	V or D of C	n/a	n/a	V or D of C	V or D of C	
9.3	Journey time check	T	V	n/a	n/a	V	V	
9.4	Braking tests							
9.4.1	Type test (all) (emergency braking)	T, S, (A)	O	O	O	O	O	UIC 540 series* EN 14531* EN 13452-2* EN 15734-2* EN 15595* EN 16185-2*
9.4.2	Routine tests	R, S, (A)	O	O or D of C	O or D of C	O	O	
9.5	Traction and braking thermal capacity tests							
	Traction thermal capacity tests	T	V or D of C	n/a	n/a	V or D of C	V or D of C	
	Braking thermal capacity tests	T, S, (A)	O	O	O	O	O	
9.6	Resistance to motion	T	V	V	V	V	V	
9.7	Speed regulating system tests	T, R, (S) (A)	V, (O)	n/a	n/a	V, (O)	V, (O)	
9.8	Automatic train protection systems	T, R, S, (A)	O	n/a	n/a	O	O	
9.9	Vehicle/track interaction							
9.9.1	Safety of running	T, R, S	O	O or D of C	O	O	O	UIC 518* EN 14363* EN 15686* EN 15687* EN 15839* EN 16235*
9.9.2	Suspension clearances, inter-vehicle clearances	T, (S)	V	V	V	V	V	
9.10	Ride comfort quality							
9.10.2	Type test	T	V	V	V	V	V	EN 12299*

Table A.2 *(2 of 2)*

Clause/ subclause	Test	Type of test	Loco	Freight	Pass-enger	Freight MU	MU	Refer to
9.10.3	Routine tests	R	V	V	V	V	V	
9.11	Kinematic gauging							
9.11.1	Type test	T, S	O or C	O or C	O or C	O or C	O or C	
9.11.2	Routine tests	R	V	V	V	V	V	
9.12	The operation of wheel flange lubricators	R, S	(O)	(O)	(O)	(O)	(O)	EN 15427*
9.13	Current collector and power supply contact system compatibility tests	T, S	O	n/a	n/a	O	O	IEC 60494 UIC 505-1* IEC 62313 Future IEC 62846
9.14	Aerodynamic effects	T, (S)	O	O	O	O	O	EN 14067*
9.15	Electromagnetic compatibility							
9.15.1	Internal interference within the vehicle	T, (S)	V, (O)	(V)	V, (O)	V, (O)	V, (O)	IEC 62236
9.15.2	External interference produced by the vehicle	T, S	O	(O)	O	O	O	IEC 62236 IEC 62427
9.15.3	Radio frequency interference	T, S	O	(O)	O	O	O	IEC 62236 IEC 62427
9.15.4	External interference to the vehicle	T, S	O	(O)	O	O	O	IEC 62236 IEC 62427
9.15.5	Electrostatic discharges	T	V	(V)	V	n/a	n/a	
9.16	Interruption & voltage/ jump and short circuit test	T	V	n/a	n/a	V	V	IEC 60850
9.17	Noise tests							
9.17.1	Type test	T	O	O	O	O	O	ISO 3095 ISO 3381 EN 15892*
9.17.2	Routine test	R	V	V	V	V	V	ISO 3095 ISO 3381
9.18	Air systems – compressor duty cycle	T, (S)	V or (O)	n/a	n/a	V or (O)	V or (O)	
9.19	Windscreen wipers	T	O	n/a	n/a	O	O	
9.20	Train control system	T, (S)	V, (O)	(V)	V, (O)	V, (O)	V, (O)	IEC 62845

Annex B
(informative)

Requirements for the European Community – Legal requirement in accordance with AC/135/2002

B.1 General

This annex is to identify the European requirements resulting from the Interoperability Directives of the Council of the European Union. The Interoperability Directives cover the mainline networks of the European member states but not urban rail as defined by those states.

To support the Directives, the European Commission has published a number of Technical Specifications for Interoperability (TSI), as shown below.

Further information can be obtained from the Guides for the Application of the TSIs produced from time to time and published by the European Rail Agency.

The information given below is correct at the time of the vote on the FDIS (see Foreword). Further directives, decisions, regulations and other documents, including revisions, will be published during the currency of this standard. It is the responsibility of the users of this standard to ensure that they are aware and make use of the correct documents.

Only the principal documents are listed below. Other directives and decisions may apply to rolling stock being supplied to member states of the EU. It is the responsibility of the person supplying to such member states to ensure that all relevant requirements are met.

B.2 Legal references

B.2.1 Directives

The following are the principal Directives currently in force:

DIRECTIVE 2008/57/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 17 June 2008 on the interoperability of the rail system within the Community as amended by 2009/131/EC of 16 October 2009 and 2011/18/EU of 1 March 2011 (Recast Interoperability Directive).

COUNCIL DIRECTIVE 2004/49/EC of 29 April 2004 on safety on the Community's railways and amending Council Directive 95/18/EC on the licensing of railway undertakings and Directive 2001/14/EC on the allocation of railway infrastructure capacity and the levying of charges for the use of railway infrastructure and safety certification as amended by 2008/57/EC of 17 June 2008 and 2008/110/EC of 16 December 2008 (Railway Safety Directive).

B.2.2 Technical specifications for interoperability

The following are the principal TSIs related to rolling stock currently in force, together with the clauses in IEC 61133 to which they apply:

COMMISSION DECISION 2008/232/EC of 21 February 2008 concerning a technical specification for interoperability relating to the 'rolling stock' sub-system of the trans-European high-speed rail system as amended by 2012/464/EU of 23 July 2012 (4.1, 8.15.6.1, 8.18.4, 8.19, 9.4.1.2, 9.4.1.5, 9.9.1.2, 9.17.1).

COMMISSION DECISION 2011/291/EU of 26 April 2011 concerning a technical specification for interoperability relating to the rolling stock subsystem — 'Locomotives and passenger rolling stock' of the trans-European conventional rail system, as amended by 2012/464/EU of 23 July 2012 (4.1, 8.15.6.1, 8.18.4, 9.4.1.2, 9.4.1.5, 9.9.1.2).

COMMISSION REGULATION (EU) 321/2013 of 13 March 2013 concerning the technical specification for interoperability relating to the subsystem 'rolling stock — freight wagons' of the rail system in the European Union (4.1, 9.4.1.2, 9.4.1.5, 9.9.1.2).

COMMISSION DECISION 2011/229/EU of 4 April 2011 concerning the technical specifications of interoperability relating to the subsystem 'rolling stock – noise' of the trans-European conventional rail system, as amended by 2012/464/EU of 23 July 2012 (8.19, 9.17.1).

COMMISSION DECISION 2008/164/EU of 21 December 2007 concerning the technical specification of interoperability relating to 'persons with reduced mobility' in the trans-European conventional and high-speed rail system, as amended by 2012/464/EU of 23 July 2012 (4.1, 8.18.3).

COMMISSION DECISION 2008/163/EU of 20 December 2007 concerning the technical specification of interoperability relating to 'safety in railway tunnels' in the trans-European conventional and high speed rail system, as amended by 2012/464/EU of 23 July 2012 (4.1, 8.15.5, 8.15.6.1).

COMMISSION DECISION 2012/88/EU of 25 January 2012 on the technical specification for interoperability relating to the control-command and signalling subsystem of the trans-European rail system, as amended by 2012/696/EU of 6 November 2012 (8.20).

COMMISSION DECISION 2010/713/EU of 9 November 2010 on modules for the procedures for assessment of conformity, suitability for use and EC verification to be used in the technical specifications for interoperability adopted under Directive 2008/57/EC of the European Parliament and of the Council (4.1).

B.3 European Standards relevant to Clauses in IEC 61133

The following European standards are relevant to the IEC 61133 clauses/subclauses listed against them and define European requirements:

EN 12299:2009, *Railway applications – Ride Comfort for Passengers, Measurement and Evaluation* (9.10.2)

EN 13129-2:2004, *Railway applications – Air conditioning for main line rolling stock – Part 2: Type tests* (8.15.5)

EN 13272:2012, *Railway applications – Electrical lighting for rolling stock in public transport systems* (8.15.6.1)

EN 13452-2:2003, *Railway applications – Braking – Mass transit brake systems – Part 2: Methods of test* (8.11.2.1, 9.4.1.2, 9.4.1.5)

EN 13775-1-6:2003-2004, *Railway applications – Measuring of new and modified freight wagons* (6 parts) (8.2.2.1)

EN 14067-4:2005 + A1:2009, *Railway applications – Aerodynamics – Part 4: Requirements and test procedures for aerodynamics on open track* (9.14)

EN 14067-5:2006 + A1:2010, *Railway applications – Aerodynamics – Part 5: Requirements and test procedures for aerodynamics in tunnels* (9.14)

EN 14067-6:2010, *Railway applications – Aerodynamics – Part 6: Requirements and test procedures for cross wind assessment* (9.14)

EN 14363:2005, *Railway applications – Testing for the acceptance of running characteristics of railway vehicles – testing of running behaviour and stationary tests* (8.3.3, 9.9.1.2)

EN 14531-1:2005, *Railway applications – Braking – Methods for calculation of stopping distances, slowing distances and immobilisation braking – Part 1: General algorithms* (9.4.1.2, 9.4.1.5)

EN 14531-6:2009, *Railway applications – Methods for calculation of stopping and slowing distances and immobilization braking – Part 6: Step by step calculations for train sets or single vehicles* (9.4.1.2, 9.4.1.5)

EN 14750-2:2006, *Railway applications – Air conditioning for urban and suburban rolling stock – Part 2: Type tests* (8.15.5)

EN 14752:2005, *Railway applications – Body entrance systems* (8.15.4)

EN 14813-2:2006 + A1:2010, *Railway applications – Air conditioning for driving cabs – Part 2: Type tests* (8.15.5, 8.18.2)

EN 15153-1:2013, *Railway applications – External visible and audible warnings for trains – Part 1: Head, marker and tail lamps* (8.20)

EN 15153-2:2013, *Railway applications – External visible and audible warnings for trains – Part 2: Warning horns* (8.20)

EN 15273:2013, *Railway applications – Gauges – Part 2: Rolling stock gauge* (8.3.2)

EN 15427:2008 + A1:2010, *Railway applications – Wheel/rail friction management– Flange lubrication* (9.12)

EN 15595:2009 + A1:2011, *Railway applications – Braking – Wheel slide protection* (9.4.1.7)

EN 15663:2009 + AC:2010, *Railway applications – Definition of vehicle reference masses* (8.5.2 – see note below)

EN 15686:2010, *Railway applications – Testing for the acceptance of running characteristics of railway vehicles with cant deficiency compensation system and/or vehicles intended to operate with higher cant deficiency than stated in EN 14363:2005, Annex G* (9.9.1.2)

EN 15687:2010, *Railway applications – Testing for the acceptance of running characteristics of freight vehicles with static axle loads higher than 225 kN and up to 250 kN* (9.9.1.2)

EN 15734-2:2010, *Railway applications – Braking systems of high speed trains – Part 2: Test methods* (8.11.2.1, 9.4.1.2, 9.4.1.5)

EN 15806:2010, *Railway applications – Braking – Static brake testing* (8.11.2.1)

EN 15839:2012, *Railway applications – Testing for the acceptance of running characteristics of railway vehicles – Freight wagons – Testing of running safety under longitudinal compressive forces* (9.9.1.2)

EN 15892:2011, *Railway applications – Noise Emission – Measurement of noise inside driver's cabs* (8.19, 9.17.1)

EN 16185-2, *Railway applications – Braking systems of multiple unit trains – Part 2: Test methods* (in preparation) (8.11.2.1, 9.4.1.2, 9.4.1.5)

EN 16235, *Railway applications – Testing for the acceptance of running characteristics of railway vehicles – Freight wagons – Conditions for dispensation of freight wagons with defined characteristics from on-track tests according to EN 14363* (9.9.1.2)

EN 16404:2014, *Railway applications – Re-railing and recovery requirements for railway vehicles* (8.4)

EN 50343:2003, *Railway applications – Rolling stock. Rules for installation of cabling* (8.7.1)

Other standards are in preparation.

NOTE regarding EN 15663:

The nearest equivalent load cases from EN 15663 to those stated in IEC 61133 are as follows:

IEC 61133	EN 15663
Minimum load	Dead mass
Normal load	Operational mass under normal payload
Exceptional load	Design mass under exceptional payload.

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UIC Leaflet 544-2: 2nd Edition, 1983, *Conditions to be observed by the dynamic brake of locomotives and motor coaches so that the extra braking effort produced can be taken into account for the calculation of the braked-weight*

UIC Leaflet 546: 5th Edition, 1967 and 5 amendments, *Brakes – High power brakes for passenger trains*

UIC Leaflet 547: 4th Edition, 1989, *Brakes – Air brake – Standard programme of tests*

UIC Leaflet 623-1: 5th Edition, 2008, *Approval procedures for the diesel engines of motive power units*

UIC Leaflet 623-2: 6th Edition, 2010, *Approval tests for the diesel engines of motive power units*

UIC Leaflet 623-3: 3rd Edition, 2003, *Series test and acceptance conditions for diesel engines of motive power units*

UIC Leaflet 651: 4th Edition, 2002, *Layout of drivers' cabs in locomotives, railcars, multiple-unit trains and driving trailers*

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SOMMAIRE

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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APPLICATIONS FERROVIAIRES – MATÉRIEL ROULANT – ESSAIS DE MATÉRIEL ROULANT APRÈS ACHÈVEMENT ET AVANT MISE EN SERVICE

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La Norme internationale IEC 61133 a été établie par le comité d'études 9 de l'IEC: Matériels et systèmes électriques ferroviaires.

Cette norme est dérivée de l'EN 50215.

Cette troisième édition annule et remplace la deuxième édition parue en 2006. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

- Les références à des normes autres que des normes internationales ont été supprimées du texte principal; les notes ne font donc référence qu'à l'Annexe B;

- L'Annexe B a été mise à jour avec les informations européennes les plus récentes; les références croisées des STI et des EN avec les articles de l'IEC 61133 ont été ajoutées.

Le texte de cette norme est issu de la deuxième édition et des documents suivants:

FDIS	Rapport de vote
9/2096/FDIS	9/2132/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation de cette norme.

Cette publication a été rédigée selon les Directives ISO/IEC, Partie 2.

Le comité a décidé que le contenu de cette publication ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous "http://webstore.iec.ch" dans les données relatives à la publication recherchée. A cette date, la publication sera

- reconduite,
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- remplacée par une édition révisée, ou
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APPLICATIONS FERROVIAIRES – MATÉRIEL ROULANT – ESSAIS DE MATÉRIEL ROULANT APRÈS ACHÈVEMENT ET AVANT MISE EN SERVICE

1 Domaine d'application

La présente Norme internationale spécifie des critères généraux permettant de démontrer par des essais que les véhicules ferroviaires nouvellement construits et achevés satisfont aux normes ou autres documents normatifs.

La présente Norme internationale s'applique en tout ou en partie à tous les véhicules ferroviaires, à l'exception des véhicules spéciaux tels les véhicules de pose de voies, les nettoyeurs de ballast et les véhicules de transport de personnel. L'étendue de l'application de la norme à ces véhicules spéciaux sera précisément mentionnée au contrat afin de prendre en compte, si nécessaire, les exigences législatives.

NOTE 1 Les parties applicables de la norme dépendront du type de véhicule (par exemple: voyageurs, wagon, remorque motorisée, etc.).

NOTE 2 Le domaine d'application de la présente norme exclut les machines de construction, ainsi que les véhicules routiers/ferroviaires pour la construction et la maintenance des infrastructures ferroviaires.

NOTE 3 La présente norme ne traite pas des essais effectués sur des composants ou des équipements avant leur installation sur le véhicule.

Dans la mesure où la présente Norme internationale est applicable, elle peut être utilisée pour les matériels ci-après:

- équipements générateurs montés sur un véhicule prévu pour des fonctions auxiliaires;
- transmissions électriques utilisées sur les trolleybus ou véhicules similaires;
- équipements électriques de commande et auxiliaires des véhicules à propulsion autre qu'électrique;
- véhicules guidés, supportés ou mus électriquement par des systèmes qui n'utilisent pas l'adhérence roue sur rail.

NOTE 4 Des exigences techniques spécifiques s'appliquent aux véhicules exploités dans le domaine ferroviaire dans l'Union européenne. La source de ces exigences est donnée à l'Annexe B. Quand une exigence européenne s'applique à un article donné, une note est insérée à la fin de l'article.

2 Références normatives

Les documents suivants sont cités en référence de manière normative, en intégralité ou en partie, dans le présent document et sont indispensables pour son application. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60077 (toutes les parties), *Applications ferroviaires – Equipements électriques du matériel roulant*

IEC 60310:2015, *Applications ferroviaires – Transformateurs de traction et bobines d'inductance à bord du matériel roulant*

IEC 60322:2001, *Applications ferroviaires – Equipements électriques du matériel roulant – Règles relatives aux résistances de puissance de construction ouverte*

IEC 60349 (toutes les parties), *Traction électrique – Machines électriques tournantes des véhicules ferroviaires et routiers*

IEC 60494-1:2013, *Applications ferroviaires – Matériel roulant – Pantographes – Caractéristiques et essais – Partie 1: Pantographes pour véhicules grandes lignes*

IEC 60494-2:2013, *Applications ferroviaires – Matériel roulant – Pantographes – Caractéristiques et essais – Partie 2: Pantographes pour métros et tramways*

IEC 60529:1989, *Degrés de protection procurés par les enveloppes (Code IP)*

IEC 60571:2012, *Applications ferroviaires – Equipements électroniques utilisés sur le matériel roulant*

IEC 60850:2014, *Applications ferroviaires – Tensions d'alimentation des réseaux de traction*

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IEC 61377-1, *Applications ferroviaires – Matériel roulant – Partie 1: Essais combinés de moteurs à courant alternatif alimentés par onduleur et de leur régulation*

IEC 61377-2, *Applications ferroviaires – Matériel roulant – Essais combinés – Partie 2: Moteurs de traction à courant continu alimentés par hacheur et leur régulation*

IEC 61377-3, *Applications ferroviaires – Matériel roulant – Partie 3: Essais combinés des moteurs à courant alternatif, alimentés par un convertisseur à deux étages, et leur régulation*

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IEC 62278:2002, *Applications ferroviaires – Spécification et démonstration de la fiabilité, de la disponibilité, de la maintenabilité et de la sécurité (FDMS)*

IEC 62313:2009, *Applications ferroviaires – Alimentation électrique et matériel roulant – Critères techniques pour la coordination entre le système d'alimentation (sous-station) et le matériel roulant*

IEC 62425, *Applications ferroviaires – Systèmes de signalisation, de télécommunications et de traitement – Systèmes électroniques de sécurité pour la signalisation*

IEC 62427:2007, *Applications ferroviaires – Compatibilité entre matériel roulant et systèmes de détection de train*

IEC 62845, *Applications ferroviaires – Système de radiocommande à distance des véhicules de traction pour application de manoeuvre*

IEC 62846, *Railway applications – Current collection systems – Requirements for and validation of measurements of the dynamic interaction between pantograph and overhead contact line*[1]

ISO/IEC 17025, *Exigences générales concernant la compétence des laboratoires d'étalonnages et d'essais*

ISO 3095, *Acoustique – Applications ferroviaires – Mesurage du bruit émis par les véhicules circulant sur rails*

ISO 3381, *Applications ferroviaires – Acoustique – Mesurage du bruit à l'intérieur des véhicules circulant sur rails*

ISO 9001:2015, *Systèmes de management de la qualité – Exigences*

NOTE Pour les applications dans l'Union européenne, se reporter également aux références données à l'Annexe B.

3 Termes, définitions et abréviations

Pour les besoins du présent document, les termes, définitions et abréviations suivants s'appliquent.

3.1
c.a.
courant alternatif

3.2
autorité d'homologation
tout organisme autre que l'acheteur ayant autorité légale pour exiger que des essais soient effectués sur les véhicules relevant du domaine d'application de la présente norme et à qui il est nécessaire de démontrer la vérification de la conformité

Note 1 à l'article: Ces organismes peuvent être différents dans chaque pays et peuvent inclure des organismes de réglementation nationaux ou internationaux, des autorités nationales compétentes en matière de sécurité, des gestionnaires d'infrastructure et, en Europe, des organismes notifiés (voir Annexe B).

3.3
contrat
tous les points des spécifications techniques acceptés à la fois par le constructeur et l'acheteur. Le contrat comprend les spécifications techniques de l'acheteur, les réponses techniques du constructeur, les comptes-rendus de réunions et tous autres documents contractuels formalisés.

3.4
c.c.
courant continu

3.5
CEM
compatibilité électromagnétique

1 À publier.

3.6
gestionnaire d'infrastructure
entreprise qui gère l'infrastructure ferroviaire, y compris, par exemple, la voie, la signalisation, les communications et les structures

3.7
IP
protection contre la pénétration

Note 1 à l'article: L'abréviation "IP" est dérivée du terme anglais développé correspondant "Ingress Protection".

3.8
constructeur
entreprise qui a la responsabilité de maîtrise d'œuvre pour la fourniture du véhicule en tant que système

Note 1 à l'article: Il peut exister plus d'un constructeur si le contrat pour le véhicule est réparti entre deux ou plusieurs parties.

3.9
ateliers du constructeur
lieu où les véhicules sont assemblés et où les essais statiques sont généralement réalisés

3.10
niveau de modification
définition de l'état de modification de l'équipement pour lequel les résultats de l'essai sont valides

3.11
acheteur
entreprise qui commande le véhicule et qui en aura la propriété

Note 1 à l'article: L'acheteur peut avoir la responsabilité de négocier directement avec le constructeur, à moins que celle-ci ne soit déléguée à l'exploitant, au maître d'ouvrage ou à un consultant.

3.12
plan qualité
document spécifiant quelles procédures et ressources associées sont appliquées par qui et quand, pour un projet, un produit, un processus ou un contrat particulier (ISO 9000)

3.13
essai de série
essai auquel est soumis chaque véhicule en cours ou en fin de fabrication pour déterminer s'il respecte les critères spécifiés

3.14
relatif à la sécurité
assume la responsabilité de la sécurité

3.15
fournisseur
entreprise qui a la responsabilité de fourniture d'équipements individuels ou de groupes d'équipements au constructeur

3.16
ateliers du fournisseur
lieu où les équipements individuels ou les groupes d'équipements sont fabriqués

3.17
plan d'essai
plan des essais devant être réalisés par le constructeur tel qu'indiqué dans son plan qualité, y compris toutes les informations d'assistance concernant la conduite des essais

Note 1 à l'article: Dans le contexte de la présente norme, le plan d'essai inclut toutes les spécifications d'essai subordonnées.

3.18
essai de type
essai d'un ou plusieurs appareils, système ou véhicule achevé pour montrer que la conception est conforme aux spécifications exigées et aux normes applicables

3.19
UIC
Union Internationale des Chemins de Fer

3.20
exploitant
entreprise qui fera usage du véhicule

Note 1 à l'article: L'exploitant sera un exploitant ferroviaire qui peut être l'acheteur ou une autre partie qui utilise le véhicule pour le compte de l'acheteur par l'intermédiaire, par exemple, d'un accord de location.

3.21
documentation de validation
preuve documentée qu'un produit, un processus ou un service est conforme aux exigences ou autres documents normatifs spécifiés

3.22
essai volontaire
tout essai complémentaire (soit de type, soit de série) ajouté au plan d'essai après accord entre le constructeur et l'acheteur

3.23
WSP
antienrayeur

Note 1 à l'article: L'abréviation "WSP" est dérivée du terme anglais développé correspondant "wheelslide protection".

4 Exigences

4.1 Généralités

Le constructeur doit contrôler toutes les activités concourant à la qualité des produits pour garantir la satisfaction aux exigences des normes ou autres documents normatifs auxquels la déclaration fait référence.

A cet effet, le constructeur doit disposer de tous les moyens nécessaires pour exercer son contrôle à tous les niveaux (par exemple, matières premières, approvisionnements, production, produits finis et conditionnement). Les informations nécessaires sur le système qualité du constructeur et les résultats des essais doivent être disponibles.

Le constructeur doit mettre en place et maintenir un système qualité. Ce système doit comprendre des procédures vérifiables qui couvrent les opérations de contrôle en sortie et d'essai, y compris les normes de qualification du personnel, les spécifications d'essai, l'enregistrement des résultats d'essai, l'étalonnage des outils et instruments de mesure d'essai, le suivi de la documentation, le suivi des produits non conformes et de la formation du personnel.

Il est recommandé que les constructeurs mettent en place un système qualité conforme à l'ISO 9001.

Le plan qualité pour la conception, la fabrication, le contrôle et les essais du produit doit comprendre un plan d'essai définissant la façon dont le constructeur démontrera la conformité aux exigences spécifiées.

La configuration (numéros de type, numéros de série, statut de modification) des composants clés, y compris les révisions de logiciels, doit être consignée comme un enregistrement de "qualité".

Le contrat doit définir les différents essais à faire subir aux véhicules après achèvement et avant mise en service, afin d'assurer à l'acheteur que:

– les véhicules sont conformes aux exigences techniques du contrat (essais de type, 3.18; voir aussi 5.3.1);
– tous les véhicules sont conformes à la norme de conception validée par les essais de type (essais de série, 3.13; voir aussi 5.3.2);
– les véhicules satisfont à la législation appropriée (nationale ou régionale);
– les véhicules sont compatibles avec le système ferroviaire sur lequel ils doivent rouler, comme défini par écrit par le gestionnaire d'infrastructure.

Contrôle du véhicule, y compris l'installation de l'équipement, les canalisations et le câblage, ainsi que tous les essais de type et de série effectués sur les composants, doivent être menés de manière satisfaisante selon les normes et spécifications applicables, à l'exception de ce qui est permis en 6.1, avant de commencer les essais relevant du domaine d'application de la présente norme. Les essais traités par la présente norme doivent démontrer une interface appropriée avec les fonctions du véhicule.

La présente norme ne traite pas des types d'essais ci-après:

– essai d'endurance et de fiabilité;
– essai de développement;
– essai d'investigation (sauf pour lignes directrices uniquement);
– essai d'un système, tel qu'un essai combiné de sous-ensembles ou de systèmes.

NOTE Les exigences européennes pour les essais et le contrôle des produits sont spécifiées à l'Annexe B.

4.2 Laboratoires d'essai d'un tiers

S'il est prévu d'utiliser les laboratoires d'essai d'un tiers, cela doit être déclaré et accepté en détail; les laboratoires d'essai exigés et l'accréditation attendue doivent être inclus dans le plan d'essai (voir 4.3).

Ces dispositions doivent s'appliquer nécessairement aux:

– essais statiques requérant de transférer le véhicule vers un centre d'essai spécialisé n'appartenant ni au constructeur ni à l'acheteur;
– essais dynamiques réalisés sur un autre système n'appartenant ni au constructeur ni à l'exploitant.

Il est recommandé de faire appel à des laboratoires d'essai d'un tiers accrédités ISO/IEC 17025.

L'acheteur ou l'autorité d'homologation du pays concerné peut exiger que les essais soient effectués par un laboratoire d'essai accrédité indépendant du constructeur.

4.3 Plan d'essai

Les différents essais à réaliser doivent être présentés par le constructeur dans son plan qualité sous la forme d'un plan d'essai qui doit détailler les points suivants:

a) le programme d'essai;

b) les essais de type de composants et d'équipements devant être effectués avant d'entreprendre chaque essai de véhicule;

c) les laboratoires d'essai à utiliser, y compris, le cas échéant, les détails de leur accréditation et de leur compétence, ainsi que leur niveau d'indépendance vis-à-vis du constructeur;

d) les méthodes d'essai;

e) les conditions de charge du véhicule pour chacun des essais;

f) les conditions d'environnement pour chacun des essais;

g) les limites et tolérances de toutes les méthodes de mesure d'essai;

h) les critères d'acceptation de chaque essai;

i) la documentation de validation.

Le plan d'essai peut inclure des spécifications d'essai référencées pour inclure certains des détails ci-dessus.

Lorsque le contrat exige que la validation de certains essais ou documents incombe à l'acheteur ou à toute autorité d'homologation, ceux-ci doivent être identifiés dans le plan d'essai. Si le contrat ou les autorités d'homologation exigent que les preuves soient conservées, l'exigence doit être incluse dans le plan d'essai et l'acheteur doit accepter la spécification d'essai.

Lorsque le contrat doit démontrer la sécurité par une série d'essais issus d'une évaluation de la sécurité ou du risque réalisée conformément à l'IEC 62278 ou comme exigé par une autorité d'homologation externe, ces essais doivent être inclus dans le programme d'essai et identifiés en tant que tels dans le plan d'essai. Le terme "relatif à la sécurité" est utilisé (voir définition 3.14 dérivée de l'IEC 62425) dans la présente norme pour identifier ceux des essais qui pourraient rentrer dans cette catégorie. La décision finale quant à déterminer si un essai est relatif à la sécurité relève de ceux qui déterminent la contribution apportée par cet essai à la responsabilité liée à la sécurité.

Le processus vérifiable utilisé pour obtenir les informations nécessaires au plan d'essai doit s'assurer du caractère exhaustif de la liste des essais effectués pour soutenir la documentation de validation.

Après validation de chaque essai, la documentation de validation doit être préparée par le constructeur.

5 Catégories d'essais

5.1 Généralités

Le plan d'essai doit présenter les essais à effectuer dans les catégories ci-après:

a) les essais de mise au point préliminaires (voir 5.2);

b) les essais de réception, qui comprennent:

- les essais de type, voir 5.3.1;
- les essais de série, voir 5.3.2;
- les essais exigés par l'autorité d'homologation, voir 5.3.3;

c) les essais d'investigation (voir 5.4).

Les essais peuvent être simplifiés ou omis par accord entre l'acheteur et le constructeur:

1) s'il est démontré que les véhicules concernés sont identiques aux véhicules construits précédemment et déjà utilisés ou si les véhicules sont équipés de moteurs ou autres composants importants spécifiés par l'acheteur;
2) s'il peut être démontré par une preuve documentaire que des essais équivalents ont été réalisés dans des conditions représentatives;
3) par accord avec les autorités d'homologation compétentes, si spécifié dans le contrat. Les informations exigées peuvent être fournies par référence à d'autres normes.

5.2 Essais de mise au point préliminaires

Avant de soumettre le véhicule aux essais de réception, le constructeur peut exiger d'effectuer des essais de mise au point préliminaires qui ne peuvent pas être réalisés dans les ateliers du constructeur et qui peuvent impliquer de procéder à des essais sur les lignes ferroviaires de l'exploitant avec ou sans application de charge. Dans ce cas, le nombre d'essais minimal exigé pour une marche en toute sécurité (voir 6.2) doit être au moins effectué à la satisfaction de l'exploitant et du gestionnaire d'infrastructure.

Il convient de fixer au contrat la distance totale maximale de la série d'essais pour obtenir les réglages nécessaires, qui doit tenir compte du type de véhicule, plus particulièrement de sa vitesse maximale et des nouveaux dispositifs intégrés. En l'absence de valeur spécifiée dans le contrat, il convient d'adopter une marche maximale de 5 000 km pour les véhicules qui doivent être soumis aux essais de type.

5.3 Essais de réception

5.3.1 Essais de type

Ces essais doivent être effectués dans une durée convenue pour montrer que la conception du véhicule satisfait aux exigences de performance spécifiées dans le contrat. Ils sont énumérés dans les Tableaux A.1 et A.2 de l'Annexe A et décrits aux Articles 8 et 9.

Les essais doivent être effectués sur les premiers véhicules construits selon la conception définie sauf accord contraire au moment de l'établissement du contrat et disposition correspondante incluse dans le plan d'essai.

Si les essais de type sont effectués sur un prototype ou un véhicule de présérie, le constructeur doit conclure un accord avec l'acheteur pour spécifier les essais complémentaires à réaliser sur le premier véhicule de la série, lesdits essais devant être inclus dans le plan d'essai.

Les essais doivent être réalisés dans les conditions d'essai appropriées, telles qu'explicitées à l'Article 6.

Les essais de type volontaire ne peuvent être exigés que si le plan d'essai en fait mention.

5.3.2 Essais de série

Ces essais doivent être exécutés sur chaque véhicule fourni. Ils sont énumérés dans les Tableaux A.1 et A.2 de l'Annexe A et décrits aux Articles 8 et 9.

Il convient de sélectionner parmi les paramètres spécifiques utilisés pour l'essai de type ceux qui seront utilisés comme critères d'essai permettant de vérifier la conformité de chaque véhicule. Les essais de série doivent comporter des mesurages et des contrôles suffisants permettant de confirmer la conformité aux critères d'essai sélectionnés.

Les essais doivent être réalisés dans les conditions d'essai appropriées, telles qu'explicitées à l'Article 6.

Les résultats obtenus avec les essais de série doivent être, compte tenu des tolérances acceptables, tout aussi satisfaisants que ceux obtenus pour les essais de type.

Si les observations effectuées au cours des essais de type correspondants ne nécessitent pas de répéter tout l'essai de série, une plage ou un échantillon limité(e) d'essais de série, une forme simplifiée des essais énoncés dans les tableaux récapitulatifs ou des déclarations de conformité peuvent être acceptés par accord stipulé dans le contrat.

Les essais de série complémentaires nécessaires doivent faire l'objet d'un accord stipulé dans le contrat et être inclus dans le plan d'essai.

5.3.3 Essais exigés par l'autorité d'homologation

Les essais exigés par les autorités d'homologation et les essais de démonstration de la sécurité (voir 4.3) doivent être identifiés de manière claire dans le plan d'essai. Les essais considérés comme relevant de cette catégorie sont indiqués dans les Tableaux A.1 et A.2 de l'Annexe A.

5.4 Essais d'investigation

Les essais d'investigation sont des essais spéciaux à caractère facultatif effectués de manière à obtenir des informations complémentaires. Ces essais doivent être réalisés uniquement si le contrat le spécifie.

Ces essais peuvent être convenus par accord entre exploitant et constructeur. Dans chaque cas particulier, l'acheteur et le constructeur doivent convenir de la méthode et du programme de réalisation de ces essais.

Les résultats des essais d'investigation ne doivent pas être utilisés comme motif de non-réception du véhicule.

6 Conditions d'essai

6.1 Généralités

Sauf spécification contraire, les essais doivent être effectués dans les conditions ambiantes habituelles.

Le plan d'essai doit prendre en compte la nature et le site de chaque essai et il convient qu'il couvre:

a) les programmes d'essai de type et de série, notamment dans les cas où la présente norme laisse un libre choix aux parties;

b) les essais statiques (voir 6.2);

c) les essais dynamiques (voir 6.3);

d) les méthodes d'essai des conditions d'environnement (par exemple: neige, pluie, poussière, température, etc.) lorsque ces conditions sont saisonnières;

e) les essais en usine effectués sur les composants qui, en raison du nombre insuffisant de laboratoires d'essai appropriés dans les ateliers du fournisseur, doivent être réalisés sur le véhicule achevé (essais statiques ou dynamiques);

f) les exigences d'essai pour un équipement fourni par l'exploitant ou l'acheteur et installé dans le véhicule; ces exigences font l'objet d'un accord préalable entre les parties concernées, y compris le constructeur de l'équipement concerné.

6.2 Essais statiques

Il convient normalement d'effectuer ces essais, décrits à l'Article 8, dans les ateliers du constructeur.

Ces essais doivent également vérifier que le véhicule est suffisamment sûr pour pouvoir entreprendre les essais dynamiques.

Les laboratoires d'essai doivent être appropriés et suffisants pour s'assurer que les essais sont effectués de manière cohérente; à défaut, le constructeur doit informer l'acheteur de toute limitation des laboratoires d'essai qu'il propose eu égard à ces essais.

Lorsque des essais qui nécessitent le transport du véhicule depuis ou vers un laboratoire sont effectués dans le laboratoire d'essai d'un tiers (voir 4.2), les essais nécessaires pour s'assurer que le transport peut être effectué en toute sécurité doivent être réalisés par le constructeur.

6.3 Essais dynamiques

Les essais dynamiques sont décrits à l'Article 9.

Les essais peuvent être effectués sur les lignes sur lesquelles l'utilisation du véhicule est prévue ou, si celles-ci ne sont pas disponibles, sur des lignes de caractéristiques équivalentes ou dans des laboratoires d'essai dédiés spécialisés. Les arrangements et les emplacements d'essai doivent être spécifiés dans le contrat.

Il convient que les arrangements pour l'accès aux lignes et la disposition du personnel roulant le cas échéant soient inclus dans les conditions spécifiées dans le contrat.

Il convient que l'exigence d'exécution d'un essai ne l'emporte pas sur les réglementations des gestionnaires d'infrastructure ou du gestionnaire de laboratoire d'essai concernés.

Il convient que la disposition de toutes les installations nécessaires par l'acheteur ou le fournisseur du laboratoire d'essai pour toute préparation d'essais dynamiques (y compris l'exécution de l'essai préliminaire) soit incluse dans les conditions spécifiées dans le contrat.

Lorsque les essais dynamiques doivent être effectués sur la voie d'un autre gestionnaire d'infrastructure, l'itinéraire retenu, ses caractéristiques et les conditions de circulation doivent faire l'objet d'un accord au moment de l'élaboration du contrat.

L'attention est attirée sur la nécessité de s'assurer que les responsabilités de toutes les parties concernées par la réalisation des essais dynamiques sont clairement définies.

L'attention est également attirée sur la nécessité d'achever toutes les actions préliminaires exigées, par exemple l'application des parties des dossiers fiabilité, disponibilité et maintenabilité et des dossiers sécurité, avant d'entreprendre les essais dynamiques.

7 Documentation de validation

La documentation de validation doit contenir suffisamment d'informations pour identifier le véhicule et tous ses principaux composants et doit permettre de les retrouver dans les enregistrements d'essai. Cette documentation doit fournir au minimum:

a) le nom et l'adresse de l'entreprise établissant la documentation;

b) le nom et l'adresse du constructeur;

c) l'identification du véhicule et de ses principaux composants par leur nom, type, numéro de modèle et toute information complémentaire pertinente, par exemple le numéro de contrat, de lot ou de série et le niveau de modification;

d) les normes ou documents normatifs référencés au contrat ou dans le plan d'essai d'une manière claire et concise;

e) toute information complémentaire, par exemple la matière ou la classe des composants du véhicule;

f) la date d'établissement de la documentation;

g) la signature et le titre ou identifiant équivalent du signataire autorisé.

8 Programme des essais statiques

8.1 Généralités

Le constructeur doit élaborer le programme des essais statiques, comme défini dans le plan d'essai. Le Tableau A.1 donne une liste indicative d'essais statiques qui peuvent être inclus dans ce programme. Cette liste, qui ne doit pas être considérée comme exhaustive, peut servir de directives dans le processus d'élaboration du plan d'essai par le constructeur.

En l'absence d'exigence spécifique dans le contrat, les essais ci-après doivent faire partie du plan d'essai en fonction du type de véhicule objet du contrat.

Sauf stipulation contraire dans l'en-tête de paragraphe, les exigences suivantes concernent à la fois les essais de type et les essais de série. Lorsque des exigences différentes sont spécifiées pour ces essais, elles sont détaillées dans des paragraphes séparés pour les essais de type et pour les essais de série.

8.2 Essais de vérifications dimensionnelles

8.2.1 Objectif

Vérifier que les dimensions extérieures du véhicule, les distances d'isolement dans l'air et les connexions flexibles complètement assemblées et en ordre de marche sont conformes aux limites fixées au contrat.

8.2.2 Essais de type

8.2.2.1 Dimensions extérieures (essai relatif à la sécurité)

Pour chaque type de véhicule, les dimensions extérieures du véhicule (y compris, par exemple, la hauteur de voiture, la hauteur de coupleur, la hauteur de bogie) doivent être mesurées et comparées aux limites fixées dans le contrat, ce qui peut comprendre les conditions suivantes:

a) la plage de réglage de tous les composants appropriés (par exemple, suspension pneumatique);

b) la plage de tolérances d'usure et de dégradation (par exemple, usure des roues);

c) la plage des conditions de charge (voir 8.5.2);

d) la plage de déplacement en cas de défaut ou de dommage (par exemple, aux composants de la suspension);

e) les combinaisons les plus défavorables des cas a) à d) ci-dessus.

Les distances d'isolement dans l'air d'organes qui peuvent dépasser les dimensions limites, par exemple les portes s'ouvrant vers l'extérieur, doivent être prises en compte et vérifiées dans les conditions de service si cela est exigé au contrat.

Lorsque les dimensions sont déterminées par calcul, les dimensions appropriées doivent être identifiées afin de les vérifier et de les intégrer au plan d'essai.

NOTE Les exigences européennes de mesure des wagons de marchandises sont données à l'Annexe B.

Lorsque le contrat ne définit pas de gabarit de charge statique pour le véhicule, le constructeur doit déclarer une enveloppe cinématique ou une saillie conformément aux règles convenues dans ce même contrat. Les essais exigés pour justifier l'enveloppe cinématique ou la saillie doivent être inclus dans le plan d'essai. La détermination de l'enveloppe ou de la saillie doit tenir compte des conditions a) à e) ci-dessus, ainsi que de l'intégration d'éléments aux dimensions limites (voir 8.3).

8.2.2.2 Essai de vérification des distances d'isolement dans l'air (essais relatifs à la sécurité)

Des essais doivent être effectués pour vérifier que les distances d'isolement dans l'air spécifiées sont respectées lors des mouvements relatifs pour les conditions de charge et la géométrie de la voie spécifiées dans le contrat de la manière suivante, entre:

a) les caisses des véhicules et leurs bogies;

b) les véhicules adjacents accouplés.

Voir la note après 8.2.2.3 ci-dessous.

8.2.2.3 Essais de longueur des tuyaux et câbles

Des essais doivent être effectués pour déterminer la longueur appropriée pour les tuyaux et câbles de bogies et entre les voitures résultant des mouvements relatifs spécifiés en 8.2.2.2 pour les conditions de charge et la géométrie de la voie spécifiées dans le contrat.

NOTE Les distances d'isolement dans l'air et les longueurs déterminées au moyen des essais 8.2.2.2 et 8.2.2.3 peuvent être calculées et vérifiées également par un essai qui peut être exécuté de façon statique, à l'aide d'un plateau tournant de bogie et d'un câble porteur transversal ou lors des essais dynamiques.

8.2.2.4 Essais statiques avec organe de captage du courant (essais relatifs à la sécurité)

Il doit être déterminé, au moyen d'un essai statique, que les organes de captage du courant fonctionnent de manière satisfaisante dans les limites de mouvement et de force de contact statique spécifiées dans le contrat.

Les essais doivent être réalisés sur les pantographes, y compris les dimensions limites de déplacement latéral, spécifiées dans l'IEC 60494-1 ou l'IEC 60494-2.

NOTE Les exigences relatives au gabarit sont mentionnées dans la Fiche UIC 505-1. Les exigences européennes sont données à l'Annexe B.

8.2.3 Essais de série

Les essais de vérification des dimensions extérieures (8.2.2.1) et les essais de vérification des distances d'isolement dans l'air (8.2.2.2) doivent être effectués dans une seule condition de charge (voir 8.5.2) et limités aux dimensions principales déterminées à partir de l'essai de type.

Les pièces comportant un appareil de réglage selon l'usure des roues (telles que les calandres, les sécurités, les chasse-neige, les conduites de sablage et les antennes) doivent être contrôlées afin de vérifier qu'elles sont correctement réglées.

8.3 Essai de gabarit

8.3.1 Objectif

S'assurer que l'enveloppe du véhicule est conforme à la conception.

8.3.2 Généralités (essai de type et relatif à la sécurité)

Le contrat peut préciser la dimension du véhicule de différentes manières, exigeant différents essais de vérification, par exemple:

Gabarit de construction – si les dimensions du véhicule sont spécifiées, les contrôles dimensionnels décrits en 8.2 constituent une vérification suffisante.

Enveloppe cinématique – si une enveloppe cinématique est spécifiée, les contrôles dimensionnels en 8.2 et une analyse des mouvements dynamiques du véhicule sont exigés, ainsi que l'essai de coefficient de souplesse (essai de débattement latéral) (8.3.3) afin de valider les calculs utilisés dans l'analyse.

Saillie – si le véhicule circule sur une ligne où les distances d'isolement dans l'air sont inférieures aux distances d'isolement dans l'air normales spécifiées par le gestionnaire d'infrastructure, une saillie, prenant en considération les sections de centre et d'extrémité représentées sur des courbes, peut être exigée, de même que l'essai de coefficient de souplesse (essai de débattement latéral) (8.3.3) afin de valider les calculs de la saillie.

NOTE Les exigences européennes sont données à l'Annexe B.

8.3.3 Essai de vérification du coefficient de souplesse (essai de type et relatif à la sécurité, volontaire ou obligatoire)

Cet essai est volontaire, à moins d'être exigé pour vérifier le calcul d'une enveloppe cinématique ou d'une saillie; dans ce cas, il doit s'agir d'un essai de type obligatoire pour chaque type de véhicule concerné, lorsque le type concerné a des caractéristiques représentatives d'un certain nombre de types de véhicules.

NOTE La Fiche UIC 505-5 définit le coefficient de souplesse. Les exigences européennes sont données à l'Annexe B.

Le constructeur doit fournir les valeurs calculées du coefficient de souplesse du véhicule aux états de charge minimale et exceptionnelle (voir 8.5.2).

Le coefficient de souplesse doit être déterminé par une mesure directe statique (essai de débattement latéral), sauf si la méthode de détermination de l'enveloppe du véhicule permet un essai roulant dynamique.

8.3.4 Essai de série ou équivalent (essai relatif à la sécurité)

La géométrie de chaque véhicule doit être vérifiée par des moyens appropriés, par exemple un essai de série, avec un modèle ou un processus de production contrôlé.

8.4 Essai de vérification d'aptitude au levage (essai de type et relatif à la sécurité)

8.4.1 Objectif

Vérifier l'aptitude au levage du véhicule dans les conditions spécifiées au contrat.

8.4.2 Essai de type

L'essai consiste à lever le véhicule par les points de levage définis à l'aide de ponts-grues ou de vérins. Il doit être vérifié que les interfaces, fixations, déformations, etc. mécaniques du

véhicule restent dans les tolérances contractuelles. Les essais doivent au minimum démontrer que le véhicule peut être levé sans que cela occasionne de déformation permanente.

NOTE Les exigences européennes relatives aux essais de levage pour le réenraillement et le rétablissement sont données à l'Annexe B.

8.5 Essais de pesage

8.5.1 Objectif

S'assurer que la masse du véhicule et sa répartition sont conformes aux limites contractuelles.

Cela comprend généralement, pour chaque type de véhicule, des essais sur les paramètres suivants:

a) la masse du véhicule;

b) la charge à l'essieu mesurée;

c) la charge à la roue mesurée.

8.5.2 Conditions de charge

Les conditions de charge doivent être spécifiées au contrat. Les conditions de charge recommandées sont données au Tableau 1.

Tableau 1 – Conditions de charge recommandées

	Charge minimale	Charge normale	Charge exceptionnelle
Charges voyageurs/commerciales	0	Voir le texte suivant	
Outillage	Intégral		
Personnel	0	Supplément complet	
Niveau de sable	0	2/3	Intégral
Eau pour chauffage, toilettes, restauration, etc.	0	2/3	Intégral
Combustible	0	2/3	Intégral
Liquides de refroidissement et lubrifiants de moteur thermique	Normal	Normal	Normal
Autres liquides et lubrifiants	Normal	Normal	Normal

En l'absence d'autre information fournie par l'acheteur, les charges pour les véhicules destinés à transporter des voyageurs ou des marchandises doivent être déterminées comme suit:

– Charge minimale: état de charge du véhicule spécifié dans le contrat et dans lequel le véhicule est achevé, qui permettra le déplacement ou le remorquage de ce dernier.

– Charge normale: charge spécifiée dans le contrat pour les essais de performances, par exemple traction ou freinage.

– Charge exceptionnelle: charge maximale qui peut être utilisée en toute sécurité dans les conditions spécifiées dans le contrat et utilisée pour des essais de performances spécifiques, par exemple, freinage d'urgence.

Pour les véhicules qui ne sont pas destinés à transporter des voyageurs ou des marchandises, par exemple les locomotives, la charge voyageurs/commerciale normale et exceptionnelle est supposée nulle, c'est-à-dire la même qu'en situation de charge minimale.

Afin de réduire au minimum les manutentions de charges additionnelles, les essais de vérifications dimensionnelles et les opérations de pesage peuvent être:

– effectués dans le même état de charge;

– exécutés dans des états de charge autres que ceux spécifiés contractuellement, sous réserve d'apporter des corrections appropriées aux valeurs relevées.

NOTE Les exigences européennes des conditions de charge sont données à l'Annexe B.

8.5.3 Essais de type (essais relatifs à la sécurité)

La masse du véhicule et la charge verticale que chaque roue transmet à la voie doivent être mesurées et doivent être accompagnées d'un énoncé qui mentionne la précision de l'instrument de mesure. Les essais de pesage sont normalement effectués dans les ateliers du constructeur, mais peuvent être effectués, après accord, dans les laboratoires de l'acheteur ou de l'exploitant. Si l'instrument de mesure est utilisé en extérieur (hors d'un bâtiment), les effets des conditions d'environnement dominantes (par exemple, vent et pluie) doivent être consignés et pris en compte.

Sauf spécification contraire dans le contrat, l'état de charge du véhicule lors des opérations de pesage doit correspondre à la charge minimale et à la charge exceptionnelle. Les essais réalisés avec une charge normale peuvent être des essais d'investigation ou volontaires.

Les essais de pesage peuvent être précédés d'un réglage de la suspension, effectué avec des moyens qui n'exigent pas en principe la mesure des charges, mais uniquement des vérifications de caractère dimensionnel.

Les systèmes de suspensions primaire et secondaire doivent être actionnés immédiatement avant l'essai (par exemple, en faisant circuler le véhicule sur un tronçon de voie de niveaux différents) afin de réduire la possibilité de forces de verrouillage excessives et d'excentrement du véhicule.

Le véhicule doit être acheminé, à vitesse réduite, avec les amortisseurs à friction déconnectés et les attelages entre bogies desserrés (lorsqu'ils sont installés) à l'emplacement de pesage. Après activation du système de suspension, ainsi que pendant le pesage, le véhicule ne doit subir aucune opération de modification ou de réglage. L'état de la caisse et de la suspension déclenché par l'activation préalable du système de suspension et provenant du frottement entre les divers organes de la suspension ne doit pas être modifié artificiellement au moyen de coups, secousses ou autres.

Quatre opérations successives et complètes de pesage doivent être réalisées, le véhicule étant déplacé et mesuré deux fois dans l'un et l'autre sens, afin d'éliminer le plus possible les erreurs dues aux imprécisions d'équilibrage et aux frottements.

La valeur des mesures effectuées doit être prise comme la moyenne arithmétique des valeurs relevées au cours des opérations de pesage.

Des méthodes de pesage alternatives peuvent être appliquées, le cas échéant, au système de suspension du véhicule (par exemple, suspension à ressorts ou suspension pneumatique) ou à l'équipement de pesage disponible (par exemple, acheminement du véhicule jusqu'à l'emplacement de pesage, puis abaissement vertical de ce dernier sur la balance de pesage). Dans ce cas, les conditions et le nombre d'opérations de pesage doivent être définis dans le contrat.

La masse du véhicule et la charge sur les essieux individuels et les roues doivent satisfaire aux exigences spécifiées dans le contrat, en fonction des points suivants:

– la masse maximale et minimale, ainsi que la tolérance admissible sur la masse totale du véhicule;

– la charge maximale et la tolérance admissible sur la charge de chaque essieu du véhicule;
– la différence de charge d'un côté du véhicule par rapport à l'autre.

Les mesures ci-après doivent être soumises à l'essai si cela est prévu au contrat:

– le surplus de masse du véhicule en ordre de marche par rapport à celle spécifiée au contrat;
– pour les engins moteurs, la charge adhérente statique;
– pour les engins moteurs, la charge à l'essieu moteur comparée à la valeur moyenne des charges aux essieux moteurs destinés à exercer le même effort de traction;
– la charge à l'essieu comparée à la valeur admise sur les lignes sur lesquelles le véhicule doit circuler; cette valeur doit être indiquée au contrat;
– la charge à la file de roues comparée à la moyenne des charges aux deux files de roues et, pour un essieu donné, la charge à la roue comparée à la charge moyenne à la roue de cet essieu.

NOTE Les exigences européennes relatives aux tolérances de charge à l'essieu sont mentionnées dans les spécifications techniques d'interopérabilité identifiées à l'Annexe B.

8.5.4 Essais de série (essais relatifs à la sécurité)

Les essais de pesage définis en 8.5.3 doivent être effectués avec les restrictions ci-après.

L'état de charge du véhicule doit être la charge minimale.

Deux opérations successives de pesage doivent être effectuées.

Pour les wagons et les voitures non motorisées, une déclaration de conformité est acceptable si cela est convenu dans le contrat.

8.6 Essais d'étanchéité

8.6.1 Objectif

Vérifier que l'étanchéité (par exemple la classe IP conformément à l'IEC 60529) du véhicule et des filtres, séparateurs ou dispositifs similaires satisfait aux performances spécifiées au contrat.

8.6.2 Essais de type

Le plan d'essai doit comprendre des essais effectués sur la caisse du véhicule, les coffres et armoires d'appareillages pour vérifier que les exigences spécifiées dans le contrat sont satisfaites. Le véhicule doit être pourvu de tous ses aménagements intérieurs, équipements et trappes. Les essais doivent tenir compte des facteurs définis dans les paragraphes suivants, le cas échéant:

a) Lorsque le contrat inclut des équipements de conditionnement d'air ou de pressurisation, les parties des véhicules ou des matériels munies de ces équipements doivent être soumises à l'essai conformément à 8.15.5.

b) L'étanchéité à l'eau de la caisse et des coffrets de matériels électriques montés à l'extérieur de la caisse, y compris l'ensemble des ouvertures, portes, trappes, couvre-joints ou interstices qui pourraient laisser pénétrer l'eau ou la neige, doit être soumise à l'essai.

   L'essai de validation de l'étanchéité à l'eau doit être réalisé dans des conditions représentatives de l'environnement dans lequel les véhicules doivent fonctionner. Le régime des essais représentatifs doit être convenu dans le contrat et inclus dans le plan d'essai.

L'étanchéité des ouvertures (entrées d'air, etc.), qui dépend essentiellement de la conception et l'étanchéité des trappes (portes, fenêtres, capots, etc.), qui dépend surtout du montage et de la tenue des joints, doivent faire l'objet d'une distinction.

L'étanchéité des ouvertures et des trappes, ainsi que l'efficacité des arrangements prévus pour évacuer l'eau de certains compartiments, doivent être suffisantes pour que les pénétrations d'eau constatées ne soient pas de nature à compromettre la tenue du câblage et le fonctionnement des matériels électriques ou de tout autre appareil nécessaire à la bonne marche du véhicule.

c) L'efficacité des persiennes, auvents, filtres, séparateurs de poussières et en général de tous les dispositifs prévus pour le nettoyage de l'air soufflé dans les coffrets de matériels doit être vérifiée pour s'assurer de la sécurité du câblage, des appareillages de connexion ou de tout autre appareil nécessaire au bon fonctionnement du véhicule.

d) Le bon montage des persiennes, filtres, séparateurs de poussière, etc., doit être vérifié.

e) Les dispositions destinées à prévenir l'entrée d'autres contaminants, par exemple la neige ou le sable, doivent être soumises à l'essai pour s'assurer du fonctionnement correct des équipements, le cas échéant.

Des lignes directrices supplémentaires sur les essais d'étanchéité des enveloppes sont fournies dans l'IEC 60529.

8.6.3 Essais de série (essais volontaires)

Un essai simplifié d'étanchéité à l'eau et d'autres essais spécifiques doivent être effectués comme prévu au plan d'essai.

8.7 Essais d'isolement électrique (essais de série)

8.7.1 Généralités

Objectif: Soumettre à l'essai le bon état d'isolement des circuits électriques du véhicule.

Ces essais sont des essais de série qui peuvent être effectués sur le véhicule achevé. Ces essais peuvent également être effectués sur le véhicule partiellement terminé, dans les ateliers du constructeur dès l'achèvement du câblage, après le montage, mais avant le raccordement des matériels électriques déjà soumis à l'essai individuellement en rigidité diélectrique. Dans ce dernier cas, une vérification de l'impédance d'isolement des différents circuits doit être réalisée, une fois le véhicule terminé.

Les équipements, par exemple les machines tournantes, qui ont subi au préalable des essais d'isolement suivant une norme agréée (IEC), peuvent également être débranchés avant l'essai d'isolement du véhicule.

Si le contrat exige une double isolation des matériels électriques par rapport à la caisse, par exemple pour les trolleybus, il doit être vérifié que cette double isolation est effective et que chaque partie du système d'isolation peut répondre aux exigences des essais d'isolement décrits dans le présent paragraphe.

NOTE D'autres exigences européennes pour les essais d'isolement sont données à l'Annexe B.

8.7.2 Essai de tenue en tension

En général, l'équipement est composé de plusieurs circuits présentant des niveaux d'isolement différents; chacun de ces circuits doit être soumis à l'essai séparément par rapport à la masse, tous les autres circuits étant en principe mis à la masse.

Lorsque nécessaire, il convient que les contacteurs et appareillages de commutation soient fermés ou court-circuités pour assurer la connexion de toutes les parties du circuit. Toutes les précautions doivent être prises pour éviter l'apparition éventuelle de tensions anormales dues à des effets capacitifs ou inductifs.

Les équipements susceptibles de subir des dégâts durant ces essais, par exemple les composants électroniques, doivent être débranchés ou court-circuités. Ces équipements doivent avoir subi au préalable un essai d'isolement suivant une norme agréée.

La tension d'essai de tenue en tension doit être appliquée durant 1 min entre chacun des différents circuits de câbles et la masse. Sa valeur doit être égale à 85 % de la tension d'essai des appareils individuels définie par les normes IEC en vigueur (par exemple, IEC 60077 (toutes les parties), IEC 60310, IEC 60322, IEC 60349 (toutes les parties), IEC 61287 (toutes les parties)), pour le composant du circuit ayant la plus faible tension d'essai.

8.7.3 Essai d'impédance d'isolement

En l'absence de valeur spécifiée au contrat, la tension d'essai doit être au moins de 500 V et les valeurs minimales d'impédance d'isolement mesurées ne doivent pas être inférieures à celles données ci-dessous:

– 5 MΩ dans le cas de circuits de tension assignée supérieure ou égale à 300 V en courant continu ou à 100 V en courant alternatif;

– 1 MΩ dans le cas de circuits de tension assignée inférieure à 300 V en courant continu ou à 100 V en courant alternatif.

Une valeur inférieure à 1 MΩ peut faire l'objet d'un accord dans le contrat afin de tenir compte de conditions reconnues, par exemple une forte humidité, l'utilisation de câbles blindés, etc.

Alternativement, le constructeur doit proposer les valeurs d'impédance d'isolement à utiliser, pour approbation par l'acheteur.

Ces conditions et les conditions ambiantes (température et humidité relative) doivent être consignées.

Si un essai d'impédance d'isolement est effectué avant et après l'essai de tenue en tension, les conditions d'essai doivent être les mêmes pour ces deux essais et l'impédance mesurée lors de l'essai effectué après l'essai de tenue en tension ne doit pas être inférieure de plus de 10 % à celle mesurée dans l'essai initial.

8.8 Essais des liaisons de protection et des circuits de retour (essais de série et essais relatifs à la sécurité)

Objectif: Vérifier que les liaisons de protection et les circuits de retour du véhicule satisfont à l'exigence du contrat.

Des connexions électriques sont exigées sur le véhicule:

a) afin de déterminer le potentiel électrique de différents circuits et des pièces mécaniques du véhicule, afin d'assurer une protection contre le risque de chocs électriques;

b) afin de protéger les roulements contre tout dommage dû aux effets des courants vagabonds;

c) afin d'assurer un trajet de retour à certains circuits (par exemple, retour du courant de traction, retour auxiliaire (dont circuit de chauffage du train)).

Des essais doivent être effectués pour s'assurer que les liaisons de protection et les circuits de retour satisfont aux exigences de la norme IEC 61991.

Il doit être vérifié que les connexions flexibles sont d'une longueur suffisante pour s'adapter aux mouvements relatifs maximaux des points connectés.

Il doit être également vérifié que les bornes de masse et de retour sont aisément accessibles et visibles pour une inspection visuelle.

8.9 Essais du système pneumatique

8.9.1 Généralités

Objectif: Vérifier que tous les composants pneumatiques fonctionnent conformément au contrat lorsqu'ils sont intégrés au véhicule et connectés au système pneumatique et que l'étanchéité des équipements pneumatiques est conforme aux limites établies dans le contrat.

Si le système de freinage n'est pas pneumatique, les essais décrits dans le présent paragraphe doivent alors s'appliquer selon le cas. Toute modification des critères d'essai doit être convenue dans le contrat et incluse dans le plan d'essai.

8.9.2 Etanchéité des réservoirs principaux et autres équipements pneumatiques (essai de série et relatif à la sécurité)

8.9.2.1 Généralités

Le véhicule circulant dans les conditions normales de fonctionnement, les réservoirs principaux d'air comprimé doivent être chargés à la pression maximale de service, puis isolés des compresseurs.

8.9.2.2 Réservoirs principaux et dispositifs associés

Les différents équipements pneumatiques (circuits de frein, portes, suspensions, dispositifs électropneumatiques, etc.) étant isolés et hors pression, il doit être vérifié que la baisse de pression dans les réservoirs principaux au terme de la période spécifiée contractuellement n'est pas supérieure à la valeur spécifiée dans le contrat.

En l'absence de valeur spécifiée dans le contrat, la pression ne doit pas baisser de plus de 20 kPa (0,2 bar) après une période de 5 min par rapport à une pression initiale comprise entre les pressions de réglage maximales et minimales auxquelles est réglée la pression des réservoirs principaux.

8.9.2.3 Réservoirs principaux et dispositifs associés combinés aux autres équipements pneumatiques

Les différents équipements pneumatiques sont sous pression (à l'exclusion de ceux qui sont prévus à la conception avec certaines fuites systématiques), mais ne fonctionnent pas; il doit être vérifié que pendant une période spécifiée dans le contrat la pression dans les réservoirs principaux n'a pas baissé d'une valeur également spécifiée au contrat.

En l'absence de valeur spécifiée, la pression ne doit pas baisser, au cours d'une période de 20 min, à une valeur inférieure à la valeur minimale compatible avec le bon fonctionnement de tous les équipements, par rapport à une pression initiale comprise entre les pressions de réglage maximales et minimales auxquelles est réglée la pression des réservoirs principaux.

S'il s'agit d'une automotrice ou d'une locomotive destinée à être accouplée avec des remorques pilotes dépourvues de réservoirs principaux et qui font partie intégrante de la même rame constituée ou de la même unité multiple, les essais décrits en 8.9.2.2 et en 8.9.2.3 doivent être répétés sur la rame constituée achevée. Les limites de temps et les fuites admissibles dans ce cas précis doivent être convenues dans le contrat selon la composition de la rame constituée ou de l'unité multiple.

Selon le type de freins utilisé, le mode opératoire d'essai d'étanchéité à l'air des conduites principales de frein doit être convenu dans le contrat et inclus dans le plan d'essai.

8.9.3 Etanchéité à l'air des cylindres de freins et des réservoirs auxiliaires (essai de série et relatif à la sécurité)

En agissant sur l'organe de commande de frein ou par un autre moyen, une pression maximale de service doit être appliquée aux cylindres de frein et aux réservoirs auxiliaires associés. Les conduits d'alimentation en air doivent ensuite être isolés.

En l'absence de valeur spécifiée dans le contrat, la pression dans les cylindres de frein ne doit pas baisser de plus de 10 kPa (0,1 bar) après 3 min.

8.9.4 Vérification du fonctionnement des équipements d'air comprimé (essai de type et relatif à la sécurité s'il y a lieu)

Le fonctionnement correct de tous les équipements d'air comprimé doit être vérifié, par exemple:

– dispositifs de sécurité et de protection;
– dispositif de régulation de pression;
– robinets d'isolement (soupapes d'arrêt);
– robinets de purge;
– capteurs de pression et manostats;
– régime du compresseur, si soumis à une vérification par simulation statique (voir également 9.18);
– avertisseurs sonores;
– sécheurs d'air.

Lorsque le contrat couvre une rame constituée ou une unité multiple, le fonctionnement doit être vérifié sur la rame achevée ou l'unité multiple.

8.10 Essais du système hydraulique (essais de type, de série et relatifs à la sécurité, le cas échéant)

Objectif: Vérifier que l'étanchéité à l'huile des équipements hydrauliques est conforme aux limites établies dans le contrat et que tous les composants hydrauliques fonctionnent comme spécifié au contrat, lorsqu'ils sont intégrés et connectés au système hydraulique.

L'essai de type doit vérifier le fonctionnement correct de tous les équipements hydrauliques, par exemple:

– pompes hydrauliques;
– moteurs hydrauliques (par exemple, groupe de refroidissement, ventilateur, etc.);
– dispositifs de sécurité et de protection;
– limiteurs de pression;
– clapets antiretour;
– robinets d'arrêt;
– robinets de purge.

Dans le cas de l'essai de série, le véhicule est en ordre de marche et le système hydraulique doit être rempli à la pression maximale de service puis isolé de la pompe. Il doit être vérifié que la baisse de pression dans le système hydraulique au terme de la période spécifiée dans le contrat n'est pas supérieure à la valeur contractuelle et qu'il n'y a aucun signe visible de fuite d'huile hydraulique.

8.11 Essais des systèmes de freins à friction

8.11.1 Généralités

Objectif: Vérifier que le système de frein fonctionne conformément à la conception, afin de s'assurer que les essais dynamiques peuvent être entrepris et que tous les véhicules sont fabriqués selon la même norme.

Les systèmes ci-après doivent être vérifiés quant à leur fonctionnement statique:

a) frein d'urgence;

b) frein de service;

c) interface entre le frein à friction et le frein électrique, lorsqu'ils sont installés (dans le cas d'une vérification par simulation en lieu et place d'un essai dynamique, voir 9.4);

d) interface avec d'autres systèmes comme l'antienrayeur, l'asservissement à la charge, la commande de traction (s'ils existent);

e) jeux des timoneries de frein.

8.11.2 Systèmes de freinage à action pneumatique

8.11.2.1 Essais de type (essais relatifs à la sécurité)

Ces essais ont pour but de vérifier, en liaison avec les essais de freinage dynamique, que le fonctionnement des systèmes de freinage et la valeur des forces appliquées aux garnitures ou semelles de frein répondent aux spécifications contractuelles.

Ces essais doivent être effectués après exécution des essais des systèmes pneumatiques spécifiés en 8.9. Il doit être vérifié que les timoneries de frein sont correctement réglées. Les essais doivent être effectués dans des conditions statiques pour le frein de service afin de vérifier les caractéristiques spécifiées contractuellement en ce qui concerne l'ensemble du système de freinage pneumatique, en particulier, les temps d'application et de desserrage des freins et les pressions maximales aux cylindres de frein dans différentes conditions de fonctionnement.

Les mesures de pression et de synchronisation sur les cylindres de frein doivent être répétées pour le frein d'urgence et un certain nombre de positions intermédiaires du manipulateur de frein de service.

Il convient de vérifier, le cas échéant, le fonctionnement des valves de réduction d'effort ou autres dispositifs antienrayeurs, par exemple le temps mort, le temps d'application et le temps d'échappement. Il convient également de vérifier le fonctionnement des valves d'échappement en accord avec le signal du système antienrayeur.

Lorsque le véhicule est équipé d'un système de réglage du freinage en fonction de la charge, les pressions aux cylindres de freins doivent être mesurées, avec le véhicule dans les conditions de charge minimale, normale et exceptionnelle. Cet essai peut être effectué avec des charges simulées, sous réserve que les dispositifs de détection de la charge soient soumis à l'essai au cours d'autres essais effectués avec chaque état de charge des véhicules.

NOTE Les exigences européennes pour les procédures d'essai statique de freinage sont identifiées à l'Annexe B.

8.11.2.2 Essais de série (essais relatifs à la sécurité)

Un essai simplifié doit être effectué pour éviter de charger le véhicule. Cet essai doit démontrer que tous les systèmes de freinage sont du même niveau de performance que ceux qui ont subi les essais de type.

8.11.3 Autres systèmes (essais de type, de série et relatifs à la sécurité, le cas échéant)

Lorsque les véhicules sont équipés d'autres systèmes de freinage destinés à ralentir ou à arrêter le train, comme des freins à ressort ou hydrauliques, à commande électrique ou mécanique, des freins de voie mécaniques ou magnétiques ou tout autre système, des essais de type et de série doivent être exécutés pour atteindre le même objectif que celui défini en 8.11.1, en respectant les mêmes principes que ceux définis en 8.11.2.

8.11.4 Systèmes de sablage (essais de type, de série et relatifs à la sécurité)

Lorsque le sablage est utilisé pour faciliter le freinage, les essais doivent démontrer que les exigences du système de sablage sont satisfaites sans interférer sur les systèmes d'infrastructure, par exemple les appareils de voie et les systèmes de localisation ou de fonctionnement des trains, par exemple le circuit de freinage, le circuit électrique ou les conduits d'alimentation en air. Les critères d'essai doivent être inclus dans le plan d'essai. Si des essais dynamiques sont exigés par le contrat, ils peuvent être combinés aux essais de freinage (voir 9.4).

Pour un essai de type, les vérifications suivantes doivent être réalisées par rapport au contrat, le cas échéant:

- l'activation correcte du sablage en mode freinage (et en mode traction lorsque prévu);
- le fonctionnement correct de l'interface avec le système de détection antienrayeur;
- les moyens d'isolement de la fonction de sablage et les indications associées;
- la commande manuelle (lorsque prévue);
- l'effet du sablage sur les conduits d'alimentation auxiliaires (y compris électriques et pneumatiques);
- le contrôle de la capacité des sablières, du débit de sablage et de son utilisation, le cas échéant;
- la spécification du sable;
- la projection du sable.

Pour un essai de série, un essai de fonctionnement simplifié qui permet de vérifier le débit doit être effectué. Lorsqu'une fonction d'essai manuelle est prévue, elle peut se révéler suffisante pour l'essai de série.

8.12 Essais de type du frein de stationnement (essais relatifs à la sécurité)

Objectif: Vérifier que le frein de stationnement satisfait aux exigences spécifiées dans le contrat.

Les critères d'essai visant à démontrer l'efficacité du frein de stationnement (conditions de fonctionnement et mesurage des forces appliquées) doivent être inclus dans le plan d'essai.

Si le maintien à l'arrêt du train pendant un temps limité est assuré par un frein de stationnement sujet à des fuites (frein hydraulique ou pneumatique par exemple), le frein doit être appliqué avec l'effort maximal; il doit en outre être vérifié que pendant une période spécifiée au contrat, il n'y a pas de perte significative de l'effort d'application.

NOTE La durée de l'essai du frein de stationnement dépend des conditions de fonctionnement.

8.13 Essais du système d'alimentation en énergie auxiliaire

8.13.1 Objectif

Vérifier que les systèmes d'alimentation en énergie auxiliaire fonctionnent conformément aux spécifications contractuelles lorsqu'ils sont intégrés au véhicule et connectés à leurs propres charges, y compris les chargeurs de batteries.

8.13.2 Essais de type (essais relatifs à la sécurité le cas échéant)

Les essais doivent vérifier les performances du système d'alimentation en énergie auxiliaire relié à ses charges dans la plage de charges définie dans les spécifications.

Il doit être vérifié que les puissances absorbées et fournies par les systèmes d'alimentation en énergie auxiliaires restent dans les limites du régime continu ou d'autres régimes, ces régimes étant ceux définis par les normes applicables, comme spécifié au contrat.

Si les composants du système d'alimentation en énergie auxiliaire n'ont pas fait l'objet d'un essai complet dans les ateliers du fournisseur, du fait, par exemple, de l'absence d'installations appropriées, des essais complémentaires peuvent alors être inclus dans le plan d'essai par accord entre le constructeur et l'acheteur.

Le plan d'essai doit inclure les critères d'essai relatifs aux éléments suivants:

– la mise sous tension;
– le couplage des charges, y compris le séquencement si nécessaire;
– la charge des batteries;
– les arrangements de refroidissement;
– délestage;
– les alimentations croisées (quand un ou plusieurs véhicules sont alimentés par une source d'alimentation alternative d'un autre véhicule), y compris les commutations lors des reconfigurations.

Le cas échéant (par exemple, lorsque des machines tournantes ou un système de refroidissement extérieur font partie intégrante du système), les essais spécifiés en 8.15.2 doivent également s'appliquer au système d'alimentation en énergie auxiliaire.

Lorsque l'alimentation approvisionne des fonctions essentielles pour la sécurité du train, par exemple les freins de voie magnétiques, les essais de type doivent être identifiés comme des essais relatifs à la sécurité dans le plan d'essai.

8.13.3 Essais de série

Des essais fonctionnels et de fonctionnement doivent être effectués à la tension nominale. Les caractéristiques du système d'alimentation en énergie auxiliaire à la tension nominale doivent être comparées aux exigences spécifiées dans le contrat et aux résultats de l'essai de type.

8.14 Essais des chargeurs de batteries

8.14.1 Objectif

Vérifier que la batterie et son système de charge satisfont aux exigences spécifiées dans le contrat.

8.14.2 Essai de type

Les essais suivants doivent être effectués sur la batterie du véhicule et le chargeur de batterie afin de vérifier:

a) que l'équipement de charge de la batterie est capable de fournir une charge suffisante, mais non excessive à la batterie, comme exigé dans le contrat;

b) que l'équipement est capable de charger la batterie dans toutes les conditions de charge prévues par la spécification contractuelle du véhicule, par exemple tensions d'alimentation maximale et minimale, plage de vitesses de fonctionnement du moteur thermique, limites de température ambiante, etc.;

c) que le chargeur, à l'exception des chargeurs spécifiques de réserve, est capable d'alimenter toutes les charges assignées à la batterie, ainsi que d'autres charges le cas échéant, lorsque le véhicule est en fonctionnement, en fonction du délestage;

d) que le régime de charge dans un cycle normal d'exploitation sur une période de 24 h permet à la batterie d'être complètement chargée;

e) que la ventilation des coffres renfermant les batteries est suffisante pour assurer qu'il ne se produit aucune accumulation dangereuse de gaz pendant les périodes de charge;

f) que la batterie déchargée est capable de maintenir le véhicule en fonctionnement pendant la période et dans les conditions spécifiées dans le contrat, notamment, en fonction des sources d'alimentation essentielles comme l'éclairage de secours (voir aussi 8.15);

NOTE Le mode dégradé (délestage) peut être utilisé, par exemple avec un éclairage réduit ou en déconnectant des systèmes non essentiels.

g) que l'ondulation de tension reste en deçà du niveau maximal spécifié au contrat lorsque le chargeur de batterie fonctionne avec une batterie déconnectée.

Afin de pouvoir vérifier que les paramètres du circuit de batterie indiqués ci-dessus sont conformes aux exigences du contrat pour les conditions spécifiées dans le contrat, les paramètres suivants doivent être mesurés de façon adéquate:

1) le courant de charge maximal;
2) la tension ou tension de charge maximale dans la plage de températures spécifiée, le cas échéant;
3) la tension d'entretien;
4) le courant d'entretien;
5) le courant de décharge;
6) le temps de décharge.

Les critères d'essai doivent être inclus dans le plan d'essai.

Ces essais peuvent être effectués au cours des essais de type du système d'alimentation auxiliaire.

8.14.3 Essai de série

Pour l'essai de série sur la batterie et le chargeur, il est suffisant de vérifier:

a) le courant maximal de charge et sa valeur limite;

b) la tension maximale;

c) la tension d'entretien en régime établi;

d) le courant d'entretien en régime établi.

8.15 Essais des systèmes auxiliaires et de commande

8.15.1 Objectif

Vérifier que les systèmes auxiliaires et de commande fonctionnent comme spécifié au contrat lorsqu'ils sont intégrés au véhicule et connectés à la source d'alimentation auxiliaire appropriée et aux autres charges d'interface.

8.15.2 Essais généraux

8.15.2.1 Essais de type

Pour chacun des systèmes définis en 8.15.3 à 8.15.8, il doit être vérifié, au cours des séquences d'essais statiques, que les fonctionnements individuels et séquentiels de tous les appareils des divers circuits, y compris par exemple les appareils électropneumatiques, sont corrects et n'ont pas été affectés au cours du montage final.

Toutes les interfaces des systèmes doivent être comprises dans ces essais.

Les distances d'isolement dans l'air des équipements assemblés doivent être vérifiées, notamment au niveau des connexions.

Si exigé par le contrat, l'exploitation fonctionnelle des dispositifs de protection contre les surcharges doit être vérifiée (à l'aide de signaux simulés si nécessaire). Il doit être vérifié que les réglages des dispositifs de protection et relais réglables, etc., sont corrects.

Il doit être vérifié que le fonctionnement des appareils électropneumatiques n'est pas entravé par une trop petite section de leurs conduits d'alimentation ou un réservoir d'une capacité insuffisante.

Dans le cas d'un refroidissement forcé des matériels électriques auxiliaires et de sources d'alimentation auxiliaire, si les équipements concernés n'ont pas été soumis à l'essai en plate-forme à l'aide des mêmes groupes de refroidissement et des conduits de refroidissement de mêmes dimensions que ceux installés dans le véhicule, un essai doit être réalisé pour s'assurer que le débit d'air de refroidissement dans le véhicule est conforme à celui qui a été défini lors de la conception ou spécifié dans le contrat. Le contrôle de ce débit peut se faire en mesurant la différence de pression statique à travers les équipements auxiliaires s'il a pu être établi au préalable un tableau de correspondance entre cette différence de pression statique et le débit d'air pour les équipements soumis à l'essai. Les conduits doivent être soumis à l'essai d'étanchéité.

Le sens de rotation des machines auxiliaires et l'ordre des phases des alimentations alternatives doivent faire l'objet d'une vérification.

Les essais de démarrage des machines auxiliaires doivent être effectués en fonction du cycle de service et de la plage de fonctionnement des machines, ainsi que des conditions de démarrage spécifiées au contrat.

8.15.2.2 Essais de série

Pour tous les systèmes cités en 8.15.3 à 8.15.8, des essais fonctionnels doivent être effectués à la tension nominale. Les essais doivent comprendre plus d'un démarrage des machines auxiliaires.

Pour éviter d'effectuer des essais d'interface pour chaque véhicule, une série simplifiée d'essais de fonctionnement, issue de l'essai de type et qui utilise des valeurs ou des simulations définies le cas échéant, peut être réalisée afin de vérifier que chaque véhicule satisfait aux critères d'essai, sous réserve que tous les équipements du véhicule soumis à l'essai soient utilisés. D'autres suggestions sont mentionnées en 8.15.3 à 8.15.8.