NF EN 15194

Mai 2009

www.afnor.org

DOCUMENT PROTÉGÉ PAR LE DROIT D'AUTEUR

Contacter :
AFNOR – Norm'Info
11, rue Francis de Pressensé
93571 La Plaine Saint-Denis Cedex
Tél : 01 41 62 76 44
Fax : 01 49 17 92 02
E-mail : norminfo@afnor.org

FE114880
ISSN 0335-3931

European standard
French standard

NF EN 15194
May 2009

Classification index: **R 30-009**

ICS: 43.150

Cycles

Electrically power assisted cycles

EPAC bicycles

F : Cycles — Cycles à assistance électrique — Bicyclettes EPAC
D : Fahrräder — Elektromotorisch unterstützte Räder — EPAC Fahrräder

French standard approved

by decision of the Director General of AFNOR on April 1, 2009 taking effect on May 1, 2009.

With the approved standards NF EN 14764, dated July 2006, NF EN 14765, dated June 2006, NF EN 14766, dated June 2006 and NF EN 14781, dated June 2006, is intended to replace NF R 30-020, dated October 1998.

Correspondence

The European standard EN 15194:2009 has the status of French standard.

Analysis

This document provides requirements for electrically power assisted cycles (EPAC). It was developed in response to a demand present in all of Europe. Its purpose is to provide a standard for evaluation of electrically power assisted cycles of a type that are excluded from the type approval according to Directive 2002/24/EC.

Because of limiting the voltage to 48 VDC, there is no requirement with regard to protection against electrical hazards. The electrically power assisted bicycles shall comply with Articles 4, 5 and 6 of the European standard EN 14764:2005 in addition to the specific requirements of this standard.

It applies to electrically power assisted cycles of a maximum continuous nominal power of 0,25 kW, whose power is gradually reduced and finally stopped when the vehicle reaches a speed of 25 km/h, or sooner, if the cyclist stops pedalling.

This document specifies the safety requirements and test methods for evaluating the design and assembly of electrically power assisted bicycles and sub-assemblies dedicated to systems using a battery voltage up to 48 VDC or an integrated battery charger with an input of 230 V. It specifies requirements and test methods for engine power management systems, electrical circuits including the charging system for the assessment of the design and assembly of electrically power assisted cycles and sub-assemblies for systems having a voltage up to and including 48 VDC or integrated a battery charger with a 230 V input.

Descriptors

Technical International Thesaurus: bicycles, children, safety, accident prevention, operating requirements, steering control devices, cycle frames, brakes, vehicle wheels, pneumatic tyres, pedals, vehicle saddles, lighting, tests, mechanical tests, braking tests, technical notices.

Modifications

With respect to the replaced document, adoption of the European standard.

Corrections

Published and distributed by Association Française de Normalisation (AFNOR — French standard institute) — 11, rue Francis de Pressensé — 93571 La Plaine Saint-Denis Cedex — Tel.: + 33 (0)1 41 62 80 00 — Fax: + 33 (0)1 49 17 90 00 — www.afnor.org

National foreword

References to French standards

The correspondence between the standards figuring in the clause "Normative references" and the identical French standards is as follows:

EN 14764	*: NF EN 14764 (classification index: R 30-005)*
EN 55014-1	*: NF EN 55014-1 (classification index: C 91-014-1)*
EN 55014-2	*: NF EN 55014-2 (classification index: C 91 014-2)*
EN 60034-1	*: NF EN 60034-1 (classification index: C 51-111)*
EN 61000-3-2	*: NF EN 61000-3-2 (classification index: C 91-003-2)*
EN 61000-3-3	*: NF EN 61000-3-3 (classification index: C 91-003-3)*
ISO 2575	*: NF ISO 2575 (classification index: R 19 130)*
ISO 11452-3	*: NF ISO 11452-3 (classification index: R 13-013-3)*
ISO 11452-5	*: NF ISO 11452-5 (classification index: R 13-013-5)*
IEC 60068-2-75	*: NF EN 60068-2-75 (classification index: C 20-775)*
IEC 60529	*: NF EN 60529 (classification index: C 20-010)*

The other standards mentioned in the clause "Normative references" that do not have any correspondence in the collection of French standards are as follows (they may be obtained from AFNOR):

ISO 11451-1

ISO 11452-1

ISO 11452-4

IEC 60364-5-52

CISPR 12

CISPR 25:2008

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 15194

January 2009

ICS 43.120; 43.150

English Version

Cycles - Electrically power assisted cycles - EPAC Bicycles

Cycles - Cycles à assistance électrique - Bicyclettes EPAC

Fahrräder - Elektromotorisch unterstützte Räder - EPAC Fahrräder

This European Standard was approved by CEN on 22 November 2008.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Ref. No. EN 15194:2009: E

Contents

Page

Foreword

This document (EN 15194:2009) has been prepared by Technical Committee CEN/TC 333 “Cycles”, the secretariat of which is held by UNI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by July 2009, and conflicting national standards shall be withdrawn at the latest by July 2009.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

This European Standard gives requirements for electric power assisted cycles (EPAC).

This European Standard has been developed in response to demand throughout Europe. Its aim is to provide a standard for the assessment of electrically powered cycles of a type which are excluded from type approval by Directive 2002/24/EC.

Due to the limitation of the voltage to 48 VDC, there are no special requirements applicable to the EPAC in regard to protection against electrical hazards.

EPACs are vehicles which use the same traffic areas as cars, lorries and motorcycles, which is predominantly the street. For this reason the products concerning EMC-testing have the same basic conditions. Chapter 8 of the EC Directive 97/24 contains a very high value concerning the immunity test of electronic components with 30 V/m, nevertheless based on the application area it comes up of the implementation. Manipulation of the electronic system of EPAC by other source of interference in the scope of the public road traffic could signify considerable risks of safety regulations for the user of EPAC. The standards EN 61000-6-1 as well as EN 61000-6-3 are standards for appliances in residential, commercial and light-industrial environments which do not reach the values for the EMC immunity-test necessary in the road traffic area. In these standards the EMC immunity of the electric and electronic systems will be tested only with 3 V/m, which is the tenth part of the requirements in chapter 8 of the EC Directive 97/24. These standards are unsuitable to obtain the urgent and necessary security level.

1 Scope

This European Standard is intended to cover electrically power assisted cycles of a type which have a maximum continuous rated power of 0,25 kW, of which the output is progressively reduced and finally cut off as the vehicle reaches a speed of 25 km/h, or sooner, if the cyclist stops pedalling.

This European Standard specifies safety requirements and test methods for the assessment of the design and assembly of electrically power assisted bicycles and sub-assemblies for systems using battery voltage up to 48 VDC or integrated a battery charger with a 230 V input.

This European Standard specifies requirements and test methods for engine power management systems, electrical circuits including the charging system for the assessment of the design and assembly of electrically power assisted cycles and sub-assemblies for systems having a voltage up to and including 48 VDC or integrated a battery charger with a 230 V input.

2 Normative references

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

EN 14764:2005, *City and trekking bicycles – Safety requirements and test methods*

EN 55014-1, *Electromagnetic compatibility – Requirements for household appliances, electric tools and similar apparatus – Part 1: Emission*

EN 55014-2, *Electromagnetic compatibility – Requirements for household appliances, electric tools and similar apparatus – Part 2: Immunity product family standard*

EN 60034-1, *Rotating electrical machines – Part 1: Rating and performance*

EN 61000-3-2, *Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current ≤ 16A per phase)*

EN 61000-3-3, *Electromagnetic compatibility (EMC) – Part 3-3: Limits – Section 3: Limitation of voltage fluctuations and flicker in low-voltage supply systems for equipment with rated current ≤ 16 A*

ISO 2575, *Road vehicles – Symbols for controls, indicators and tell tales*

ISO 11451-1, *Road vehicles – Vehicle test methods for electrical disturbances from narrowband radiated electromagnetic energy – Part 1: General principles and terminology*

ISO 11452-1, *Road vehicles – Component test methods for electrical disturbances from narrowband radiated electromagnetic energy – Part 1: General principles and terminology*

ISO 11452-2, *Road vehicles – Component test methods for electrical disturbances from narrowband radiated electromagnetic energy – Part 2: Absorber-lined shielded enclosure*

ISO 11452-3, *Road vehicles – Component test methods for electrical disturbances from narrowband radiated electromagnetic energy – Part 3: Transverse electromagnetic mode (TEM) cell*

ISO 11452-4, *Road vehicles – Component test methods for electrical disturbances from narrowband radiated electromagnetic energy – Part 4: Bulk current injection (BCI)*

ISO 11452-5, *Road vehicles – Component test methods for electrical disturbances from narrowband radiated electromagnetic energy – Part 5: Stripline*

IEC 60068-2-75:1998, *Environmental testing – Part 2: Tests – Test Eh: Hammer tests*

IEC 60364-5-52:2001, *Electrical installations of buildings – Part 5-52: Selection and erection of electrical equipment – Wiring systems*

IEC 60529:1991, *Degrees of protection provided by enclosures (IP Code)*

CISPR 12, *Vehicles, boats and internal combustion engines – Radio disturbance characteristics – Limits and methods of measurement for the protection of off-board receivers*

CISPR 25:2008, *Vehicles, boats and internal combustion engines - Radio disturbance characteristics - Limits and methods of measurement for the protection of on-board receivers*

3 Terms and definitions

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

3.1
cycle
vehicle that has at least two wheels and is propelled solely or mainly by the muscular energy of the person in that vehicle, in particular by means of pedals

3.2
bicycle
two-wheeled cycle

3.3
fully assembled bicycle
bicycle fitted with all the components necessary for its intended use

3.4
electrically power assisted cycle (EPAC)
cycle, equipped with pedals and an auxiliary electric motor, which cannot be propelled exclusively by means of this auxiliary electric motor

3.5
no load current point
current for which there is no torque on the driving wheel

3.6
full discharge of the battery
point at which the battery does not deliver any power/energy to the motor, according to the manufacturer's specifications

3.7
cut off speed
speed reached, by the EPAC, at the moment the current has dropped to zero or to the no load current value

3.8
maximum assisted speed by design
maximum design speed up to which assistance is provided

3.9
electromagnetic compatibility
ability of a vehicle or one of its electrical/electronic systems to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbance to anything in that environment

3.10
electromagnetic disturbance
electromagnetic phenomenon which may degrade the performance of a vehicle or one of its electronic/electrical systems

NOTE An electromagnetic disturbance may be electromagnetic noise, an unwanted signal or a change in the propagation medium itself.

3.11
electromagnetic immunity
ability of a vehicle or one of its electronic/electrical systems to perform without degradation of its performance in the presence of specific electromagnetic disturbance

3.12
electromagnetic environment
all electromagnetic phenomena present in a given situation

3.13
reference limit
nominal level to which both the component type-approval of the vehicle and the conformity-of-production limit value refer

3.14
reference antenna
balanced half-wave dipole tuned to the measured frequency

3.15
wide-band emission
emission which has a bandwidth exceeding that of a specific receiver or measuring instrument

3.16
narrow-band emission
emission which has a bandwidth less than that of a specific receiver or measuring instrument

3.17
electronic/electrical subassembly (ESA)
electronic and/or electrical component, or an assembly of components provided for installation into a vehicle, together with all electrical connections and associated wiring for the execution of several specific functions

3.18
ESA test
test carried out on one or more specific ESAs

3.19
vehicle type with regard to electromagnetic compatibility
vehicles that do not differ essentially in design and construction from the following aspect:

— general layout of the electronic and/or electrical components;

— overall size, layout and shape of the engine mounting and the disposition of the high-voltage wiring (where present);

— raw material from which both the vehicle chassis and bodywork are constructed (e.g., a chassis or body made of glass fibre, aluminium or steel)

3.20
ESA type in relation to electromagnetic compatibility
separate technical ESA unit that does not differ from other units in its essential design and construction aspects

NOTE For example:

— the function performed by the ESA;
— the general layout of the electronic and/or electrical components;
— direct vehicle control performed by the rider acting on the steering, the brakes and the accelerator control.

3.21
rated voltage
voltage declared by the manufacturer of the bicycle

3.22
continuous rated power
continuous (or constant) output power specified by manufacturer, at which the motor reaches its thermal equilibrium at given ambient conditions

NOTE Thermal equilibrium: temperatures of motor parts do not vary more than 2K per hour.

3.23
brake lever cut-off switch
device that cuts off the motor assistance while using the brake lever

3.24
integrated charger
charger which is a part of the bicycle and needs tools to be disassembled from it

4 Requirements

4.1 General

Electrically power-assisted bicycles shall comply with Clause 4, 5 and 6 of the European Standard EN 14764:2005 in addition to the specific requirements in Clause 4.2 of this standard.

4.2 EPAC specific additional requirements

4.2.1 Electric circuit

The electrical control system shall be designed so that, should it malfunction in a hazardous manner, it shall switch off power to the electric motor.

If symbols are used, their meaning shall be described in the instructions for use. Their function is one described in ISO 2575, their design shall be in accordance to that standard.

4.2.2 Batteries

4.2.2.1 Requirements

EPAC and pack of batteries shall be designed in order to avoid risk of fire, mechanical deterioration resulting from abnormal use. Compliance is checked by the test described in 4.2.2.2.

During the test the EPAC and the batteries shall not emit flames, molten metal or poisonous ignitable gas in hazardous amounts and any enclosure shall show no damage that could impair compliance with this European Standard.

Safety and compatibility of the combination battery/charger combination shall be ensured, according to the manufacturer's specifications.

The battery terminals shall be protected against creating an accidental short circuit. Care shall be taken to ensure that the batteries are protected against overcharging. An appropriate overheating and short circuit protection device shall be fitted.

NOTE Indication and example of solutions are given in Annex A.

Batteries and the charger unit shall be labelled in order to be able to check their compatibility.

4.2.2.2 Test method

1) Battery terminals are short-circuited with the batteries in a fully charged condition.

2) Motor terminals are short-circuited; all commands are in ON position, whilst the batteries are fully charged.

3) The EPAC is operated with the electric motor or drive system locked up so as to fully discharge the battery or until the system stops.

4) The battery is charged for double the recommended charging period or for 24 hours depending upon which is the longest period.

4.2.3 Electric cables and connections

4.2.3.1 Requirements

Cable and plug temperature shall be lower than that specified by the manufacturer of the cables and plugs. There shall be no corrosion on plug pins and no damage to cable and plug insulation.

4.2.3.2 Test method

Discharge the fully charged EPAC battery to the discharging limit specified by the EPAC or ESA manufacturer at the maximum current allowable by the system and record it, giving consideration to the electric motor and/or the controller and/or the battery controller. Measure the cable and plug temperatures and ensure, by examination, that there is no deterioration of the insulation on either assembly.

4.2.3.3 Wiring

a) Wire ways shall be smooth and free from sharp edges.

b) Wires shall be protected so that they do not come into contact with burrs, cooling fins or similar sharp edges that may cause damage to their insulation. Holes in metal through which insulated wires pass shall have smooth well-rounded surfaces or be provided with bushings.

c) Wiring shall be effectively prevented from coming into contact with moving parts.

Separate parts of the EPAC that can move in normal use or during user maintenance relative to each other, shall not cause undue stress to electrical connections and internal conductors, including those providing earthing continuity.

Compliance with a), b), c) shall be checked by inspection.

d) If an open coil spring is used, it shall be correctly installed and insulated. Flexible metallic tubes shall not cause damage to the insulation of the conductors contained within them.

Compliance with d) shall be checked by inspection and by the following test method.

If flexing occurs in normal use, the appliance is placed in its normal operational position and is supplied at rated voltage under normal operation.

e) The movable part is moved backwards and forwards, so that the conductor is flexed through the largest angle permitted by its construction.

For conductors that are flexed in normal use, flex movable part for 10 000 cycles at a test frequency of 0,5 Hz.

For conductors that are flexed during user maintenance, flex the movable part for 100 cycles at the same frequency at (20 ± 5) °C.

The wiring and its connections shall withstand the electrical strength test. The test voltage expressed in V shall be equal to $(500 + 2 \times Vr)$ for 2 min and applied between live parts and other metal parts only.

NOTE Vr is the rated voltage.

f) The insulation of internal wiring shall withstand the electrical stress likely to occur in normal use.

g) In case of integrated battery charger, electric safety of battery charger applies.

4.2.3.4 Power cables and conduits

Conduit entries, cable entries and knock-outs shall be constructed or located so that the introduction of the conduit or cable does not reduce the protection measures adopted by the manufacturer.

Compliance is checked by inspection.

NOTE Power cables selection should be made referring to IEC 60364-5-52:2001, Clauses 522.1.2, 523.1523.3 and Table A 52-10.

4.2.3.5 External and internal electrical connections

Electrical connection shall comply with IEC 60364-5-52:2001, Clauses 526.1 and 526.2.

4.2.3.6 Moisture resistance

The EPAC are subjected to the test of IEC 60529 as follows: IPX4 appliances as described in Clause 14.2.4.a.

4.2.3.7 Mechanical strength

EPAC shall have adequate mechanical strength and be constructed to withstand such rough handling that may be expected in normal use. Compliance is checked by:

— applying impacts to the battery pack mounted on the EPAC by means of the spring hammer as specified in IEC 60068-2-75. The battery pack is rigidly supported and three impacts are applied to every point of the enclosure that is likely to be weak with an impact energy of (0,7 ± 0,05) J. After the test the battery pack shall show no damage that could impair compliance with this European Standard;

— detachable battery packs are submitted to free fall at a height of 0,90 meter in three different positions.

After the test the battery pack shall show no damage that could lead to emission of dangerous substances (gas or liquid) ignition, fire or overheating.

NOTE It is recalled to the attention that batteries had to fulfil all relevant tests to ensure safety.

4.2.4 Power management

4.2.4.1 Requirements

When tested by the method described in 4.2.4.2 the recordings shall show that:

a) assistance shall be provided only when the cyclist pedals forward. This requirement has to be checked according to the test methods described in 4.2.4.2.2 a);

b) assistance shall be cut off when the cyclist stops pedalling forward such that the cut off distance does not exceed 5 m with the use of brake lever cut off switch or 2 m without the use of brake lever cut off switch. This requirement has to be checked according to the test methods described in 4.2.4.2.2 b);

c) the output or assistance shall be progressively reduced (see Annex B) and finally cut off as the vehicle reaches the maximum assistance speed as designed. This requirement has to be checked according to the test methods described in 4.2.4.2;

d) the assistance shall be progressively and smoothly managed.

4.2.4.2 Test method – Electric motor management

4.2.4.2.1 Test conditions

a) The test may be performed either on a test track, a test bench or on a stand which keeps the motor driven wheel free of the ground.

b) The test track shall be according to EN 14764:2005, Clause 4.6.8.5.1.1.

c) The time-measuring device shall have an accuracy of ± 2%.

d) The ambient temperature shall be between 5 °C and 35 °C.

e) Maximum wind speed shall not exceed 3 m/s.

f) The battery shall be fully charged according to the manufacturer's instructions.

4.2.4.2.2 Test procedure

a) Check that there is no electric motor assistance when pedalling backwards. The test to ensure the compliance to this clause shall be adapted to the technology used. For example, pedal backwards and check the no load current point or that no torque is delivered on the driving wheel.

b) Worst case conditions of gear ratio and speed shall be applied.

c) Worst condition for speed is defined as 90% of cut off speed.

d) Measure the distance travelled from cessation of pedalling and actuating the switch brake simultaneously (if any) to no power corresponding to no load current point provided by the electric motor by using:

— speed versus time measurement,

— direct or indirect torque versus distance measurement (e.g. motor current),

— or any other appropriate method.

e) Carry out the test ten times and then average.

4.2.4.3 Start up assistance mode

4.2.4.3.1 Requirements

EPAC can be equipped with a start up assistance mode up to 6 km/h designed speed or lower values as specified by the manufacturer. Unauthorized use shall be prevented.

This mode shall be activated by the voluntary and maintained action of the user either when riding without pedalling or when the user is pushing the cycle.

4.2.4.3.2 Test method

4.2.4.3.2.1 Test conditions

a) The test may be performed either on a test track, a test bench or on a stand that keeps the motor driven wheel free of the ground.

b) The speed-measuring device shall have the following characteristics:

— Accuracy: ± 2%

— Resolution: 0,1 km/h

c) The ambient temperature shall be between 5 °C and 35 °C.

d) Maximum wind speed: 3 m/s.

e) The battery shall be fully charged according to the manufacturer's instructions.

4.2.4.3.2.2 Test procedure

a) Pre-condition the EPAC by running it for 5 min at 80% of the maximum assistance speed as declared by the manufacturer, then stop.

b) Activate the start up assistance mode and verify that the speed increases up to 6 km/h maximum designed speed or lower value.

c) Verify that speed is going down to 0 km/h when start up assistance mode is deactivated and the current drops to a value equal to or less than no load current point when free rolling.

d) Activate the start up assistance mode.

e) Verify that speed decreases when the start up assistance mode is activated and the current drops to a value equal to or less than no load current point.

f) Activate the start up assistance mode and maintain it for 1 min.

g) Verify that speed is equal to or less than 6 km/h.

4.2.5 Electro Magnetic Compatibility

4.2.5.1 Emission

The EPAC and ESA shall conform to Annex C.

4.2.5.2 Immunity

The EPAC and ESA shall conform to Annex C.

4.2.5.3 Battery charger

As an EPAC is not intended to be used while charging, for integrated charger the whole EPAC plus integrated charger shall be tested.

The following European standards apply for battery charger: EN 55014-1, EN55014-2, EN61000-3-2, EN61000-3-3.

4.2.6 Maximum speed for which the electric motor gives assistance

4.2.6.1 Requirements

The maximum speed for which the electric motor gives assistance may differ by ± 5% of the speed indicated on the label described within Clause 5 when determined according to the test method described in 4.2.6.2, from 25 km/h or lower values as specified by the manufacturer.

During a production conformity check, the maximum speed may differ by ± 10% from the above-mentioned determined value.

4.2.6.2 Test method

4.2.6.2.1 Test conditions

a) The test may be performed either on a test track, a test bench or on a stand that keeps the motor driven wheel free of the ground.

b) The speed-measuring device shall have the following characteristics:

— Accuracy: ± 2%

— Resolution: 0,1 km/h

c) The ambient temperature shall be between 5 °C and 35 °C.

d) Maximum wind speed: 3 m/s.

e) The battery shall be fully charged according to the manufacturer instructions.

4.2.6.2.2 Test procedure

Any appropriate method for checking for this requirement is acceptable; one solution is to measure the cut-off speed, another being to measure the torque output. The following example describes the cut-off speed test.

a) Pre-condition the EPAC by running it for 5 min at 80% of the maximum assistance speed as declared by the manufacturer.

b) Record continuously the current and note the speed at which the current drops to a value equal to or less than “no load current point”.

c) Whilst pedalling, ride steadily to reach a speed equal to 1,25 times (if possible by design) the maximum assistance speed as declared by the manufacturer.

d) Verify the noted value in b) is equal to or less than the maximum speed declared by the manufacturer.

4.2.7 Maximum power measurement

4.2.7.1 Measurement at the engine shaft

The maximum continuous rated power shall be measured according to EN 60034-1 when the motor reaches its thermal equilibrium as specified by the manufacturer.

NOTE Thermal equilibrium: temperatures of motor parts do not vary more than 2K per hour.

In circumstance where the power is measured directly at the shaft of the electronic motor, the result of the measurement shall be decreased by 1,10 to consider the measurement uncertainty and then by 1,05 to include for example the transmission losses, unless the real values of these losses are determined.

4.2.7.2 Alternative method

When the power is measured at the wheel, the result of the measurement is the reading value.

Annex D gives guidance on how to measure the power at the wheel.

5 Marking, labelling

In addition to the requirements of EN 14764, the EPAC shall be visibly and durably marked according to EN 15194 as follows:

— EPAC
According to EN 15194

— XX km/h[1)]

— XX W[2)]

6 Instruction for use

In addition to the instructions required by the bicycles standard EN 14764, each EPAC shall be provided with a set of instructions containing information on:

1) concept and description of electric assistance;

2) recommendation for washing;

3) control and tell tales;

4) specific EPAC recommendations for use;

5) specific EPAC warnings;

6) recommendations about battery charging and charger use as well as the importance of following the instruction contained on the label of the battery charger.

---

1) cut off speed

2) electric motor maximum continuous rated power

Annex A
(informative)

Example of recommendation for battery charging

Safety and quality of battery charging can be greatly improved by sensing the battery temperature during charging.

Most battery charger manufacturers set their chargers to have an optimal ambient temperature of 20 °C to 25 °C. Lower temperatures result in under charge, higher temperatures result in over charge.

Whilst it is normal when building battery packs from Ni-Cad, Ni-Mh and Li-ion battery cells, to include temperature sensing, this is not always the case with valve regulated lead acid (VRLA) batteries.

The main reason for including temperature sensing in VRLA batteries is to protect against one or more cells within the battery pack becoming short circuited. This lowers the terminal voltage and can allow the charger to supply more power than is required, which can lead to a dangerous thermal situation.

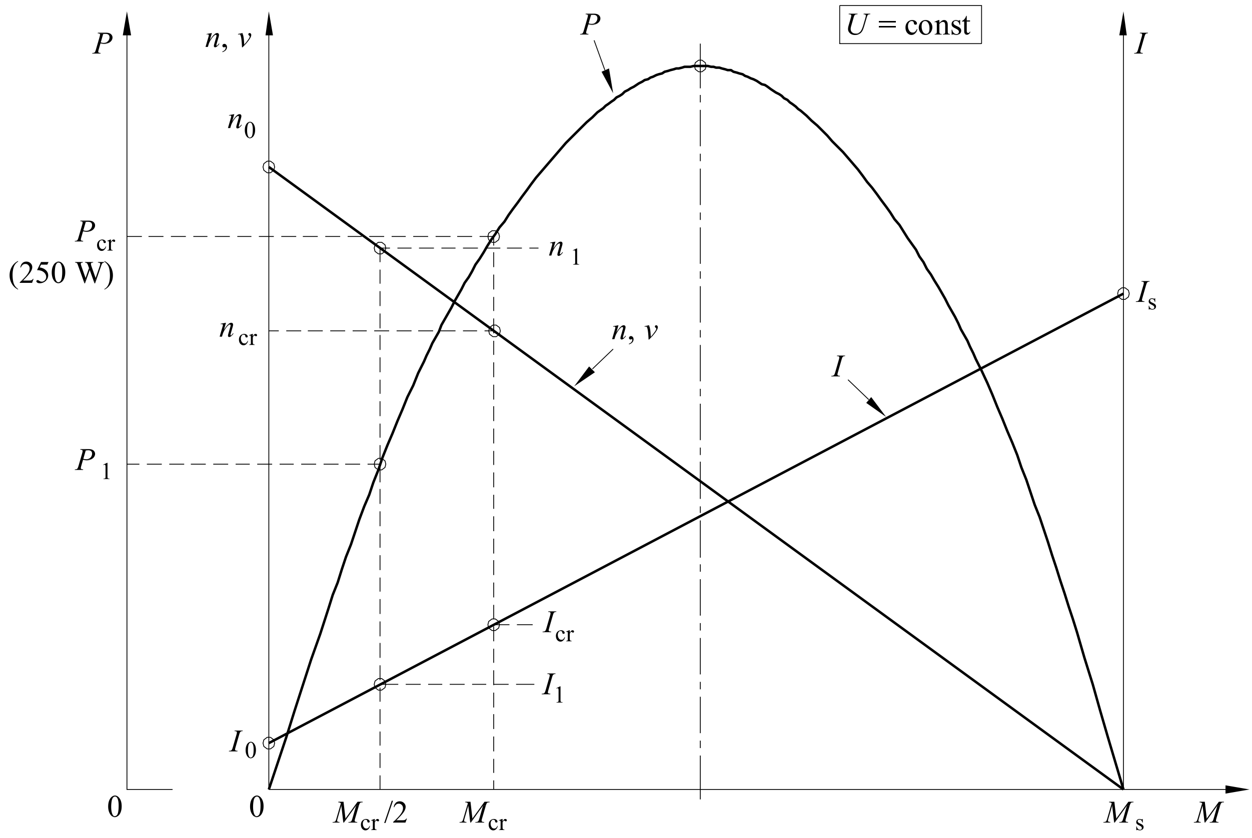
Temperature sensors should be fitted to each battery within the pack and this information fed back to the battery charger.

It is recommended that positive temperature coefficient (PTC) thermistors are used. All thermistors should be connected in series between the charger temperature pin (T) and the battery pack negative pin (-). Should any battery or cells within the pack reach the temperature given by the battery manufacturer (e.g.; 60 °C, 70 °C…) the charger thermal detection circuitry should be adjusted to detect this condition and take suitable measures to stop any further increase in temperature.

Annex B
(informative)

Example of relation between speed/torque/current

This Annex gives one example of relation between speed/torque/current with progressively reduced output power (see Figure B.1).



Key

Quantities		Indices	
U	voltage [V]	cr	continuous rated
M	torque [Nm]	s	standstill
n	speed [rpm]	0	no load
v	speed [km/h]	1	load point
I	current [A]	$n_0 \equiv v_0$ δ 25km/h	
P	output-power [W]		

Figure B.1 — Relation between P, n and M

The relationship between motor current I and torque M is linear according to:

$$M = k(I - I_0) \qquad \text{(B.1)}$$

where

M torque [Nm]
k torque constant [Nm/A]
I current [A]
I_0 no load current [A]

The relation of power is:

$$P = 2 \times \pi \times M \times n \qquad \text{(B.2)}$$

where

P output-power [W]
n speed [rpm]

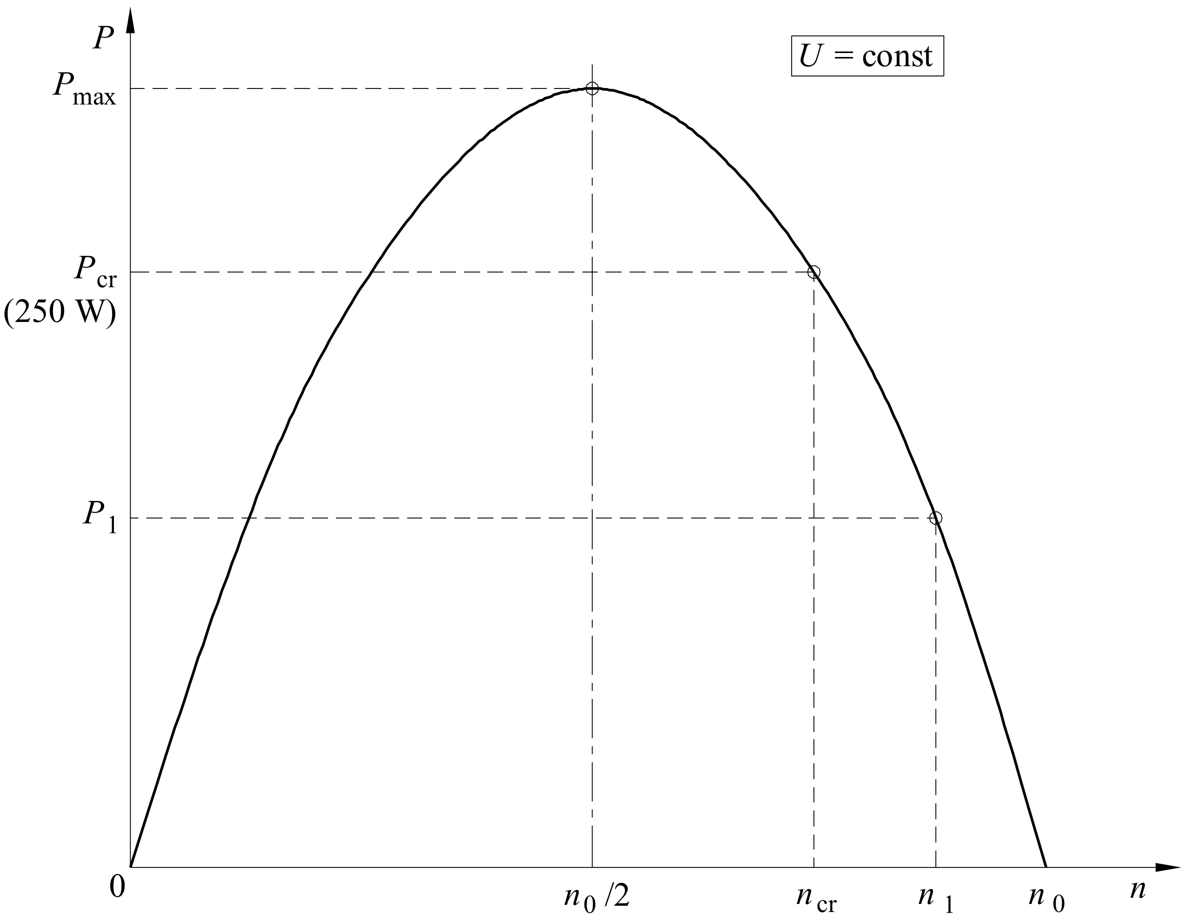


Figure B.2 — Speed-torque diagram function

Because the natural speed-torque-diagram is a linear falling function (at constant voltage U) the output-power-torque and the output-power-speed function is a parabolic one (see Figure B.2). Therefore, if the torque falls linear from M_{cr} (torque at P_{cr} – continuous rated power) to zero, the motor current falls linear to I_0 and the power P falls progressively from P_{cr} to zero.

The corresponding relations are: $P_1 > P_{cr} - P_1$ or $P_1 > \frac{P_{cr}}{2}$ if $n_1 = \frac{(n_{cr} + n_0)}{2}$ (B.3)

One can verify this relation in two steps:

Firstly, reducing the torque to $\frac{M_{cr}}{2}$ respectively increasing the speed to $n_1 = \frac{(n_{cr} + n_0)}{2}$, corresponding to $I_1 = \frac{(I_{cr} - I_0)}{2}$

Secondly, reducing the torque from $\frac{M_{cr}}{2}$ to zero respectively increasing the speed to no load speed n_0, corresponding to no load current.

In the first step, the reduction of power is smaller than in the second one.

So, the power is progressively reduced and finally cut off as the vehicle reaches the maximum assistance speed.

Annex C
(normative)

Electromagnetic compatibility of EPAC and ESA

C.1 Conditions applying to vehicles and to electrical/electronic sub-assemblies (ESA)

C.1.1 Marking

All ESAs, with the exception of cables shall bear the following and these marks shall be indelible and clearly legible:

a) make or name of the manufacturer of the ESAs and their components;

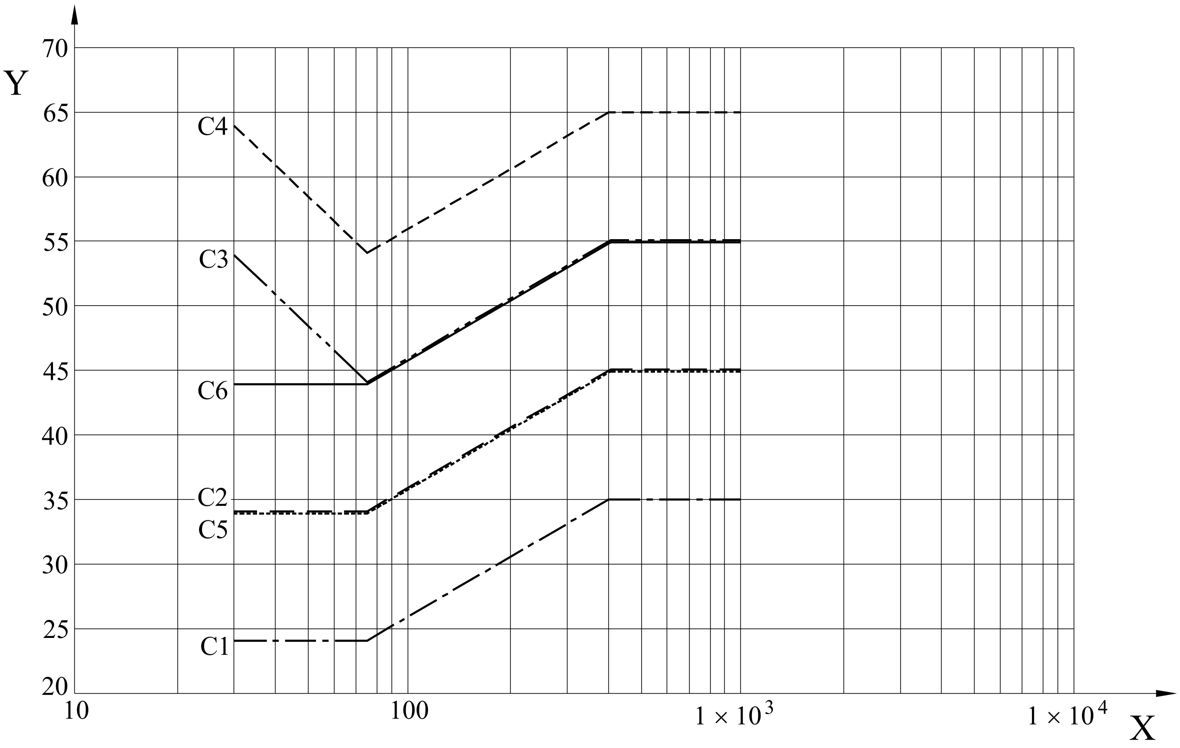
b) trade description.

C.1.2 Requirements

C.1.2.1 General requirements

All vehicles and ESAs shall be designed and constructed in such a way that, under normal conditions of use, they meet the conditions laid down in this annex.

NOTE An overview of the electromagnetic radiation emission reference limits is given in Figure C.1.



Key

X frequency f in MHz

Y reference limits L in dB [µV/m)

C1 requirements relating to narrow-band radiation emission from vehicle, antenna at 10 m

C2 requirements relating to broad-band radiation emission from vehicle, antenna at 10 m

C3 requirements relating to narrow-band ESA radiation emission, antenna at 1m

C4 requirements relating to broad-band ESA radiation emission, antenna at 1 m

C5 requirements relating to narrow-band radiation emission from vehicle, antenna at 3 m

C6 requirements relating to broad-band radiation emission from vehicle, antenna at 3 m

Figure C.1 — Overview of electromagnetic radiation emissions reference limits

Table C.1 — Overview of electromagnetic radiation emissions reference limits – Curves characteristics

Characteristic	**Value**	**Band-width**	**Antenna distance** [m]	**Equation for L** [dB(µV/m)] **within f** [MHz]		
				30…75	75…400	400…1000
C 1	mean value	narrow-band	10 ± 0,2	24=const.	24+15,13·log(f/75)	35=const.
C 2	quasi-peak	broad-band	10 ± 0,2	34=const.	34+15,13·log(f/75)	45=const.
C 3	mean value	narrow-band	1,0 ± 0,05	54-25,13·log(f/30)	44+15,13·log(f/75)	55=const.
C 4	quasi-peak	broad-band	1,0 ± 0,05	64-25,13·log(f/30)	54+15,13·log(f/75)	65=const.
C 5	mean value	narrow-band	3 ± 0,05	34=const.	34+15,13·log(f/75)	45=const.
C 6	quasi-peak	broad-band	3 ± 0,05	44=const.	44+15,13·log(f/75)	55=const.

However, the measuring methods used in checking the immunity of vehicles and ESAs to electromagnetic radiation are described in C.4 and C.7.

C.1.2.2 Broad-band radiation from vehicles

C.1.2.2.1 General

The electromagnetic radiation generated by the vehicle type submitted for testing are to be measured by the method described in C.2.

C.1.2.2.2 Vehicle reference limits (broad-band)

C.1.2.2.2.1 If measurements are taken using the method described in C.2, in respect of a vehicle-antenna distance of (10,0 ± 0,2) m, the radiation reference limit will be 34 dB microvolts/m in the 30-75 MHz frequency band and 34-45 dB microvolts/m in the 75 to 400 MHz frequency band. This limit will increase by the frequency logarithm for frequencies above 75 MHz. In the 400-1 000 MHz frequency band the limit remains constant at 45 dB.

C.1.2.2.2.2 If measurements are taken using the method described in C.2, in respect of a vehicle-antenna distance of (3,0 ± 0,05) m, 10 dB shall be added to the limit.

C.1.2.2.2.3 The measured values expressed in dB (microvolts/m) shall be 2 dB below the reference limit for the vehicle submitted for testing.

C.1.2.3 Requirements relating to narrow-band radiation emissions from vehicles

C.1.2.3.1 General

The electromagnetic radiation from the vehicle submitted for testing is to be measured by the method described in C.3.

C.1.2.3.2 Vehicle reference limits for vehicle narrow-band radiation

C.1.2.3.2.1 If measurements are taken using the method described in C.3, in respect of a vehicle-antenna distance of (10,0 ± 0,2) m, the radiation reference limit will be 24 dB in the 30-75 MHz frequency band and 24-35 dB in the 75-400 MHz frequency band. This limit will increase by the frequency logarithm for frequencies above 75 MHz. In the 400-1 000 MHz frequency band the limit remains constant at 35 dB.

C.1.2.3.2.2 If measurements are taken using the method described in C.3, in respect of a vehicle-antenna distance of (3,0 ± 0,05) m, 10 dB shall be added to the limit.

C.1.2.3.2.3 The measured values for the vehicle type submitted for testing expressed in dB (microvolts/m), shall be 2 below the reference limit.

For conformity of production testing do not remove the 2 dB from the reference limit.

C.1.2.4 Requirements regarding vehicle immunity to electromagnetic radiation

C.1.2.4.1 Measuring method

Tests to determine the immunity of the vehicle type to electromagnetic radiation shall be conducted in accordance with the method described in C.4.

C.1.2.4.2 Vehicle immunity reference limits

C.1.2.4.2.1 If measurements are taken using the method described in C.4, the field strength reference level shall be 24 volts/m r.m.s. in over 90 % of the 20 MHz to 2 000 MHz frequency band and 20 volts/m r.m.s. over the whole 20 MHz to 2 000 MHz frequency band.

C.1.2.4.2.2 The vehicle representative of the type submitted for testing shall not display any deterioration in the direct control of the vehicle which might be observed by the driver or by any other road user when the vehicle in question is in the state defined in C.4, and when it is subjected to the field strength expressed in volts/m, which shall be 25 % above the reference level.

C.1.2.5 Requirements concerning broad-band ESA radiation

C.1.2.5.1 Measuring method

The electromagnetic radiation generated by the ESA submitted for component type-approval shall be measured by the method described in C.5.

C.1.2.5.2 ESA broad-band reference limits

C.1.2.5.2.1 If measurements are taken using the method described in C.5, in respect of ESA antenna distance of (1,0 ± 0,05) m, the radiation reference limit will be 64-54 dB (microvolts/m) within the 30-75 MHz frequency band, this limit decreasing by the frequency logarithm, and 54-65 dB (microvolts/m) in the 75-400 MHz band, this limit increasing by the frequency logarithm.

In the 400-1 000 MHz frequency band the limit remains constant at 65 dB (1 800 microvolts/m).

C.1.2.5.2.2 The measured values for the ESA submitted for approval, expressed in dB (microvolts/m), shall be at least 2,0 dB below the reference limits.

C.1.2.6 Requirements concerning narrow-band ESA radiation emission

C.1.2.6.1 Method of measurement

The electromagnetic radiation generated by the ESA submitted for component type-approval is to be measured in accordance with the method described in C.6.

C.1.2.6.2 ESA narrow-band reference limits

C.1.2.6.2.1 If measurements are taken using the method described in C.6, in respect of ESA antenna distance of (1,0 ± 0,05) m, the radiation reference limit will be 54-44 dB (microvolts/m) in the 30-75 MHz frequency band, this limit decreasing by the frequency logarithm, and 44-55 dB (microvolts/m) in the 75-400 MHz band, this limit increasing by the frequency logarithm.

In the 400-1 000 MHz frequency band the limit remains constant at 55 dB (560 microvolts/m).

C.1.2.6.2.2 The measured values for the ESA submitted for competent type-approval, expressed in dB (microvolts/m), shall be at 2 dB below the reference limits.

For conformity of production testing do not remove the 2 dB from the reference limit.

C.1.2.7 Requirements concerning ESA immunity to electromagnetic radiation

C.1.2.7.1 Method of measurement

The immunity to electromagnetic radiation of the ESA submitted for component type approval will be tested by means of one of the methods described in C.7.

C.1.2.7.2 ESA immunity reference limits

C.1.2.7.2.1 If measurements are taken using the methods described in C.7, the immunity test reference levels will be 48 volts/m for the 150 mm stripline testing method, 12 volts/m for the 800 mm stripline testing method, 60 volts/m for the TEM cell testing method, 48 mA for the Bulk Current Injection (BCI) testing method and 24 volts/m for the Absorber lined Chamber testing method.

C.1.2.7.2.2 The ESAs representative of the type submitted for testing may not exhibit any malfunction which is able to cause any degradation on the direct control of the vehicle perceptible to the driver or other road user if the vehicle is in the state defined in Figure C.1 at a field strength or current expressed in appropriate linear units 25% above the reference limit.

C.2 Method of measuring broad-band electromagnetic radiation from vehicles

C.2.1 Measuring equipment

A peak detector shall be used to measure broad-band electromagnetic radiation.

Limits given in C.1.2.2.2.1 are for quasi-peak detector. It is possible to use peak detector, in this case a correction factor of 20 dB shall be applied to this limit.

NOTE The measuring equipment is described in CISPR 12.

C.2.2 Test method

According to CISPR 12.

C.2.2.1 Test conditions

According to CISPR 12.

C.2.2.2 State of the vehicle during the test

Apply a load in order to test at 75% ± 10% of the continuous rated power declared by the manufacturer.

NOTE 1 The load can be achieved by braking, home trainer…

NOTE 2 For example, the test can be performed when the engine is running alone or when the driver on it using the brake.

C.2.2.3 Antenna type, position and orientation

According to CISPR 12.

C.2.3 Measurement

According to CISPR 12.

C.3 Method of measuring narrow band electromagnetic radiation from vehicles

C.3.1 General

C.3.1.1 Measuring equipment

An average-value detector is used to measure narrow-band electromagnetic radiation.

NOTE The measuring equipment is described in CISPR 12.

C.3.1.2 Test method

According to CISPR 12.

C.3.1.3 Test conditions

According to CISPR 12.

C.3.1.4 State of the vehicle during the tests

Apply a load in order to test at 75% ± 10% of the continuous rated power declared by the manufacturer.

NOTE 1 The load can be achieved by braking, home trainer…

NOTE 2 For example, the test can be performed when the engine is running alone or when the driver on it using the brake.

C.3.2 Antenna type, position and orientation

According to CISPR 12.

C.4 Methods of testing vehicle immunity to electromagnetic radiation

C.4.1 General

These tests are designed to demonstrate the insensitivity of the vehicle to any factor which may alter the quality of its direct control. The vehicle shall be exposed to the electromagnetic fields, described in this Annex, and shall be monitored during the tests.

C.4.2 Expression of results

The field strengths shall be expressed in Volts/m for all the tests described in this Annex.

C.4.3 Test conditions

The test equipment shall be capable of generating the field strengths in the range of frequencies defined in this Annex, and shall meet the (national) legal requirements regarding electromagnetic signal. The control and monitoring equipment shall not be susceptible to radiation fields whereby the tests could be invalidated.

C.4.4 State of the vehicle during the tests

C.4.4.1 The mass of the vehicle shall be equal to the mass in running order.

a) The engine shall turn the driving wheels at a constant speed predetermined by the testing authority in agreement with the vehicle manufacturer.

b) All vehicle systems shall be operating normally.

c) There shall be no electrical connection between the vehicle and the test surface and no connections between the vehicle and the equipment, save where so required by C.4.4.1 a) or C.4.4.2.

d) The test shall be done in at least the following conditions:

   1) standstill mode;

   2) 90% of the "start up assistance mode";

   3) 90% of the design maximum assistance speed.

Contact between the wheels and the test surface is not regarded as an electrical connection.

C.4.4.2 Where ESA's are involved in the direct control of the vehicle and where these systems do not operate under the conditions described in C.4.4.1 a), the testing authority may carry out separate tests on the systems in question under conditions agreed with the vehicle manufacturer.

C.4.4.3 During the tests on the vehicle, only non-interference-generating equipment may be used.

C.4.4.4 Under normal conditions, the vehicle shall be facing the antenna.

C.4.5 Type, position and orientation of the field generator

C.4.5.1 Type of field generator

a) The criterion for the selection of the field generator type is the capacity of the latter to attain the prescribed field strength at the reference point (see C.4.5.4) and at the appropriate frequencies.

b) Either the antenna(s) or a transmission line system (TLS) may be used as the field generating device(s).

c) The design and orientation of the field generator shall be such that the field is polarised both horizontally and vertically at frequencies between 30 MHz and 2000 MHz.

C.4.5.2 Measurement height and distance

C.4.5.2.1 Height

C.4.5.2.1.1 The phase mid-point of all antennas shall not be less than 1,5 m above the vehicle plane.

C.4.5.2.1.2 No part of the antenna radiator elements shall be less than 0,25 m from the vehicle plane.

C.4.5.2.2 Measuring distance

C.4.5.2.2.1 Greater homogeneity of the field may be obtained by placing the field generator as far as technically possible from the vehicle. This distance will normally be in the range 1 to 5 m.

C.4.5.2.2.2 If the test is carried out in a closed installation, the radiator elements of the field generator shall not be less than 0,5 m from any type of radio frequency absorption material and not less than 1,5 m from the wall of the installation in question. There shall be no absorption material between the transmitting antenna and the vehicle under test.

C.4.5.3 Position of the antenna in relation to the vehicle

C.4.5.3.1 Reference point

C.4.5.3.1.1 The field generator shall be positioned in the median longitudinal plane of the vehicle.

C.4.5.3.1.2 No part of the TLS, except the vehicle plane, may be less than 0,5 m from any part of the vehicle.

C.4.5.3.1.3 Any field generator placed above the vehicle shall cover at least 75% of the length of the vehicle.

C.4.5.3.1.4 The reference point is the point at which the field strengths are established and is defined as follows:

a) horizontally, at least two metres from the antenna phase mid-point or, vertically, at least one metre from the TLS radiator elements;

b) in the median longitudinal plane of the vehicle;

c) at a height of (1,0 ± 0,05) m above the vehicle plane;

or

— at (1,0 ± 0,2) m behind the vertical centre line of the vehicle's front wheel in the case of tricycles;

or

— at (0,2 ± 0,2) m behind the vertical centre line of the vehicle's front wheel in the case of bicycles.

C.4.5.4 Position of the vehicle

If it is chosen to subject the rear part of the vehicle to radiation, the reference point shall be established as stated in C.5.3.1. In this case the vehicle will be positioned with its front part facing in the opposite direction to the antenna and as if it had been rotated horizontally through 180 degrees about its central point. The distance between the antenna and the nearest part of the outer surface of the vehicle shall remain the same.

C.4.6 Requisite test and condition

C.4.6.1 Range of frequencies, duration of the tests, polarisation

The vehicle shall be exposed to electromagnetic radiation in the 20-2000 MHz frequency range.

a) Measurement shall be made in the 20 to 2000 MHz frequency range with frequency steps according to ISO 11451-1, with a dwell time of (2 ± 0,2) s for each frequency.

b) The vertical polarisation modes described in C.4.5.1 c) shall be selected by common agreement between manufacturer and testing body.

c) All other test parameters are as defined in this clause.

C.4.6.2 Tests to check deterioration in direct control

C.4.6.2.1 A vehicle is deemed to fulfil the requisite immunity conditions if, during the tests carried out in the manner required by this clause, there are no abnormal changes in the speed of the vehicle's drive wheels, there are no signs of operational deterioration which might mislead other road users and there are no other noticeable phenomena which could result in a deterioration in the direct control of the vehicle.

C.4.6.2.2 For the purpose of monitoring the external part of the vehicle and of determining whether the conditions laid down in C.4.6.2.1 have been met, a video camera may be used.

C.4.6.2.3 If a vehicle does not meet the requirements of the tests defined in C.4.6.2, steps shall be taken to verify that the faults occurred under normal conditions and are not attributable to spurious fields.

C.4.7 Generation of the requisite field strength

C.4.7.1 Test method

a) The "substitution method" is to be used for the purpose of creating the field test conditions.

b) Substitution method: for each test frequency required, the RF power level of the field generator shall be set so as to produce the required test field strength at the reference point of the test area without the vehicle being present. This RF input power level, as well as all other relevant settings on the field generator shall be recorded in the test report (calibration curve). The recorded information is to be used for type-approval purposes. Should any alterations be made to the equipment at the test location, the substitution method shall be repeated.

c) The vehicle is then brought to the test installation and positioned in accordance with the conditions laid down in C.4.5. The power required by C.4.7.1 b) is then applied to the field generator for each of the frequencies indicated in C.4.6.1 a).

d) Whatever field-definition parameter is chosen in accordance with the conditions laid down in C.4.7.1 b), the same parameter shall be used in order to determine the strength of that field throughout the test.

e) For the purposes of this test, the same field generating equipment and the same equipment configuration shall be used as in the operations conducted in pursuance of C.4.7.1 b).

f) Field strength measuring device:

   under the substitution method, the device used to determine the field strength during the calibration stage should take the form either of a compact isotropic probe for measuring field strength or of a calibrated receiving antenna.

   During the calibration phase of the substitution method, the phase mid-point of the field-strength measuring device shall coincide with the reference point.

   If a calibrated receiving antenna is used as the field strength measuring device, readings will be obtained in three directions at right angles to each other. The equivalent isotropic value corresponding to these measurements is to be regarded as the field strength.

g) In order to take account of differences in vehicle geometry, a number of reference points shall be established for the relevant test installation.

C.4.7.2 Field strength contour

During the calibration phase (before the vehicle is positioned on the test surface) the field strength shall not be less than 50% of the nominal field strength at the following locations:

i) for all field-generating devices, (1,0 ± 0,02) m on either side of the reference point on a line passing through this point, and perpendicular to the median longitudinal plane of the vehicle;

ii) in the case of a TLS, (1,5 ± 0,02) m on a line passing through the reference point, and situated in the median longitudinal plane of the vehicle.

C.4.7.3 Characteristics of the test signal to be generated

C.4.7.3.1 Peak value of the modulated test field strength

The peak value of the modulated test field strength shall correspond to that of the unmodulated test field strength, the actual value in volts/m of which is defined in C.1.2.4.2.

C.4.7.3.2 Test signal waveform

The test signal shall be a radio-frequency sinusoidal wave, amplitude-modulated by a sinusoidal 1 kHz wave at a modulation rate m of 0,8 ± 0,04 (peak value).

C.4.7.3.3 Modulation rate

The modulation rate m is defined as follows:

m ≥ NUM > peak envelope value - minimum envelope value > DEN > peak envelope value + minimum envelope value

The envelope describes the curve formed by the edges of the modulated carrier as seen on an oscillograph.

C.4.8 Inspection and monitoring equipment

For the purposes of monitoring the external part of the vehicle and the passenger compartment and of determining whether the conditions laid down in C.4.6.2.2 have been met, use will be made of a video camera or cameras.

C.5 Method of measuring broad-band electromagnetic radiation from separate technical units (ESA)

C.5.1 General

C.5.1.1 Measuring equipment

A broad peak detector shall be used to measure broad-band electromagnetic emissions.

NOTE The measuring equipment is described in CISPR 12.

C.5.1.2 Test method - Test conditions

According to CISPR 25:2008 Absorber lined Chamber.

C.5.2 State of the ESA during the test

According to CISPR 25:2008 Absorber lined Chamber.

C.5.3 Antenna type, position and orientation

According to CISPR 25:2008 Absorber lined Chamber.

C.6 Method of measuring narrow-band electromagnetic radiation from separate technical units (ESAs)

C.6.1 General

C.6.1.1 Measuring equipment

A average-value detector is used to measure the narrow-band electromagnetic radiation.

NOTE The measuring equipment is described in CISPR 12.

C.6.1.2 Test method

According to CISPR 25:2008 Absorber lined Chamber.

C.6.2 Test conditions

According to CISPR 25:2008 Absorber lined Chamber.

C.6.3 State of the ESA during the tests

According to CISPR 25:2008 Absorber lined Chamber.

C.6.4 Antenna type, position and orientation

According to CISPR 25:2008 Absorber lined Chamber.

C.7 Methods of testing the ESA immunity to electromagnetic radiation

C.7.1 General

These tests are designed to demonstrate the insensitivity of the ESA to any factor which may alter the quality of its direct control. The ESA shall be exposed to the electromagnetic fields, described in C.7, and shall be monitored during the tests.

C.7.2 Expression of results

The field strengths shall be expressed in either in mA (BCI) or in Volts/m for all the other tests described in C.7.

C.7.3 Test conditions

The test equipment shall be capable of generating the current or the field strengths in the range of frequencies defined in this Annex, and shall meet the (national) legal requirements regarding electromagnetic signal. The control and monitoring equipment shall not be susceptible to radiation fields whereby the tests could be invalidated.

C.7.4 State of the ESA during the tests

Where ESA's are involved in the direct control of the vehicle and where these systems do not operate under the conditions described in C.4.4.1 a), the testing authority may carry out separate tests on the systems in question under conditions agreed with the vehicle manufacturer.

C.7.5 Requisite test and condition

C.7.5.1 Test methods

ESAs shall comply with the limits (C.1.2.7.2) for one of the following test methods, at the manufacturer's discretion, within the range of 20 - 2 000 MHz:

1) stripline test;

2) bulk current injection test;

3) TEM-cell test;

4) absorber lined Chamber, only in vertical polarization.

NOTE To avoid radiation from electromagnetic fields during tests, it is recommended to carry them out in a shielded area.

C.7.5.2 Range of frequencies, duration of the tests, polarisation

The vehicle shall be exposed to electromagnetic radiation in the 20-2 000 MHz frequency range.

1) Measurement shall be made in the 20 to 2000 MHz frequency range with frequency steps according to ISO 11452-1, with a dwell time of (2 ± 0,2) s for each frequency.

2) All other test parameters are as defined in this clause.

C.7.5.3 Tests to check deterioration in direct control

C.7.5.3.1 A vehicle is deemed to fulfil the requisite immunity conditions if, during the tests carried out in the manner required by this clause, there are no abnormal changes in the speed of the vehicle's drive wheels, there are no signs of operational deterioration which might mislead other road users and there are no other noticeable phenomena which could result in a deterioration in the direct control of the vehicle.

C.7.5.3.2 For vehicle observation purposes, only the monitoring equipment described in C.4.6.2.2 may be used.

C.7.5.3.3 If a vehicle does not meet the requirements of the tests defined in C.4.6.2, steps shall be taken to verify that the faults occurred under normal conditions are not attributable to spurious fields.

C.7.6 Generation of the requisite field strength

C.7.6.1 Test method

C.7.6.1.1 Stripline test

According to ISO 11452-5.

C.7.6.1.2 BCI test

According to ISO 11452-4.

C.7.6.1.3 TEM cel test

According to ISO 11452-3.

C.7.6.1.4 Absorber line Chamber test

According to ISO 11452-2.

C.7.6.2 Characteristics of the test signal to be generated

C.7.6.2.1 Peak value of the modulated test field strength

The peak value of the modulated test field strength shall correspond to that of the unmodulated test current or field strength, the actual value in mAmps or in volts/m of which is defined in C.1.2.7.2.

C.7.6.2.2 Test signal waveform

The test signal shall be a radio-frequency sinusoidal wave, amplitude-modulated by a sinusoidal 1 kHz wave at a modulation rate m of 0,8 ± 0,04.

C.7.6.2.3 Modulation rate

The modulation rate m is defined as follows:

m ≥ NUM > peak envelope value - minimum envelope value > DEN > peak envelope value + minimum envelope value

The envelope describes the curve formed by the edges of the modulated carrier as seen on an oscillograph.

C.7.7 Inspection and monitoring equipment

For the purposes of monitoring the external part of the vehicle and the passenger compartment and of determining whether the conditions laid down in C.4.6.2.2 have been met, use will be made of a video camera or cameras.

C.8 ESD test

ESD test shall be performed according to EN 61000-4-2 at 4 kV for contact discharge and 8 kV for air discharge with immunity criteria B.

Annex D
(informative)

Maximum power measurement - Alternative method

D.1 Generalities

This Annex gives guidance on how to measure the power at the wheel.

The maximum power which the bicycle gives assistance may differ by ± 5% of the power indicated on the label described in Clause 5. During a production conformity check, the maximum speed may differ by ± 10% from the above-mentioned determined value. The test shall be performed without pedalling using only the electrical assistance system (the test bicycle shall be prepared accordingly).

D.2 Test conditions

a) The test may be performed either on a test track, a test bench or on a stand that keeps the motor driven wheel free of the ground.

b) The speed-measuring device should have the following characteristics:

— Accuracy: ± 2%

— Resolution: 0,1 km/h

c) The ambient temperature should be between 5 °C and 35 °C.

d) Maximum wind speed: 3 m/s.

e) The battery should be fully charged according to the manufacturer's instructions.

f) The test should be performed with mass of the test bicycle equal to 150 kg.

D.3 Test procedure

Any appropriate method for checking for this requirement is acceptable.

a) Pre-condition the EPAC by running it for 5 min at 80% of the maximum assistance speed as declared by the manufacturer.

b) Stop the bicycle.

c) Note the time between the action start and the EPAC to travel 20 meters.

d) Verify the speed value is equal or less than the maximum speed declared by the manufacturer after 20 metres (D).

e) Verify the maximum continuous rated power at wheel is: $P = m \times \frac{2D^2}{T^3}$ with the time T which is the noted value in c).

NOTE Considering that on a test track, the engine temperature is not stable, and the grip of the tyre on the road can be variable, the result of the measurement should be decreased by 1,10 to consider the measurement uncertainty. The measure is compared to the limit given in the scope of this European Standard.

Bibliography

[1] EN 50272-4, *Safety requirements for secondary batteries and battery installations - Part 4: Batteries for use in portable appliances*

[2] EN 61000-4-2:2001, *Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques – Section 2: Electrostatic discharge immunity test – Basic EMC publication*

[3] EN 61000-6-1, *Electromagnetic compatibility (EMC) - Part 6-1: Generic standards; Immunity for residential, commercial and light-industrial environments*

[4] EN 61000-6-3, *Electromagnetic compatibility (EMC) - Part 6-3: Generic standards; Emission standard for residential, commercial and light-industrial environments*

[5] IEC 61951-1, *Secondary cells and batteries containing alkaline or other non acid electrolytes – Portable sealed rechargeable single cells – Part 1: Nickel cadmium*

[6] IEC 61951-2, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Portable sealed rechargeable single cells – Part 2: Nickel metal hydride*

[7] IEC 61960, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Secondary lithium cells and batteries for portable applications*

[8] IEC 62133, *Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for portable sealed secondary cells, and for batteries made from them, for use in portable applications*

[9] IEC/TR 62188, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Design and manufacturing recommendations for portable batteries made from sealed secondary cells*

[10] IEC/TR2 61438, *Possible safety and health hazards in the use of alkaline secondary cells and batteries – Guide to equipment manufacturers and users*

[11] IEC 62281, *Safety of primary and secondary lithium cells and batteries during transport*

[12] IEC 61959, *Secondary cells and batteries containing alkaline or other non-acid electrolytes - Mechanical tests for sealed portable secondary cells and batteries*

[13] IEC 60245-1, *Rubber insulated cables - Rated voltages up to and including 450/750 V - Part 1: General requirements*