

Electric Vehicle Safety

Session # 19

Proposal of amendments to the rules of the UN Regulation No. 100

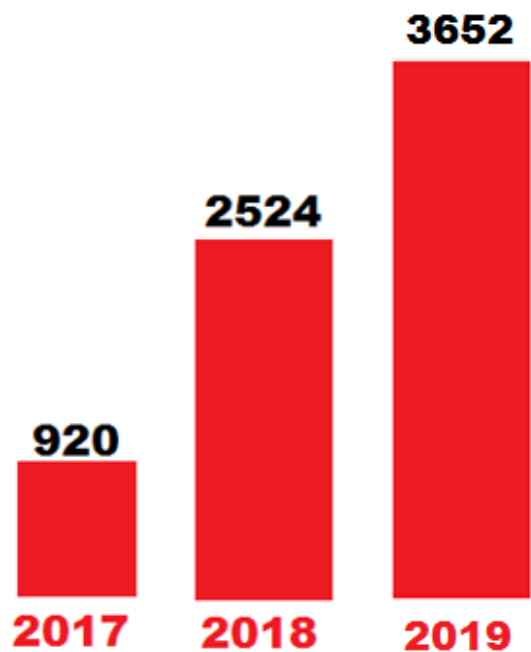
Suggestions of expert from the Russian Federation

Dr. Kirill Karpukhin

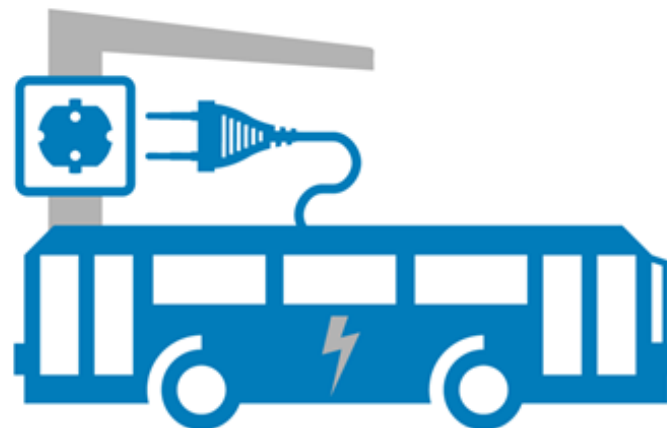
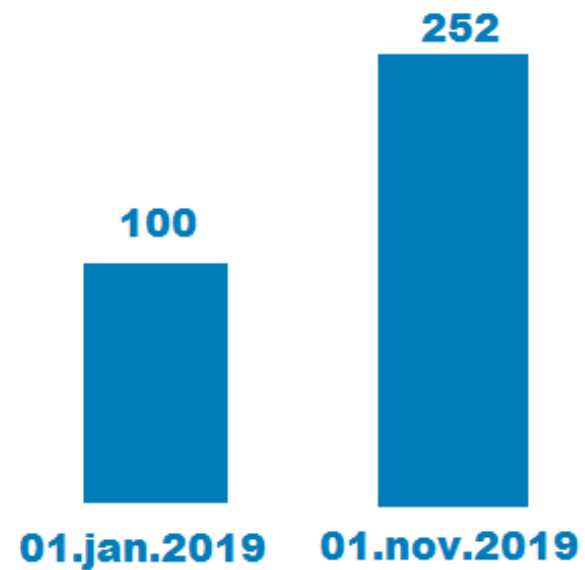
03-05 December 2019, Berlin



Statistics of the development of electric vehicles in the Russian Federation



The growth rate of the number of personal EV



The growth rate of the number of electric buses in Moscow

Adjustment of section 2 “Definitions”

Paragraphs 2.2, 2.14, 2.19, 2.21, 2.26, shall be deleted.

Paragraphs have been deleted since it is proposed to use complete sealing of all electric power train elements which prevents from both direct and indirect contact with live parts.

Paragraph 2.14 has been deleted since it is proposed to use complete sealing of all electric power train elements at which there are no unprotected conductive parts.

Paragraphs 2.19, 2.26 and 5.2.2 have been deleted since prohibition of use and application of open type traction batteries is provided by the amendments made.

Paragraph 2.11 amend, to read:

"Electric power train" means the electrical circuit which includes the ~~traction motor(s)~~ Electromechanical converter and may include the REESS, the electric energy conversion system, the electronic converters, the associated wiring harness and connectors, and the coupling system for charging the REESS.

Justification

The current wording of paragraph 2.11 is not correct enough since the electric traction motor operates in both traction and generator (regenerative braking) modes. In addition to that, a vehicle with a combined power unit includes the generator electric power train which operates in both engine mode – at ICE (internal combustion engine) start, and generator mode – at REESS charging.

Adjustment of section 2 “Definitions”

Paragraph 2.28 amend, to read:

"Protection degree" means the protection provided by an enclosure against access to hazardous parts, ingress of solid foreign objects and (or) water and checked by standard test methods in accordance with provisions of IEC 60529 Degrees of Protection Provided by Enclosures. ~~a barrier/enclosure related to the contact with live parts by a test probe, such as a test finger (IPXXB) or a test wire (IPXXD), as defined in Annex 3.~~"

Justification

New revision of paragraph 2.28 covers description of the protection degrees proposed for use for sealing of electric power train elements.

Paragraph 2.30 amend, to read:

"2.30 "Rupture" means opening(s) through the casing of any functional cell assembly created or enlarged by an event, preventing from providing the protection degree specified by the present Regulation ~~large enough for a 12 mm diameter test finger (IPXXB) to penetrate and make contact with live parts (see Annex 3).~~

Justification

New revision of paragraph 2.30 considers requirements for provision of IP68, IP66/IP68 protection degrees for the electric power train elements.

Currently, the majority of electric machines and REESS produced in vehicles of category M and N already meet this degree of protection, as they have liquid systems to maintain the required temperature.

Some electric vehicles passed the tests of the manufacturer to overcome the water barrier, that is, many have long solved this problem, but this solution needs to be fixed by law on electric vehicles with high-voltage components.

Examples of electric vehicles



Tests of the Think City (2008) on the movement in the water



Tests of the Nissan Leaf on the movement in the water



Aurus Senat with HVB (IP67)



“We don’t recommended this, but Model S floats well enough to turn it into a boat for short periods Of time. Thrust via wheel rotation”
Tesla CEO Elon Musk



Jaguar i-peace wade through water as deep as roughly 20 inches.



FOMM - Able to move on water surface with the original wheels in case of emergency



Adjustment of section 2 “Definitions”

Insert new paragraph 2.40, to read:

"2.40 "Closed chemical reaction system" means a thermodynamic system which is capable of exchanging heat and energy, but not matter, with the environment.“

Justification

Paragraph 2.40 introduces a definition of a closed chemical reaction system.

According to the proposed amendments it is allowed to use traction batteries operating based on the closed chemical reaction principle.

Insert new paragraph 2.41, to read:

"2.41 "Enclosure" means the part providing protection for the equipment against exposure to certain external factors and protection against direct contact from any direction of access".¹

Justification

Paragraph 2.41 introduces a definition of an enclosure in order to specify devices used to ensure electric power train sealing.

¹The definition taken from the International Electrotechnical Vocabulary requires the following explanations:

- 1) The enclosures provide protection for people and animals from access to hazardous parts.
- 2) The barriers, form of openings or any other means (whether they are a part of the enclosure or are formed with equipment inside the enclosure) intended for preventing or limiting access of special test devices are considered to be a part of the enclosure, excluding the cases where they are removed without using a wrench or another tool.

Adjustment of section 5 “Part I: Requirements of a vehicle with regard to its electrical safety”

Paragraphs 5.1.1 – 5.1.1.2, 5.1.1.4.2, 5.1.2.1, 5.1.2.2 ,5.2.2 , 5.4 – 5.4.10 shall be deleted.

Justification

Paragraph 5.1.1.4.2 has been deleted since in the conditions of complete sealing of all electric power train elements in accordance with IP68, IP66/IP68 protection degree presence of the symbol mentioned in this paragraph is not necessary.

Paragraph 5.1.1.3 amend, to read:

5.1.1.3 Service disconnect

For a service disconnect which can be opened, disassembled or removed without corresponding tools, ~~it is acceptable if protection degree IPXXB is satisfied~~ protection degree at least equal to IP68 or higher shall be provided under a condition where it is opened, disassembled or removed without corresponding tools.

Paragraph 5.1.3.2 amend, to read:

5.1.3.2 ...

- a) Double or more layers of solid insulators; ~~barriers or enclosures that meet the requirement in paragraph 5.1.1. independently, for example wiring harness;~~

Justification

New revision of paragraph 5.1.3.2 has been introduced since under introduction of IP68, IP66/IP68 protection degree current requirements become irrelevant.

Adjustment of section 5 “Part I: Requirements of a vehicle with regard to its electrical safety”

Insert new paragraphs 5.5 to 5.5.3, to read:

5.5. Electric power train

5.5.1 For protection of the electric power train elements inside the passenger compartment or luggage compartment, the protection degree at least equal to IP68 or higher shall be provided.

5.5.2 For protection of the electric power train elements in areas other than the passenger compartment or luggage compartment, the protection degree at least equal to IP66/IP68 or higher shall be provided.

5.5.3 The traction batteries shall be executed according to the principle of the closed chemical reaction system.

Justification

Introduction of paragraph 5.5 "Electric Power Train" is intended to improve passive safety, including electrical one, of the vehicle as well as its fire safety.

Adjustment of section 6 “Part II: Requirements of a REESS with regard to its safety”

Paragraphs 6.10 to 6.10.2, shall be deleted.

Insert new paragraphs 6.11 to 6.11.2, to read:

6.11 Water ingress protection.

6.11.1 The REESS shall meet the requirements of paragraph 5.5 of this Regulation with regard to the traction batteries protection degree and design.

6.11.2 The tests and acceptance criteria are according to IEC 60529.

Justification

Paragraphs 5.5.1 to 5.5.2, 6.11 to 6.11.2

The necessity of executing protection degree IP66/IP68 for the electric power train elements located outside the passenger compartment and luggage compartment, and IP68 for the electric power train elements located inside the passenger compartment and luggage compartment, according to Standard IEC 60529 "Degrees of Protection Provided by Enclosures (IP Code)", shall let the vehicle passengers and people nearby, including the rescue service personnel, avoid lethal electric shock in case of the vehicle being flooded by water, avoid an explosion of the hydrogen accumulating as a result of electrolysis.

Water has relatively high conductivity dependent on its mineralization. The mineralization of natural water changes within a wide range. The majority of rivers has mineralization from a few dozen milligrams per litre upto several hundred. It should be considered that electric resistance of the human body in water decreases 20 to 50 times. The consequences for the state of the electric vehicle passengers in case of the battery having 300-400 V voltage being exposed to water are obvious. Moreover, in case of contact of uninsulated areas of high-voltage circuits with water, an electrolytic process begins with the release of hydrogen and oxygen. This will lead to threat of hydrogen accumulating and exploding, for example, at rescue operations in case of a road accident.

The test performed with a **A123 AMP20M1HD-A** battery cell showed that approximately 0.035 litre of hydrogen is released within an hour in case of tap water electrolysis. Respectively, in case a battery consisting of one hundred battery cells is submerged into water of a comparable chemical composition, 3.5 litres of hydrogen or about 5 litres of an explosive or detonating mixture will be released within an hour. Upon that, it is necessary to consider higher conductivity of water from natural sources: reservoirs, rain, especially sea, and, respectively, increase of explosive mixture formation intensity.

We consider that for prevention of tragic consequences at partial or complete vehicle flooding, i.e. long immersion in water, as well as influence of sharp water flows or spurts on the vehicle as a result of a road accident, natural disasters, etc., it is necessary to provide IP66/IP68 protection degree according to IEC 60529 for the electric power train elements located outside of the passenger compartment and luggage compartment and IP68 protection degree according to IEC 60529 for the electric power train elements located inside the passenger compartment and luggage compartment. Since the probability of influence of water flows on the electric power train elements located inside the passenger compartment and luggage compartment is low, we consider it inexpedient to provide the protection for these elements from sharp water flows or spurts.

Justification

Paragraphs 5.5.3, 6.11 to 6.11.2

To meet the requirements specified in paragraphs 5.5.1 and 5.5.2, use of gas-evolving types of batteries is excluded, and installation of only sealed batteries with a closed chemical process is possible. Therefore, it is suggested to formalize the use of batteries with a closed chemical process only as traction batteries. The analysis of modern vehicles with an electric or hybrid power train shows that the open type traction batteries are currently not applied in the specified vehicle types due to a number of reasons:

Quite low battery energy density. As a result, the weight of such batteries is higher than of other batteries.

High tolerance to deep discharge or over-discharge: if the battery discharge exceeds 80%, the battery service life decreases significantly.

And the recommended value of 60 per cent of discharge only decreases the battery energy density even more.

The service issue – regular control of the electrolyte level in the battery (at least once a week) is required, as well as charge in a specialized and very well-ventilated room.

Quite low charge efficiency factor (EF) – ca. 30 per cent of the electric power initially spent is lost during battery charge.

Complete discharge is adverse to the battery: if it occurs, its service life decreases significantly.

It is very difficult to predict the battery failure time even approximately.

At high discharge current, there is an issue of incomplete charge supply by the battery.

The main disadvantage of this battery type is hydrogen emission during charge. This represents a certain threat and prevents from ensuring the sealing of the batteries.

Adjustment of section 6 “Part II: Requirements of a REESS with regard to its safety”

Paragraph 6.4.1.3 amend, to read:

"6.4.1.3 Acceptance criteria

During the test there shall be no evidence of:

- a) Fire;
- b) Explosion;
- c1) Electrolyte leakage if tested according to paragraph 6.4.1.1.:

i) For a period from the impact until 30 minutes after the impact there shall be no electrolyte spillage from the REESS into the passenger compartment;

~~(ii) No more than 7 per cent by volume of the REESS electrolyte capacity shall spill from the REESS to the outside of the passenger compartment (for open type traction batteries a limitation to a maximum of 5 litres also applies);~~

c2) Electrolyte leakage if tested according to paragraph 6.4.1.2.

After the vehicle based test (paragraph 6.4.1.1.), a REESS which is located inside the passenger compartment shall remain in the installed location and the REESS components shall remain inside REESS boundaries. No part of any REESS that is located outside the passenger compartment shall enter the passenger compartment during or after the impact test procedures.

After the component based test (paragraph 6.4.1.2.) the tested-device shall be retained by its mounting and its components shall remain inside its boundaries.

For a high voltage REESS the isolation resistance of the tested-device shall ensure at least 100 Ω /Volt for the whole REESS measured after the test in accordance with Annex 4A or Annex 4B to this Regulation, ~~or the protection degree IPXXB shall be fulfilled for the tested device.~~

For a REESS tested in accordance with paragraph 6.4.1.2., the evidence of electrolyte leakage shall be verified by visual inspection without disassembling any part of the tested-device.

To confirm compliance to (c1) of paragraph 6.4.1.3. an appropriate coating shall, if necessary, be applied to the physical protection (casing) in order to confirm if there is any electrolyte leakage from the REESS resulting from the impact test. Unless the manufacturer provides a means to differentiate between the leakage of different liquids, all liquid leakage shall be considered as the electrolyte".

Adjustment of section 6 “Part II: Requirements of a REESS with regard to its safety”

Paragraph 6.4.2.3, amend to read:

"6.4.2.3 Acceptance criteria

During the test there shall be no evidence of:

- a) Fire;
- b) Explosion;
- c1) Electrolyte leakage if tested according to paragraph 6.4.1.1.:

i) For a period from the impact until 30 minutes after the impact there shall be no electrolyte spillage from the REESS into the passenger compartment.

~~ii) No more than 7 per cent by volume of the REESS electrolyte capacity shall spill from the REESS to the outside of the passenger compartment (for open type traction batteries a limitation to a maximum of 5 litres also applies).~~

c2) Electrolyte leakage if tested according to paragraph 6.4.2.2. For a high voltage REESS, the isolation resistance of the tested-device shall ensure at least 100 Ω /Volt for the whole REESS measured in accordance with Annex 4A or Annex 4B of this Regulation ~~or the protection degree IPXXB shall be fulfilled for the Tested Device.~~

If tested according to paragraph 6.4.2.2., the evidence of electrolyte leakage shall be verified by visual inspection without disassembling any part of the tested-device.

To confirm compliance to (c1) of paragraph 6.4.2.3. an appropriate coating shall, if necessary, be applied to the physical protection (casing) in order to confirm if there is any electrolyte leakage from the REESS resulting from the impact test. Unless the manufacturer provides a means to differentiate between the leakage of different liquids, all liquid leakage shall be considered as the electrolyte.

Justification

Paragraphs 6.4.1.3 and 6.4.2.3 consider requirements for provision of IP68, IP66/IP68 protection degrees for the electric power train elements. The transitional provisions have been prepared in accordance with principles specified in Guidelines ECE/TRANS/WP.29/1044/Rev.2. The due dates for introduction of new requirements specified in the transitional provisions are determined by the necessity to prepare the industry for implementation of new requirements.

Adjustment of section 12 Transitional provisions

Paragraphs 12.1 to 12.4, amend to read:

12.1 As from the official date of entry into force of the 03 series of amendments, no Contracting Party applying this UN Regulation shall refuse to grant or accept the UN type approvals under this UN Regulation as amended by the 03 series of amendments.

12.2 As from [1 September 2022], Contracting Parties applying this UN Regulation are not obliged to accept the UN type approvals which were granted for the first time in accordance with any of the preceding series of amendments after [1 September 2022].

12.3 Before [1 September 2025], Contracting Parties applying this UN Regulation shall accept the UN type approvals which were granted for the first time in accordance with any of the preceding series of amendments before [1 September 2022].

12.4 As from [1 September 2025], Contracting Parties applying this UN Regulation are not obliged to accept type approvals which were granted in accordance with any of the preceding series of amendments to this Regulation.

Adjustment of Annex

Annex 3, shall be deleted.

Annex 7, shall be deleted.

Justification

Annex 3 has been deleted due to irrelevancy of the specified test methods at introduction of new requirements for sealing of the electric power train elements.

Annex 7 has been deleted due to refusal from the open type traction batteries, as a result of which the specified requirements are irrelevant.

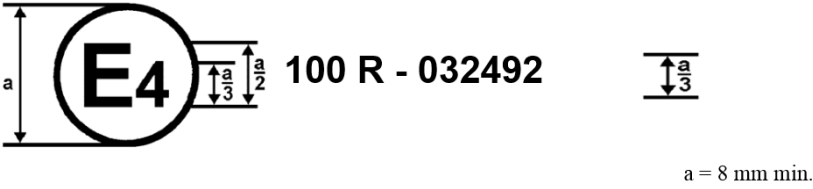
Annex 2 has been amended due to introduction of new series of amendments.

Annex 2, amend to read:

Arrangements of the approval marks

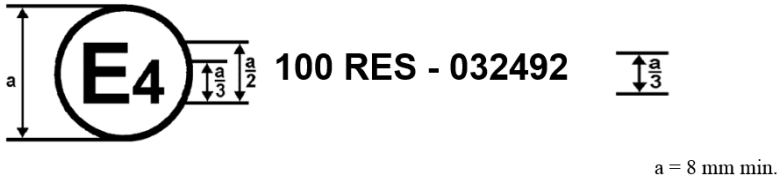
Model A (see paragraph 4.4 of this Regulation)

Figure 1



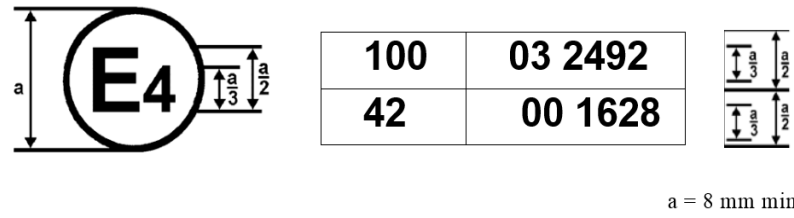
The approval mark in Figure 1 affixed to a vehicle shows that the road vehicle type concerned has been approved in the Netherlands (E 4), pursuant to Regulation No. 100, and under the approval number 032492. The first two digits of the approval number indicate that the approval was granted in accordance with the requirements of Regulation No. 100 as amended by 03 series of amendments.

Figure 2



The approval mark in Figure 2 affixed to a REESS shows that the REESS type ("ES") concerned has been approved in the Netherlands (E 4), pursuant to Regulation No. 100, and under the approval number 032492. The first two digits of the approval number indicate that the approval was granted in accordance with the requirements of Regulation No. 100 as amended by 03 series of amendments.

Model B (see paragraph 4.5 of this Regulation)



The above approval mark affixed to a vehicle shows that the road vehicle concerned has been approved in the Netherlands (E4) pursuant to Regulations Nos. 100 and 42*. The first two digits of the approval number indicate that, at the dates when the respective approvals were granted, Regulation No. 100 was amended by the 03 series of amendments and Regulation No. 42 was still in its original form.

* The latter number is given only as an example.



Thanks for your attention.

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