

Regulation (EC) No 79/2009 of the European Parliament and of the Council of 14 January 2009 on type-approval of hydrogen-powered motor vehicles, and amending Directive 2007/46/EC (Text with EEA relevance)

REGULATION (EC) No 79/2009 OF THE  
EUROPEAN PARLIAMENT AND OF THE COUNCIL

of 14 January 2009

on type-approval of hydrogen-powered motor  
vehicles, and amending Directive 2007/46/EC

(Text with EEA relevance)

THE EUROPEAN PARLIAMENT AND THE COUNCIL OF THE EUROPEAN UNION,

Having regard to the Treaty establishing the European Community, and in particular Article 95 thereof,

Having regard to the proposal from the Commission,

Having regard to the opinion of the European Economic and Social Committee<sup>(1)</sup>,

Acting in accordance with the procedure laid down in Article 251 of the Treaty<sup>(2)</sup>,

Whereas:

- (1) The internal market comprises an area without internal frontiers in which the free movement of goods, persons, services and capital is ensured. To that end, a comprehensive Community type-approval system for motor vehicles is in place. The technical requirements for the type-approval of motor vehicles with regard to hydrogen propulsion should be harmonised to avoid the adoption of different requirements in different Member States and to ensure the proper functioning of the internal market while, at the same time, ensuring a high level of environmental protection and public safety.
- (2) This Regulation is a separate regulation for the purposes of the Community type-approval procedure provided for by Directive 2007/46/EC of the European Parliament and of the Council of 5 September 2007 establishing a framework for the approval of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles (Framework Directive)<sup>(3)</sup>. Therefore, Annexes IV, VI and XI to that Directive should be amended accordingly.
- (3) Following the request of the European Parliament, a new regulatory approach has been applied to EC vehicle legislation. This Regulation should therefore lay down only fundamental provisions on requirements for the type-approval of hydrogen systems and components, whereas the technical specifications should be laid down by implementing measures adopted in accordance with Council Decision 1999/468/EC of 28 June 1999 laying down the procedures for the exercise of implementing powers conferred on the Commission<sup>(4)</sup>.

- (4) In particular, the Commission should be empowered to establish the requirements and test procedures relating to new forms of hydrogen storage or usage, additional hydrogen components and the propulsion system. The Commission should also be empowered to establish specific procedures, tests and requirements with regard to the impact protection of hydrogen-powered vehicles and integrated system safety requirements. Since those measures are of general scope and are designed to amend non-essential elements of this Regulation by supplementing it with new non-essential elements, they must be adopted in accordance with the regulatory procedure with scrutiny provided for in Article 5a of Decision 1999/468/EC.
- (5) In the transport sector, one of the main aims should be a greater proportion of more environmentally friendly vehicles. Additional efforts should be undertaken in order to place more of those vehicles on the market. The introduction of vehicles with alternative fuels can significantly improve the quality of urban air and consequently also the state of public health.
- (6) Hydrogen is considered as a clean way of powering vehicles for the future, on the way towards a pollution-free economy based on the reuse of raw materials and on renewable energy resources, as vehicles propelled with hydrogen emit neither carbon-based pollutants nor greenhouse gases. Since hydrogen is an energy vector and not an energy source, the climate-policy value of hydrogen power depends on the source from which the hydrogen is obtained. Care should therefore be taken that hydrogen fuel is produced in a sustainable manner, as far as possible from renewable energy resources, so that the overall environmental balance of introducing hydrogen as a fuel for motor vehicles is positive.
- (7) The CARS 21 High Level Group stated in its final report that ‘efforts with a view to increasing international harmonisation of motor vehicle regulations should be maintained where appropriate, with a view to involve the key vehicle markets and to extend harmonisation to areas not yet covered, notably both in the framework of the 1958 and the 1998 Agreements of the UNECE’. In line with this recommendation, the Commission should continue to support the development of internationally harmonised requirements for motor vehicles under the auspices of UNECE. In particular, if a Global Technical Regulation (GTR) on hydrogen and fuel cell vehicles is adopted, the Commission should consider the possibility of adapting the requirements laid down in this Regulation to those established in the GTR.
- (8) Hydrogen mixtures could be used as a transition fuel towards the use of pure hydrogen, to facilitate the introduction of hydrogen-powered vehicles in Member States where the natural gas infrastructure is good. The Commission should therefore develop requirements for the use of mixtures of hydrogen and natural gas/biomethane, especially a mixing ratio of hydrogen and gas which takes account of technical feasibility and environmental benefits.
- (9) Defining the type-approval framework for hydrogen-powered vehicles would contribute to the confidence in the new technology of potential users and the public at large.

- (10) Therefore, it is necessary to create an adequate framework in order to accelerate the placing on the market of vehicles with innovative propulsion technologies and vehicles which use alternative fuels with a low environmental impact.
- (11) The majority of manufacturers are making important investments in the development of hydrogen technology and have already started to place such vehicles on the market. In the future, it is likely that the share of hydrogen-powered vehicles in the total fleet will increase. Therefore, the specification of common requirements concerning the safety of hydrogen-powered vehicles is necessary. As manufacturers might follow different approaches to the development of hydrogen-powered vehicles, it is necessary to establish safety requirements in a technology-neutral manner.
- (12) It is necessary to establish those safety requirements for the hydrogen systems and their components which are necessary in order to obtain type-approval.
- (13) For type-approval of hydrogen-powered vehicles, it is necessary to establish requirements for the installation of hydrogen systems and their components in the vehicle.
- (14) Owing to the characteristics of the fuel, hydrogen-powered vehicles may require a specific treatment from rescue services. It is therefore necessary to lay down requirements for the clear and rapid identification of such vehicles, allowing the rescue services to be informed of the fuel stored on board the vehicle. Whilst the means of identification should be fit for that purpose it should, as far as possible, avoid being of a nature that is likely to give rise to concern among the public.
- (15) It is also important to set out the obligations of manufacturers concerning the adoption of appropriate measures to prevent misfuelling of hydrogen-powered vehicles.
- (16) Hydrogen-powered vehicles are unlikely to be successful on the market unless adequate filling-station infrastructure is made available in Europe. The Commission should therefore look into suitable measures to support the establishment of a Europe-wide filling-station network for hydrogen-powered vehicles.
- (17) Innovative small vehicles, designated under EC type-approval legislation as L category vehicles, are considered as early users of hydrogen as a fuel. Introducing hydrogen for these vehicles requires less effort, as the technical challenge and level of investment required is not as high as in the case of M and N category vehicles, as defined in Annex II to Directive 2007/46/EC. The Commission should, no later than 1 January 2010, evaluate the possibility of regulating the type-approval of hydrogen L category vehicles.
- (18) Since the objective of this Regulation, namely the achievement of the internal market through the introduction of common technical requirements concerning motor vehicles using hydrogen, cannot be sufficiently achieved by the Member States and can therefore, by reason of its scale, be better achieved at Community level, the Community may adopt measures, in accordance with the principle of subsidiarity, as set out in Article 5 of the Treaty. In accordance with the principle of proportionality, as set out in

that Article, this Regulation does not go beyond what is necessary in order to achieve that objective,

HAVE ADOPTED THIS REGULATION:

### *Article 1*

#### **Subject matter**

This Regulation establishes requirements for the type-approval of motor vehicles with regard to hydrogen propulsion and for the type-approval of hydrogen components and hydrogen systems. This Regulation also establishes requirements for the installation of such components and systems.

### *Article 2*

#### **Scope**

This Regulation shall apply to:

1. hydrogen-powered vehicles of categories M and N, as defined in Section A of Annex II to Directive 2007/46/EC, including impact protection and the electric safety of such vehicles;
2. hydrogen components designed for motor vehicles of categories M and N, as listed in Annex I;
3. hydrogen systems designed for motor vehicles of categories M and N, including new forms of hydrogen storage or usage.

### *Article 3*

#### **Definitions**

- 1 For the purposes of this Regulation, the following definitions shall apply:
  - a 'hydrogen-powered vehicle' means any motor vehicle that uses hydrogen as fuel to propel the vehicle;
  - b 'propulsion system' means the internal combustion engine or fuel cell system used to propel the vehicle;
  - c 'hydrogen component' means the hydrogen container and all other parts of the hydrogen-powered vehicle that are in direct contact with hydrogen or which form part of a hydrogen system;
  - d 'hydrogen system' means an assembly of hydrogen components and connecting parts fitted on hydrogen-powered vehicles, excluding the propulsion systems or auxiliary power units;
  - e 'maximum allowable working pressure' (MAWP) means the maximum pressure to which a component is designed to be subjected to and which is the basis for determining the strength of the component under consideration;
  - f 'nominal working pressure' (NWP) means, as regards containers, the settled pressure at a uniform temperature of 288K (15 °C) for a full container, or as regards other components, the pressure level at which a component typically operates;

g ‘inner tank’ means the part of the hydrogen container designed to use liquid hydrogen that contains the cryogenic hydrogen.

2 For the purposes of paragraph 1(d), ‘hydrogen systems’ shall include, *inter alia*, the following:

- a usage monitoring and control systems;
- b vehicle interface systems;
- c excess flow systems;
- d overpressure protection systems;
- e heat exchanger failure detection systems.

#### *Article 4*

### **Obligations of manufacturers**

1 Manufacturers shall demonstrate that all new hydrogen-powered vehicles sold, registered or put into service within the Community and all hydrogen components or hydrogen systems sold or put into service within the Community are type-approved in accordance with this Regulation and its implementing measures.

2 For the purposes of vehicle type-approval, manufacturers shall equip hydrogen-powered vehicles with hydrogen components and systems that comply with the requirements of this Regulation and its implementing measures and are installed in accordance with this Regulation and its implementing measures.

3 For the purposes of the type-approval of components and systems, manufacturers shall ensure that hydrogen components and systems comply with the requirements of this Regulation and its implementing measures.

4 Manufacturers shall provide the approval authorities with appropriate information concerning the vehicle specifications and test conditions.

5 Manufacturers shall provide information for the purposes of inspection of hydrogen components and systems during the service life of the vehicle.

#### *Article 5*

### **General requirements for hydrogen components and systems**

Manufacturers shall ensure that:

- (a) hydrogen components and systems function in a correct and safe way and reliably withstand electrical, mechanical, thermal and chemical operating conditions without leaking or visibly deforming;
- (b) hydrogen systems are protected against over-pressurisation;
- (c) the materials used for those parts of the hydrogen components and systems which are to be in direct contact with hydrogen are compatible with hydrogen;
- (d) hydrogen components and systems reliably withstand expected temperatures and pressures during their expected lifetime;

- (e) hydrogen components and systems reliably withstand the range of operating temperatures laid down in the implementing measures;
- (f) hydrogen components are marked in accordance with the implementing measures;
- (g) hydrogen components with directional flow have the flow direction clearly indicated;
- (h) hydrogen components and systems are designed in such a way that they can be installed in accordance with the requirements of Annex VI.

#### *Article 6*

##### **Requirements for hydrogen containers designed to use liquid hydrogen**

Hydrogen containers designed to use liquid hydrogen shall be tested in accordance with the test procedures set out in Annex II.

#### *Article 7*

##### **Requirements for hydrogen components, other than containers, designed to use liquid hydrogen**

- 1 Hydrogen components, other than containers, designed to use liquid hydrogen shall be tested in accordance with the test procedures set out in Annex III with regard to their type.
- 2 Pressure relief devices shall be designed so as to ensure that the pressure in the inner tank or in any other hydrogen component does not exceed a permissible value. The values shall be set in proportion to the maximum allowable working pressure (MAWP) of the hydrogen system. A safety system for heat exchangers shall be provided for the detection of their failure.

#### *Article 8*

##### **Requirements for hydrogen containers designed to use compressed (gaseous) hydrogen**

- 1 Hydrogen containers designed to use compressed (gaseous) hydrogen shall be classified in accordance with point 1 of Annex IV.
- 2 The containers referred to in paragraph 1 shall be tested in accordance with the test procedures set out in Annex IV with regard to their type.
- 3 A detailed description of all principal properties of the material and tolerances used in the design of the container shall be provided, including the results of tests to which the material has been subjected.

#### *Article 9*

##### **Requirements for hydrogen components, other than containers, designed to use compressed (gaseous) hydrogen**

Hydrogen components, other than containers, designed to use compressed (gaseous) hydrogen shall be tested in accordance with the test procedures set out in Annex V with regard to their type.

## Article 10

### **General requirements for the installation of hydrogen components and systems**

Hydrogen components and systems shall be installed in accordance with the requirements of Annex VI.

## Article 11

### **Timetable for application**

- 1 With effect from 24 February 2011, national authorities shall refuse to grant:
  - a EC type-approval or national type-approval in respect of new types of vehicle on grounds relating to hydrogen propulsion, where such vehicle does not comply with the requirements of this Regulation or of its implementing measures; and
  - b EC type-approval in respect of new types of hydrogen component or system, where such component or system does not comply with the requirements of this Regulation or of its implementing measures.
- 2 With effect from 24 February 2012, national authorities shall:
  - a on grounds relating to hydrogen propulsion, consider certificates of conformity for new vehicles to be no longer valid for the purposes of Article 26 of Directive 2007/46/EC, and prohibit the registration, sale and entry into service of such vehicles, where such vehicles do not comply with the requirements of this Regulation or of its implementing measures; and
  - b prohibit the sale and entry into service of new hydrogen components or systems, where such components or systems do not comply with the requirements of this Regulation or of its implementing measures.
- 3 Without prejudice to paragraphs 1 and 2, and subject to the entry into force of implementing measures adopted pursuant to Article 12(1), if a manufacturer so requests, national authorities shall not:
  - a on grounds relating to hydrogen propulsion, refuse to grant EC type-approval or national type-approval for new types of vehicle, or EC type-approval for new types of hydrogen component or system, where such vehicle, component or system complies with the requirements of this Regulation and its implementing measures; or
  - b prohibit the registration, sale and entry into service of new vehicles or the sale and entry into service of new hydrogen components or systems, where such vehicles, components or systems comply with the requirements of this Regulation and its implementing measures.

## Article 12

### **Implementing measures**

- 1 The Commission shall adopt the following implementing measures:
  - a administrative provisions for the EC type-approval of vehicles, with regard to hydrogen propulsion, and hydrogen components and systems;
  - b rules on the information to be provided by manufacturers for the purposes of the type-approval and inspection referred to in Article 4(4) and (5);

- c detailed rules for the test procedures set out in Annexes II to V;
- d detailed rules concerning the requirements for the installation of hydrogen components and systems set out in Annex VI;
- e detailed rules concerning the requirements for the safe and reliable functioning of hydrogen components and systems set out in Article 5;
- f detailed rules for the labelling or other means of clear and rapid identification of hydrogen-powered vehicles referred to in point 16 of Annex VI.

Those measures, designed to amend non-essential elements of this Regulation by supplementing it, shall be adopted in accordance with the regulatory procedure with scrutiny referred to in Article 13(2).

- 2 The Commission may adopt the following implementing measures:
- a specifications for requirements relating to any of the following:
    - the use of pure hydrogen or a mixture of hydrogen and natural gas/biomethane,
    - new forms of hydrogen storage or usage,
    - the impact protection of vehicles with regard to the integrity of hydrogen components and systems,
    - integrated system safety requirements, covering at least the detection of leakage and requirements relating to purge gas,
    - electrical isolation and electric safety;
  - b other measures necessary for the application of this Regulation.

Those measures, designed to amend non-essential elements of this Regulation by supplementing it, shall be adopted in accordance with the regulatory procedure with scrutiny referred to in Article 13(2).

#### *Article 13*

#### **Committee procedure**

1 The Commission shall be assisted by the Technical Committee — Motor Vehicles (TCMV) established by Article 40(1) of Directive 2007/46/EC.

2 Where reference is made to this paragraph, Article 5a(1) to (4) and Article 7 of Decision 1999/468/EC shall apply, having regard to the provisions of Article 8 thereof.

#### *Article 14*

#### **Amendments to Directive 2007/46/EC**

Annexes IV, VI and XI to Directive 2007/46/EC shall be amended in accordance with Annex VII to this Regulation.

#### *Article 15*

#### **Penalties for non-compliance**

1 Member States shall lay down the provisions on penalties applicable for infringement by manufacturers of the provisions of this Regulation and its implementing measures and shall take all measures necessary to ensure that they are implemented. The penalties provided for shall



be effective, proportionate and dissuasive. By 24 August 2010, Member States shall notify those provisions to the Commission, and shall notify it without delay of any subsequent amendment affecting them.

2 The types of infringement which are subject to a penalty shall include at least the following:

- a making false declarations during an approval procedure or a procedure leading to a recall;
- b falsifying test results for type-approval or in-use compliance;
- c withholding data or technical specifications which could lead to recall or withdrawal of type-approval;
- d refusal to provide access to information;
- e use of defeat devices.

#### *Article 16*

#### **Entry into force**

This Regulation shall enter into force on the 20th day following its publication in the *Official Journal of the European Union*.

It shall apply from 24 February 2011, with the exception of Article 11(3) and Article 12, which shall apply from the date of entry into force of this Regulation, and Article 11(2), which shall apply from the date set out therein.

This Regulation shall be binding in its entirety and directly applicable in all Member States.

Done at Strasbourg, 14 January 2009.

*For the European Parliament*

*The President*

H.-G. PÖTTERING

*For the Council*

*The President*

A. VONDRA

## ANNEX I

## List of hydrogen components to be type-approved

Where fitted to a hydrogen-powered vehicle, the following hydrogen components must be type-approved:

- (a) components designed to use liquid hydrogen:
1. container;
  2. automatic shut-off valve;
  3. check valve or non-return valve (if used as a safety device);
  4. flexible fuel line (if upstream of first automatic shut-off valve or other safety devices);
  5. heat exchanger;
  6. manual or automatic valve;
  7. pressure regulator;
  8. pressure relief valve;
  9. pressure, temperature and flow sensors (if used as a safety device);
  10. refuelling connection or receptacle;
  11. hydrogen leakage detection sensors;
- (b) components designed to use compressed (gaseous) hydrogen with a nominal working pressure of over 3,0 MPa:
1. container;
  2. automatic shut-off valve;
  3. container assembly;
  4. fittings;
  5. flexible fuel line;
  6. heat exchanger;
  7. hydrogen filter;
  8. manual or automatic valve;
  9. non-return valve;
  10. pressure regulator;
  11. pressure relief device;
  12. pressure relief valve;
  13. refuelling connection or receptacle;
  14. removable storage system connector;

15. pressure, temperature, hydrogen and flow sensors (if used as a safety device);
16. hydrogen leakage detection sensors.

## ANNEX II

### Applicable test procedures for hydrogen containers designed to use liquid hydrogen

Type of test
Burst test
Bonfire test
Maximum filling level test
Pressure test
Leak test

The test procedures to be applied for the type-approval of hydrogen containers designed to use liquid hydrogen must include:

- (a) Burst test: the purpose of the test is to provide evidence that the hydrogen container does not fail before a specified level of high pressure, the burst pressure (safety factor multiplied by the MAWP) is exceeded. In order to obtain type-approval, the value of the real burst pressure during the test must exceed the required minimum burst pressure.
- (b) Bonfire test: the purpose of the test is to provide evidence that the container with its fire protection system does not burst when tested under specified fire conditions.
- (c) Maximum filling level test: the purpose of the test is to provide evidence that the system, which prevents overfilling of the container, works adequately and that the level of hydrogen during the filling procedure never causes the opening of the pressure relief devices.
- (d) Pressure test: the purpose of the test is to provide evidence that the hydrogen container can withstand a specified level of high pressure. In order to prove this, the container is pressurised to a given value for a specified time. After the test the container must not show any signs of visible permanent deformation or visible leaks.
- (e) Leak test: the purpose of the test is to provide evidence that the hydrogen container does not show evidence of leakage under specified conditions. In order to prove this, the container is pressurised to its nominal working pressure. It must not show any evidence of leakage detected through cracks, pores or other similar defects.

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## ANNEX III

Applicable test procedures for hydrogen components,  
other than containers, designed to use liquid hydrogen

HYDROGEN COMPONENT	TYPE OF TEST										
	Pressure test	External leakage test	Endurance test	Operational test	Porosity test	Resistance to dry-heat test	Ozone ageing test	Temperature cycle test	Pressure cycle test	Hydrogen compatibility test	Seat leakage test
Pressure relief devices	→	→		→	→			→		→	
Valves	→	→	→		→	→	→	→		→	→
Heat exchangers	→	→			→	→	→	→		→	
Refuelling connections or receptacles		→	→		→	→	→	→		→	→
Pressure regulators	→	→	→		→	→	→	→		→	→
Sensors	→	→			→	→	→	→		→	
Flexible fuel lines	→	→			→	→	→	→	→	→	

Subject to specific requirements in relation to any of the hydrogen components, the test procedures to be applied for the type-approval of hydrogen components, other than containers, designed to use liquid hydrogen must include:

- Pressure test: the purpose of the test is to provide evidence that the hydrogen components can withstand a level of pressure which is higher than the working pressure of the component. The hydrogen components must not show any visible evidence of leak, deformation, rupture or cracks when the pressure is increased to a certain level.
- External leakage test: the purpose of the test is to provide evidence that the hydrogen components are free from external leakage. The hydrogen components must not show evidence of porosity.
- Endurance test: the purpose of the test is to provide evidence that the hydrogen components are capable of continuous reliable operation. The test consists of carrying out a specific number of test cycles for the hydrogen component under specified temperature and pressure conditions. A test cycle means the normal operation (i.e. one opening and one closing) of the hydrogen component.
- Operational test: the purpose of the test is to provide evidence that the hydrogen components are capable of operating reliably.

- (e) Corrosion resistance test: the purpose of the test is to provide evidence that the hydrogen components are capable of resisting corrosion. In order to prove this, the hydrogen components are submitted to contact with specified chemicals.
- (f) Resistance to dry-heat test: the purpose of the test is to provide evidence that the non-metallic hydrogen components are capable of resisting high temperature. In order to prove this, the components are exposed to air at the maximum operating temperature.
- (g) Ozone ageing test: the purpose of the test is to provide evidence that the non-metallic hydrogen components are capable of resisting ageing due to ozone. In order to prove this, the components are exposed to air with high ozone concentration.
- (h) Temperature cycle test: the purpose of the test is to provide evidence that the hydrogen components are capable of resisting high variations of temperature. In order to prove this, the hydrogen components are submitted to a temperature cycle of specified duration from the minimum operating temperature up to the maximum operating temperature.
- (i) Pressure cycle test: the purpose of the test is to provide evidence that the hydrogen components are capable of resisting high variations of pressure. In order to prove this, the hydrogen components are submitted to a pressure change from atmospheric pressure to the maximum allowable working pressure (MAWP) and then back to atmospheric pressure within a short period of time.
- (j) Hydrogen compatibility test: the purpose of the test is to provide evidence that metallic hydrogen components (i.e. cylinders and valves) are not susceptible to hydrogen embrittlement. In hydrogen components that are subjected to frequent load cycles, conditions that can lead to local fatigue and the initiation and propagation of fatigue cracks in the structure must be avoided.
- (k) Seat leakage test: the purpose of the test is to provide evidence that hydrogen components are free from leakage while installed in the hydrogen system.

## ANNEX IV

Applicable test procedures for hydrogen containers  
designed to use compressed (gaseous) hydrogen

Type of test	Applicable to container type			
	1	2	3	4
Burst test	↘	↘	↘	↘
Ambient temperature pressure cycle test	↘	↘	↘	↘
LBB performance test	↘	↘	↘	↘
Bonfire test	↘	↘	↘	↘
Penetration test	↘	↘	↘	↘

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Chemical exposure test		➤	➤	➤
Composite flaw tolerance test		➤	➤	➤
Accelerated stress rupture test		➤	➤	➤
Extreme temperature pressure cycle test		➤	➤	➤
Impact damage test			➤	➤
Leak test				➤
Permeation test				➤
Boss torque test				➤
Hydrogen gas cycle test				➤

1. Classification of hydrogen containers designed to use compressed (gaseous) hydrogen:

Type 1	Seamless metallic container
Type 2	Hoop wrapped container with a seamless metallic liner
Type 3	Fully wrapped container with a seamless or welded metallic liner
Type 4	Fully wrapped container with a non-metallic liner.

2. The test procedures to be applied for the type-approval of hydrogen containers designed to use compressed (gaseous) hydrogen must include:

- (a) Burst test: the purpose of the test is to provide the value of the pressure at which the container bursts. In order to prove this, the container is pressurised to a given value, which must be higher than the nominal working pressure of the container. The burst pressure of the container must exceed a specified pressure. The burst pressure of the container must be recorded and be kept by the manufacturer throughout the service life of the container.
- (b) Ambient temperature pressure cycle test: the purpose of the test is to provide evidence that the hydrogen container is capable of resisting high variations of pressure. In order to prove this, pressure cycles are carried out on the container until a failure occurs or until a specified number of cycles is reached by increasing and decreasing the pressure to a specified value. The containers must not fail before reaching a specified number of cycles. The number of cycles to failure, along with the location and description of the failure, must be documented. The manufacturer must keep the results throughout the service life of the container.
- (c) Leak before break (LBB) performance test: the purpose of the test is to provide evidence that the hydrogen container fails by leakage before rupture. In order to prove this, pressure cycles are carried out on the container by increasing and decreasing

the pressure to a specified value. The containers tested must either fail by leakage or exceed a specified number of test cycles without failure. The number of cycles to failure, along with the location and description of the failure, must be recorded.

- (d) Bonfire test: the purpose of the test is to provide evidence that the container with its fire protection system does not burst when tested under specified fire conditions. The container, pressurised to working pressure, must only vent through the pressure relief device and must not rupture.
- (e) Penetration test: the purpose of the test is to provide evidence that the container does not rupture when penetrated by a bullet. In order to prove this, the complete container with its protective coating is pressurised and penetrated by a bullet. The container must not rupture.
- (f) Chemical exposure test: the purpose of the test is to provide evidence that the container can withstand exposure to specified chemical substances. In order to prove this, the container is exposed to various chemical solutions. The pressure of the container is increased to a given value and a burst test as referred to under point (a) is carried out. The container must achieve a specified burst pressure, which must be recorded.
- (g) Composite flaw tolerance test: the purpose of the test is to provide evidence that the hydrogen container is capable of resisting exposure to high pressure. In order to prove this, flaws of specified geometry are cut into the container sidewall and a specified number of pressure cycles carried out. The container must not leak or rupture within a number of cycles, but may fail by leakage during the remaining test cycles. The number of cycles to failure, along with the location and description of the failure, must be recorded.
- (h) Accelerated stress rupture test: the purpose of the test is to provide evidence that the hydrogen container is capable of resisting exposure to high pressure and high temperatures at the limit of the allowable operating range for an extended period of time. In order to prove this, the container is exposed for a specified time to specified pressure and temperature conditions, and subsequently undergoes a burst test as referred to under point (a). The container must achieve a specified burst pressure.
- (i) Extreme temperature pressure cycle test: the purpose of the test is to provide evidence that the hydrogen container can withstand variations of pressure under different temperature conditions. In order to prove this, the container, free of any protective coating, is hydrostatically cycle tested by being subjected to extreme ambient conditions, and subsequently undergoes a burst test and a leak test as referred to under points (a) and (k). When cycle tested, the containers must not show evidence of rupture, leakage or fibre unravelling. The containers must not burst at a specified pressure.
- (j) Impact damage test: the purpose of the test is to provide evidence that the hydrogen container remains operational after being submitted to the specified mechanical impacts. In order to prove this, the container is subjected to a drop test, and a specified number of pressure cycles are carried out. The container must not leak or rupture within a specified number of cycles, but may fail by leakage during the remaining test cycles.
- (k) Leak test: the purpose of the test is to provide evidence that the hydrogen container does not show evidence of leakage under the specified conditions. In order to prove this, the container is pressurised to its nominal working pressure. It must not show any evidence of leakage detected through cracks, pores or similar defects.

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- (l) Permeation test: the purpose of the test is to provide evidence that the hydrogen container does not permeate more than a specified rate. In order to prove this, the container is pressurised with hydrogen gas to nominal working pressure and then monitored for permeation in a closed chamber for a specified time under specified temperature conditions.
- (m) Boss torque test: the purpose of the test is to provide evidence that the hydrogen container is capable of resisting the specified torque. In order to prove this, a torque is applied to the container from different directions. Then a burst test and a leak test as referred to under points (a) and (k) are carried out. The container must meet the burst and leak test requirements. The applied torque, leakage and burst pressure must be recorded.
- (n) Hydrogen gas cycle test: the purpose of the test is to provide evidence that the hydrogen container is capable of resisting high variations of pressure when hydrogen gas is used. In order to prove this, the container is subjected to a number of pressure cycles with the use of hydrogen gas and a leak test as referred to under point (k). Deteriorations, such as fatigue cracking or electrostatic discharge of the container, are inspected. The container must meet leak test requirements. The container must be free of any deterioration, such as fatigue cracking or electrostatic discharge.

## ANNEX V

Applicable test procedures for hydrogen components, other than containers, designed to use compressed (gaseous) hydrogen

HYDROGEN COMPONENTS	TYPE OF TEST					
	Material tests	Corrosion resistance test	Endurance test	Pressure cycle test	Internal leakage test	External leakage test
Pressure relief devices	➤	➤	➤	➤	➤	➤
Automatic valves	➤	➤	➤	➤	➤	➤
Manual valves	➤	➤	➤	➤	➤	➤
Non-return valves	➤	➤	➤	➤	➤	➤
Pressure relief valves	➤	➤	➤	➤	➤	➤
Heat exchangers	➤	➤		➤		➤
Refuelling connections	➤	➤	➤	➤	➤	➤



or receptacles						
Pressure regulators	➤	➤	➤	➤	➤	➤
Sensors for hydrogen systems	➤	➤	➤	➤		➤
Flexible fuel lines	➤	➤	➤	➤		➤
Fittings	➤	➤	➤	➤		➤
Hydrogen filters	➤	➤		➤		➤
Removable storage system connectors	➤	➤	➤	➤		➤

Subject to specific requirements for any of the hydrogen components, the test procedures to be applied for the type-approval of hydrogen components, other than containers, designed to use compressed (gaseous) hydrogen must include:

1. Material tests:
  - 1.1. Hydrogen compatibility test set out in point (j) of Annex III.
  - 1.2. Ageing test: the purpose of the test is to check whether the non-metallic material used in a hydrogen component can withstand ageing. No visible cracking of the test samples is allowed.
  - 1.3. Ozone compatibility test: the purpose of the test is to check whether the elastomer material of a hydrogen component is compatible with ozone exposure. No visible cracking of the test samples is allowed.
2. Corrosion resistance test set out in point (e) of Annex III.
3. Endurance test set out in point (c) of Annex III.
4. Pressure cycle test set out in point (i) of Annex III. The hydrogen components must not show visible signs of deformation or extrusion and must fulfil the requirements of the internal and external leakage tests.
5. Internal leakage test: the purpose of the test is to provide evidence that the specified hydrogen components are free from internal leakage. In order to prove this, the hydrogen components are pressurised under different temperature conditions and observed for leakage. The hydrogen components must stay bubble free and must not leak internally at a higher rate than a specified number.
6. External leakage test set out in point (b) of Annex III.

## ANNEX VI

## Requirements for the installation of hydrogen components and systems

1. The hydrogen system must be installed in such a way that it is protected against damage.

It must be isolated from heat sources in the vehicle.

2. The hydrogen container may only be removed for replacement with another hydrogen container, for the purpose of refuelling or for maintenance.

In the case of an internal combustion engine, the container must not be installed in the engine compartment of the vehicle.

It must be adequately protected against all kinds of corrosion.

3. Measures must be taken to prevent misfuelling of the vehicle and hydrogen leakage during refilling and to make sure that the removal of a removable hydrogen storage system is done safely.
4. The refuelling connection or receptacle must be secured against maladjustment and protected from dirt and water. The refuelling connection or receptacle must be integrated with a non-return valve or a valve with the same function. If the refuelling connection is not mounted directly on the container, the refuelling line must be secured by a non-return valve or a valve with the same function which is mounted directly on or within the container.
5. The hydrogen container must be mounted and fixed so that the specified accelerations can be absorbed without damage to the safety related parts when the hydrogen containers are full.
6. The hydrogen fuel supply lines must be secured with an automatic shut-off valve mounted directly on or within the container. The valve shall close if a malfunction of the hydrogen system so requires or any other event that results in the leakage of hydrogen occurs. When the propulsion system is switched off, the fuel supply from the container to the propulsion system must be switched off and remain closed until the system is required to operate.
7. In the event of an accident, the automatic shut-off valve mounted directly on or within the container shall interrupt the flow of gas from the container.
8. Hydrogen components, including any protective materials that form part of such components, must not project beyond the outline of the vehicle or protective structure. This does not apply to a hydrogen component which is adequately protected and no part of which is located outside this protective structure.
9. The hydrogen system must be installed in such a way that it is protected against damage so far as is reasonably practicable, such as damage due to moving vehicle components, impacts, grit, the loading or unloading of the vehicle or the shifting of loads.
10. Hydrogen components must not be located near the exhaust of an internal combustion engine or other heat source, unless such components are adequately shielded against heat.

11. The ventilating or heating system for the passenger compartment and places where leakage or accumulation of hydrogen is possible must be designed so that hydrogen is not drawn into the vehicle.
12. In the event of an accident, it must be ensured so far as is reasonably practicable that the pressure relief device and the associated venting system remain capable of functioning. The venting system of the pressure relief device must be adequately protected against dirt and water.
13. The passenger compartment of the vehicle must be separated from the hydrogen system in order to avoid accumulation of hydrogen. It must be ensured that any fuel leaking from the container or its accessories does not escape to the passenger compartment of the vehicle.
14. Hydrogen components that could leak hydrogen within the passenger or luggage compartment or other non-ventilated compartment must be enclosed by a gas-tight housing or by an equivalent solution as specified in the implementing measures.
15. Electrically operated devices containing hydrogen must be insulated in such a manner that no current passes through hydrogen containing parts in order to prevent electric sparks in the case of a fracture.

Metallic components of the hydrogen system must have electrical continuity with the vehicle's earth.

16. Labels or other means of identification must be used to indicate to rescue services that the vehicle is powered by hydrogen and that liquid or compressed (gaseous) hydrogen is used.

## ANNEX VII

### Amendments to Directive 2007/46/EC

Directive 2007/46/EC is hereby amended as follows:

1. In Part I of Annex IV, the following row shall be added to the table:

Item	Subject	Regulatory act reference	Official Journal reference	Applicability									
				M <sub>1</sub>	M <sub>2</sub>	M <sub>3</sub>	N <sub>1</sub>	N <sub>2</sub>	N <sub>3</sub>	O <sub>1</sub>	O <sub>2</sub>	O <sub>3</sub>	O <sub>4</sub>
'62	Hydrogen system	Regulation (EC) No 79/2009	35, X 4.2.2009, p. 32	X	X	X	X	X	X				

2. In the Appendix to Part I of Annex IV, the following row shall be added to the table:

Subject	Regulatory act reference	Official Journal reference	M <sub>1</sub>

*Status: This is the original version (as it was originally adopted).*

'62	Hydrogen system	Regulation (EC) No 79/2009	L 35, 4.2.2009, p. 32	X'
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3. In the Appendix to Annex VI, the following row shall be added to the table:

	Subject	Regulatory act reference <sup>(1)</sup>	As amended by	Applicable to versions
'62.	Hydrogen system	Regulation (EC) No 79/2009'		

4. In Appendix 1 to Annex XI, the following row shall be added to the table:

Item	Subject	Regulatory act reference	$M_1 \leq 2$ 500 <sup>(1)</sup> kg	$M_1 > 2$ 500 <sup>(1)</sup> kg	$M_2$	$M_3$
'62	Hydrogen system	Regulation (EC) No 79/2009	Q	G + Q	G + Q	G + Q'

5. In Appendix 2 to Annex XI, the following row shall be added to the table:

Item	Subject	Regulatory act reference	$M_1$	$M_2$	$M_3$	$N_1$	$N_2$	$N_3$	$O_1$	$O_2$	$O_3$	$O_4$
'62	Hydrogen system	Regulation (EC) No 79/2009	A	A	A	A	A	A'				

6. In Appendix 3 to Annex XI, the following row shall be added to the table:

Item	Subject	Regulatory act reference	$M_1$
'62	Hydrogen system	Regulation (EC) No 79/2009	X'

7. In Appendix 4 to Annex XI, the following row shall be added to the table:

Item	Subject	Regulatory act reference	$M_3$	$N_1$	$N_2$	$N_3$	$O_1$	$O_2$	$O_3$	$O_4$
'62	Hydrogen system	Regulation (EC) No 79/2009	Q	Q	Q	Q'				

8. In Appendix 5 to Annex XI, the following row shall be added to the table:

<b>Item</b>	<b>Subject</b>	<b>Regulatory act reference</b>	<b>Mobile crane of category N<sub>3</sub></b>
'62	Hydrogen system	Regulation (EC) No 79/2009	X'

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*Status: This is the original version (as it was originally adopted).*

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- (1) Opinion delivered on 9 July 2008.
- (2) Opinion of the European Parliament of 3 September 2008 (not yet published in the Official Journal) and Council Decision of 16 December 2008.
- (3) [OJ L 263, 9.10.2007, p. 1.](#)
- (4) [OJ L 184, 17.7.1999, p. 23.](#)