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Preliminary draft proposal for a Regulation of the European Parliament and of the Council relating to the type-approval of hydrogen powered motor vehicles

version 2

updated on 13 July 2006

EXPLANATORY MEMORANDUM

1. OBJECTIVE OF THE PROPOSAL

The European Commission has devoted increasing attention, in its effort to promote more efficient energy systems, to the issues of diversification of energy sources, more decentralised production of energy, climate change and reduction of the environmental impact of road transport. Hydrogen, not a source of energy, but a promising energy carrier that can be used as fuel in internal combustion engines and fuel cells has been identified as a major factor towards these objectives. European Union-funded projects are already advancing research for, and development of hydrogen technologies.

The Commission is working on the role that hydrogen could play in achieving sustainable energy, and on how to transform that potential into reality. The overall policy of the European Union on sustainable development must encompass an ambitious strategy on hydrogen to provide for a high level of environmental protection and to diversify energy sources.

Hydrogen can be used in mobile applications like cars, delivery vehicles and buses. With the use of hydrogen, a clean energy carrier, either directly or in fuel-cell systems in vehicles there are no carbon emissions (carbon monoxide, unburnt hydrocarbons or particulates) in the exhaust pipe. Thus, using hydrogen will contribute to the improvement of air quality in cities. Additionally, no greenhouse gases are produced from motor vehicles.

Today, major car manufacturers are making important investments for developing the hydrogen and fuel cell technology, and are close to offering vehicles on a commercial basis.

An important factor in the design and manufacture of motor vehicles is the regulatory aspect. Legislation is not intended as a barrier to innovation and development but as a means of facilitating the introduction of technologically advanced vehicles. Here vehicle type-approval plays a substantial role, especially in the safety and environmental fields. The appropriate adaptation of the existing legislation will aid the approval and placing on the market of vehicles using hydrogen and will contribute to the confidence in the new technology for potential users and the public at large.

2. BACKGROUND

UN-ECE Regulations No. 67[1] and 110[2], which are accepted in the European type-approval regulatory system, introduce requirements relating to the type-approval of

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[1] Uniform provisions concerning:
I. approval of specific equipment of motor vehicles using liquefied petroleum gases in their propulsion system;
II. approval of a vehicle fitted with specific equipment for the use of liquefied petroleum gases in its propulsion system with regard to the installation of such equipment.

components and vehicles propelled by LPG (liquefied petroleum gas) and NG (natural gas) respectively.

The present proposal has been structured in a similar way to those two regulations.

3. CONTENT OF THE PROPOSAL

This proposal for a Regulation of the European Parliament and the Council specifies technical requirements to be applied for the type-approval of any of the elements (hydrogen containers and hydrogen components other than containers) included in the hydrogen fuel system in order to ensure that hydrogen related components are working in a proper and safe way.

It includes requirements for the installation of hydrogen components or systems in vehicles.

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[2] Uniform provisions concerning :
I. specific components of motor vehicles using compressed natural gas (cng) in their propulsion system;
II. vehicles with regard to the installation of specific components of an approved type for the use of compressed natural gas (cng) in their propulsion system.

Preliminary draft proposal for a

REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

relating to the type-approval of hydrogen powered motor vehicles

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[3],

Having regard to the opinion of the European Economic and Social Committee[4],

Acting in accordance with the procedure laid down in Article 251 of the Treaty[5],

Whereas:

(1) Directive XXXX/XX/EC of the European Parliament and of the Council on the approval of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles[6] ("Framework Directive") establishes a comprehensive system for the type approval of motor vehicles. It does so in the interest of the free movement of motor vehicles in the internal market of the European Community. A fully harmonised internal market is essential for the competitiveness of the automotive industry which depends on large open markets for the sale and distribution of its products.

(2) [Article 9] of the Framework Directive refers to a number of regulatory acts that manufacturers have to comply with in order to obtain type approval. The present Regulation constitutes such a separate legal act.

(3) Its objective is to lay down harmonised rules on the construction of motor vehicles with a view to ensuring the functioning of the internal market while at the same time providing for a high level of environmental protection and public safety.

(4) One of the strategic objectives of the Commission in the coming years is to work, in partnership with the European Parliament and the Council, towards creating long-term prosperity in Europe, and in particular to restore sustainable dynamic growth and jobs, in accordance with the Lisbon strategy. Delivering on this far-reaching goal will

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3 OJ C […], […], p. […].
4 OJ C […], […], p. […].
5 OJ C […], […], p. […].
6 This refers to the Commission's proposal 2004/0153 (COD) that is pending in the codecision process. References to the Framework Directive will be updated as soon as it is adopted.

require not only horizontal actions affecting all enterprises, but also vertical initiatives, focusing on the specificities of particular sectors including the automotive industry.

(5) In the transport sector, an increased share of more environmentally friendly vehicles should be aimed at and additional efforts should be undertaken in order to place more environmentally friendly vehicles on the market.

(6) An adequate framework should be created as soon as possible to accelerate the introduction onto the market of vehicles with innovative propulsion technologies and vehicles which use alternative fuels with a low environmental impact.

(7) The introduction of vehicles with alternative fuels can produce a significant improvement in the urban air quality.

(8) Hydrogen is considered as a clean way of powering vehicles as vehicles propelled with hydrogen produce neither carbon based pollutants nor emissions of green-house gases.

(9) Major car manufacturers are making important investments for developing the hydrogen technology, and have already presented vehicles for demonstration purposes.

(10) The approval and placing on the market of vehicles using hydrogen in the internal market will contribute to the confidence in the new technology for potential users and the public at large.

(11) Safety measures for the components of the hydrogen system have to be implemented for the type-approval of such components.

(12) The installation of those components in the vehicle has to be taken into account for the approval of the vehicle.

(13) The objectives of this Regulation, namely the realisation of the internal market through the introduction of common technical requirements concerning motor vehicles using hydrogen, cannot be sufficiently achieved by the Member States. Due to the scale of the action required the objectives can be better achieved at Community level. Therefore, 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 for that purpose,

HAVE ADOPTED THIS REGULATION:

Article 1

Subject matter

This Regulation lays down the requirements for the type approval of hydrogen powered vehicles with respect to hydrogen components and hydrogen systems, and for the type-approval of hydrogen components. It also includes requirements for the installation of hydrogen components or systems in hydrogen powered vehicles.

Article 2

Scope

1. This Regulation applies to:

   (a) hydrogen powered vehicles of categories M and N;

   (b) hydrogen systems for motor vehicles of categories M and N;

   (c) hydrogen components integrated in the hydrogen system of motor vehicles of categories M and N.

Article 3

Definitions

For the purposes of this Regulation the following definitions shall apply:

1. “vehicle” means any motor vehicle as defined in Article [3] of [the Framework Directive] falling within the scope of this Regulation;

2. “vehicle type” means hydrogen powered vehicles fitted with components for the use of hydrogen which do not differ with respect to the following conditions:

2.1. the manufacturer;

2.2. the type designation established by the manufacturer;

2.3. the essential aspects of construction and design:

2.3.1. chassis/floor pan;

2.3.2. the installation of the hydrogen components;

2.4. type(s) of components.

3. "hydrogen system" means an assembly of hydrogen components and connecting parts fitted on motor vehicles using hydrogen, excluding the propulsion system(s) (internal combustion engine or fuel cell, which is used to propel the vehicle) and/or auxiliary power unit(s). For the purpose of this Regulation the following are considered hydrogen systems:

3.1 usage monitoring and control system;

3.2. vehicle interface system;

3.3. excess flow system;

3.4. overpressure protection system;

3.5. heat exchanger failure detection system.

4. “hydrogen component" means the container and all other components that are in direct contact with hydrogen or which form part of a system installed because of the use of hydrogen. For the purpose of this Regulation the following are considered components:

4.1. pressure relief device;

4.2. pressure relief valve;

4.3. automatic valve;

4.4. manual valve;

4.5. check valve or non-return valve;

4.6. heat exchanger;

4.7. refuelling connection or receptacle;

4.8. pressure regulator;

4.9. pressure, temperature, hydrogen or flow sensors if used as a safety device;

4.10. flexible fuel line;

4.11. fittings;

4.12. hydrogen filter;

4.13. removable storage system connector.

5. “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.

Article 4

Manufacturers’ Obligations

1. From the dates set out in this Regulation, vehicle manufacturers shall demonstrate that all new vehicles sold, registered or put into service in the Community are type approved in accordance with this Regulation and its implementing measures.

2. The manufacturers shall equip vehicles with hydrogen components that are designed, constructed and assembled so as to enable the vehicles to comply with this Regulation and its implementing measures.

3. Vehicle manufacturers shall provide to type approval authorities appropriate information about the vehicle specifications and test conditions.

4. Vehicle manufacturers shall provide information for periodic inspection of the hydrogen components during the service life of the vehicle. The information to be

provided for the purpose of periodic inspection shall be specified in the implementing legislation.

Article 5

Requirements for hydrogen components and systems

1. The requirements that manufacturers need to fulfil include the following :

   (a) The hydrogen components, including the hydrogen container, shall function in a correct and safe way. They shall reliably withstand the electrical, mechanical, thermal and chemical operating conditions. They shall stay gas tight.

   (b) Materials of the hydrogen components which are in contact with hydrogen shall be compatible with it.

   (c) All hydrogen components with directional flow shall have the flow direction clearly indicated.

   (d) Those parts of a hydrogen component whose correct and safe functioning is liable to be influenced by hydrogen or high pressure shall be submitted to the relevant test procedures.

2. Requirements for documentation, fault strategy and verification with respect to the safety aspects of complex electronic vehicle control systems shall be provided in the implementing legislation. Manufacturers shall ensure that hydrogen systems fulfil these requirements.

3. Specifications for the Maximum Allowable Working Pressure (MAWP) in the hydrogen system and protection against over-pressurisation shall be provided in the implementing legislation. The MAWP of the hydrogen components of the hydrogen system will be fixed as a function of the MAWP of the inner tank or maximum pressure the hydrogen component is subjected to.

Article 6

Test procedures for hydrogen components designed to use liquid hydrogen

1. Hydrogen components designed to use liquid hydrogen shall be subject to the test procedures as described in this Article and in Annex I, Tables 1 and 2.

2. Subject to specific requirements for any of the hydrogen components, the test procedures to be applied for the type-approval of hydrogen components shall include:

   (a) Inner tank burst test: The purpose of the inner tank burst test is to provide evidence that the hydrogen container can withstand a specified level of high pressure, the burst pressure. In order to obtain type-approval, the tank shall withstand the pressure without major deformations.

(b) Thermal autonomy under fire test: The purpose of the thermal autonomy under fire test is to provide evidence that the tank can withstand external fire for a specific time. The tank shall not burst and the pressure inside the tank shall not exceed a permissible range.

(c) Maximum filling level test: The purpose of the maximum filling level test is to provide evidence that the level of hydrogen does not exceed a certain percentage of the volume of the inner tank.

(d) Pressure test: The purpose of the pressure test is to provide evidence that the hydrogen containing components can withstand a pressure, which is higher than the working pressure of the component. A hydrogen component shall not show any visible evidence of leak, deformation, rupture or cracks when the pressure is increased to a certain rate.

(e) External leakage test: The purpose of the external leakage test is to provide evidence that the hydrogen components are free from external leakage and shall not show evidence of porosity.

(f) Endurance test: The purpose of the endurance test is to provide evidence that the hydrogen components are capable of reliable operation continuously. The test consists of carrying out a specific number of test cycles for the hydrogen component under various temperature and pressure conditions. A test cycle means the normal operation (i.e. one opening and one closing) of the hydrogen component.

(g) Operational test: The purpose of the operational test is to provide evidence that the hydrogen components are capable of operating reliably.

(h) Corrosion resistance test: The purpose of the corrosion resistance test is to provide evidence that the hydrogen components are capable of resisting corrosion. In order to prove this, the hydrogen components shall be submitted to contact with specified chemicals.

(i) Resistance to dry-heat: The purpose of the dry-heat resistance test is to provide evidence that the hydrogen components are capable of resisting high temperature. In order to prove this, the hydrogen components shall be exposed to air at the maximum operating temperature.

(j) Ozone ageing: The purpose of the ozone ageing test is to provide evidence that the hydrogen components are capable of resisting ageing due to ozone. In order to prove this, the hydrogen components shall be exposed to air with high ozone concentration.

(k) Temperature cycle test: The purpose of the temperature cycle 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 shall be submitted to a long temperature cycle from the minimum operating temperature up to the maximum operating temperature.

(l) Pressure cycle test: The purpose of the pressure cycle 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 shall be submitted to a pressure change from atmospheric pressure to the Maximum Allowable Working Pressure (MAWP) and shall decrease to atmospheric pressure within a short period of time.

(m) Hydrogen compatibility test: The purpose of the hydrogen compatibility 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 shall be avoided.

(n) Seat leakage test: The purpose of the seat leakage test is to provide evidence that hydrogen components are free from leakage while installed in the hydrogen system.

3. The results of the tests shall be recorded in a test certificate.

4. The detailed technical requirements and standards (ISO, EN, ASTM, etc.) describing the test procedures will be specified in implementing measures adopted in accordance with the provisions of Article 14.

Article 7

Requirements for hydrogen components designed to use liquid hydrogen

1. The hydrogen containers and the other hydrogen components designed to use liquid hydrogen shall be type-approved pursuant to the provisions laid down in the implementing legislation after performing the applicable test procedures. The hydrogen containers and the other hydrogen components shall be marked in accordance with the provisions laid down in the implementing measures.

The requirements that shall be fulfilled include the following:

(a) Hydrogen containers: The test procedures to carry out are the tests referred to in Article 6(2) a) to c).

(b) Pressure relief devices: The pressure relief devices have to be designed to ensure that the pressure in the inner tank or in other hydrogen components does not exceed a permissible value. The values are set in proportion to the Maximum Allowable Working Pressure (MAWP) of the hydrogen system. The tests to be carried out to obtain type-approval are the tests referred to in Article 6(2) d), e), g), h) and k).

(c) Valves: The tests to be carried out to obtain type-approval are the tests referred to in Article 6(2) d) to f); h) to k) and n).

(d) Heat exchangers: The allowable pressure in the heat exchanger will be defined in the implementing legislation. A safety system shall be provided to prevent failure of the heat exchanger. The tests to be carried out to obtain type-approval are the tests referred to in Article 6(2) d), e) and h) to k).

(e) Refuelling connections: The tests to be carried out to obtain type-approval are the tests referred to in Article 6(2) d) to f); h) to k) and n).

(f) Pressure regulators: The tests to be carried out to obtain type-approval are the tests referred to in Article 6(2) d) to f); h) to k) and n).

(g) Sensors: The tests to be carried out to obtain type-approval are the tests referred to in Article 6(2) d), e) and h) to k).

(h) Flexible fuel lines: The tests to be carried out to obtain type-approval are the tests referred to in Article 6(2) d), e) and h) to l).

Article 8

Test procedures for hydrogen components designed to use compressed (gaseous) hydrogen

1. Hydrogen components designed to use compressed (gaseous) hydrogen shall be subject to the test procedures as described in this Article and in Annex I, Tables 3 and 4.

2. In accordance with Annex I, Table 3, the test procedures to be applied for the type-approval of hydrogen containers shall include:

(a) Burst test: The purpose of the burst test is to provide evidence that the hydrogen container can withstand a specified level of high pressure. In order to prove this, the container shall be pressurized to a given value, which should be higher than the nominal working pressure of the container. The burst pressure of the container shall exceed a specified pressure. The burst pressure of the container shall be recorded and shall be kept by the manufacturer throughout the service life of the container.

(b) Ambient temperature pressure cycle test: The purpose of the ambient temperature pressure cycle test is to provide evidence that the hydrogen container is capable of resisting high variations of pressure. In order to prove this, pressure cycles shall be 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 shall not fail before reaching a specified number of cycles. The number of cycles to failure, along with the location and description of the failure shall be documented. The manufacturer shall keep the results throughout the service life of the container.

(c) LBB (leak before break) performance test: The purpose of the leak before break performance test is to provide evidence that the hydrogen container is capable of resisting high variations of pressure. In order to prove this, pressure cycles shall be carried out on the container by increasing and decreasing the pressure to a specified value. The containers tested shall either fail by leakage or shall exceed a specified number of test cycles without failure. The number of cycles to failure, along with the location and description of the failure shall be recorded.

(d) Bonfire test: The purpose of the bonfire test is to provide evidence that the container with its fire protection system does not burst when tested under the specified fire conditions. The container, pressurized to working pressure shall only vent through the pressure relief device and shall not rupture.

(e) Penetration test: The purpose of the penetration 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 shall be pressurized and penetrated by a bullet. The container shall not rupture.

(f) Chemical exposure test: The purpose of the chemical exposure test is to provide evidence that the container can withstand exposure to the specified chemical substances. In order to prove this, the container shall be exposed to various chemical solutions. The pressure of the container shall be increased to a given value and a burst test shall be carried out. The container shall achieve a specified burst pressure, which shall be recorded.

(g) Composite flaw tolerance test: The purpose of the composite flaw tolerance test is to provide evidence that the hydrogen container is capable of resisting exposure to high pressure. In order to prove this, flaws shall be cut into the container sidewall and a specified number of pressure cycles shall be carried out. The container shall 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 shall be recorded.

(h) Accelerated stress rupture test: The purpose of the accelerated stress rupture test is to provide evidence that the hydrogen container is capable of resisting exposure to high pressure. In order to prove this, the pressure of the container shall be increased to a given value and a burst test as referred to under a) above shall be carried out. The container shall achieve a specified burst pressure.

(i) Extreme temperature pressure cycle test: The purpose of the extreme temperature pressure cycle 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 shall be hydrostatically cycle tested by subjecting it to extreme ambient conditions and then carrying out a burst test and a leak test as referred to under a) and k). The containers shall be cycle tested without showing evidence of rupture, leakage or fibre unravelling. The containers shall not burst at a specified pressure.

(j) Impact damage test: The purpose of the impact damage test is to provide evidence that the hydrogen container remains operational after submitting it to the specified mechanical impacts. In order to prove this, the container shall be subjected to a drop test and a specified number of pressure cycles shall be carried out. The container shall 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 leak 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 shall be pressurised to its nominal working

pressure. It shall not show any evidence of leakage detected through cracks, pores or similar defects.

(l) Permeation test: The purpose of the permeation test is to provide evidence that the hydrogen container does not allow more gas to permeate than it is permitted. In order to prove this, the container shall be pressurized with hydrogen gas to nominal working pressure and then monitored for permeation in a closed chamber for a given time. The permeation rate shall not exceed a specified value.

(m) Boss torque test: The purpose of the boss torque test is to provide evidence that the hydrogen container is capable of resisting the specified torque pressure. In order to prove this, a torque shall be applied to the container from different directions. Then, a burst test and a leak test as referred to under a) and k) above shall be carried out. The container shall meet the burst and leak test requirements. The applied torque, leakage and burst pressure shall be recorded. The manufacturer shall keep the results of the test on file throughout the service life of the container.

(n) Hydrogen gas cycle test: The purpose of the hydrogen gas cycle 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 shall be subject to a number of pressure cycles with the use of hydrogen gas and a leak test as referred to under k) above. The deteriorations of the container shall be inspected. The container shall meet leak test requirements. The container shall be free of any deterioration, such as fatigue cracking or electrostatic discharge.

3. The test procedures to be applied for the type-approval of hydrogen components other than hydrogen containers shall include:

(a) Material tests:

– Hydrogen compatibility test, as referred to in Article 6(2) m).

– 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.

– 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.

(b) Corrosion resistance test, as referred to in Article 6(2) h).

(c) Endurance test, as referred to in Article 6(2) f). The applicable test procedure and the requirements to fulfil vary for each type of hydrogen component.

(d) Hydraulic pressure cycle test, as referred to in Article 6(2) l). The hydrogen components shall not show visible sign of extrusion and shall fulfil the requirements of the internal and external leakage test.

(e) Internal leakage test: The purpose of the internal leakage test is to provide evidence that the hydrogen components are free from internal leakage. In order to prove this, the hydrogen components shall be pressurized under different temperature conditions and observed for leakage. The hydrogen component shall stay bubble free and shall not leak internally at a higher rate than a specified number.

(f) External leakage test as referred to in Article 6(2) e).

4. The results of the tests shall be presented in a test certificate.

5. The detailed technical requirements and standards (ISO, EN, ASTM, etc.) describing the test procedures will be specified in implementing measures adopted in accordance with the provisions of Article 14.

6. The implementing measures shall specify the applicable service conditions for hydrogen systems using compressed (gaseous) hydrogen including the requirement for the manufacturer to specify the service life of the hydrogen components and the working pressure of the hydrogen system. They shall also state the applicable standard for the used compressed (gaseous) hydrogen and will include specifications for the range of operating temperatures for materials used in hydrogen components.

Article 9

Requirements for hydrogen components designed to use compressed (gaseous) hydrogen

1. Hydrogen containers and hydrogen components for the use of compressed (gaseous) hydrogen shall be classified according to Annex I (1), (2).

2. The hydrogen containers and the other hydrogen components designed to use compressed (gaseous) hydrogen shall be type-approved pursuant to the provisions laid down in the implementing legislation after performing the applicable test procedures. The hydrogen containers and the other hydrogen components shall be marked in accordance with the provisions laid down in the implementing measures.

The requirements that shall be fulfilled include the following:

(a) Containers:

– For different types of hydrogen containers, test procedures shall be carried out, as described in Annex I, Table 3 and

– a detailed description of all principal material properties and tolerances used in the container design shall be provided, including the results of the tests to which the material has been submitted. Those tests shall be specified in the implementing legislation.

(b) Pressure relief devices: The tests to be carried out to obtain type-approval are the tests referred to in Article 8(3) a) to f).

(c) Valves: The tests to be carried out to obtain type-approval for automatic, manual, non-return and pressure-relief valves are the tests referred to in Article 8(3) a) to f).

(d) Heat exchangers: The tests to be carried out to obtain type-approval are the tests referred to in Article 8(3) a), b), d) and f).

(e) Refuelling connections (receptacles): The tests to be carried out to obtain type-approval are the tests referred to in Article 8(3) a) to f).

(f) Pressure regulators: The tests to be carried out to obtain type-approval are the tests referred to in Article 8(3) a) to f).

(g) Sensors: The tests to be carried out to obtain type-approval are the tests referred to in Article 8(3) a) to d) and f).

(h) Flexible fuel lines: The tests to be carried out to obtain type-approval are the tests referred to in Article 8(3) a) to d) and f).

(i) Fittings: The tests to be carried out to obtain type-approval are the tests referred to in Article 8(3) a) to d) and f).

(j) Hydrogen filters: The tests to be carried out to obtain type-approval are the tests referred to in Article 8(3) a), b), d) and f).

(k) Removable storage system connectors: The tests to be carried out to obtain type-approval are the tests referred to in Article 8(3) a) to d) and f).

3. The applicable test procedures for the type-approval of hydrogen components other than containers are summarized in Annex I, Table 4.

Article 10

General requirements for the installation of hydrogen components and systems

The requirements for the installation of hydrogen components and systems shall include the following:

(a) The hydrogen system shall function in a correct and safe way. It shall reliably withstand the electrical, mechanical, thermal and chemical operating conditions without leaking or visibly deforming.

(b) Hydrogen components shall be type-approved pursuant to the provisions laid down in the implementing measures adopted according to Article 14 with a description of the procedure to be followed in case of an application for type-approval.

(c) The materials used in the hydrogen system shall be compatible with liquid or gaseous hydrogen. They shall withstand expected temperatures and pressures. The hydrogen system shall be installed such that it is protected against damage. It should be isolated from heat sources in the vehicle.

(d) Hydrogen components shall reliably withstand a range of operating temperatures. The ranges of operating temperatures for hydrogen components used in different types of propulsion systems shall be specified in the implementing legislation.

(e) Unless specified otherwise, the hydrogen container shall be permanently installed on-board the vehicle and may only be removed for maintenance. It shall be adequately protected against any kind of corrosion. The container must be mounted and fixed so that the specified accelerations can be absorbed without damage of the safety related parts when the hydrogen containers are full.

(f) No hydrogen component, including any protective materials that form part of such components, shall project beyond the outline of the vehicle or protective structure. This shall not apply if a hydrogen component is adequately protected and no part of the hydrogen component is located outside this protective structure.

(g) The hydrogen system shall be installed such that it is protected against damage so far as is reasonably practical, such as damage due to moving vehicle components, impacts, grit or due to the loading or unloading of the vehicle or the shifting of loads.

(h) No hydrogen component shall be located near the exhaust of an internal combustion engine or other heat source, unless such components are adequately shielded against heat.

(i) The ventilating or heating system for a passenger compartment and places where leakage or accumulation of hydrogen is possible shall be kept apart so that hydrogen is not drawn into the vehicle.

(j) In the event of hydrogen leakage or venting, hydrogen shall not be allowed to accumulate in enclosed or semi-enclosed spaces.

(k) In the event of accidents it must be ensured so far as is reasonably practicable that the pressure relief device and the associated ventilation remain capable of functioning. The ventilation of the pressure relief device shall be adequately protected against dirt and water. Requirements relating to the mounting of pressure relief devices to the hydrogen container and the requirements of the necessary ventilation shall be specified in the implementing legislation.

(l) The passenger compartment of the vehicle should be separated from the hydrogen system in order to avoid accumulation of hydrogen.

(m) Hydrogen components that could leak hydrogen and that are mounted within the passenger or luggage compartment or other non-ventilated compartment shall be enclosed by a gas tight housing or by an equivalent solution as specified in the implementing legislation.

(n) The hydrogen fuel supply lines and the refuelling line shall be secured with an automatic valve. The automatic valves shall close if any malfunction of the hydrogen system occurs and in the event of a crash or of a break of the fuel

supply line(s). When the engine system is switched off, the fuel supply to the system shall be switched off and remain closed until the system is required to operate.

(o) The refuelling connection shall be secured against maladjustment and shall be protected from dirt and water. It shall be ensured that the system cannot be operated and the vehicle cannot move while the refuelling system is connected to the filling station. A label shall be affixed close to the refuelling connection showing that liquid hydrogen is used.

(p) Electrically operated devices containing hydrogen shall:

(1) 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,

(2) have the electrical system of the device insulated from the body of the vehicle.

Article 11

Specific requirements for the installation of hydrogen components designed to use liquid hydrogen

The requirements for the installation of hydrogen components designed for the use of liquid hydrogen shall include the following:

(a) Appropriate automatic measures shall be adopted in coordination with the refuelling station to ensure that no uncontrolled hydrogen release occurs during the filling procedure.

(b) The specifications regarding the minimum set of hydrogen components of a hydrogen system and the voluntary components of such a system shall be specified in the implementing legislation.

Article 12

Specific requirements for the installation of hydrogen components designed to use compressed (gaseous) hydrogen

The requirements for the installation of hydrogen components designed for the use of compressed (gaseous) hydrogen shall include the following:

(a) The range of average gas temperatures shall be specified in the implementing legislation. The manufacturer has to make sure that the hydrogen system is protected against over-pressurisation.

(b) A removable hydrogen storage system may be removed only for refilling. It shall not be installed in the engine compartment of the vehicle.

(c) Measures have to be implemented to prevent hydrogen leakage during refilling a removable hydrogen storage system and to make sure that the removal of such a system can be done safely.

(d) A label shall be affixed close to the refuelling connection showing that gaseous hydrogen is used and showing information on the working pressure of the container. The place of installation of the refuelling system on the vehicle shall be specified in the implementing legislation.

Article 13

Type-approval

1. With effect from [6 months from the date of entry into force of this Regulation], if a manufacturer so requests, Member States may not, on grounds relating to hydrogen systems and hydrogen components:

   – refuse, in respect of a new type of vehicle, to grant EC type-approval, or national type approval, or

   – prohibit the registration, sale or entry into service of a new vehicle,

   if the hydrogen systems and the hydrogen components comply with the requirements set out in this Regulation and its implementing measures and are installed in accordance with the requirements set out in this Regulation and its implementing measures.

2. With effect from [24 months from the date of entry into force], Member States shall refuse, on grounds relating to hydrogen systems and hydrogen components, to grant EC type-approval or national type-approval in respect of new types of vehicles if the hydrogen systems or the hydrogen components do not comply with the requirements set out in this Regulation and its implementing measures or are not installed in accordance with the requirements set out in this Regulation and its implementing measures.

3. With effect from [36 months from the date of entry into force] for new vehicles, Member States shall:

   – consider certificates of conformity to be no longer valid for the purposes of Article [25] of [the Framework Directive], and

   – on grounds relating to hydrogen systems and hydrogen components, refuse registration and prohibit the sale and entry into service of vehicles

   if the hydrogen systems or the hydrogen components do not comply with the requirements set out in this Regulation and its implementing measures or are not installed in accordance with the requirements set out in this Regulation and its implementing measures.

4. With effect from [6 months from the date of entry into force of this Regulation] Member States may not refuse to grant EC type-approval or national type-approval

for a hydrogen component if it satisfies the requirements set out in this Regulation and its implementing measures.

5. With effect from [24 months from the date of entry into force], Member States shall refuse to grant EC type-approval or national type-approval for a hydrogen component if it does not satisfy the relevant requirements set out in this Regulation and its implementing measures.

Article 14

Implementing measures and amendments

By [6 months from the date of entry into force], the measures for the implementation of the provisions of this Regulation and in particular of Articles from 4 to 12, shall be adopted in accordance with the procedure referred to in [Article 37(2)] of [the Framework Directive]. The same procedure shall be used for amendments of this Regulation and its Annexes, in particular if other forms of storing or using hydrogen in motor vehicles become available.

Article 15

Amendments to [the Framework Directive]

[The Framework Directive] is hereby amended in accordance with Annex II to this Regulation.

Article 16

Amendments to other pieces of legislation

[to be filled in later]

Article 17

Sanctions for non-compliance

1. Member States shall lay down the provisions on penalties applicable for infringement of the provisions of the present Regulation and shall take all measures necessary to ensure that they are implemented. The penalties provided for must be effective, proportionate and dissuasive. Member States shall notify those provisions to the Commission no later than eighteen months after entry into force of this Regulation and shall notify it without delay of any subsequent amendment affecting them.

2. The types of infringements which are subject to a penalty shall include:

   (a) making false declarations during the approval procedures or procedures 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; and

(d) use of defeat devices.

Article 18

Entry into force

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

2. If the adoption of the amendments or implementing measures referred to in Articles from 4 to 12 and 14 is delayed beyond [6 months after the entry into force of this Regulation], the dates mentioned in paragraphs 2, 3 and 5 of Article 13 shall be replaced by the dates mentioned in the amendments or the implementing measures.

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

Done at Brussels, […]

For the European Parliament	*For the Council*
The President	*The President*
[…]	*[…]*

ANNEX I

Table 1: Applicable test procedures for hydrogen containers designed for the use of liquid hydrogen

Type of test
Inner tank burst test
Thermal autonomy under fire test
Maximum filling level test

Table 2: Applicable test procedures for hydrogen components other than containers designed for the use of liquid hydrogen

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

Table 3: Applicable test procedures for hydrogen containers designed for the use of 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	✓	✓	✓	✓
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. A container designed for the use of compressed (gaseous) hydrogen shall be classified into the following types according to the type of construction:

   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. Hydrogen components shall be classified with regard to their nominal working pressure and function as defined below:

   Class 0 High-pressure components/systems including fuel lines and fittings containing hydrogen at a nominal working pressure greater than 3.0 MPa

Class 1 Medium-pressure components/systems including fuel lines and fittings containing hydrogen at a nominal working pressure greater than 0.45 MPa and up to and including 3.0 MPa

Class 2 Low-pressure components/systems including fuel lines and fittings containing hydrogen at a nominal working pressure up to and including 0.45 MPa.

Table 4: Applicable test procedures for hydrogen components other than containers designed for the use of compressed (gaseous) hydrogen

	TYPE OF TEST					
HYDROGEN COMPONENT	Material tests	Corrosion resistance test	Endurance test	Hydraulic pressure cycle test	Internal leakage test	External leakage test
Pressure relief devices	✓	✓	✓	✓	✓	✓
Automatic valves	✓	✓	✓	✓	✓	✓
Manual valves	✓	✓	✓	✓	✓	✓
Non-return valves	✓	✓	✓	✓	✓	✓
Pressure relief valves	✓	✓	✓	✓	✓	✓
Heat exchangers	✓	✓		✓		✓
Receptacles	✓	✓	✓	✓	✓	✓
Pressure regulators	✓	✓	✓	✓	✓	✓
Sensors for hydrogen systems	✓	✓	✓	✓		✓
Flexible fuel lines	✓	✓	✓	✓		✓
Fittings	✓	✓	✓	✓		✓
Hydrogen filters	✓	✓		✓		✓
Removable storage system connectors	✓	✓	✓	✓		✓

ANNEX II

Amendments to the Framework Directive

The Framework Directive is amended as follows:

1. In Annex IV, part I, in point 55 the following shall be added:

Subject	Regulatory act reference	Official Journal reference	Applicability									
			M_1	M_2	M_3	N_1	N_2	N_3	O_1	O_2	O_3	O_4
55. Hydrogen	[…./…/EC]	L .., …, p. ..	X	X	X	X	X	X				

2. In Annex VI, Appendix 1, in point 55 the following shall be added:

Subject	Regulatory act reference	As amended by	Applicable to Variants
55. Hydrogen	[…./…/EC]		

3. In Annex XI, Appendix 1, in point 55 the following shall be added:

Item	Subject	Regulatory act reference	$M_1 \leq 2\,500$ ([1]) kg	$M_1 > 2\,500$ ([1]) kg	M_2	M_3
55	Hydrogen	[…./…/EC]	*Q*	*G+Q*	*G+Q*	*G+Q*

4. In Annex XI, Appendix 2 in point 55 the following shall be added:

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
55	Hydrogen	[…./…/EC]	*A*	*A*	*A*	*A*	*A*	*A*				

5. In Annex XI, Appendix 3 in point 55 the following shall be added:

Item	Subject	Regulatory act reference	M_2	M_3	N_1	N_2	N_3	O_1	O_2	O_3	O_4
55	Hydrogen	[…../…/EC]	Q	Q	Q	Q	Q				

6. *In Annex XI, Appendix 4* in point 55 the following shall be added*:*

Item	*Subject*	*Regulatory act reference*	*Mobile crane of category N3*
55	*Hydrogen*	*[…./…/EC]*	*X*