# 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)

# 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 | ↘ | ↘ | ↘ | ↘ |
| 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.

(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.

**Changes to legislation:**
There are outstanding changes not yet made to Regulation (EC) No 79/2009 of the European Parliament and of the Council. Any changes that have already been made to the legislation appear in the content and are referenced with annotations.
View outstanding changes

**Changes and effects yet to be applied to the whole legislation item and associated provisions**

- Signature words omitted by S.I. 2022/1273 reg. 52(8)
- Art. 2(1) words substituted by S.I. 2022/1273 reg. 52(2)
- Art. 11(1)(a) words omitted by S.I. 2022/1273 reg. 52(4)(a)(iv)
- Art. 11(3)(a) words omitted by S.I. 2022/1273 reg. 52(4)(c)(iv)
- Art. 12(e) word omitted by S.I. 2022/1273 reg. 52(5)(b)