Multilateral Agreement M316
under section 1.5.1 of ADR, concerning the working pressure of composite cylinders intended for the carriage of hydrogen (UN 1049)

1. By derogation from the provisions of 6.2.5.5 of ADR, the minimum burst ratio (burst pressure divided by test pressure) for composite cylinders intended for the carriage of hydrogen is equal to 1.5. Therefore, the cylinders can be filled and carried at a working pressure of 4/3 Po, where Po is the working pressure not exceeding 525 bar, calculated in accordance with the packing instruction P200 of ADR. The conditions in 2 below shall be met.

2. This agreement only applies to fully wrapped carbon fiber cylinders complying with the following requirements:

2.1. The cylinders shall be designed and manufactured in accordance with EN 12245: 2009 +A1:2011, fulfilling the tests as required in the following Annex.

2.2. The cylinders shall be used in bundles or MEGCs or battery-vehicles to be protected from external impact by the frame.

2.3. The following marks shall be applied:

- on each cylinder, the mark confirming the approval for PW = Po bar,

- on the bundle or MEGC or battery-vehicle data plate, in addition to the PW = Po bar marking, the indication of PW = 4/3 Po bar followed by M316 and the stamp and identification number of the inspection body approved by a competent authority which has signed this agreement.

2.4. The bundles or MEGCs or battery-vehicles shall be equipped with a main valve designed, manufactured and tested for at least 4/3 Po bar service pressure.

2.5. After 2.5 years from the date of signature of this multilateral agreement, an evaluation is performed to consider any operational issues such as defects during inspection at the time of filling. In addition, a bursting test on a representative sample may be performed to assess the resistance of cylinders is not impaired by ageing.

3. This agreement shall be valid until 31 December 2023 for the carriage on the territories of the ADR Contracting Parties signatory to this agreement. If it is revoked before that date by one of the signatories, it shall remain valid until the above mentioned date only for carriage on the territories of those ADR Contracting Parties signatory to this agreement which have not revoked it.

Done in

The Competent Authority for ADR in

Annex to Multilateral Agreement M316
Tests to be conducted

The procedure and criteria as specified in clause 5.2 Requirements and test methods of EN 12245:2009 +A1:2011 concerning Tests 1, 2, 16, 17, 18 and 19 are fulfilled.

The procedure and criteria as specified in clause 5.2 of EN 12245:2009 +A1:2011 concerning Tests 4, 5, 6, 8, 9, 10, 11, 12, 13 and 14, and the additional Tests A and B are fulfilled in the following conditions:

No	Test	Procedure according to	Criteria
4	Pressure test of finished cylinders at ambient temperature	5.2.4.1 hydraulic test pressure increased to 1.25 (4/3 Po)	as per EN 12245
5	Cylinder burst test	5.2.5.1	$p_b \geq 2.25$ (4/3 Po)
6	Resistance to pressure cycles at test pressure and ambient temperature	5.2.6.1 ≤ 5 cycles/min, Pmin ≤ 5 bar(*)	p_h = 1.25 (4/3 Po), 15 000 cycles mini
8	Exposure to elevated temperature at test pressure	5.2.8.1 for 20 year lifetime, test at 1.25 (4/3 Po) and 70°C for 1000 h for more than 20 year lifetime, test at 1.25 (4/3 Po) and 70°C for 2000 h	$p_b \geq 2.25$ (4/3 Po)
9	Drop test	5.2.9.2 and 5 drops in different position at 1.8 m max height ≤ 5 cycles/min, Pmin ≤ 5 bar(*)	3000 cycles up to 4/3 Po without burst or leak 9000 cycles without burst
10	Flawed cylinder test	5.2.10.1 ≤ 5 cycles/min, Pmin ≤ 5 bar(*)	one cylinder, $p_b \geq 1.8$ (4/3 Po) and one cylinder cycling test at 4/3 Po for 5000 cycles (leak after 1000 cycles tolerated)
11	Extreme temperature cycle test	5.2.11.1	burst pressure after tests ≥ 2.08 (4/3 Po)
12	Fire resistance test	5.2.12.1 test at 4/3 Po. The cylinders are not fitted with a pressure relief device	4 min in a fire without burst
13	High velocity impact test	5.2.13.1 and one cylinder filled to 4/3 Po, impacted by a 7.62 mm (0.30 calibre) armour piercing projectile (of length between 37 and 51 mm) with a nominal speed of 850 m/s in the cylinder side wall at a nominal angle of 45° - 1 shot	as per EN 12245
14	Permeability test	5.2.14.1 and 2 cylinders filled at 4/3 Po with H2: one after proof test and 1000 cycles between 5 bar and 4/3 Po(*), and one after proof test, neck strength test and 1000 cycles between 5 bar and 4/3 Po (*)	The maximum permeation rate X shall be recorded in ml/h/l of and should be X ≤ 10,00. Finally, the value of X shall be chosen, according to the application. The total permissible amount of permeation as calculated from all of the cylinders of the bundle/MEGC/battery-vehicle as applicable, shall be considered in a risk assessment. The value shall be agreed by the manufacturer, owner and inspection body and shall be indicated on the approval certificate and marked on the bundle/MEGC/battery-vehicle .
A	Liner collapse test	filling-emptying cycle representative of operating conditions	no liner collapse
B	Slow burst test	2 cylinders are pressurized at a rate not exceeding 20 % of 1.25 (4/3 Po) bar/h	no criteria – to be eventually used as a reference

(*): When the equipment does not allow reaching 5 bar minimum pressure, a maximum pressure of 30 bar is allowed and a pressure difference of 1.25 (4/3 Po) minus 5 bar (or 4/3 Po, depending on the test) shall be maintained during the cycling test between the highest and the lowest pressures in the cycle.