

Committee of Experts on the Transport of Dangerous Goods and on the Globally Harmonized System of Classification and Labelling of Chemicals

Sub-Committee of Experts on the Transport of Dangerous Goods

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Transportation of Gases:

Miscellaneous

Flammable gases in non-refillable pressure receptacles

Transmitted by the Council on the Safe Transportation of Hazardous Articles (COSTHA)

I. Background

1. The Heating, Ventilating, Air Conditioning and Refrigerating (HVAC&R) industry is currently going through a series of transitions. First, Chlorofluorocarbons (CFCs) and Hydrochlorofluorocarbons (HCFCs) were invented in the 1920's and with its non-flammable and low toxic characteristics, it became a popular use as refrigerants for HVAC&R, solvents, and other applications. However, in 1974, Frank Sherwood Rowland and Mario J. Molina suggested that these substances can deplete the ozone layer, and this led to the creation of the Montreal Protocol to phase out these so-called ozone depleting substances (ODS) in 1987 and the Montreal Protocol was ratified by 198 parties, making it the first universally ratified treaty in the United Nations history.

2. As these ODS were being phased down and out, alternative refrigerants like Hydrofluorocarbons (HFCs) became common. In fact, due to this, the Government of the United States of America (USA) submitted a proposal to the Sub-Committee as noted in report ST/SG/AC.10/C.3/30 on July 22, 1998 for a creation of UN 3358: Refrigerating machines, containing flammable, non-toxic gases, with a special provision 291, which allowed these machines to be transported with flammable gas with less than 12 kg charge except for air shipments.

3. HFCs unlike ODS, do not harm the ozone layer. However, these non-ODS HFC gases have a relatively high global warming potential (GWP), which can be 1 000 to 10 000 times more than CO₂. This raised a big concern that led to the creation of the Kigali Amendment of the Montreal Protocol in 2016, which began a production freeze in 2019 and a gradual phase down of HFCs based on their GWP values up to 80 to 85 per cent reduction from baseline. Advanced countries also known as non-A5 countries will phase down 85 per cent by 2036, and emerging countries known as A5 countries will phase down 80 per cent by 2045 or 85 per cent by 2047. As of July 1, 2024, 160 states and the European Union ratified the Amendment.

4. As these high GWP HFC refrigerants are being phased down, alternative refrigerants such as lower GWP HFC, Hydrofluoroolefins (HFOs), HFC/HFO blends, and hydrocarbons are being used. For example, in the USA, currently used refrigerant R410A (a blend of HFC-32 and HFC-125) has a GWP of 2088, but is being transitioned to HFC-32 (GWP of 675) and R454B (GWP of 466) for residential HVAC systems. The trade-off from high ODS/GWP to low or no GWP refrigerants is flammability and toxicity. The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) which classifies flammability and toxicity has created a new flammability class 2L which is mildly flammable

with a burning velocity of 10 cm/sec or less. The UN *GHS*¹ has also created a similar classification Category 1B flammable gas to distinguish between highly flammable and mildly flammable gases.

5. HVAC&R has been essential to people's life by reducing health issues, and to refrigeration also by preserving food. This need will continue to rise, and according to International Energy Agency (IEA), The Future of Cooling report issued in 2018 predicts the use of air conditioners to triple by 2050. In addition, the acceleration of the use of heat pump systems is rapidly growing, this all leads to the use of lower or no GWP refrigerant gases which are flammable. In 2022, the United Nations Refrigeration, Air Conditioning and Heat Pumps Technical Options Committee (RTOC) report also mentions that it is expected that the phasedown according to the Kigali Amendment will rapidly advance the use of low- and ultra-low GWP alternatives.

6. HVAC systems are mostly pre-charged with refrigerants at production facilities. However, additional refrigerants need to be charged on-site to adjust the required volume-based refrigerant piping that connects between an evaporator and condensing unit. Refrigerant is also used during repairs or to top off leaked amounts. In the refrigeration sector, refrigerants are commonly charged on site as the system is being built. These refrigerants have been commonly used in non-refillable pressure receptacles in either 11.3 kg or 13.6 kg filling for non-flammable refrigerants.

7. With the industry's transition from high GWP refrigerants to low or no GWP refrigerants, there needs to be adequate supply chain of alternative refrigerants that is flammable.

II. Issue

8. *Model Regulations*, paragraph 4.1.6.1.9 (b) states:

“Non-refillable pressure receptacles shall:

(b) Be of a water capacity less than or equal to 1.25 litres when filled with flammable or toxic gas;

...”

9. This requirement limits refrigerant cylinders to a charge size of 1 kg, and therefore HVAC&R contractors would have to use many cylinders to fill up a system. The other option is to use refillable pressure receptacles, but this is not common in areas such as Latin/South America, Southeast Asia, and the Global South as there are limited or no refrigerant distributors that can collect and refill refrigerants into refillable pressure cylinders.

III. Proposals

10. To address this issue, it is proposed to take the following actions:

(i) Introduce a new entry UN XXXX, REFRIGERANT GAS, FLAMMABLE, N.O.S.

(ii) Create a new special provision XYZ to state:

“XYZ Non refillable pressure receptacles shall be water capacity less than or equal to 25 litre (55 pounds) for a service pressure of 34.5 bar (500 p.s.i.g.) or less with UN GHS 1B flammable gas with pressure relief device that is governed by the national authority of the country of use such as Compressed Gas Association (CGA) Publication S-1.1.

Note: UN GHS Category 1B flammable gas

¹ *Globally Harmonized System of Classification and Labelling of Chemicals (GHS)*

Gases which meet the flammability criteria for Category 1A, but which are not pyrophoric, nor chemically unstable, and which have at least either:

- (a) a lower flammability limit of more than 6 % by volume in air; or
- (b) a fundamental burning velocity of less than 10 cm/s.”

(iii) Apply special provision to the following entries:

- (a) UN XXXX REFRIGERANT GAS, FLAMMABLE, N.O.S;
- (b) UN 3161 LIQUIFIED GAS, FLAMMABLE, N.O.S; and
- (c) UN 3252 DIFLUOROMETHANE.

IV. Justification

11. There are two reasons why it can be considered that 1.25 litre limitation can be increased.

Internationally, there are various regulations that allows charge size above 1.25 litres:

- (a) In the USA, US DOT regulations states the following:

49 CFR § 178.65 Specification 39 non-reusable cylinder

(a)(1) Size limitation.

Maximum water capacity may not exceed: (i) 55 pounds (1,526 cubic inches for a service pressure of 500 p.s.i.g. or less, and (ii) 10 pounds (277 cubic inches) for a service pressure in excess of 500 p.s.i.g.

There have been thousands if not millions of 4.5 kg or 11.3 kg of Class 2.1 R1234yf: UN 3161 Liquefied Gas, Flammable, N.O.S. (2,3,3,3-TETRAFLUOROPROP-1-ENE) in DOT-39 non-refillable pressure receptacles being circulated within the USA since 2012.

(b) In Japan, Class 2.1 R32: UN 3252 Difluoromethane and R1234yf: UN 3161 Liquefied Gas, Flammable, N.O.S. (2,3,3,3-TETRAFLUOROPROP-1-ENE) is classified as particular inert gas under the High Pressure Gas Safety Act, and is considered as 2.2 non-flammable, and these gases have been circulated within Japan also since 2012.

(c) In China, Class 2.1 R32: UN3252 Difluoromethane and R1234yf: UN 3161 Liquefied Gas, Flammable, N.O.S. (2,3,3,3-TETRAFLUOROPROP-1-ENE) is allowed to be charged up to 10 kg under their national GB/T 17268-2020 and TSG 23-2021 standards and have been in circulation.

(d) Since 2012, there has been more than 280 million units of UN 3358: Refrigerating machines, containing flammable, non-toxic, liquefied gas being circulated in over 130 countries (as of December 2023). Under special provision 291, these machines are allowed to be transported with flammable gas with less than 12 kg charge except for air shipment. Based on its minimum ignition energy, UN 1978 Propane is 260 times higher than UN 3252 Difluoromethane, which would mean that 12 kg of pre-charged propane would be equivalent to 3 120 kg of difluoromethane in a refrigerating machine.

12. **In the cases of sub-paragraphs 11 (a), (b), (c), and (d), more than a decade has passed and there has not been any accidents reported.**

13. Furthermore, one global refrigerant producer has been distributing R1234yf in US DOT-39 cylinders (mostly in 4.5 kg and 11.3 kg net amounts) from 2013 and to date, they were able to reduce over 1 kMT of steel, 0.07 kMT of cardboard, and 3 k TEU (Twenty-Foot Equivalent Unit) worth of shipment from distributing in non-refillable cylinders above 1.25 L in the USA. Based on our calculations, on a global scale, it would reduce approximately 62 kMT of steel, over 3 kMT of cardboard use, and 184 k TEUs annually (Global excluding

countries like European Union (EU), India, Canada, and Australia where non-refillable cylinders are not allowed. USA, Japan, and China are excluded as non-refillable cylinders above 1.25 L are allowed. In countries like Brazil, Malaysia, Mexico, South Korea, Thailand, and Vietnam where there are HVAC manufacturing sites, 60 per cent of overall volume is assumed to be non-refillable cylinders while the remainder is in bulk ISO tanks for OEM supply).

14. In summary, HVAC&R systems will expand in the coming years and that means more refrigerants, especially low or no GWP refrigerants that are flammable, will also have an increasing demand. As detailed in sub-paragraph 11 **(a), (b), and (c), non-refillable cylinders that have a higher charge volume than 1.25 litre have been in circulations in millions for over a decade, and with no incident being reported; they have a proven safety track record.** Therefore, increasing the limit of non-refillable pressure receptacles' water capacity from 1.25 litre to 25 litre (55 pounds) for a service pressure of 34.5 bar (500 p.s.i.g.) or less with UN GHS 1B flammable gas and fitted with a pressure relief device that is governed by the national authority of the country of use such as Compressed Gas Association (CGA) Publication S-1.1 is unlikely to cause additional safety hazard.
