

INFORMAL GROUP ON GASEOUS FUEL VEHICLES
Within the UN GRPE (WP29)
PROPOSED AMENDMENT

Name of Organisation submitting Amendment/Work Item

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Regulation name and reference number

REGULATION N. 115 (retrofit)

Specific language for Amendment/Work Item

ENGLISH

Name of Amendment/Work Item

NMHC – THC emission limit applicable to retrofit vehicles

Amendment to Reg. ECE-ONU N.115

An amendment to R115 should be proposed, to include an exemption for gasoline engines converted to CNG by retrofit operators to meet the requirement on the EURO 5 and 6 limiting the THC emission to 0,1 g/km, and only meet the limit imposed to NMHC emission

The ECE UN regulation R 115 refers to regulation R 83 for emission limits applicable to LD (M1 and N1) vehicles. The limit in R 83 only reaches the level of Euro 4, for the time being.

Then there is the European regulation R 715 (Euro 5 – Euro 6), which is not ECE UN, and is only applicable to European countries.

So, retrofit systems homologation, can only refer to Euro 3/4 levels, till R83 future amendment introducing new limits as R715.

Option 1

- A measurement is done of CH₄ and NMHC emissions.
- NMHC limit only must be met; if the NMHC limit is not included in R83 applicable series (e.g. E3/4), NMHC limit has to be calculated as 90% of THC limit.

- The CH₄ measurement result figure is used to calculate the CO₂ equivalent, based on the GWP, global warming potential, of methane (GWP methane: at 20 years time horizon = 72)
- The resulting figure is added to the amount of CO₂ actually emitted by the engine.

Example:

- THC emission = 0,1 g/km;
- NMHC emission = 0,01 g/km;
- CH₄ emission = 0,09 g/km;
- CO₂ equivalent emission (20 years horizon) = 0,09 x 72 = 6.48 g/km, to be added to the CO₂ actually emitted by the engine.

GWP values and lifetimes of some gaseous substances from 2007 IPCC AR4 (2001 IPCC TAR in brackets) with a 20, 100 and 500 year time horizon

substance	atmospheric lifetime years	GWP time horizon		
		20 years	100 years	500 years
carbon dioxide CO ₂	50 - 200	1	1	
Methane CH ₄	12 (12)	72 (62)	25 (23)	7.6 (7)
Nitrous oxide N ₂ O	114 (114)	310 (275)	298 (296)	153 (156)
HFC-23 (hydrofluorocarbon)	270 (260)	12,000 (9,400)	14,800 (12,000)	12,200 (10,000)
HFC – 404A (hydrofluorocarbon)	>48		3,260 (IPCC 1996)	
HFC-134a (hydrofluorocarbon)	14 (13.8)	3,830 (3,300)	1,430 (1,300)	435 (400)
SF ₆ sulphur hexafluoride	3,200 (3,200)	16,300 (15,100)	22,800 (22,200)	32,600 (32,400)

TAR = third assessment report

AR 4 = fourth assessment report

Note: this option would be quite in line with the attempt made by Members of the European Parliament to set penalties to car-makers for car emission exceeding EU-set limits for vehicle CO₂ emissions. In late 2007, the European Commission proposed that the average CO₂ emissions of new cars must be reduced to 130 g/km from 2012. According to this proposal, if the binding target is missed, car manufacturers will be fined € 95 per gram over the limit by 2015.

Option 2

A measurement is done of CH₄ and NMHC emissions. The measured THC level, to be compared to the limit, is recalculated as THC level of the equivalent vehicle fitted with a methane optimized catalyst.

$$\text{THC}_{\text{equivalent}} = ((1 - \text{meth}_{\text{MOC}}) / (1 - \text{meth}_{\text{GOC}})) \times \text{CH}_{4\text{meas}} + \text{NMHC}_{\text{meas}}$$

Where:

- meth_{MOC} is methane conversion efficiency of a Methane Optimized Catalyst
- meth_{GOC} is methane conversion efficiency of a Gasoline Optimized Catalyst

e.g.

$$\text{THC}_{\text{equivalent}} = ((1 - 0.99) / (1 - 0.5)) \times 0.09 + 0.01 = 0.0118 \text{ g/km}$$

Rationale: (Why is it important/required?)

Composition of THC and health effect

The THC contained in the exhaust emissions of the gasoline engines are mostly composed by NMHC (more than 90%), and the rest is made of CH₄. Opposite, the THC contained in the exhaust emissions of the NGV are mostly made of CH₄ (roughly 90%), and less than 10% is made of NMHC. The NMHC are toxic pollutants. Some of them are considered or recognized as carcinogenic (e.g. aromatics hydrocarbons like benzene, toluene, xylene). Some of them are ozone precursors. The NMHC have all these negative effects mainly because of their high reactivity. But thanks to this reactivity, it is quite easy to treat them in a successful way with normal catalysts. Methane, opposite, has a high molecule stability, which results in low reactivity. So it is neither toxic, nor carcinogenic. And it is not considered as an ozone precursor. The emission regulation in North America already recognized these positive aspects long ago. And also the European regulation on emissions of HD vehicles do, in that in both cases a limit is only imposed to NMHC.

Reactivity, and needed technology

But there is a side effect: this low reactivity makes it difficult for normal catalysts to effectively convert CH₄ into its basic components (i.e. CO₂ and H₂O). The gasoline car engines that have to meet the 0,1 g/km THC limit imposed at first in EURO 4, and now also in EURO 5 and EURO 6 limits, adopt catalysts with a content of precious metals (platinum, palladium, rhodium), of about 50 g/ft³ (normal), or 80 ÷ 120 g/ft³ (high performance), that quite easily convert the THC emissions (in this case composed by more than 90% of NMHC) into their basic components, CO₂ and H₂O. When designing CNG dedicated, mono-valent or bi-fuel vehicles, OEMs have to adopt some special catalysts, with a far higher content of precious metals, from 150÷200 g/ft³, up to 300 g/ft³, to be able to limit the THC emissions (which in this case means more than 90% methane), at the level of 0,1 g/km which is imposed by the new limits from EURO 4 to EURO 6. This makes the new NGV models meeting the EURO 4/5/6 limits more expensive than they were in the past. This is not good for the development of this sector. The increased cost of vehicles is not justified by environmental reasons. But in some way, the OEMs can afford this, with their laboratories being able to produce the proper solutions, and large budgets available for R&D. So OEMs can resign to this requirement, which they can meet. Of course the new CNG car models will be more expensive than they would be without a THC limit to be met. And the situation is even worse, far worse, for the retrofit side of the NGV market, for which the 0.1 g/km limit imposed to THC emissions in EURO 4 was a problem already, and it remains in place with EURO 5/6. The retrofit operators (manufacturers of components and workshop operators) cannot go so far as to study and add any special catalyst to the engines they convert. Neither

them, nor their customers can afford this. Very simply, having to meet this requirement with a converted car might mean rendering the conversion impossible from the regulation point of view. The original catalyst, efficient enough with the gasoline exhaust emissions (NMHC), would be less effective with the CNG exhaust emissions (CH_4). To convert exhaust pipe CH_4 to $\text{CO}_2 + \text{H}_2\text{O}$, it takes a far better and effective (hence expensive) catalyst than in the case of the NMHC. This is just because of the non reactivity of the methane molecule. Such a stable molecule cannot be that active as an ozone precursor, as somebody seems to believe; the two things, simply do not match each other. Either the methane is hard to be converted by the catalysts, or it is reactive. There have been experts boasting this last one to be the case, but no evidence of this was ever produced. The difficulty of destroying the molecule of CH_4 instead is a plain fact.

Market share

The regulators, the car industry, the component manufacturers, and the gas industry, in their own interest, must defend retrofit from being put in jeopardy. This side of the NGV sector is still responsible for a substantial share of the NGV market in many countries. In Italy, for example it means 30,000 new NGV per year at the present time. In countries like Brazil (1,400,000 NGVs), Argentina (1,600,000 NGVs), India (330,000 NGVs), Pakistan (1,600,000 NGVs), a substantial part (in some cases all) of the new NGVs that join in every year are belonging to the category of vehicles converted by retrofit operators.

Buoyancy

The NGV sector has to strongly oppose any methane emission limits. Asking for a limit to CH_4 emissions of automotive engines, would be like worrying about the salt content of water used to extinguish a fire. The environmental benefits of NGVs are so important, that they do more than dwarfing the side effect (greenhouse effect) of CH_4 emission. It is necessary to consider something that has always been left behind. The methane emitted to the atmosphere can not originate ozone at the level of the troposphere. First of all, it is not reactive enough to do this. But even if it was, we must not forget an important detail of physics. Methane is far lighter than air (it's density is 0.7 kg/cubic metre instead of 1.3 of air); thus it's buoyancy (what happens to the children's rubber balloons at fairs) makes it to rise very quickly up to the stratosphere, where, even if turning into ozone (which is still very doubtful), this would be beneficial to our health, protecting us from detrimental ultraviolet sun light. So the regulation of methane emissions from vehicles is a mistake, for many different reasons.

CNG and bio-methane in different applications

There are also other elements to be evaluated in this context. For example, when processing manure to produce bio-methane, which is subsequently burnt in an engine, producing CO_2 , the overall methane emissions are reduced. Hence, by setting a too tough limit on methane in the tailpipe emissions of a car, regulators may defeat the purpose of reducing greenhouse gas emissions. Either the manure is not processed at all (with far higher methane emissions), or it is used for production of biogas burnt to generate electric power, but without the tough emission controls that apply for methane burnt in a car. The use of CNG or bio-methane to fuel a modern car originates anyway far lower CH_4 emissions compared to its use to fuel all the other appliances (furnaces, ovens, burners) to which no regulation similar to those in force for vehicles apply. So, burning the fuel in a modern vehicle, meeting tough exhaust requirements, would actually help to ensure minimal methane emissions.

N₂O emissions

For quite some time in the future diesel will, in most countries, be a much more used fuel than NG/biomethane. There are test results which show that the GHG effects of N₂O emissions from diesel vehicles are higher than the GHG effects of methane emitted from a vehicle operating at the currently allowed maximum methane levels. Yet N₂O emissions are not measured and controlled. The regulation in this sector needs a reasonable balance. NGVs will offer very significant GHG reductions and generally a very low level of pollutants. The advantages which are offered by the use of NGVs should not be blocked as a consequence of the introduction of too harsh methane emission levels.

Natural and anthropogenic sources of CH₄

The global world emissions of CH₄ from natural origin (wetlands, rice fields, termites, ocean, hydrates), and from anthropogenic origin (energy, landfills, ruminants, waste, biomass burning), is calculated to be 600 million tons/year. Compared to this amount of methane, the global emission of methane that could be reasonably expected from the NGV sector is negligible. In fact, the maximum total amount of CH₄ which would be released by NGVs in case of an optimistic penetration of 10% of the world LD automotive market (which would mean roughly 60 million LD vehicles running on CNG), based on an emission rate of a single vehicle of 0.1 g/km (the present THC limit, which in the case of NGV is composed by more than 90% of methane), and an average yearly mileage of 20,000 km/year, would be: 120,000 tons per year. This would correspond to the 0.02% of the total methane emissions.

It does not seem very sensible to run the risk of destroying the retrofit market, just in order to avoid adding an amount (max) of CH₄ of 0.2 kg to a ton.

Emissions of methane

Houweling et al. (1999) give the following values for methane emissions (Tg/a=teragrams per year):

Global average methane concentrations from measurement (NOAA*)

Origin	CH ₄ emission		
	Mass Tg/year (million ton/year)	Type (%/a)	Total (%/a)
<u>Natural Emissions</u>			
<u>Wetlands</u> (incl. Rice agriculture)	225	83	37
<u>Termites</u>	20	7	3
<u>Ocean</u>	15	6	3
<u>Hydrates</u>	10	4	2
Natural Total	270	100	45
<u>Anthropogenic Emissions</u>			
Energy	110	33	18
<u>Landfills</u>	40	12	7
<u>Ruminants</u> (Livestock)	115	35	19
Waste treatment	25	8	4

Biomass burning	40	12	7
Anthropogenic Total	330	100	55
grand total	600		100
*NOAA = National Oceanic and Atmospheric Administration			

Source: (Wikipedia) U.S. Environmental Protection Agency

GW

When a retrofit workshop converts a gasoline car emitting 160 g/km of CO₂ to run on natural gas, that car immediately saves 40 g/km (20% or more) of CO₂.

Even in the case where that car, when running on CNG also emits 0.1 g/km of CH₄, taking into account the GWI potential of methane at 20 years (72 times higher than that of CO₂), the equivalent CO₂ emission would be: 0.1 x 72 = 7.2 g/km; we would still be left with a 32.8 g/km CO₂ bonus. Do we really want to renounce to this? Many people won't buy an OEM NGV, if they have a gasoline car which is still in good conditions and must be destroyed in case it can not be converted to CNG.

Analysis/testing or data requirements to support the Amendment/Work item
(could be anticipated or existing supporting documentation)

Please submit comments to new work items to:

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