

A Explanatory Report

<REMARK. THE EXPLANATORY REPORT WILL DESCRIBE AND EXPLAIN THE ISSUES; WHICH WILL BE DEFINED IN PART B OF THIS DOCUMENT: THEREFORE THE NUMBERING OF THE CHAPTERS IS IDENTICAL: FOR THE TIME BEEING PART A IS MAINLY WITHOUT TEXT; WHICH WILL BE ADDED LATER>

0. Background

Some existing and future (developed) UN Regulations and UN GTRs contains terms, definitions and classifications regarding:

- Vehicle propulsion type (e.g. EV, FCV)
- Energy converter (e.g. ICE, FC, Electric Motor)
- Energy delivery system
- Energy storage system (e.g. fuel tank, battery)

In some cases these classifications and definitions are different in regulations, and the current activities to develop regulations for innovative power trains and alternative fuels may lead to a more inconsistent situation, if no coordination happens. A frame-system of a classification with the main terms and definitions introduced in S.R.1 and R.E.3 would be helpful. It should build a frame that ensures consistency for all definitions used in UN Regulations or UN Global Technical Regulations by providing

a general and principle systematic (not too detailed), that enables the addition of future technologies at later stages.

At the March 2012 session, WP.29 mandated an informal group under GRPE (Vehicle Propulsion System definitions – VPSD), to develop a proposal for a frame system of terms, definitions and classifications regarding vehicle propulsion systems for the introduction into R.E.3 and S.R.1.

It can be discussed whether fuel definitions (gasoline, diesel, LPG,CNG,LNG, E10, E85, ...) should be included in this system of VPSD. It is proposed to consider this in a second phase.

Principles:

- Use of existing definitions
 - *don't create new definitions – if possible --*
- Develop only necessary definitions
 - *needed for the clear understanding of requirements in UN-R's or GTR's –*
- Only a frame system in S.R.1 & R.E.3 should be developed
 - *more detailed definitions in UN-R's or GTR's –*
 - *frame system should enable consistency*
- --*frame system should be simple to the extend possible*
- Technology neutral to the extend possible
- System should enable the addition of new definitions concerning new technologies, fitting easily into the existing structure of definitions.
- The hierarchy system of the definitions (structure) should contain a minimum number of levels (to the extend possible).

<remark: the numbering of the following sections are/should be identical to the numbering of the sections in part B of this document>

1. Powertrain

In national/international regulations and standards one can find different definitions of propulsion system and powertrain. To understand the propulsion system as the combination of the energy storage system, the energy supply system and the powertrain follows mainly the approach of ISO standards and national Chinese standards.

It was decided to define the powertrain as the part of the vehicle containing the energy storage system, the energy delivery system, the energy converter and the drivetrain. The main reason was to simplify the definitions and to avoid unnecessary hierarchical levels.

- Exclusion of auxiliary devices (e.g. auxiliary battery, starter motor, actuator)

2. Energy Storage System

The proposal structures energy storage systems into refillable (fuel) and rechargeable (electric/non electric) systems. This is in principle in line with language of existing regulations. As alternative the definitions can be structured in chemical (liquid, gaseous, solid), electrical (accumulator, capacitor) or mechanical (flywheel, compressed gas) storage systems.

2.1. Fuel storage system

- (liquid, compressed gaseous)

Is LPG a liquid or a compressed gas? Is liquid gasoline or diesel the same category as LNG?

suggestion: liquid at NTP, compressed gaseous, compressed liquefied, cryogenic liquid, solid (e.g. hydrides)

- Refillable internally or externally

2.2. Rechargeable Energy Storage System (ReESS)

In WP.29 and GR's since long the problem of the definitions RESS and REESS was discussed. RESS is used in UN-R 92 (Replacement Silencer System). Therefore ELSA iwg decided to use REESS in UN-R 100 (Rechargeable Energy Storage System). Unfortunately this definition in UN-R 100 doesn't differentiate between electric and non-electric REESS. It is proposed to use the acronym ReESS. As alternative REESS can be defined as Rechargeable Electric Energy Storage System.

2.2: RESS is the term used in ISO Standards. For harmonization sake it should be maintained. Will there be any confusing with the silencer system ?

2.2.1 Electric ReESS (battery, capacitor)

[2.2.2. Non electric ReESS]

3. Energy delivery system

The differentiation between energy storage system and energy delivery system might be problematic in cases, where some parts are combined, e.g. a fuel pump integrated in the tank. It needs to be considered, if energy storage and delivery can be combined in one definition.

3.1. Fuel delivery System

3.2. Electric power conditioning device

[3.3. Delivery system between non electric ReESS and energy converter]

4. Energy Converter

ICE (PI, CI), EM and FC are already defined and regulated in existing regulations. Other types of energy converters like HCCI (homogeneous charge compression ignition), turbine or compressed air engine can be added later, after they are regulated.

4.1. Internal Combustion Engine (ICE)

4.1.1. Positive Ignition engine (PI)

4.1.2. Compressed Ignition engine (CI)

[4.1.3. & 4.1.4. 2stroke, 4 stroke]]

4.2. Electric Motor (EM)

4.3. Fuel Cell (FC)

[5. Drivetrain]

6. ICE vehicle

- General remark to sections 6. – 8.. It was decided to introduce “vehicle definitions” rather than powertrain or engine related definitions. If in any regulation requires such definitions (e.g. engine definitions in regulations like UN-R 49) a similar wording can be used.

6.1. Mono Fuel vehicle

6.2. Bi Fuel Vehicle

- It needs to be discussed how to deal with the exemption of 15l gasoline tank.
- The case needs to be discussed, where engines need to use gasoline for the engine start phase only (like LPG).

6.3. Flex Fuel Vehicle

6.4. Dual Fuel Vehicle

7. Hybrid vehicle

- A sub categorisation into parallel, serial and mixed Hybrid vehicles is not necessary at the moment, because this differentiation is not reflected in the requirements. The important criteria are switch yes/no and OVC/NOVC (which are defined in section 9.)

8. Electrified Vehicle (EV)

Electrified Powertrain with at least one EM

8.1. Pure [Battery] electric vehicle (PEV [BEV])

BEV is the term used in ISO Standards.

Note: No vehicles which draw energy from a consumable fuel only for the purpose of re- charging the electrical energy/power storage device (“range extender”)

8.2. Hybrid Electric Vehicle (HEV)

Including:

"16. 'hybrid electric vehicle' (HEV) means a vehicle, **including vehicles which draw energy from a consumable fuel only for the purpose of re- charging the electrical energy/power storage device (“range extender”)** , that, for the purpose of mechanical propulsion, draws energy from both of the following on-vehicle sources of stored energy/ power:

(a) a consumable fuel;

(b) a battery, capacitor, flywheel/generator or other electrical energy/power storage device;"

8.3. Fuel Cell Vehicle (FCV)

8.4. Fuel Cell Hybrid Electric Vehicle (FCHEV)

It should be discussed whether this differentiation between FCV and FCHEV is needed. However, the usual concept with FC, EM, battery and H₂-storage should be considered as a hybrid concept concerning testing and requirements.

9. Characteristics [Criteria] of vehicle powertrains

9.1. External chargeable (Plug In - Electric En.) yes/no [OVC/NOVC]

9.2. Mode Switch yes/no

9.3. Recuperation yes/no

9.4. Electric Energy Consumption

9.5. Fuel Consumption

9.6. CO₂ Emissions

9.7. Pollutant Emissions (gaseous and particulates)

9.8. Evaporative Emissions

9.9. Crankcase Emissions

9.10. State of Charge

9.11. Electric Range

9.12. Low voltage / high voltage

9.13. Start/stop system



B Draft Annex for R.E.3 and S.R.1

Proposal for Annex XY for R.E.3/ Annex YZ for S.R.1

Definitions regarding vehicle powertrains with power take off by the wheels of the vehicle.

1. “Powertrain” means the combination of energy storage system(s), energy delivery system(s), energy converter(s) and drivetrain(s)[transmission], on board of the vehicle for the purpose of vehicle propulsion. Auxiliary devices (e.g. auxiliary battery, starter motor, actuator) are not considered as devices for the purpose of vehicle propulsion.
2. “Energy Storage System” means the part of the powertrain that can store fuel or electric energy or any other forms of energy and which can be refilled or recharged externally and/or internally.

2.1. “Fuel Storage System” means an energy storage system (including a tank or a container or an assembly of them), storing liquid fuel or compressed gas on board of the vehicle.

2.2. “Rechargeable Energy Storage System (ReESS)” means an energy storage system storing energy forms or energy carriers other than fuels.

2.2.1 “Electric ReESS” means an energy storing system storing electric energy (e.g. battery, capacitor).

[2.2.2. Non electric ReESS (like flywheel, pressure storage)].

3. “Energy delivery system” means the parts and subsystems transporting [forwarding] and processing the energy or energy carrier from the energy storage system to the energy converter.

3.1. “Fuel delivery system” means the parts and subsystems transporting [forwarding] and processing one or more fuels to the Internal Combustion Engine (ICE) or Fuel Cell (FC).

3.2. “Electric power conditioning device” [Electronic converter] means the parts and subsystems processing [controlling and/or converting] the electric energy from the electric RESS to the Electric Motor (EM).

<source: EU-L-Cat.-regulation [source UN R 100]>

[3.3. Delivery system between non electric ReESS and energy converter].

4. “Energy Converter” means the part of the powertrain converting one form of energy (e.g. chemical, electric, mechanical) into a different one.

4.1. “Internal Combustion Engine (ICE)” means an energy converter with intermittent or continuous oxidation of combustible material

<source: WLTP-2012-033, amended>

4.1.1. "Positive Ignition engine (PI)" means an ICE in which combustion is initiated by a localised high temperature in the combustion chamber produced by energy supplied from a source external to the engine.

<source: WLTP-2012-033, amended>

4.1.2. "Compression Ignition engine (CI)" means an ICE which uses the latent heat built up by compressing air inside a combustion chamber as the means for igniting fuel. [Diesel engines use compression ignition].
[Compression ignition engine" means an engine in which combustion is initiated by heat produced from compression of the air in the cylinder or combustion space.]

<source: WLTP-2012-033, amended>

[4.1.3. & 4.1.4. 2stroke, 4 stroke]]

4.2. "Electric Motor [Machine] (EM)" means an energy converter transferring electric energy into mechanical energy [or vice versa (generator)].

4.3. "Fuel Cell (FC)" means an energy converter transforming chemical energy (Hydrogen) direct into electric energy.

[5. Drivetrain, ...

... all parts and systems (clutch, transmission, cardan, shaft, ...) between "the last" energy converter and the wheels of the vehicle for the purpose of power take off or power transmission]

6. "ICE vehicle" means a vehicle with a powertrain containing exclusively one or more ICE(s) as energy converter.

6.1. “Mono Fuel Vehicle” means a vehicle powered by purely one type of fuel and which ICE is designed to run only on that specific fuel.

Mono-Fuel also applies to a light duty gaseous vehicles with max 15 liter gasoline tank.

6.2. “Bi Fuel Vehicle” means a vehicle with a powertrain containing two separated fuel storage systems and a fuel delivery system transporting [forwarding] and processing either one or the other of the two different fuels.

‘Bi-fuel vehicle’ means a vehicle with two separate fuel storage systems that ~~can run part-time on two different fuels and~~ is designed to run on only one fuel at a time. The simultaneous use of both fuels is limited in amount or duration.

From some March 2012 email correspondence between Alex Lawson, Diego Goldin (NGV Global ISO man), and Jeff, when AEGPL and the Italians introduced their new definition for bi-fuel vehicles we have the following correspondence:

I have asked several times if it is not possible to create a new category. These vehicles are not bi-fuel, by the accepted definition we have even included in the ISO Standard after a long chain of mails in and around new year (December 2008 & January 2009 !!!)

Bi-fuel NGV: Vehicle that has two independent fuel systems (one of them for natural gas) and can run alternatively on either fuel, but only on one at a time.

I have no doubt that they fall under the dual-fuel category:

6.3. “Flex Fuel Vehicle” means a vehicle with a fuel storage system, able to store mixtures of two or more fuels and with an ICE which is designed to run on mixtures of two or more fuels.

- 6.4. “Dual Fuel Vehicle” means a vehicle containing a fuel delivery system mixing two different fuels taken from two separated fuel storage systems, where the consumed amount of one of the fuels relative to the other one may vary depending on operation.

< source: ECE/TRANS/WP.29/GRPE/2012/13/Rev.1, amended >

Dual-fuel Vehicle/engine: Vehicle that has two independent fuel systems and can run on both fuels simultaneously. It also may run on one fuel alone.

2.1.17. "Dual-fuel engine" means an engine system that is designed to simultaneously operate with diesel fuel and a gaseous fuel, both fuels being metered separately, where the consumed amount of one of the fuels relative to the other one may vary depending on the operation.

2.1.19 "Dual-fuel vehicle" means a vehicle that is powered by a dual-fuel engine and that supplies the fuels used by the engine from separate on-board storage systems.

7. “Hybrid Vehicle (HV)” means a vehicle with a powertrain containing at least two different [types of] energy converters and two different [one kind of/types of] energy storage systems.

<source: EU-L-Cat.-regulation - amended >

8. “Electrified Vehicle (EV)” means a vehicle with a powertrain containing at least one EM as energy converter.

8.1. “Pure [Battery] Electric Vehicle (PEV [BEV])” means a vehicle with a powertrain containing exclusively one or more EM(s) as energy converter and exclusively one or more electric ReESS(s) [(at least one of each)].

8.2. “Hybrid Electric Vehicle (HEV)” means a Hybrid Vehicle (HV) with a powertrain containing one or more Electric Motor(s) (EM(s)) as one of the energy converter(s).

8.3. "Fuel Cell Vehicle (FCV)" means a vehicle with a powertrain containing exclusively one or more Fuel Cell(s) (FC(s)) and one or more electric motor(s) as energy converter.

8.4. "Fuel Cell Hybrid Electric Vehicle (FCHEV)" means a FCV with a powertrain containing one or more fuel storage system(s) and one or more ReESS.

9. Characteristics [Criteria] of vehicle powertrains

*<remark: wording in section 91.still to be completed;
order of the items will change finally>*

9.1. External chargeable (Plug In - Electric En.) yes/no

9.2. Mode Switch yes/no

9.3. Recuperation yes/no

9.4. Electric Energy Consumption

9.5. Fuel Consumption

9.6. CO2 Emissions

9.7. Pollutant Emissions (gaseous and particulates)

9.8. Evaporative Emissions

9.9. Crankcase Emissions

9.10. State of Charge

9.11. Electric Range

9.12. Low voltage / high voltage

9.13. Start/stop system