

Transmitted by the expert from the European Commission

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(VPSD meeting, 26 February 2013, agenda item 12.)

Vehicle Propulsion System Definitions version 28.02.2013

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 powertrain system~~ type (e.g. EV, FCV)
- Energy converter ~~or propulsion~~ (e.g. ICE, FC, Electric Motor)
- ~~Energy delivery system~~
- Energy storage ~~and delivery~~ system (e.g. fuel tank, ~~fuel tubing~~, battery etc)

In some cases these classifications and definitions are different in the regulations and the current activities to develop regulations for innovative power trains and alternative fuels may lead to an even 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

Kommentar [DL1]:

Part A:
It has not yet been adapted to the progress made in Part B.
It will be later on removed from the final "Annex for R.E.3 and S.R.1" and it will appear in a separate document.

Kommentar [g2]: 27 Mar 13: to be deleted as agreed

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~~ powertrain 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, H₂ ...) should be included in this system of VPSD. It is proposed to consider this issue 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 extent possible*
- Technology neutral to the extent 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 extent possible).

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

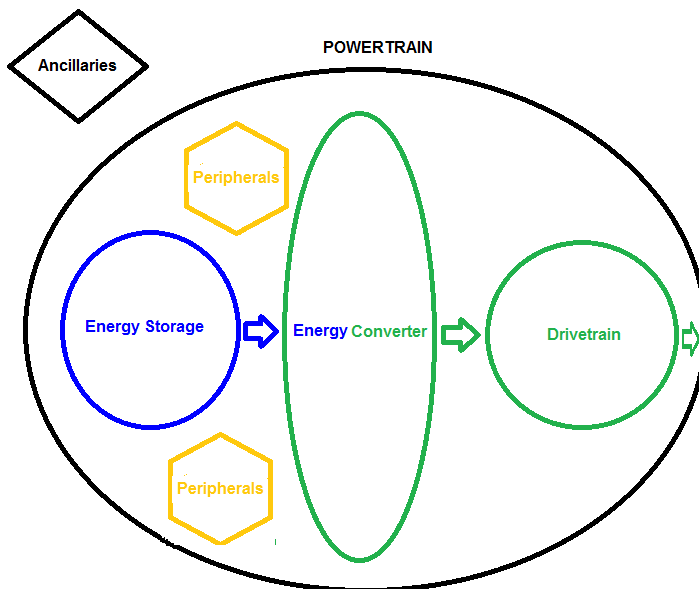
1. Powertrain

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.

Propulsion = Energy converter plus peripherals (e.g. for a conventional combustion engine: intake system, fuel delivery system, exhaust system including emission and sound abatement systems, energy converter control units etc.)

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



Kommentar [EC3]: An engine is "propelled" with a fuel, therefore there is an equivalence between "engine" and "propulsion".

Kommentar [g4]: 27 Mar 13: to be defined

Kommentar [g5]: 27 Mar 13: to be defined and to be clarified that an ancillary is not a (positive) contributor to propelling the vehicle.

2. Energy Storage System

The proposal structures energy storage systems into refillable (fuel) and rechargeable (electric/non electric) and energy recovery/recuperation 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), pneumatic (compressed gas) or hydraulic storage systems.

2.1. Fuel storage system

- (liquid, cryogenic, compressed gaseous)
- 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 UNECE Regulation No. 92 (Replacement Exhaust Silencer System). Therefore ELSA iwg Informal Group Meeting decided to use REESS in UNECE Regulation No. 100 (Rechargeable Energy Storage System). Unfortunately this definition in UNECE Regulation No. 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.

Kommentar [SMD6]: 27.02.2013

2.2.1 Electric ReESS (e.g. battery, capacitor)

{2.2.2. electricMechanicalNon-electric ReESS } (e.g. flywheel, pressure storage)

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.~~

Kommentar [g7]: Agreed

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 Electric Machine and FC Fuel Cell~~ 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.

Kommentar [g8]: In order to open the possibility of external combustion engines and get them approved we propose deleting "I". CE = combustion engine

Kommentar [g9]: OK

4.1. ~~Internal~~ Combustion Engine (ICE)

Kommentar [g10]: See comment above

~~4.1.1. Positive Ignition engine (PI)~~

~~4.1.2. Compressed Ignition engine (CI)~~

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

Kommentar [g11]: Not required

4.2. Electric ~~Motor Machine~~ (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 UNECE Regulation No. 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, Ethanol or CNG).

Kommentar [g12]: That comment would need to be put under "mono fuel" vehicle. The EC favours allowing a mono-fuel vehicle a to have a max 15l petrol tank to e.g. support starting of the engine.

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~~)

8.2. Hybrid Electric Vehicle (HEV)

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/s~~Stop/start 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 Ancillary devices (e.g. auxiliary battery, starter motor, actuator, etc.)~~ are not considered as devices for the purpose of vehicle propulsion.

Kommentar [g13]: 27 Mar 13: should be deleted to prevent examples in the definitions

Kommentar [dl14]: Mr Coleman to prepare a separate definition on auxiliary or ancillary devices

~~Propulsion' means a combustion engine, an electric motor, any hybrid application or a combination of these engine types or any other engine type with its peripheral systems and components;~~

2. "Energy Storage System" means the part of the powertrain that can store ~~chemical fuel or~~ electrical or mechanical 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 ~~refillable chemical~~ energy storage system ~~(including a tank or a container or an assembly of them), storing liquid fuel, cryogenic fuel or compressed gaseous fuel~~ 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 electrical energy ~~(e.g. battery, capacitor)~~.

Kommentar [g15]: 27 Mar 13: should be deleted to prevent examples in the definitions

Kommentar [SMD16]:

~~2.2.2. Non-electric Mechanical ReESS means a system storing mechanical energy (like e.g. flywheel, pressure storage).~~

Kommentar [g17]: 27 Mar 13: should be deleted to prevent examples in the definitions

~~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.

Kommentar [DL18]: to be renumbered once deletion of para.3 is agreed

Kommentar [SMD19]: Strike out

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

~~<source: WLTP-2012-033, amended>~~

Kommentar [g20]: Definition is not complete for an ICE, as intermittent of continuous oxidation only refers to combustion and not to "internal". Proposal: one of the 2 ICE alternatives below

Kommentar [dl21]: Mr Coleman to improve definition

~~4.1.a. "Internal Combustion Engine (ICE)" means an energy converter in which combustion of the fuel takes place in a confined space, producing expanding gases that are used directly to provide mechanical power.~~

Kommentar [SMD22]: If I recall properly, §4.1. and the previous §4.1.a. were to be consolidated. Wrong?

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 electrical energy.

Kommentar [g23]: In the (far) future there may be different ways then only using direct oxidation of hydrogen. The scope of the definition should be kept as wide as possible to prevent legal barriers to technical progress.

5. "Drivetrain", ... "Drive train" means the connected parts of the powertrain, after the output of the propulsion(s) including, the (torque converter) clutch(es), the transmission and its control, either a drive shaft or belt drive or chain drive, the differentials, the final drive, and the driven wheel tyre (radius) downstream of the final energy converter.;

Kommentar [g24]: Drivetrain to be reinstated

6.a6.: "Pure ICE vehicle" means a vehicle equipped with a powertrain containing exclusively one or more ICE(s) as energy converter.

OR

"Pure CE vehicle" means a vehicle where all energy converters are combustion engines".

Kommentar [dl25]:
To reflect on the „all“

6.1.a. "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 that is designed to run primarily on one type of fuel;

Kommentar [dl26]:
Discussion open: primarily or exclusively?

6.1.b. "Mono fuel gaseous vehicle" means a mono fuel vehicle that primarily runs on LPG, NG/biomethane, or hydrogen but may also have a petrol system for emergency purposes or starting only, where the petrol tank does not contain more than [15] litres of petrol;

Kommentar [dl27]:
To be further reviewed:
1.. Does gaseous encloses LPG?
2. What about skipping this definition and putting the exemptions in Regulations?

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 that can run part-time on two different fuels and is designed to run on only one fuel at a time;

6.2.a. 'Bi-fuel gas(eous) vehicle' means a bi-fuel vehicle that can run on petrol and also on either LPG, NG/biomethane or hydrogen;

6.3. "Flex Fuel Vehicle" means a vehicle with a one fuel storage system that containing an run on different blends of two or more fuels a blended fuel:

Kommentar [g28]: For the definition it is essential that it is only one fuel storage system and not multiple. This would make it a bi- or tri-fuel vehicle.

6.4. "Dual Fuel Vehicle" means a vehicle containing a fuel delivery system mixing/blending 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.

Kommentar [dl29]: To be further reviewed. Bi-fuel: what is it?

Kommentar [g30]: Consider simplifying

'Dual Fuel vehicle' means a vehicle equipped with a propulsion running on a blend of two different fuels;

How to define a flex fuel vehicle (e.g. petrol / ethanol) also equipped with a CNG or LPG system ? These applications exist in e.g. Brasil

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

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.

Kommentar [dl31]: To ask GFV if OK

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

8. "Electrified Vehicle (EV)" means a vehicle with a powertrain containing at least one Electric Machine as an energy converter.

OR

..... "Electrified Vehicle (EV)" means a vehicle with a powertrain containing at least one non-peripheral energy converter as electric machine.

8.1. "Pure Battery Electric Vehicle (PEV-BEV)" means a vehicle with a powertrain containing exclusively one or more EMelectric machine(s) as energy converter and exclusively one or more electric rechargeable energy storage system(s) (ReESS)(s) [(at least one of each)].

OR

8.1. "Pure Electric Vehicle (PEV)" means a vehicle with a powertrain where all energy converters are electric machines and all storage systems are rechargeable storage systems (ReESS).

8.2. "Hybrid Electric Vehicle (HEV)" means a Hybrid Vehicle (HV) with a powertrain containing one or more Eelectric Motor(s) machine(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-fuel Cell-cell(s) (FC(s))~~ and ~~one or more~~ electric ~~motor~~machine(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.~~

Kommentar [dl32]:
Is there a need for this definition?
VPSD-participants deemed not.
Is anyone requiring it?

9. Characteristics [Criteria] of vehicle powertrains

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

Kommentar [DL33]:
The text has not yet been reviewed as from
Chapter 9

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

Kommentar [g34]: Not required, self
explanatory

9.2. Mode Switch yes/no

Kommentar [g35]: Mode switches can
be used for various other applications in
automotive technology. Recommendation
to define mode switch in the context.

~~9.3. Energy Recuperation yes/no~~

Kommentar [g36]: Risk of barrier to
technical progress in case definition too
narrowly defined, it might be better to
define this in the context.

9.4. Electric Energy Consumption

9.5. Fuel Consumption means the amount of fuel consumed, calculated by the carbon balance method;

Kommentar [g37]: Same comment as
for 9.4. electric energy consumption. If
deemed necessary please refer to proposal.

9.6. ~~CO2~~ Green House Gas (GHG) ~~E~~missions means gases emitted from the propulsion that contribute to the greenhouse effect by absorbing infrared radiation produced by solar warming of the Earth's surface.

Kommentar [g38]: If in the future
other chemical substances (methane,
chlorofluorocarbons, black carbon, even
water vapour etc) might be included in the
Green House Gas emissions of a vehicle it
may be preferable to be prepared and not
only referring to CO2 emissions as opposed
to pollutant emissions.

9.7. ~~Gaseous P~~ollutant ~~species~~ ~~E~~missions (gaseous and particulates) means the exhaust gas emissions of carbon monoxide (CO), oxides of nitrogen (NOx) expressed in nitrogen dioxide (NO2) equivalent and hydrocarbons (HC); |

Kommentar [SMD39]:
At the moment, "species" replaces
"pollutants" in the GTR.

Kommentar [SMD40]: NH3? Others?

9.7.a. 'Particulate matter' means components of the exhaust gas which are removed from the diluted exhaust gas at a maximum temperature of 325 K (52 °C) by means of the filters described in the test procedure for verifying average tailpipe emissions;

9.7.b. 'Tailpipe emissions' of or 'exhaust emissions' means the emission of gaseous pollutants and particulate matter at the tailpipe of the vehicle;

Kommentar [SMD41]: 27.02.2012: "Or" replaces "of".

9.7.d. 'Pollution control device' means those components of a vehicle that control or reduce tailpipe and/or evaporative emissions;

9.7.e. 'Catalytic converter' or 'Catalyst' means an emission pollution control device which converts toxic by-products of combustion in the exhaust of an engine to less toxic other substances by way of catalysed chemical reactions;

Kommentar [g42]: Agreed

Kommentar [SMD43]: Could the adjective "toxic" be eliminated?

Kommentar [SMD44]: Comments?

9.8. 'Evaporative Emissions' means the hydrocarbon vapours lost from the fuel storage and supply system of a motor vehicle and not those from tailpipe emissions;

9.9. Crankcase Emissions means emissions from spaces in or external to an engine which are connected to the oil sump crankcase by internal or external ducts through which gases and vapour can escape;

Kommentar [SMD45]: "Dry sump" engines contain little oil. Crankcase encompasses both wet and dry sump systems.

~~9.10. State of Charge~~

Kommentar [g46]: Result of measurement procedure with resulting equation in R101. Equation is more precise than generic definition, therefore explicit definition for state of charge not deemed necessary.

9.11. 'Electric Range' means for vehicles powered by an electric powertrain only or by a hybrid electric powertrain with off-vehicle charging, the distance that can be driven electrically on one fully charged battery (or other electric energy storage device) as measured according to the procedure described in [TBD];

Kommentar [g47]: Result of measurement procedure with resulting equation in R101. Equation is more precise than generic definition, therefore explicit definition for electric range not deemed necessary.

9.12. Low voltage / high voltage

9.13. Start/s/Stop/start system' means automatic stop and start of the combustion engine to reduce the amount of idling, thereby reducing fuel consumption,

pollutant and [CO₂] [GHG] emissions:

9.14. 'Engine capacity' or 'engine displacement' means:

(a) for reciprocating piston engines, the nominal engine swept volume;

(b) for rotary-piston (Wankel) engines, double the nominal engine swept volume;

9.15. 'Gaseous fuel system' means a system composed of gaseous fuel storage, fuel delivery, metering and control components fitted to an engine in order to allow the engine to run on LPG, CNG or hydrogen as a mono-fuel, bi-fuel or multi-fuel application;
