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agenda item 9)

GRSG 109th session

AEGPL presentation to ECE/TRANS/WP.29/GRSG/2015/35

LPG
EXCEPTIONAL ENERGY

AEGPL EUROPE

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- Bi-fuel vehicle (LPG-petrol)
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AEGPL amendment proposal Scope

- The new provisions will apply only to:

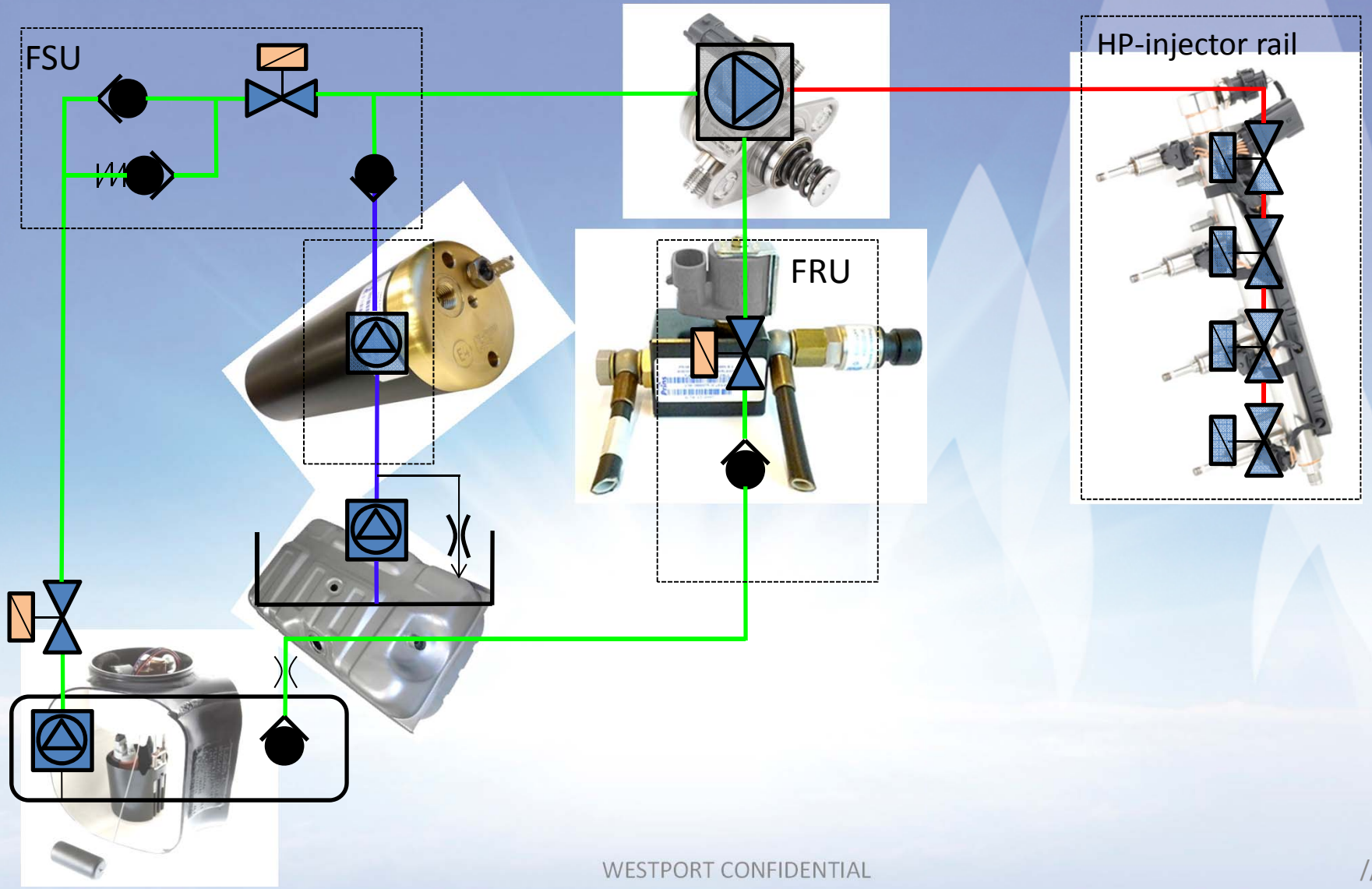
"Interconnected LPG-system" meaning a LPG-system having interconnections with the petrol or diesel fuelling system that include a hydraulic path through which flows of petrol or diesel into the LPG container, or vice versa, may occur

- excludes LPG-systems with no hydraulic interconnections with the petrol/diesel fuelling system *(traditional PFI)* as well as systems with interconnections that do not include a hydraulic path through which flows of petrol or diesel into the LPG tank, or vice versa, may occur;
- **Note:** *As for "petrol or diesel fuelling system", it is implicitly meant the hydraulic circuit upstream the fuel injection/aspiration point.*

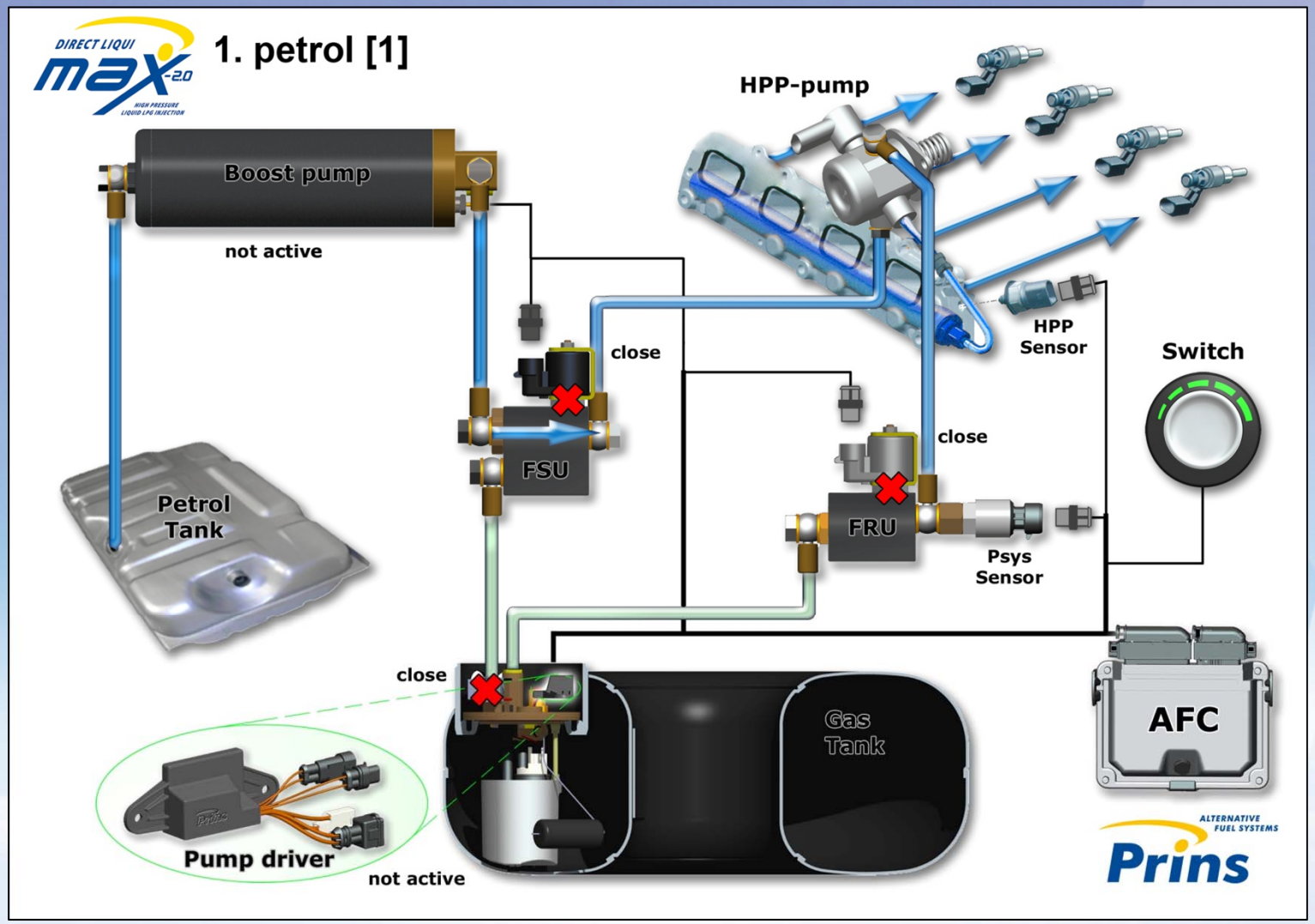
Dual-fuel vehicle (LPG-diesel) Amendment proposal

- LPG into diesel tank:
  - The manufacturer shall demonstrate to the technical service that the safety concept of the LPG-system prevents any flow of LPG into the diesel tank.
  - If the technical service deems that the safety concept is not fully effective in preventing such flows, the technical service may require to implement appropriate provisions to remove from the diesel tank any amount of LPG that is likely to flow, as soon as the vehicle is run in diesel mode.
- Diesel into LPG tank:
  - The manufacturer shall demonstrate to the technical service that the safety concept of the LPG-system prevents any flow of diesel into the LPG container.
  - If the technical service deems that the safety concept is not fully effective in preventing such flows, the technical service may require to implement appropriate provisions to remove from the LPG container any amount of diesel that is likely to flow, as soon as the vehicle is run in dual fuel mode.

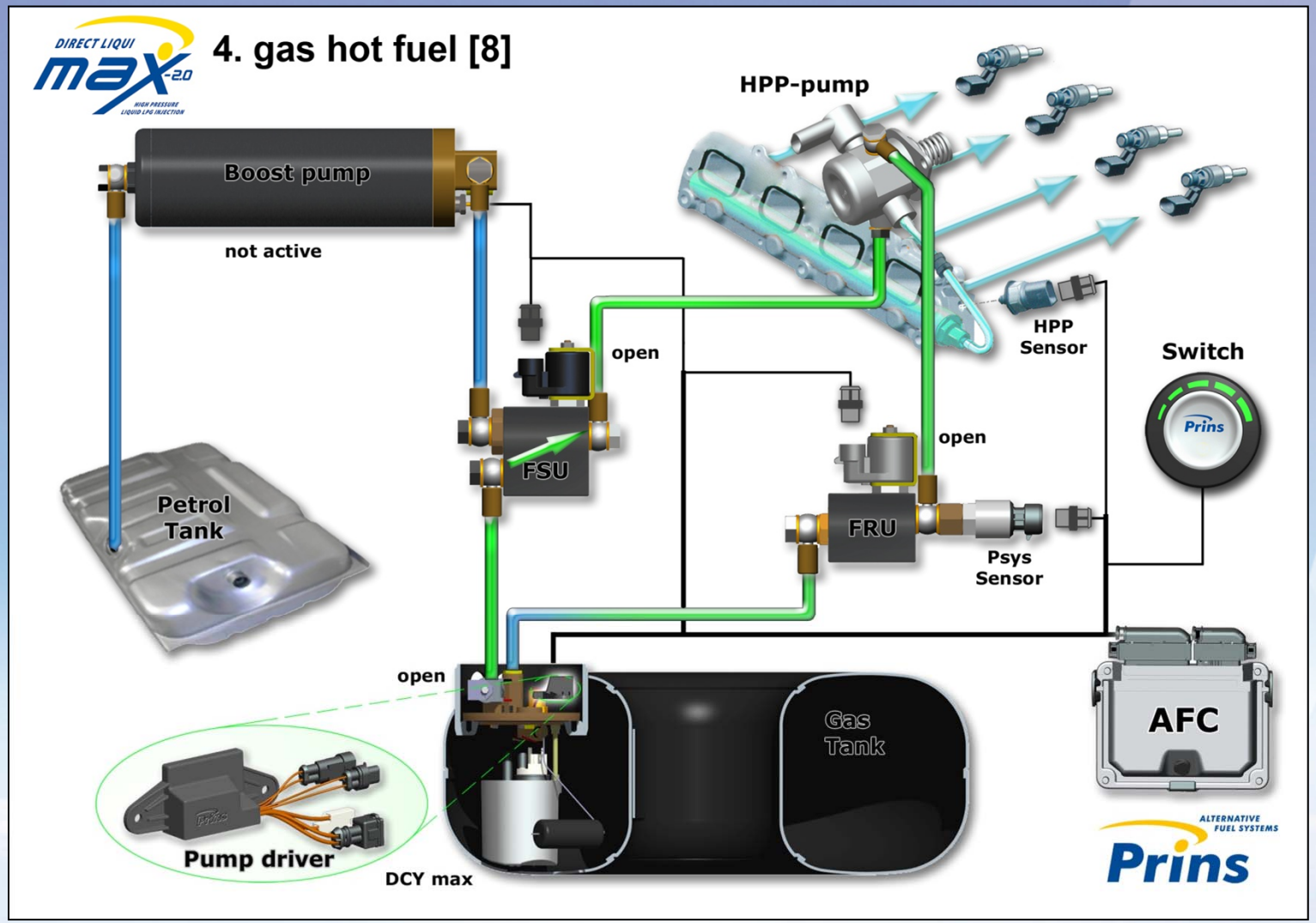
Bi-fuel vehicle (LPG-Petrol)
LDI system set-up



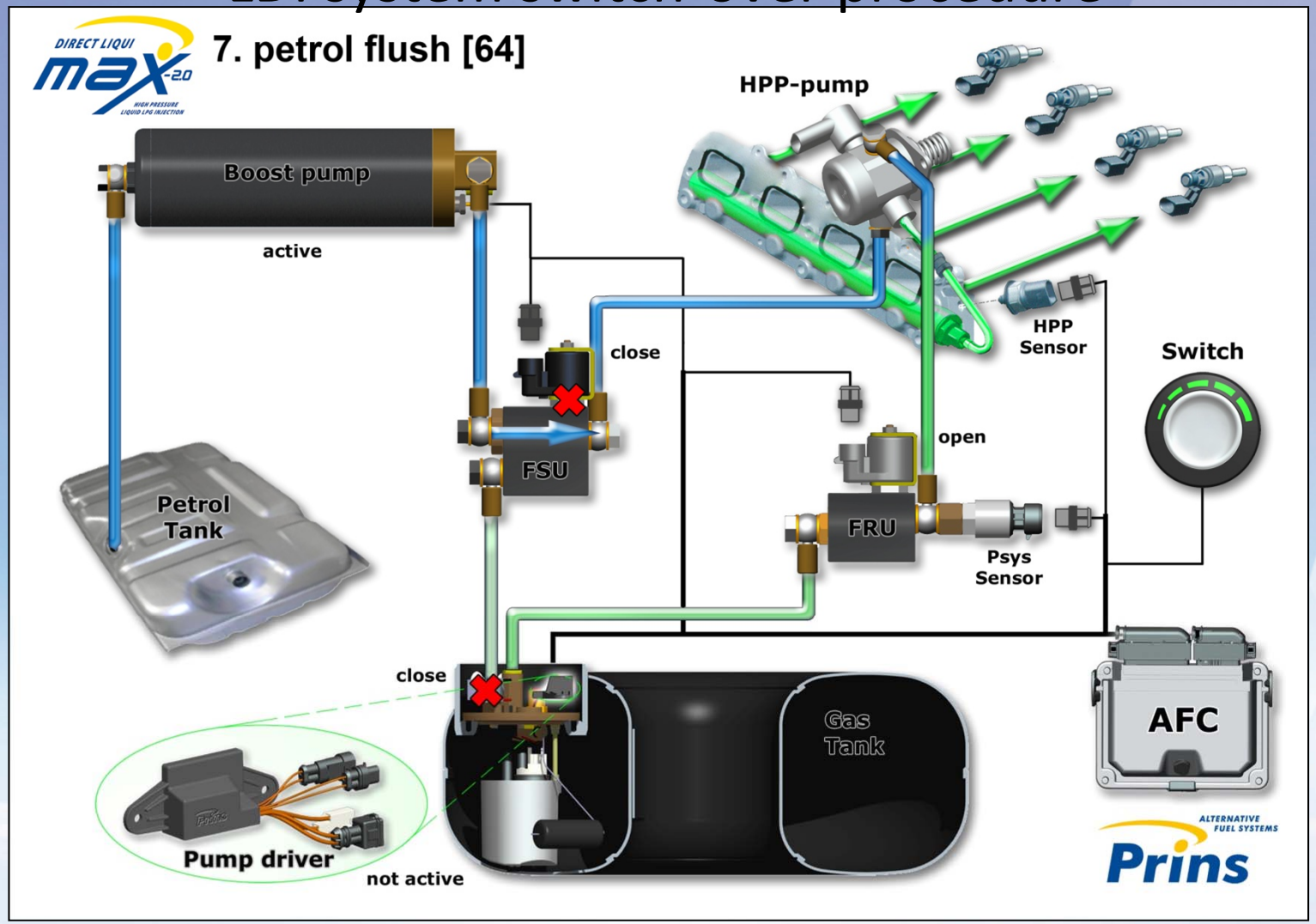
Bi-fuel vehicle (LPG-Petrol)
LDI system switch-over procedure



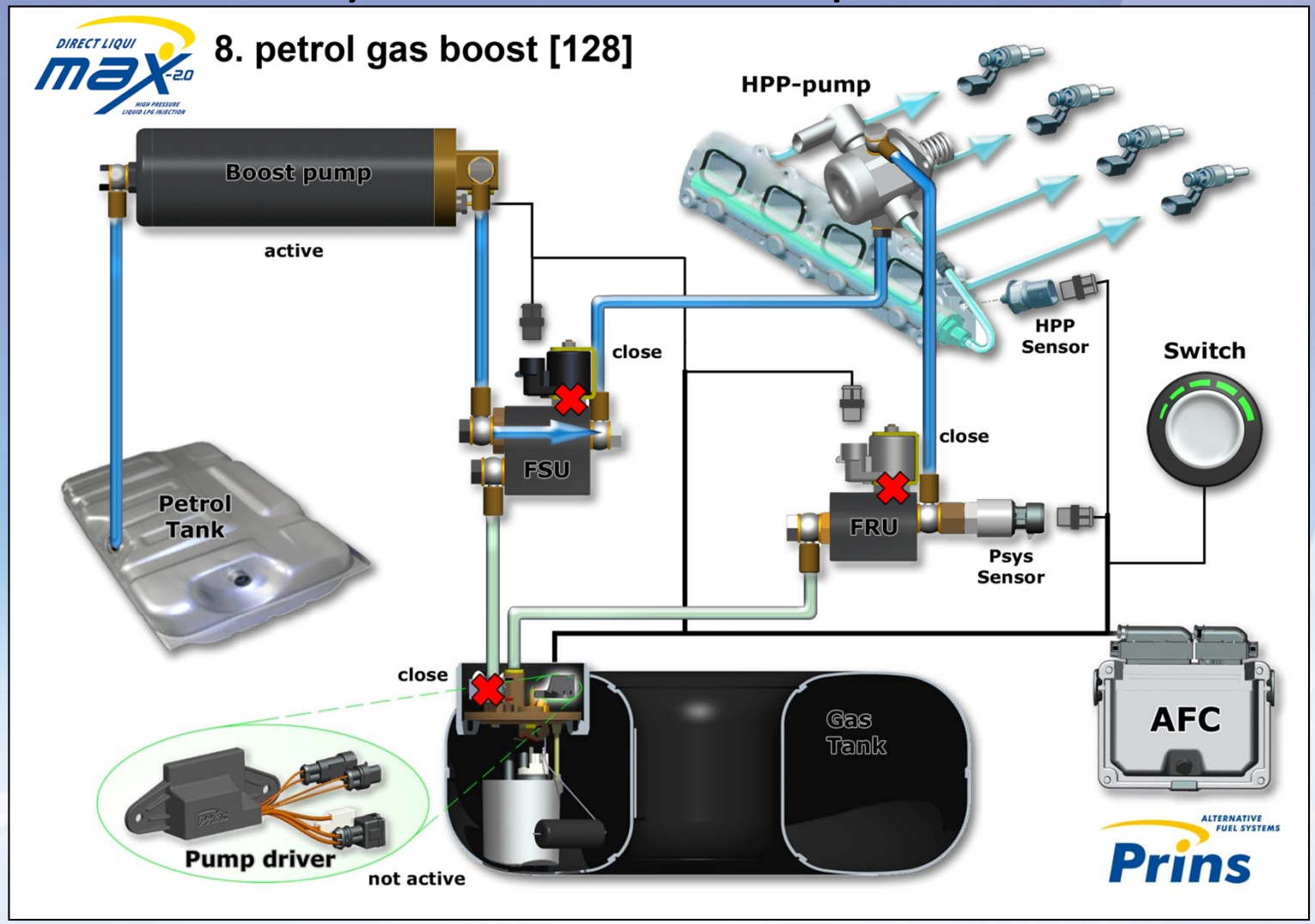
Bi-fuel vehicle (LPG-Petrol)
LDI system switch-over procedure



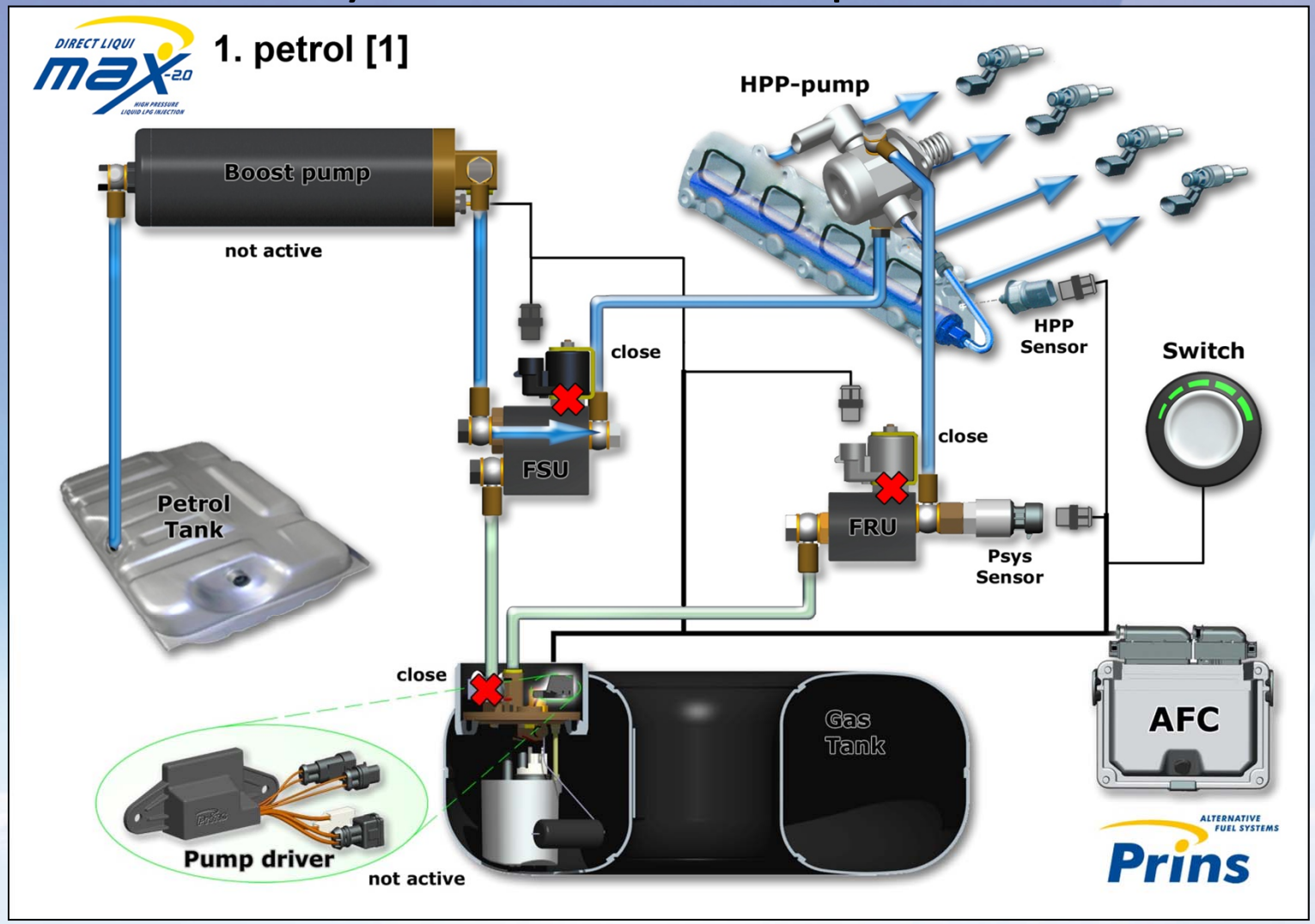
Bi-fuel vehicle (LPG-Petrol)
LDI system switch-over procedure



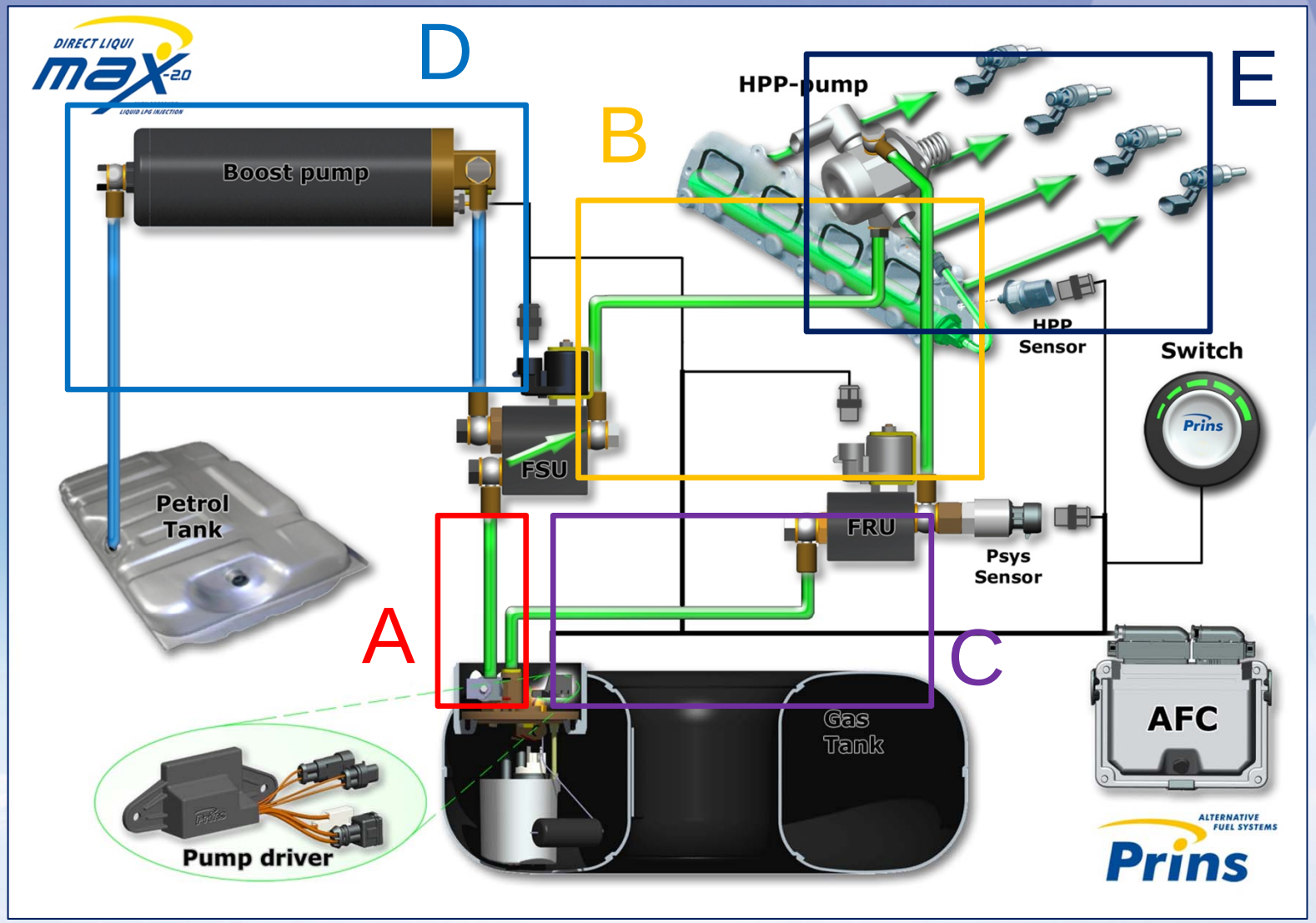
Bi-fuel vehicle (LPG-Petrol)
LDI system switch-over procedure



Bi-fuel vehicle (LPG-Petrol)
LDI system switch-over procedure



Bi-fuel vehicle (LPG-Petrol)
LDI system - volumes definition



Bi-fuel vehicle (LPG-Petrol)
LDI system switch-over procedure

- The switch-over procedure in the LDI system is modeled in such a way to minimize any petrol flow in to the LPG tank.
- The quantity of petrol that is used for the LPG > Petrol switch-over is equal to the Volume B multiplied by a safety factor. (in Theory without the safety factor there should not be any petrol (volume D) entering volume C, overflowing volume B)
- In applications this total purged volume is lower than volume C
- The petrol present in volume B and in volume C will be purged in the LPG tank during the Petrol > LPG switch-over.

Bi-fuel vehicle (LPG-Petrol)
AEGPL amendment proposal - Objectives

- Improve the safety aspects of gas systems which allow limited flows of petrol into the LPG tank during specific operations.
- Example: current LPG direct injection systems (LDI): a small flow of petrol is flushed into the LPG tank in the rare cases in which the system acts, automatically or upon user's request, a switch over between fuel modes.
- Motivation: The unconditioned prohibition of such reverse flows would determine the unjustifiable ban from the market of such innovative systems to the detriment of the environment, as these new gas systems significantly reduce the emission of pollutants and greenhouse gases with respect to analogous petrol technologies.
- In particular, the proposal aims at preventing the following:
  - flows of LPG into the petrol tank;
  - the damage to LPG components which may come into contact with petrol;
  - the overfilling of LPG tank;
  - the over-blending of petrol into LPG above the limits set out by envi regulations

Bi-fuel vehicle (LPG-Petrol)
LPG into petrol tank

- The manufacturer shall demonstrate to the technical service that the safety concept of the LPG-system prevents any flow of LPG into the petrol tank.
- If the technical service deems that the safety concept is not fully effective in preventing such flows, the technical service may require to implement appropriate provisions to remove from the petrol tank any amount of LPG that is likely to flow, as soon as the vehicle is run in petrol mode.

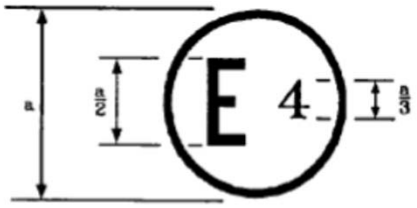
Petrol into LPG components

Preliminary considerations

- the presence of petrol in the LPG tank does not create pressure-related risks as it has a lower volatility;
- the flush of petrol into the LPG tank is triggered only by the switch-over from an operational mode to the other one, and since the LDI gas fuelling system cranks, warms up and runs only on gas, this event is very rare;
- petrol has got a thermal expansion coefficient that is negligible vs LPG one, hence, the presence of some amount of petrol in place of LPG improves the safety level as regards the pressure-related risks,
- 80 per cent is a rather conservative filling limit, with a significant margin versus 85 per cent, that is the correct one, as established also in TPED and PED directives and, for instance, in Korean regulations;

Bi-fuel vehicle (LPG-Petrol)
LPG-system components – Compatibility with petrol

- **Requirement**
  - Non-metallic, metallic or a mixture of metallic and non-metallic LPG components, including flexible hoses and their elements, and non-metallic, metallic or a mixture of metallic and non-metallic parts of LPG components which may come into contact with petrol shall be compatible with petrol (in addition to LPG).
- **Tests**
  - Non-metallic parts o components shall be subject to an immersion test (ISO 1817) in petrol (E10);
  - Metallic components or parts shall be subject to a corrosion resistance test (R 67/01, Annex 15, par. 12)
- **Marking**
  - They shall bear a specific approval mark:



67 R—012439-NM CLASS #[1]

a ≥ 5 mm

[1] Class 0, 1, 2, 2A or 3

Bi-fuel vehicle (LPG-Petrol)
Anti-overfilling - requirements and tests (1/2)

Switch-over operations

Requirements

- Electronic Control Unit shall inhibit, by controlling the fuel selection system, the vehicle operation in petrol mode after each switch-over operation to LPG mode until a volume of liquid fuel equivalent to that flown into the LPG tank during such an operation is consumed

Tests

- a test to measure the fuel flush volume when switching-over
- a test to demonstrate the capability of the ECU in disabling the petrol mode until the volume above is consumed after a switch-over operation

Bi-fuel vehicle (LPG-Petrol)
Anti-overfilling - requirements and tests (2/2)

Operations other than switch-over

- The manufacturer shall demonstrate to the technical service that the safety concept of the LPG-system prevents any flow of petrol into the LPG container.
- If the technical service deems that the safety concept is not fully effective in preventing such flows, the technical service may require to implement appropriate provisions to remove from the LPG container any amount of petrol that is likely to flow, as soon as the vehicle is run in LPG mode.

Marking

- The ECU shall bear a specific marking, with the wording "ICS"

Bi-fuel vehicle (LPG-Petrol)
Anti-overblending - requirements and tests

Requirements

- Means shall be provided to prevent that flows of petrol into the LPG fuel container could lead to a content of petrol higher than 16 per cent of the actual volume contained in the LPG tank. (equivalent to 20 per cent by energy as required by Regulations Nos. 83 and 115).
- In particular, the LPG-system shall be capable to set the permanent disablement of petrol mode (i.e. disablement until LPG container gets empty) when the concentration of petrol into the actual liquid fuel in the LPG tank exceeds the max blending limit of 16 per cent by volume
- A proper documentation shall be provided to describe the equipment and the strategy used to implement the over-blending measure.

Test

- the number of switch-over operations before the petrol mode disablement becomes permanent shall be less than the number that would cause the over-blending, taking into account:
  - the measured fuel flush volume per each switch-over operation (see test for overfilling);
  - the volume of LPG that is present in the tank at the beginning of the test;
  - that after each switch-over a volume of liquid fuel equivalent to that flown during the switch-over phase is consumed