

LPG as a motive fuel for vehicles in the transport of Dangerous Goods

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Transport of Dangerous Goods
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Contents

- Introduction
- General Information
 - Properties of LPG
 - Description of Systems
- Risk Assessment
 - Interaction between cargo and fuel
 - Effect of fuel spillage on the construction
 - Effect of cargo fire on fuel system installation
 - Different types of hazard posed by using LPG instead of diesel as fuel
 - Adequate safety distance during refuelling operation

Introduction

- Diesel Dual Fuel Technology
 - Part of diesel fuel is supplanted by gaseous fuel (LPG or others)
 - LPG industry would like to use their own fuel (at least in part)
- feasible for heavy duty vehicles
- Support from European Commission
- Heavy Duty Dual Fuel Task Force (subgroup of informal Gaseous Fuel Vehicle Group – GFV in WP.29)



Properties of LPG

Properties	Petrol	Diesel	LPG	CNG	LNG
Lower Explosive Limit (LEL) –	1.2%	0.6%	1.8%	5%	
Upper Explosive Limit (UEL)	7.1%	7.5%	8.5%	15%	
Auto ignition Temperature	246 °C	210 °C	450 °C	540 °C	
Boiling temperature	40°-200°C	180°-360°C	-42.6° C	-161° C	
Flash point	-43 °C	55 °C	-104 °C	-188 °C	
Dispersion quality	none	none	medium	high	medium

Properties of LPG

- Flash vaporisation under normal atmospheric conditions
- Flows to the ground due to higher density than air
- Disperses under even moderate wind conditions
- Difficult to ignite in windy weather
- Fire brigades (HAZMAT crew) have established validated procedures for LPG leaks
- Has cryogenic mild effect, relatively simple protective gear sufficient

LPG Systems

Components type approved according to Regulation R.67-01

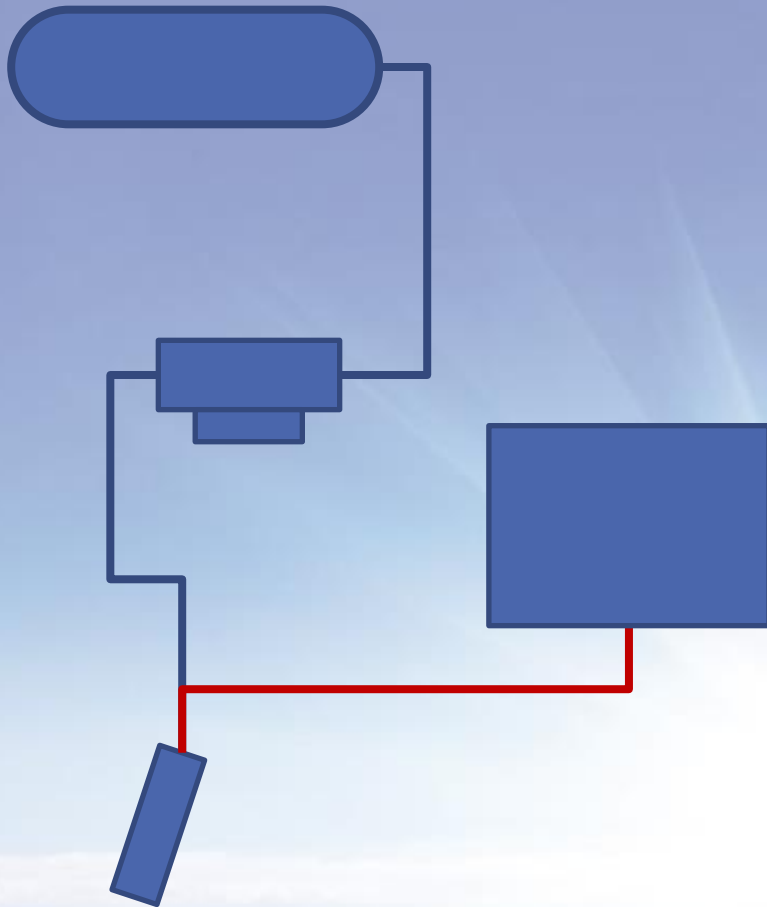
Installation according to rules and guidance in R.67-01 (Part II)

Safety

Certified installer workshops with trained qualified personell

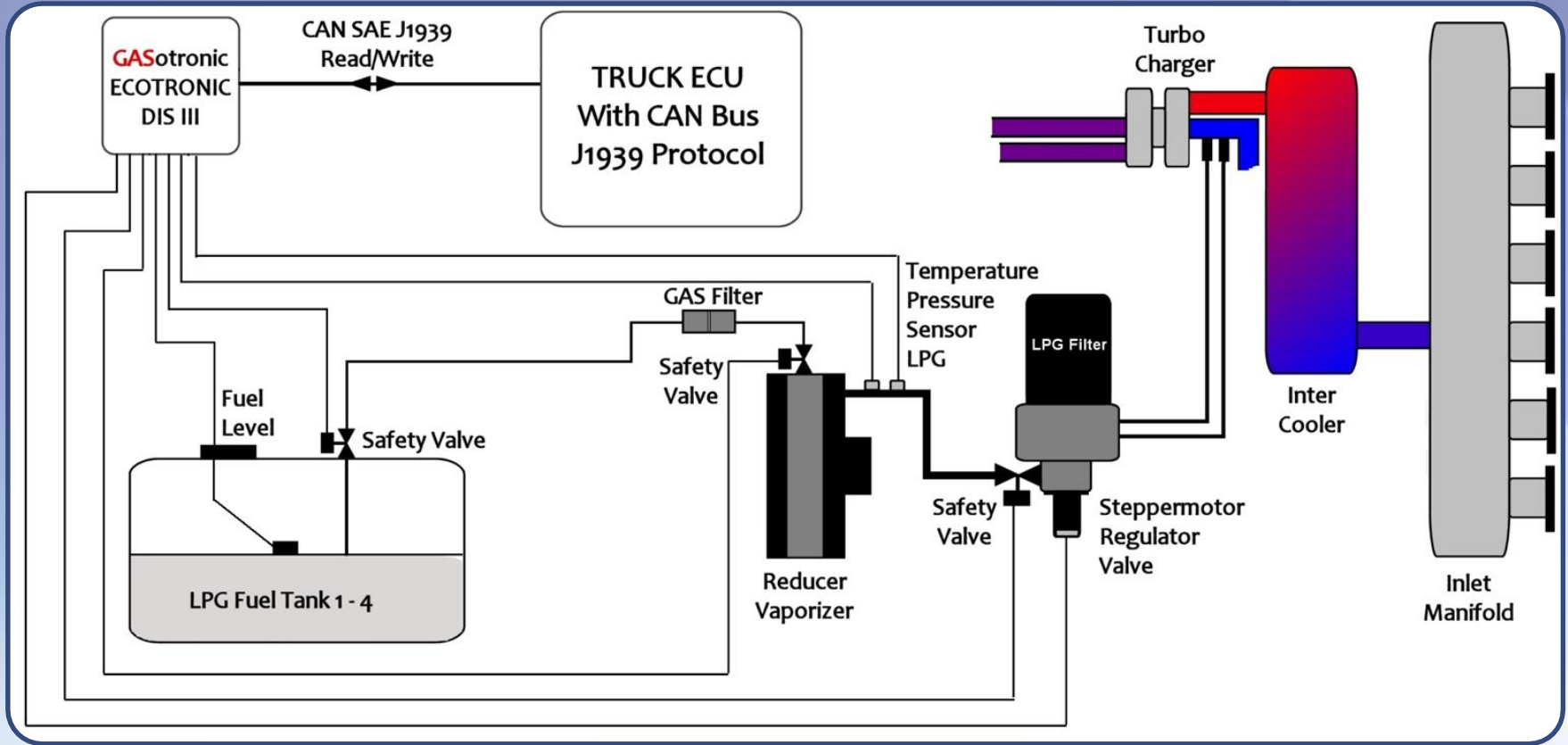
Operators with practice in handling dangerous goods

LPG System Components



- Tank (one or more tanks or tank bundles)
- Single fuel line (some cases return line)
- Vaporiser / regulator with shutoff solenoids (in some cases separate shutoff solenoids are used)
- Injectors (or other methods of metering / needlevalve)
- Electronic controls (ECU, sensors etc.)

Exemplary Schematic of one Manufacturer



LPG Tank safety

- Fuel tank designs shall be
 - compliant with the requirements of R67-01 Annex 10,
 - impact and drop tested (besides passing pressure tests),
 - tested under fire conditions with the fire temperature exceeding at least 590° C
- The tank shall not burst but safely relieve internal pressure by discharging in a controlled manner as described by the manufacturer.
- high resistance to engulfing fire conditions is thus proven
- Composite fuel tanks specimens are pressure cycled 20,000 times

Additional Safety Elements

- Orientation of PRV needs to be taken into account
 - high pressure discharge from the (emergency) PRV
 - discharged gas needs to be directed away from the load (as already prescribed for LNG in the ADR regulation)
- Fuel systems and engine injection system have safety barriers
 - shut off valve
 - excess flow valveto prevent outflow of gas when system integrity is compromised
- Engine stoppage (deliberate or accidental) leads to automatic shutting off of the tank preventing the outflow of gas.

Example Tank Installations



Risks to be addressed

- Interaction between cargo and fuel
 - LPG noncorrosive and chemically stable
- Effect of fuel spillage on the construction
 - only moderate chill effect (evap temp $\sim -40^{\circ}\text{C}$)
- Effect of cargo fire on fuel system installation
 - bonfire test ensures safe behaviour under fire conditions
- Different types of hazard posed by using LPG instead of diesel
 - LPG tanks by far more resistant to damage
 - leakage from piping system prevented by shut-off valves

- Adequate safety distance during refuelling operation
 - refuelling infrastructure designed to fulfil general requirements for third party refuelling
 - CEN Standards EN14678-1 and EN 14678-3 written for dispenser respectively forecourt installation
- Measures to be taken in case of an engine fire
 - no difference in behaviour known in comparison to other fuel
 - no special methods or procedures prescribed
 - automatic fuel shut-off minimises fuel leakage