European Experience and Case study of SCR Passenger Car Integration

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Inergy Research

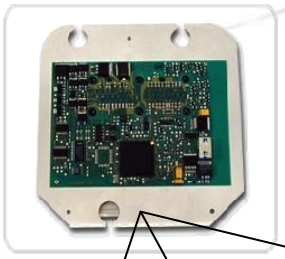
Program

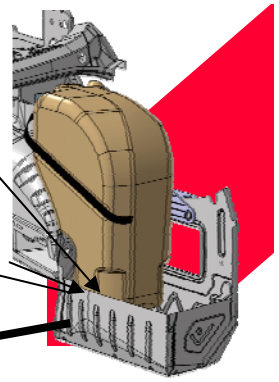
- SCR system overview
- Focus on some functions
  - Storage
  - Filling
  - Venting
  - Heating
  - Injection
  - Control
- Case studies: system integration examples

SCR Technology : System Overview

1 Urea solution tank
2 Temperature sensor
3 Level sensor
4 Supply module
5 ECU
6 Injector
7 Exhaust-gas temperature sensor
8 Exhaust-gas sensor
9 Treated exhaust gas

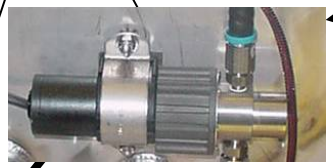
Engine





1
2
3
5
6

Exhaust gas



4
7
8
9

SCR Catalyst

Urea
$(NH_2)_2CO$

Exhaust gas + water + ammonia

NOx Reduction Reaction :

hydrolysis

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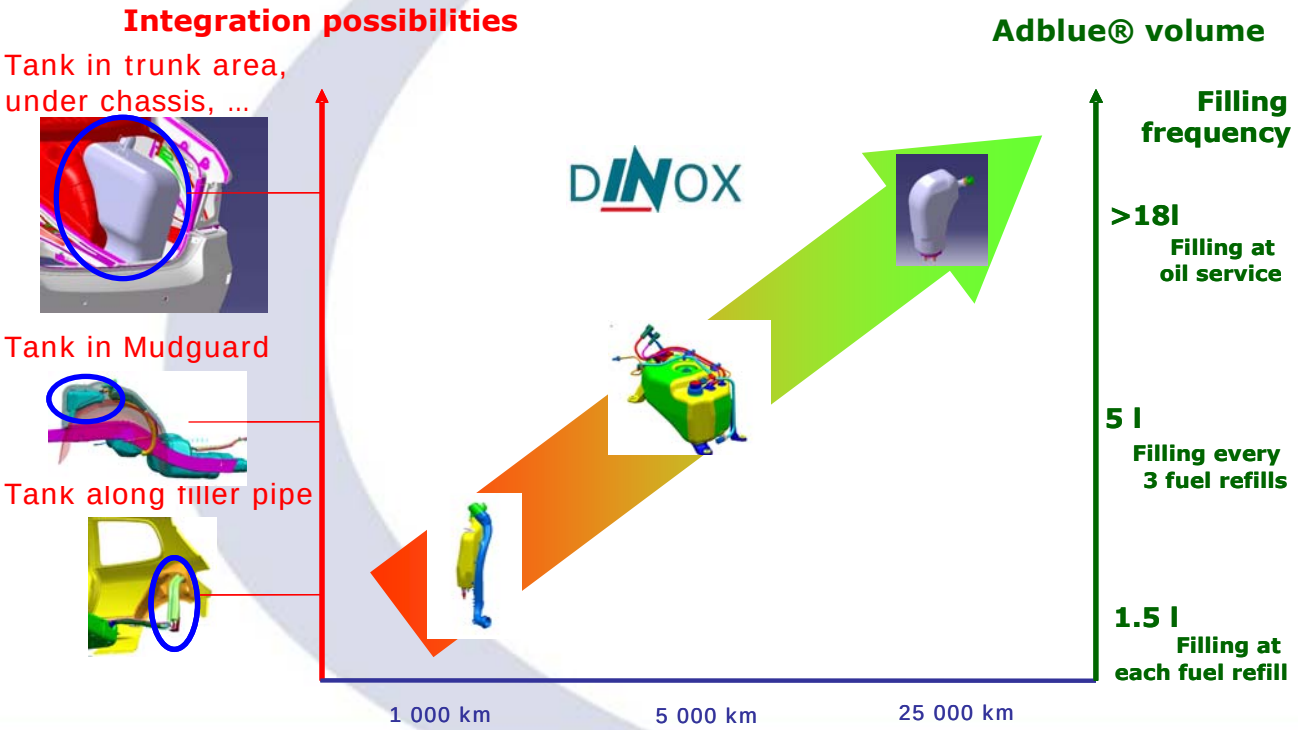
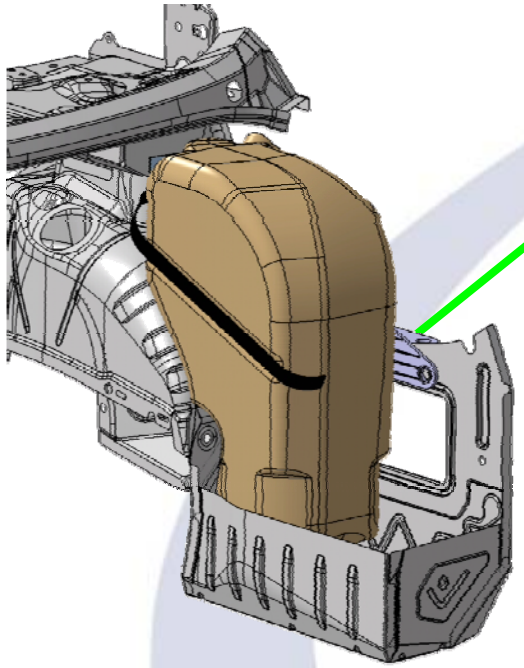
SCR-System : AdBlue® tank

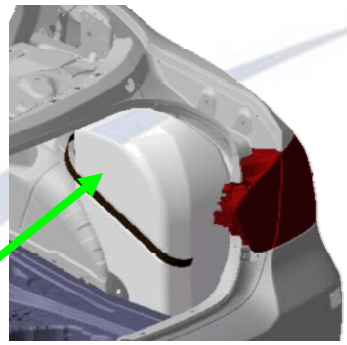
- Consumption : approximately 1 l/1000 km for a Passenger Car (depending on Engine NOx generation, injection/dosing quality, etc.)
- Integration into the vehicle.



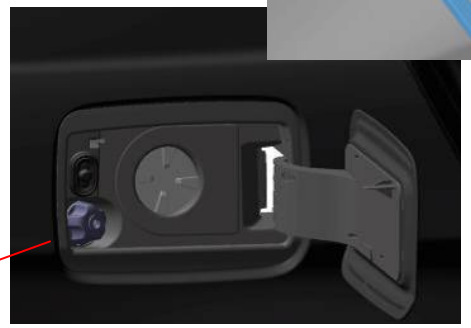
Inergy SCR system : system integration – Filling, Storage, Venting

Inergy concept with tank in trunk





Refilling at trap
Poke-Yoke function



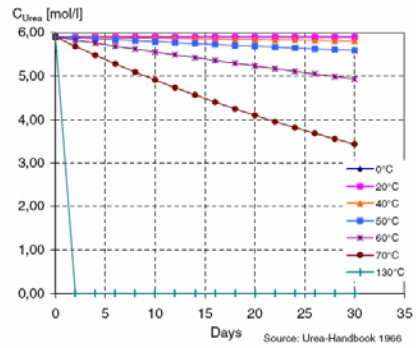
Cap with
integrated OPR

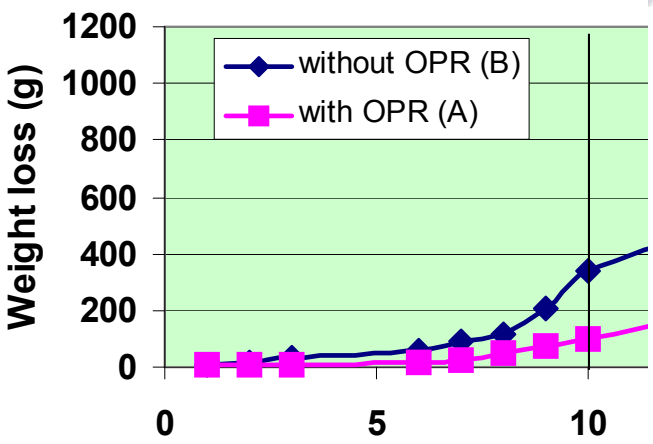
- Venting to the outside required
- Over Pressure Relief valve (200-450 mbar +/- 50 mbar)

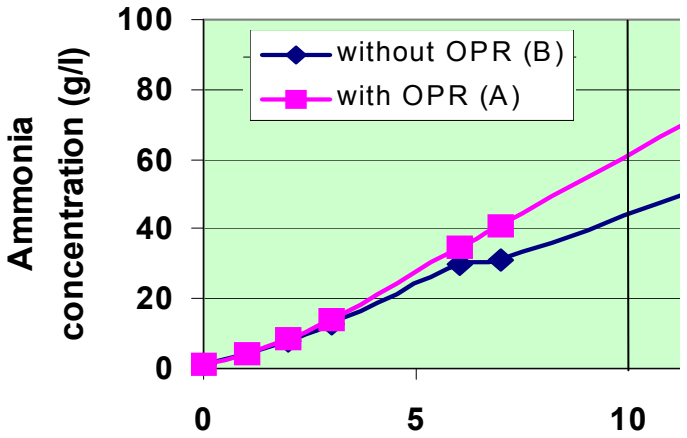
- Advantage : all functions in 1 concept

Ammonia release + AdBlue® concentration evolution

- Ammonia release
  - Tank initially filled with 10 l Adblue®
  - **80 °C constant temperature**
  - Over Pressure Relief opening pressure : 450 mbar
  - Measurement over 10 days







With Over Pressure Relief, 50 % more ammonia stays in solution and can be injected in the exhaust line

2% change in concentration with OPR compared to 4% without OPR after extreme/exagerated ageing phase

Ammonia release + AdBlue concentration evolution

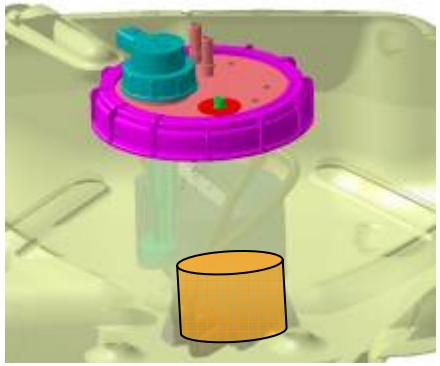
- Monitoring the ammonia amount

  potentially released by venting and wall permeation

  - Tank installed in a chamber
    of a known volume
  - Sampling the chamber atmosphere
    at regular time interval
  - Use of an ammonia reactive cartridge
    (lowest sensitivity range : 0.25 – 3 ppm)
    to measure ammonia concentration

- Example of results :
  - Car trunk internal volume : 0.35 m³ (estimation)
  - After 40 hours at continuous 40°C : no detection of any trace of ammonia vapour. → < 3 ppm of ammonia vapour

SCR-System : Heating system



Experiments :

Heater in swirl pot.

Initial temperature	T = -40°C
Heater power (electrical power)	P = 100 W
Heating time	t = 8 minutes (for measurement equipment)
Volume molten and ready for supply	**150 ml**

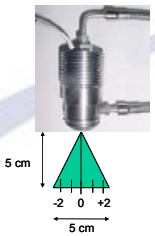
INERGY proposes an electrical heater with a power below 200 W (to include also preheating of pump and lines)

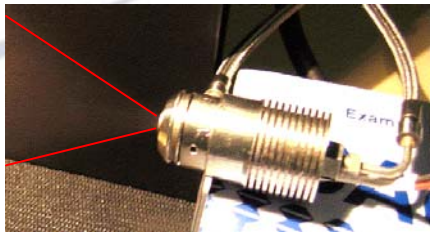
Injector : Performance factors and integration

Injector performance :

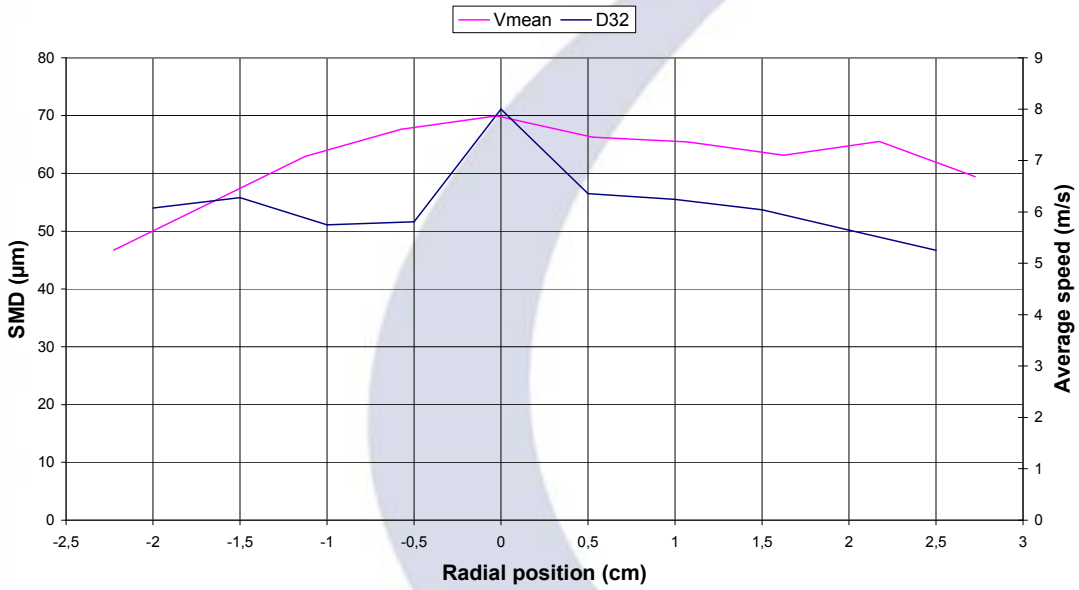
Droplet size and speed

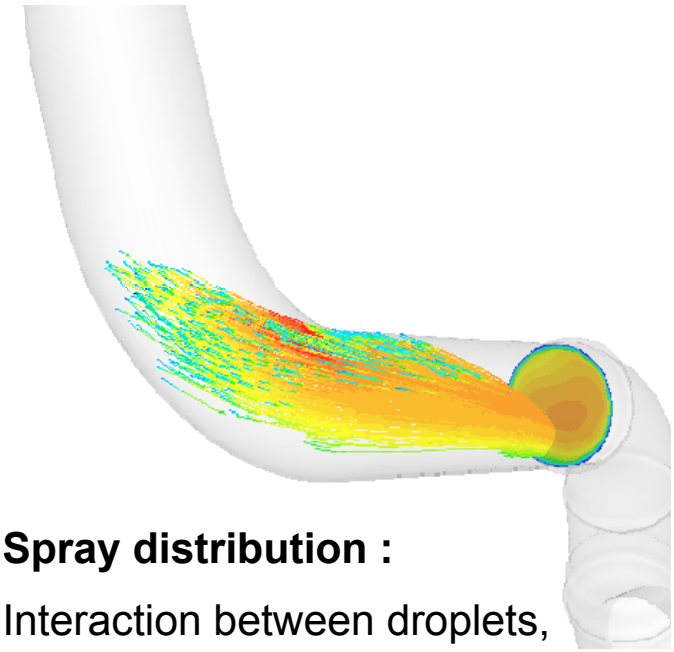
(Spray measurement 50% on-time)





Droplet size and Mean speed





Spray distribution :

Interaction between droplets, gas flow and pipe wall

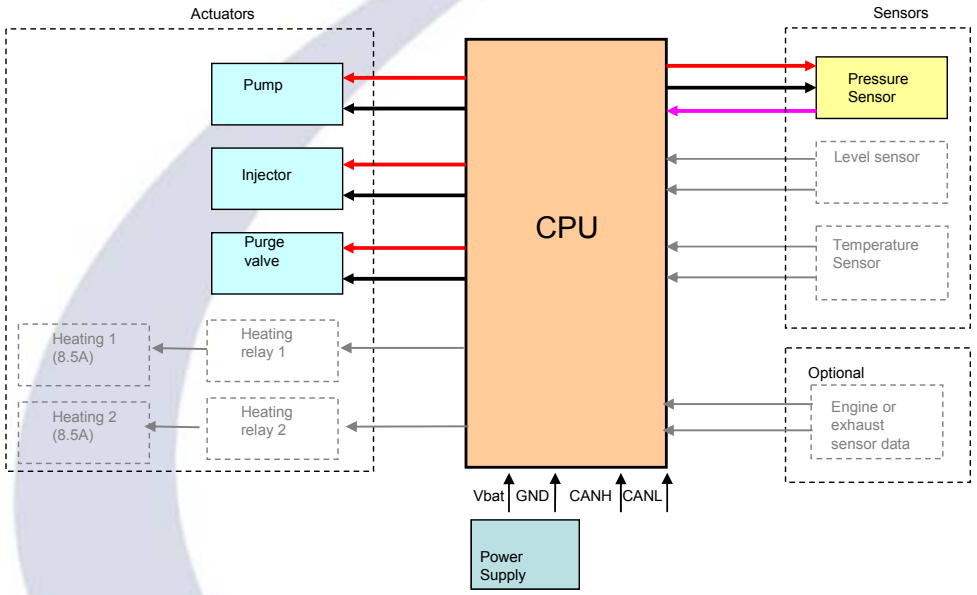
Overall droplet size : 54,6 µm
Overall average speed : 7,0 m/s

Inergy Electrical Control unit

- At the centre of the SCR system

Outputs :

- Dosing control
- Spray quality control
- Tank/lines heating
- Tank/lines purging



Inputs :

- System pressure
- Tank level signal
- Tank temperature signal
- Exhaust system sensor data
- Engine control data

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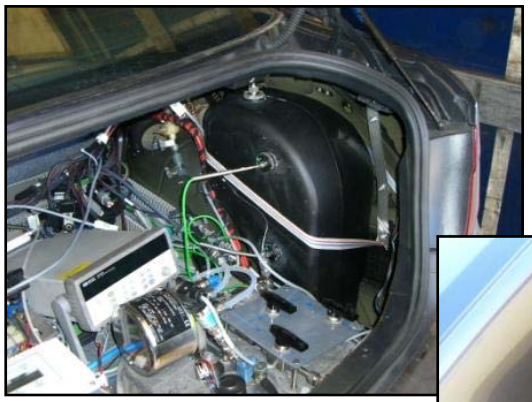
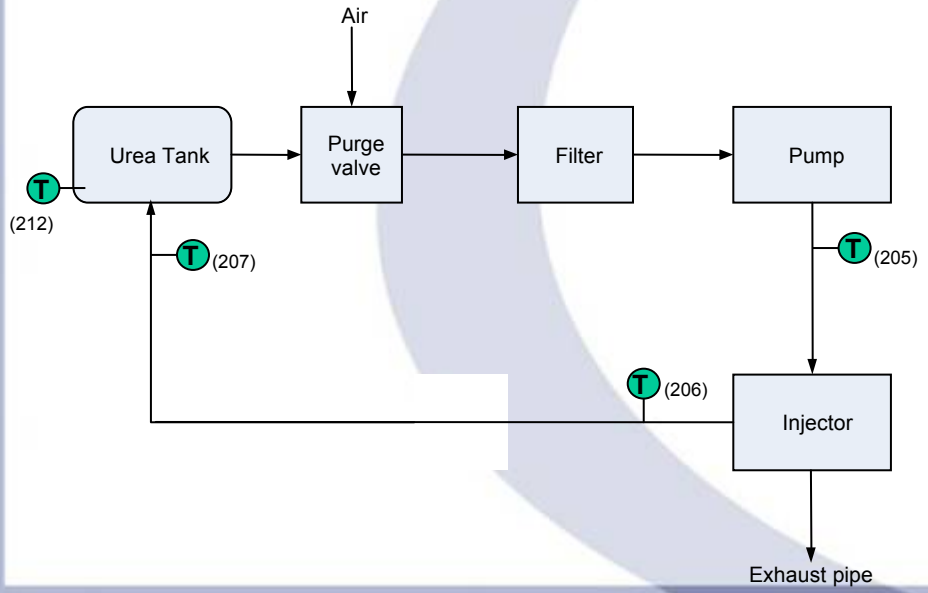
Case 1: Passenger Car tested in hot conditions

- Personal car equipped with Dinox system
  - Tank inside of trunk
  - Purge valve, filter and pump in trunk
  - Injector mounted on exhaust line
  - PA Lines:

    Starting from trunk

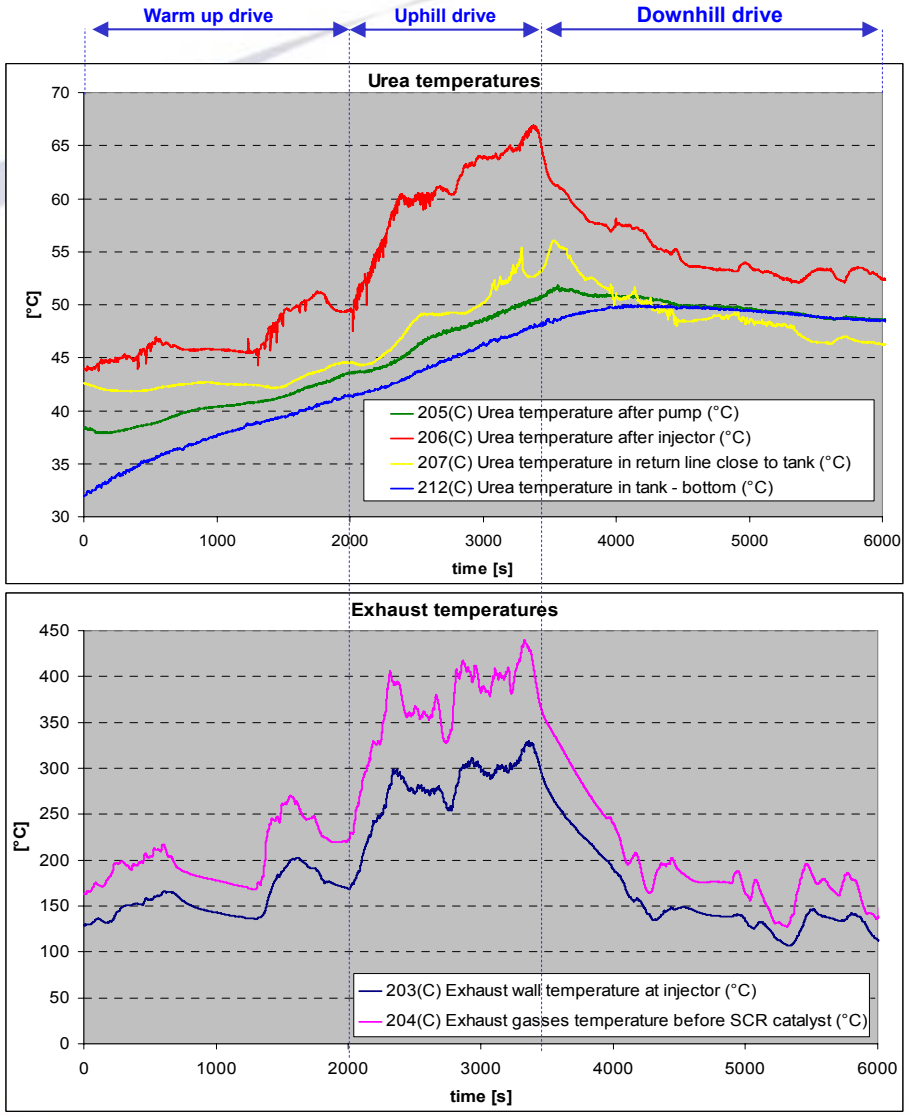
    Going below car body to injector and back to trunk
  - Urea flow rate: 12kg/h (controlled by flowmeter)



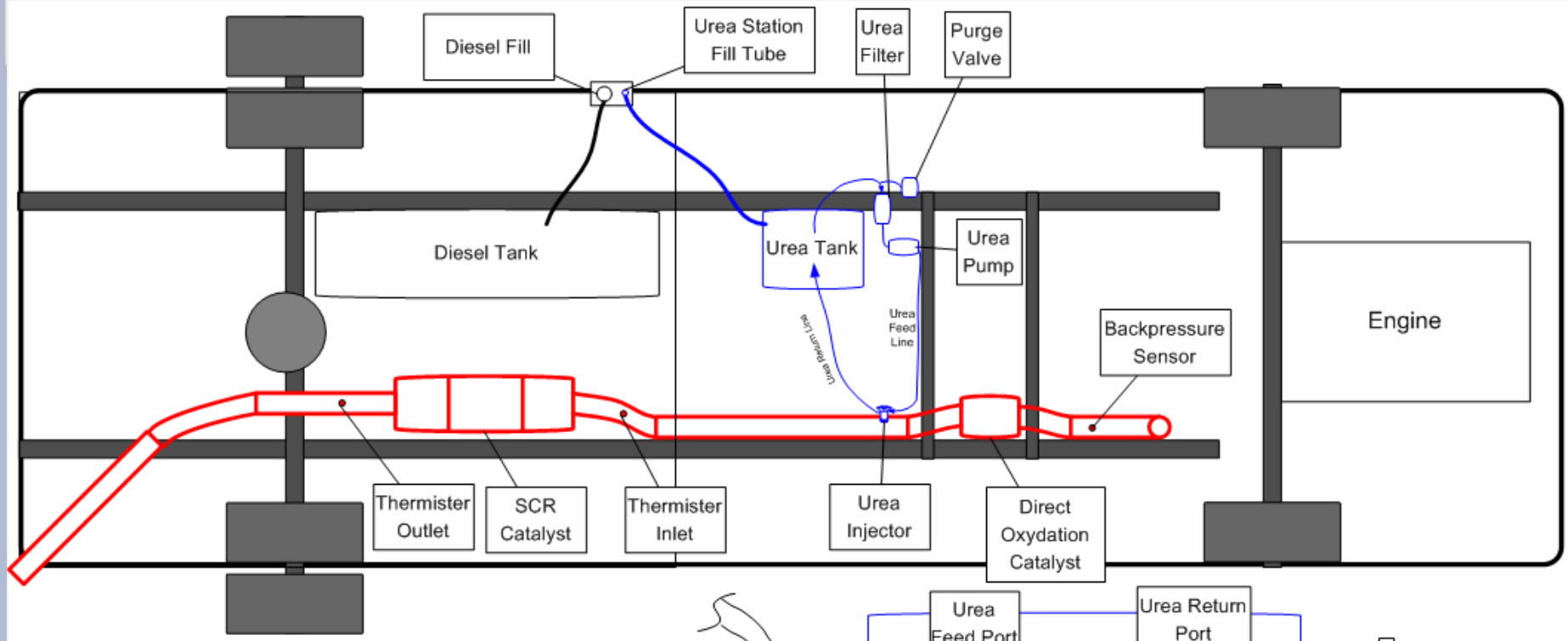


Case 1: Passenger Car tested in hot conditions (Pico Veleta test drive)

- Critical test conditions: very small urea volume in tank (3l)
- In tank urea temperature exceeds hardly 50°C
  - Confirmed by test started at 50°C by artificial heating: reached only 54°C at mountain top.
- With average urea volume (10l), urea temperature in tank hardly reached 43°C (with same test protocol)
- ➔ limited generation of ammonia inside tank

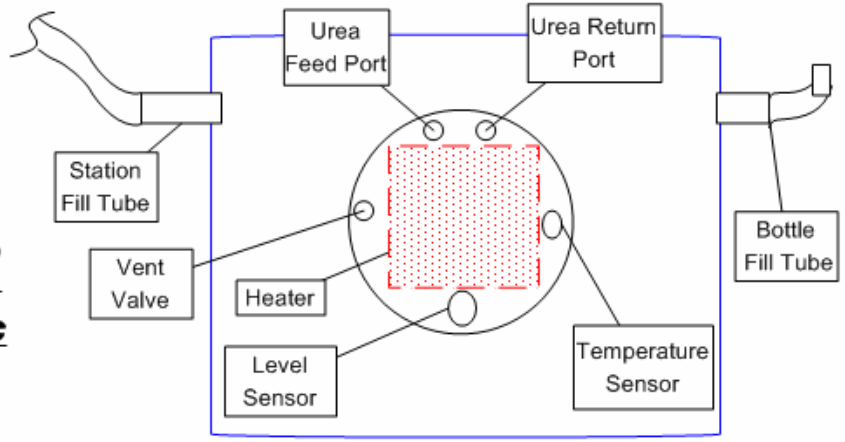


Case 2: Light Duty Truck



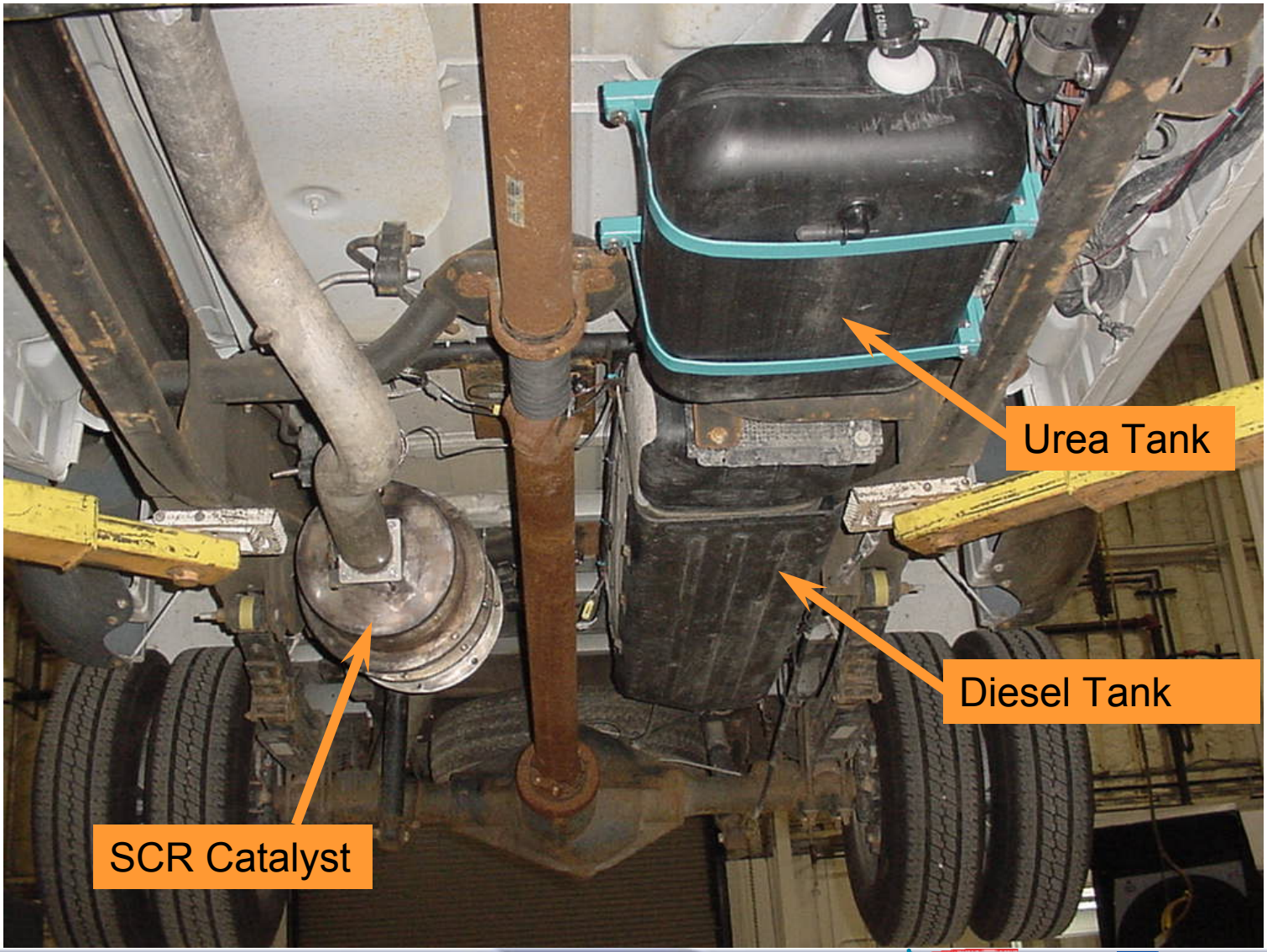
Urea SCR System

Test Vehicle Schematic

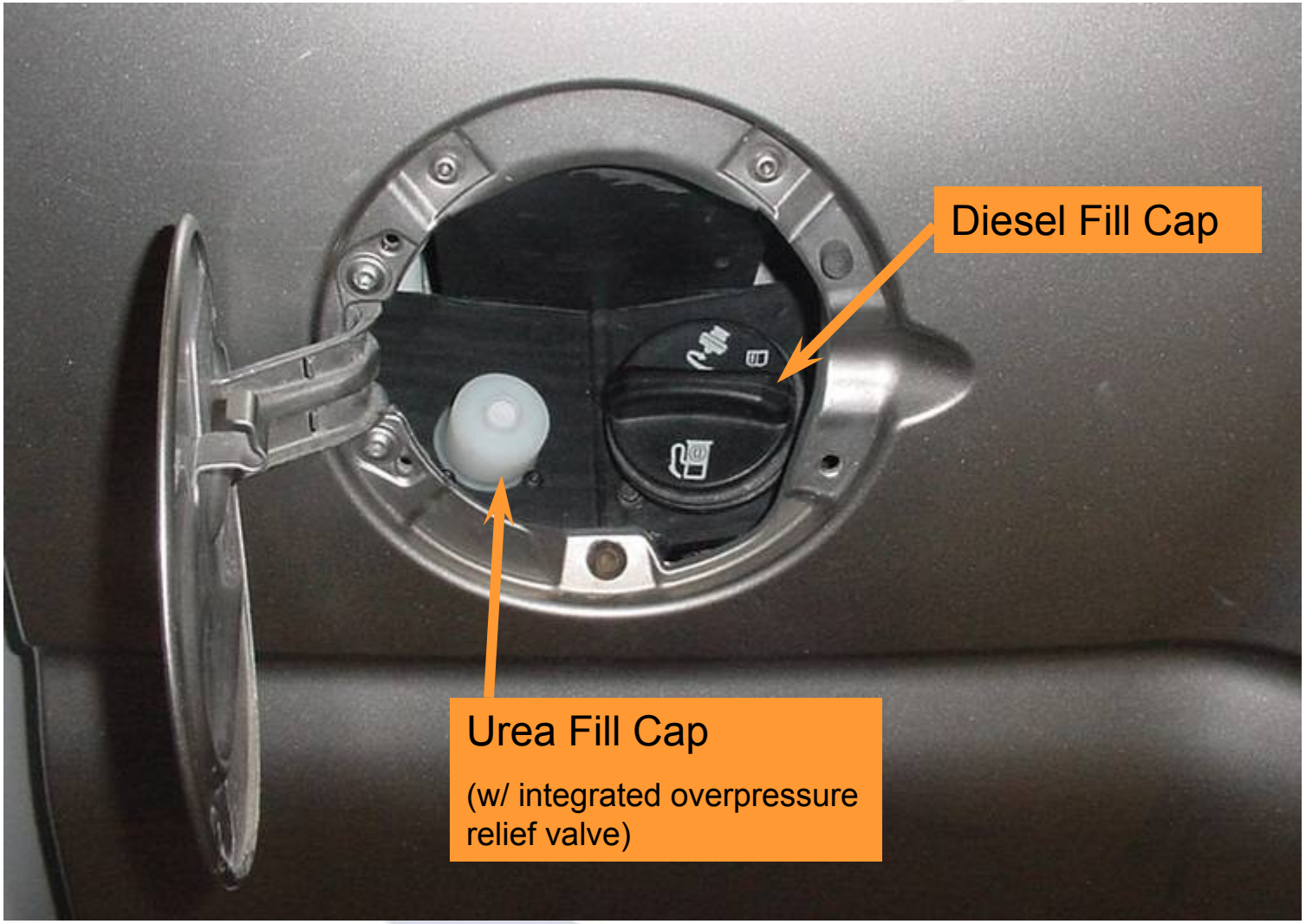


Tank Detail

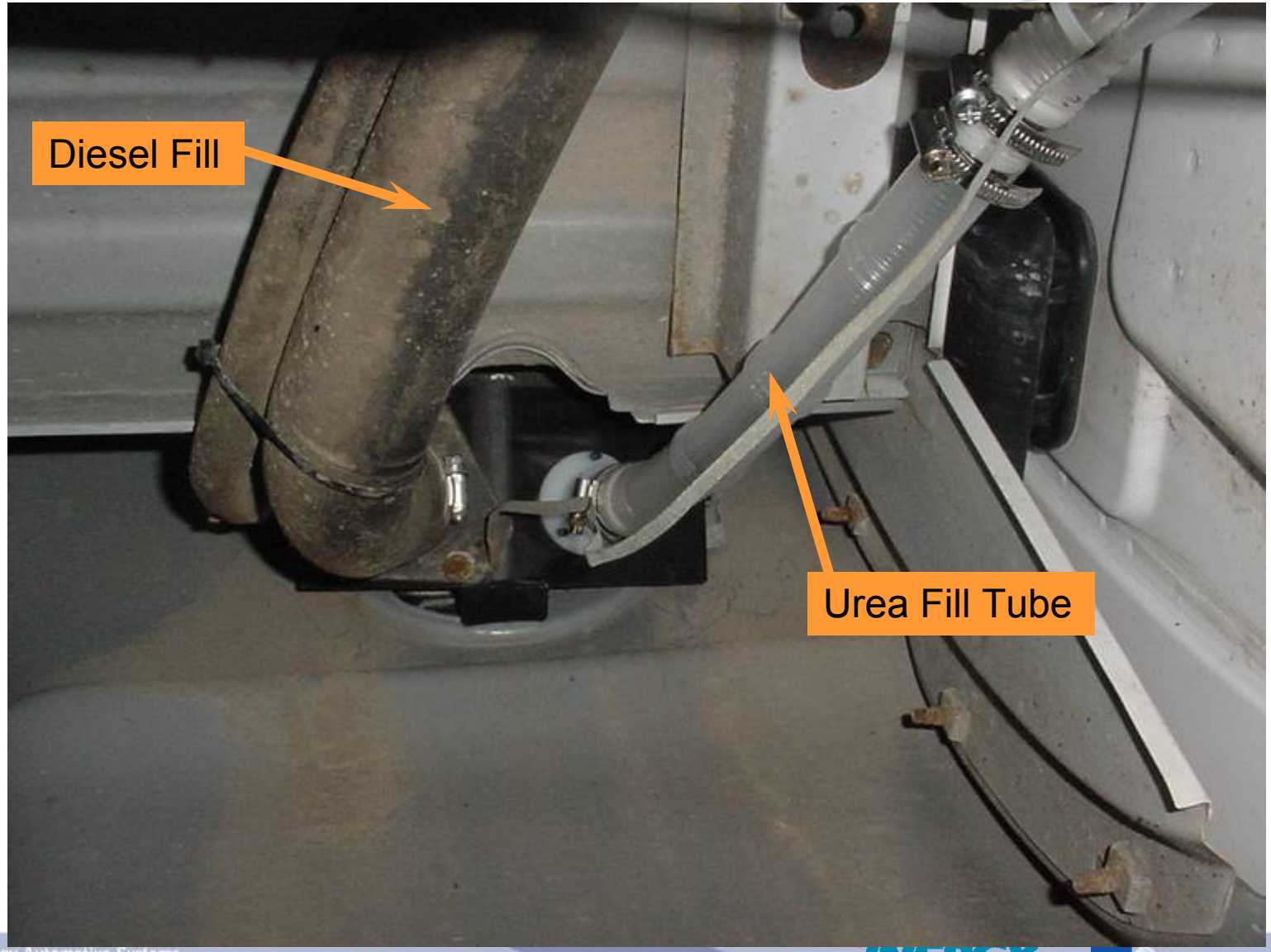
Case 2: LDT Underside



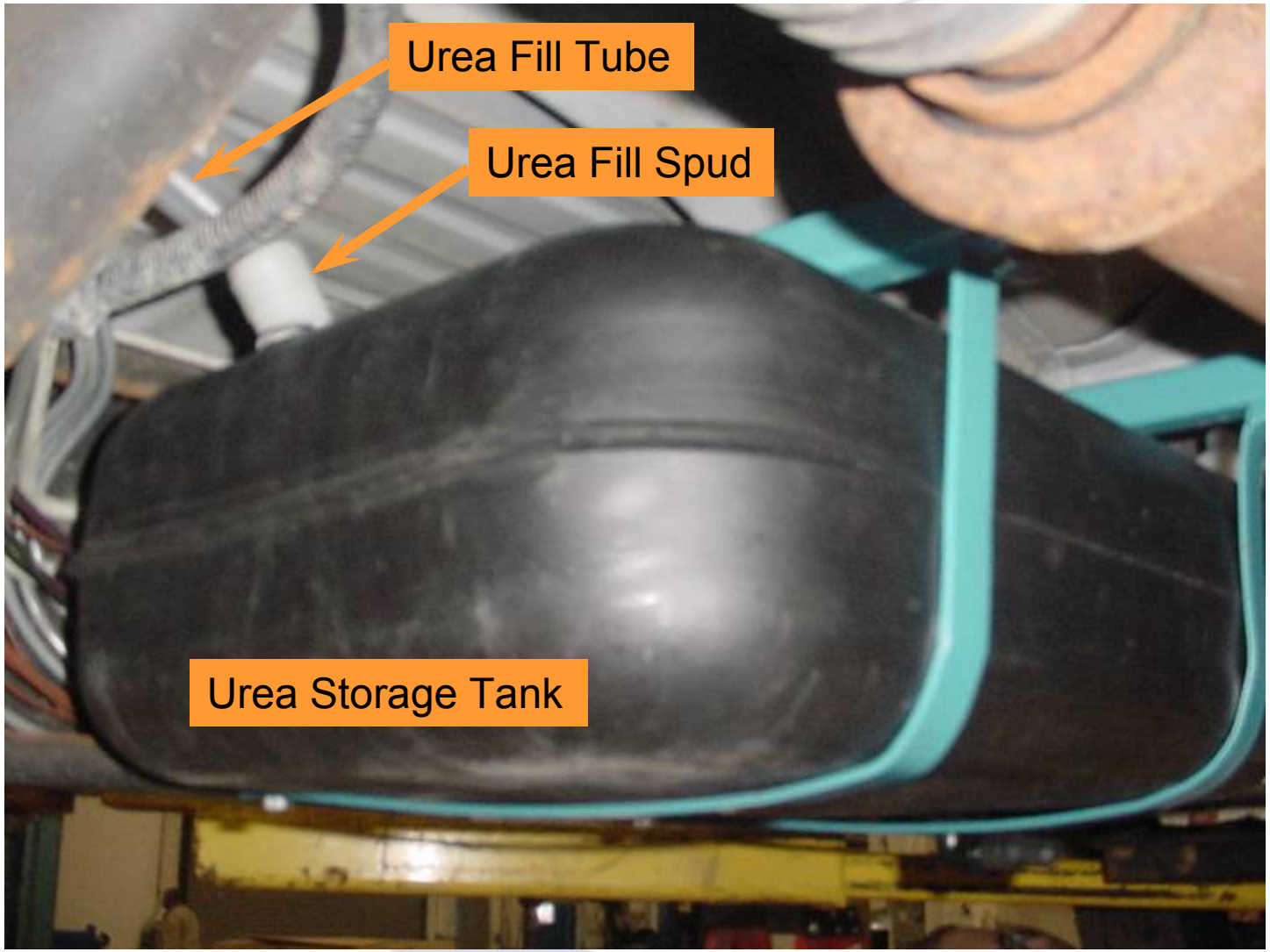
Case 2: Filler Pocket (Diesel & Urea Station Filling)



Case 2: Filler Pocket (Underside) & Fill Pipes



Case 2: Station Fill Spud Option



Conclusion

- OEMs strategies and requirements can be met, i.e. volume of SCR tanks depending upon driving range and refilling intervals
- Plastics offer flexible integration solutions in view of spatial and operational constraints
- Global optimization of the system is essential in tight passenger car environment
- With its longtime experience of fuel systems and diesel emissions reductions, Inergy is offering complete design, development and validation of SCR systems for passenger cars and light duty vehicles, from tank to injector

Contact

www.inergyautomotive.com

Thank you!

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