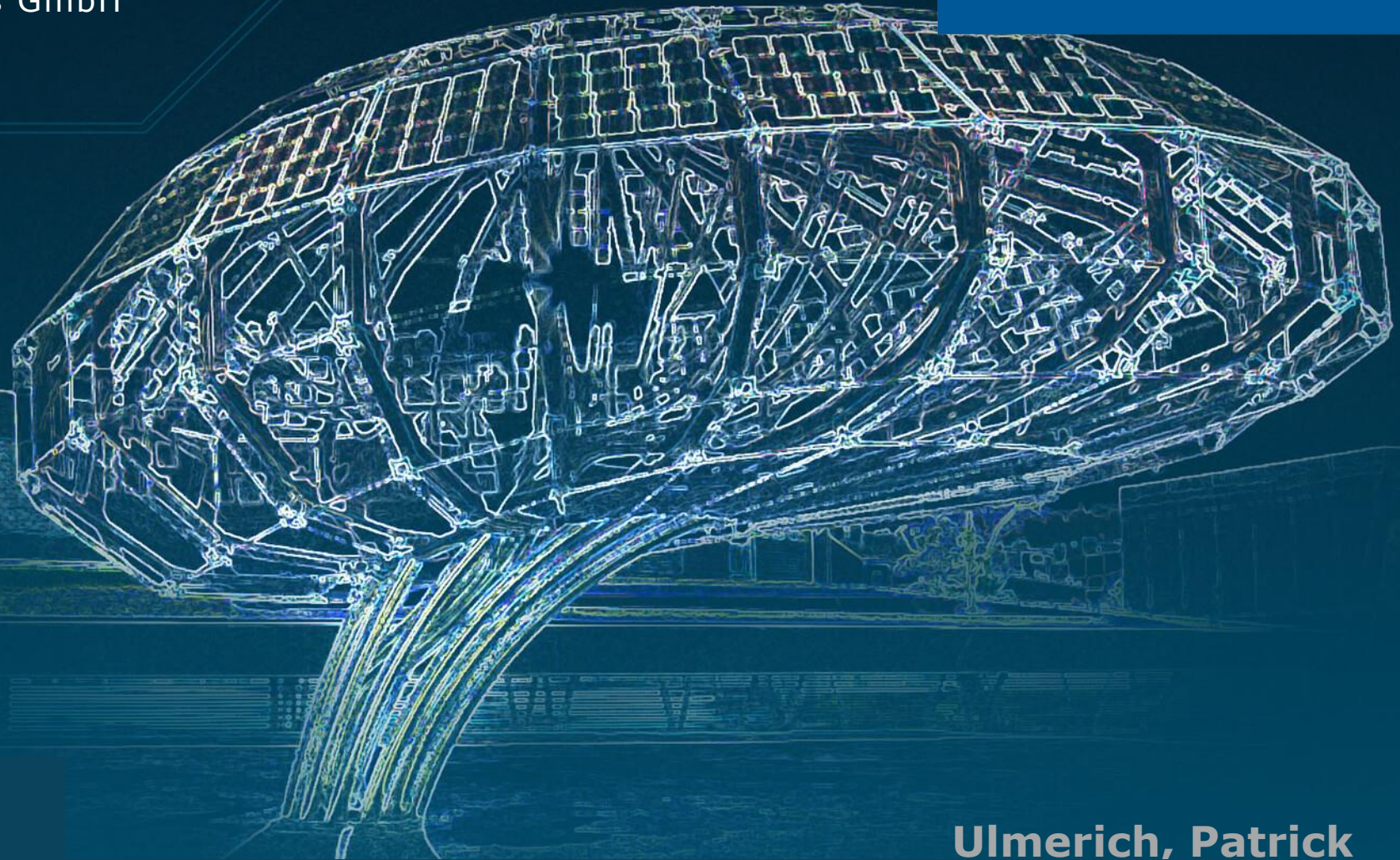


AVL Emission Test Systems GmbH

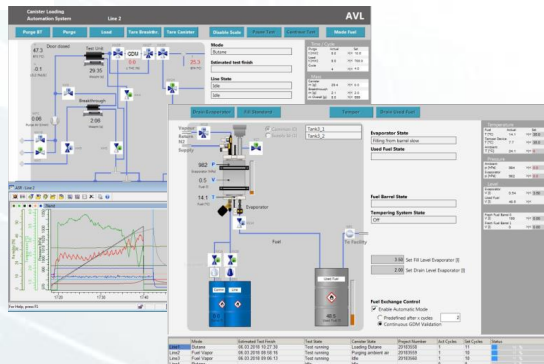


# AVL EVAP

Spezifische Lösungen für Verdunstungsemissionsmessungen

**Ulmerich, Patrick**

# EVAP TESTING & SYSTEMLÖSUNGEN



Patrick Ulmerich, Dipl.-Ing. (FH)  
Application Manager

Seit 1994 im Emission-Bereich tätig  
EVAP-Applikation seit 1999

AVL



# Verdunstungsemissionen

## ▪ Markttrends

Gesetzgebung & Neuigkeiten

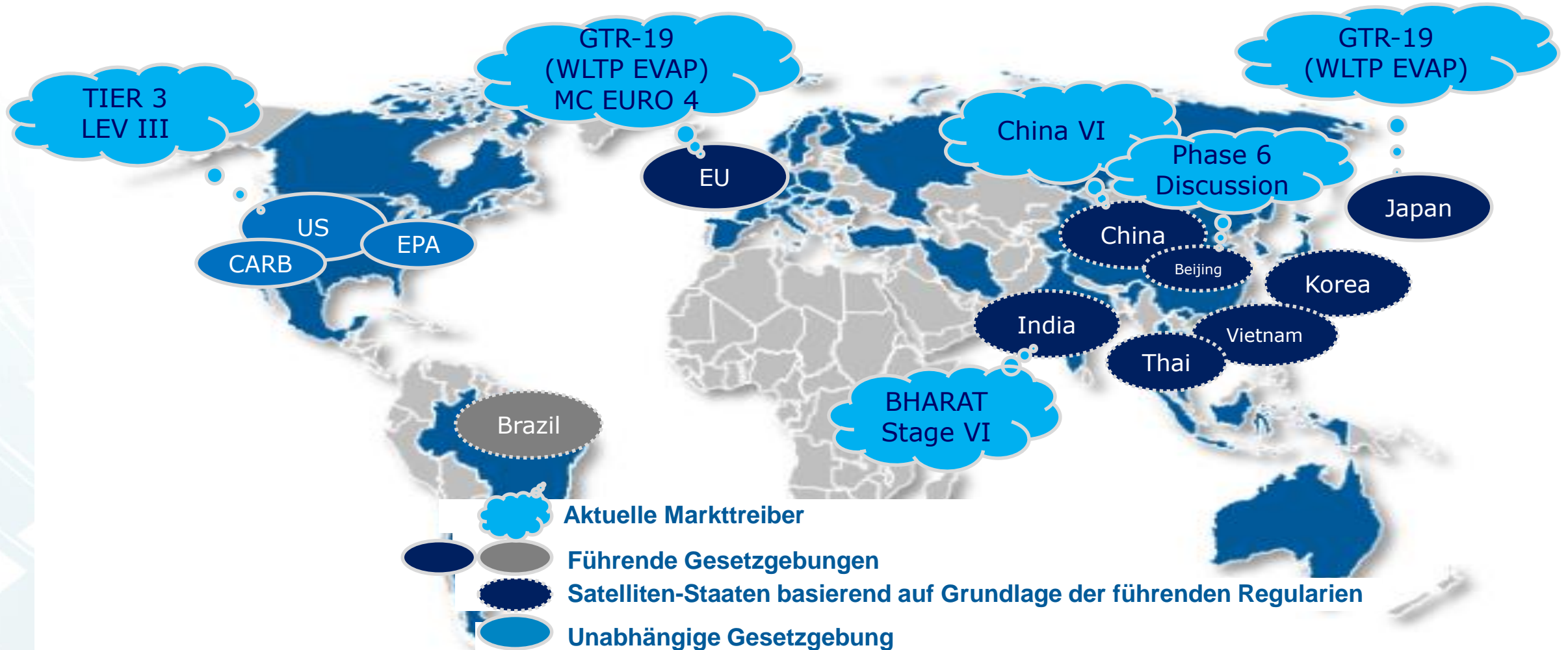
## ▪ Technologie

AKF-Konditionierung Kraftstoff

## ▪ RL-Testing

## ▪ Resümee

# ÜBERSICHT GESETZGEBUNGEN



Verdunstungsemissionen (THC) werden mit Hilfe unterschiedlicher Prozeduren und Prozessen, ermittelt und ausgewertet. Die Grenzwerte sind für unterschiedlichste Klassen (z.B. PKW, Motorräder, ATV's, Offroad-Kleinmotoren, etc.), in Abhängigkeit der lokalen Standards limitiert.

# EVAP MARKT – AUSBLICK GESETZGEBUNG

1. Welle (2016 – 2018)

2. Welle (2019 – 2022) erw.

ORVR, 2-Tages-Diurnal, AKF-Alterung, etc.

ORVR GTR, RL-Test, Drucktankssysteme, COP, In-Service-Conf., etc.

CHINA GB6 a (LD)

CHINA GB6 b (LD)

GTR-19 (WLTP EVAP) 1

GTR-19 (WLTP EVAP) 2

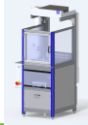
Mittel- und langfristige Trends und ihre Auswirkungen

# VERDUNSTUNGSEMISSIONEN - TESTTYPEN

## EVAP Test Preparation

Canister Conditioning & Testing

CANLOAD SYSTEMS



or



### Diurnal Test



Evaporative THC emissions “over the day” while the vehicle is parked 24h, 48h, 72h



### Bleed Emission Test



Like Diurnal test, but the bleed emissions (openings of the fuel system) are analyzed separately by a separate small Pass SHED within the VV/VT-SHED chamber



### Puff-Loss Test



Sealed Tanks System Test based on 12h Diurnal Cycle



### Hot-Soak Test



THC-Emissions after vehicle driven (engine is tested) during (chassis dyno TC ED) required



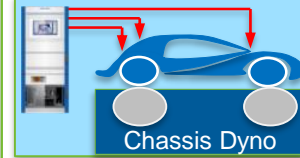
### ORVR Test / Spit back



Onboard Refueling Vapor Recovery test determines fuel vapor THC emissions coming out of the tank by new fuel being pumped into it



### Point-Source Test



Evaporative THC emissions during driving the vehicle on a chassis dyno are measured at points, where evaporated THC might be emitted



### Running-Loss Test



Evaporative emissions during driving the vehicle on a chassis dyno which is based on the SHED



### Component Testing



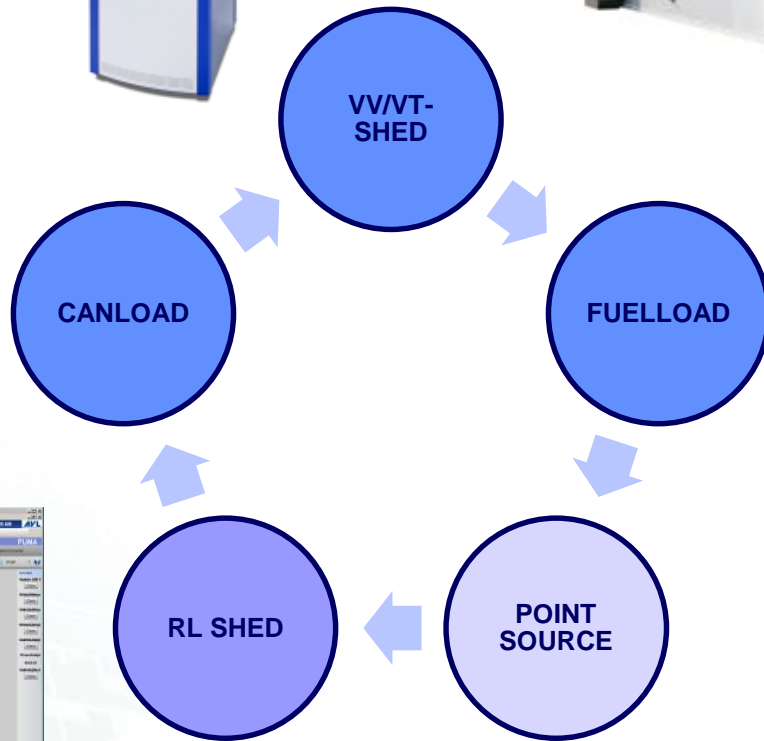
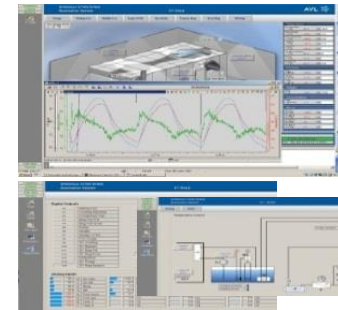
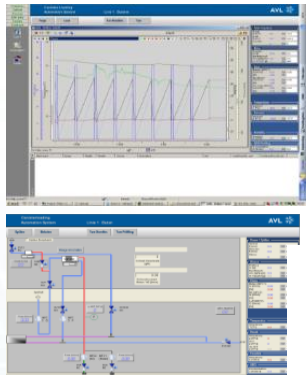
Testing of components of Suppliers Fuel or ers



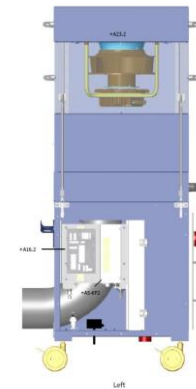
Canister Aging  
CANLOAD  
Canister Aging 300 cycles GWC followed by 5 cycles of BWC



# EVAP PRODUKT-PORTFOLIO



Parameter	Value	Parameter	Value	Parameter	Value	Parameter	Value
Baromet	29.645	CVT	3.827	HC	-0.19	NO	0.19
Cell Temp	71.789	CPH	100.000	NOx	15.52	NOx	0.25
Depth	14.318	CPH	43.860	CO	0.19	CO	0.58
				CO2	14.55	CO2	701.85
				CO2	1.82	CO2	697.28
				CO2	0.24	CO2	15.20
				CO2	0.64	CO2	15.33



# EVAP APPLIKATION: LD-FAHRZEUGE

Testkandidat	SHED Kammer				Testgeräte und Zubehör					Analytik						Konditionierung				
UUT	SHED Chamber	Variable Vol. / Temp	Passive Chamber	Running Loss SHED	Heating Devices	Running Loss CD	ORVR Devices	Spit-Back Devices	Point Source	THC Analysis	CH4 Analysis	Ethanol Analysis	NH3 Analysis	iCal GDU	iCal CFO	AKF Kond.	Kraftstoff Dampf	Spülluft Kond.	Betankung	Kraftstoff Kond.
EU		✓								✓				✓	✓	✓	✓	✓	✓	✓
USA		✓	✓	✓	✓	✓	✓	(✓)	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓
Japan		✓								✓				✓	✓	✓	✓	✓	✓	✓
China		✓	✓		✓		✓			✓				✓	✓	✓	✓	✓	✓	✓
Brazil	✓	✓			✓					✓		✓		✓	✓	✓	✓	✓	✓	✓
Korea		✓								✓				✓	✓	✓	✓	✓	✓	✓

✓ Rf mit FID (100% Ethanol)

✓ Vorschrift

✓ Option oder Alternative / In Diskussion



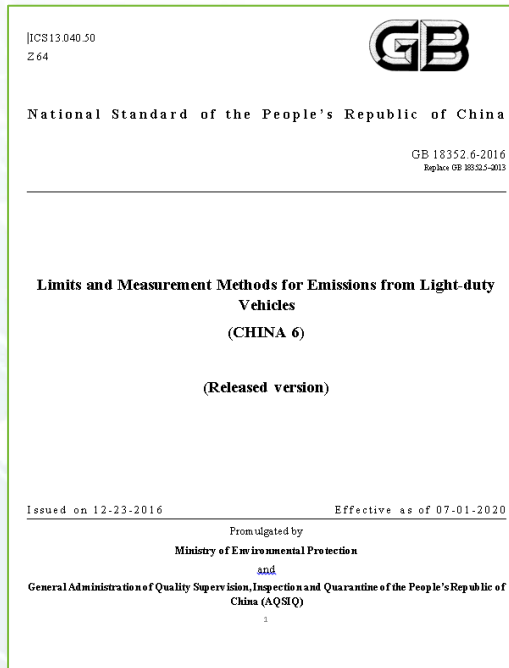
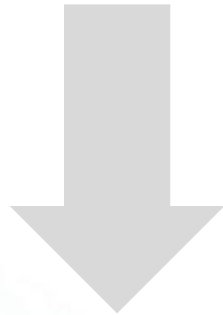


China GB 6

# ZEITPLAN - CHINA GB6 (LD)



**23/12/2016: China GB 6 Finale Version**



## Umsetzungszeitraum

	New Type	Register
6a	2019.01.01	2020.01.01
6b	2022.01.01	2023.01.01
RDE	2022.01.01	2023.01.01

Index	Contents
Annex C	Type I test: Average tailpipe emissions after a cold start
Annex D	Type II test: RDE (Real Driving Emission)
Annex E	Type III test: Crankcase Gas Emission
<b>Annex F</b>	<b>Type IV test: Determination of evaporative emission</b>
Annex H	Type VI test: Verifying the average low ambient temperature CO, HC and NOx tailpipe emissions after a cold start
<b>Annex I</b>	<b>Type VII test: ORVR</b>
Annex J	OBD
Annex R	Hybrid vehicle test procedure

# GB6 – ÜBERBLICK

## GTR 15: TEMPERATURE REQUIREMENTS

**UN-ECE R-83: Temperature in Soak-Area and Test bed**

- Temperature shall be between 20 and 30°C and relative stabile.

**GTR-15: Temperature in Soak-Area and Test bed**

- 23°C This is a set point (296°K)
- 23°C +/-3°C Temperature soak area, on a 5 minute running average
- 23°C +/-3°C Temperature set point and tolerances during engine start
- 23°C +/- 5°C Temperature set point and tolerances during test

**China GB 6: Temperature in Soak-Area and Test bed**

- 23°C This is a set point (296°K)
- 23°C +/-3°C Temperature soak area, on a 5 minute running average
- 23°C +/-5°C Temperature set point and tolerances during test

Note: GTR-15 defines temperatures in °K (296°K+/-5), here it is shown in °C without decimals, for a better understanding and in mind keeping.  
Geggenu, P. Ulmerich, ETS Products\AM-Folder, 14.03.2017

## TYPE IV TEST- IMPACT TO EVAP SYSTEM

	Limit (g/test)	Deterioration Factor	0.06 (g/test)
China 5	2.0		
China 6a/6b	0.70		
EU 6c	2.0		

- ORVR refers to US EPA Evaporation test procedure (→ TYPE VII Test)
- High temperature soak (38°C ± 2°C)
- High temperature chassis dyno driving (38°C ± 2°C)
- High temperature Hot soak test (38°C ± 2°C)
- 48 hours Diurnal Test

Geggenu, P. Ulmerich, ETS Products\AM-Folder, 14.03.2017

- Anlehnung an die GTR-15 Anforderungen z.B. Temperaturkonditionierung während der Prep-Fahrzyklen oder der Fahrzeugstabilisierung (SOAK)
- Neue und deutlich reduzierte Grenzwerte 0.7g/Test (HS+D, ORVR 0.05g/l)
- Neue, erhöhte Heissabstell (Hot-SOAK)-Temperatur → 38°C
- Hochtemperatur-Prep. Fahrzyklus → 38°C
- Verlängerung bzw. Verdopplung der Parksimulation Test-Prozedur (Diurnal) von 24h → 48h

# CHINA 6 – INFORMATION



## TYPE IV TEST- IMPACT TO EVAP WORKFLOW

**1 New pre-condition cycle in Chassis dyno**  
 Driving cycle: (WLTC 3b - EVAP) low speed + medium speed + high speed + **high speed**;

Class 1 ≤ 22 Wkg	Low 1	Medium 1	Low 1
Class 2 > 22 ≤ 34 Wkg	Low 2	Medium 2	High 2
Class 3a > 34 Wkg v_max ≤ 120 km/h	Low 3	Medium 3-1	High 3-1
Class 3b > 34 Wkg v_max > 120 km/h	Low 3	Medium 3-2	High 3-2

**2 High temperature chassis dyno driving cycle (38°C ± 2°C)**  
 Driving cycle: low speed + 2 min idle + medium speed + 2 min idle + high speed + 2 min idle + **high speed** + 2 min idle; (WLTC 3b - EVAP)

Confidential | 11 March 2018 | 20

## TYPE VII – ORVR IMPACT TO EVAP WORKFLOW

**3 Vehicle pre-condition driving cycle**  
 Driving cycle: sustaining mode For HEV vehicle, repeated (WLTCs-EVAP) until charge-

Class 1 ≤ 22 Wkg	Low 1	Medium 1	Low 1
Class 2 > 22 ≤ 34 Wkg	Low 2	Medium 2	High 2
Class 3a > 34 Wkg v_max ≤ 120 km/h	Low 3	Medium 3-1	High 3-1
Class 3b > 34 Wkg v_max > 120 km/h	Low 3	Medium 3-2	High 3-2

**4 ORVR control system Vehicle pre-condition driving cycle**  
 Driving cycle: (WLTC 3b-EVAP) low speed + low speed + medium speed + low speed;

Confidential | 11 March 2018 | 21

Spezielle EVAP-Fahrzyklen abgeleitet von den bekannten WLTC-Zyklen mit dem Fokus auf einem "Worst-Case" Szenario → AKF-Spülen



Ausy-Anforderungen – EVAP spezifische Vorkonditionierfahrzyklen

# CHINA 6 - INFORMATION

## Hoch-Temperatur Konditionierung (Soak)

Temperatur-Sollwert: **38°C ± 2°C**



Relativ einfache Temperatur-Konditionierung

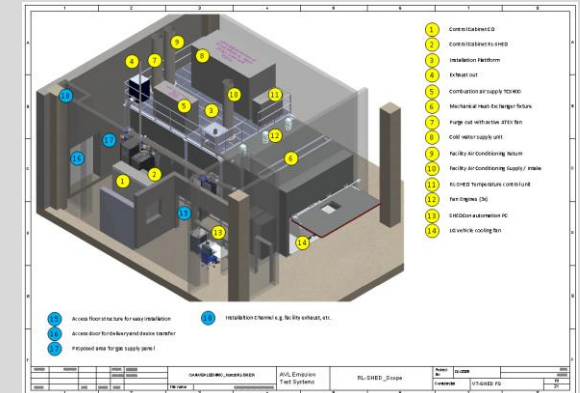
- In speziellen zusätzlichen Containern
- Im Standard-SHED

W  
o  
r  
k  
f  
l  
o  
w

## Hoch-Temperatur Konditionier-Fahrzyklus

Temperatur-Sollwert : **38°C ± 2°C**

**Notweniges Investment für eine RL-SHED  
oder alternativ eine Klimakammer!**



## High temperature Hot Soak Test (SHED)

Temperatur-Sollwert : **38°C ± 2°C**  
(Temperaturbereich Testprozedur: 33°C ~ 41°C)



Standard VT-SHED Operation  
(Hot-Soak 38°C)

# CHINA 6 – ORVR ANFORDERUNGEN

## TYPE VII – ORVR IMPACT TO EVAP SYSTEM



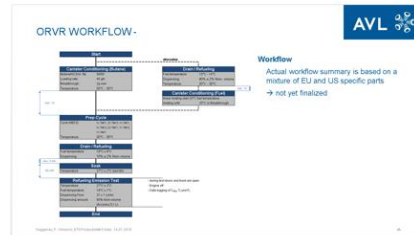
- Refer to US EPA ORVR test procedure
- Drive cycle refers to WLTC - EVAP

	Limit (g/L)
China 6a/6b	0.05

Deterioration Factor	0.01 (g/L)
----------------------	------------

### Test requirement

SHED enclosure ambient temperature: 23 °C ± 3 °C

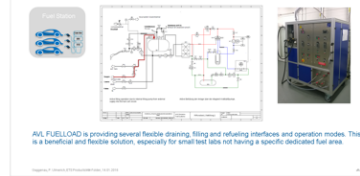


Geggenau, P., Ulmerich, ETS Products\AM-Folder, 14.03.2017

## TYPE VII – ORVR IMPACT TO EVAP SYSTEM



### AVL EVAPORATIVE EMISSION TEST SYSTEMS



Geggenau, P., Ulmerich, ETS Products\AM-Folder, 14.03.2017

### FUELLOAD

- Two refilling nozzles (EU and EPA): → available as option
- With fuel vapor recovery function: → available as option
- Fuel temperature: 20°C ± 1°C
- Filling rate: 37 ± 1 L/min
- SHEDCon and Fuelload: → available, new settings

Enhanced ORVR "modules" (fully)

Improved design

Additional Capacity

**Markt  
Treiber**

- Betankungsprozedur (ORVR) ähnelt sehr der bestehenden US Prozedur
- Vorstellung der 2. Generation des AVL FUELLOAD Betankungssystems
- Zusatz ORVR-Lüfter optimiert die Mischung und stellt das hohe analytische Ansprechverhalten sicher
- Neuer ORVR-Betankungsbeutel mit Abschlussadaptern und spezifischen Zapfpistolenadaptern


AVL



# GTR-19 (WLTP EVAP) INFORMATION

WLTP EVAP TASK FORCE Meetings

# GTR-19 INFORMATION

EURO Directorate Industrial	
United Nations	
 Economic and Social	
Economic Commission for Europe	
Evap OIL#	D P
E#1	
E#2	
E#3	
E#4	
E#5	C
E#11	
E#12	Te
E#13	
E#14	Te
E#15	

**Global Registry**

Created on 18 November 2004, pursuant to Article 6 of the Agreement concerning the establishing of global technical regulations for wheeled vehicles, equipment and parts which can be fitted and/or be used on wheeled vehicles (ECE/TRANS/132 and Corr.1) done at Geneva on 25 June 1998

**Addendum 19: Global technical regulation No. 19**

Global technical regulation on the EVAPorative emission test procedure for the Worldwide harmonized Light vehicle Test Procedure (WLTP EVAP)

Established in the Global Registry on 21 June 2017

riefly. The test for running losses would a dynamometer incorporated, i.e. very detectors. These methodologies are only

**emissions (SHED test):**

**of evaporative emissions in** have eventually led to the

14. **At this time, the WLTP EVAP test procedure focuses only on the evaporative emissions that can occur during parking events.** Running losses and refuelling emissions are out of the scope of the current WLTP EVAP procedure.

**et Tank Ageing:**

**Fuel Ageing:**

**Proposal for a new global technical regulation on Evaporative Emissions for the Light vehicles Test Procedure (WLTP EVAP)**

**Submitted by the Informal Working Group on Worldwide harmonized Light vehicles Test Procedure (IWG)**

The text reproduced below was prepared by the Informal Working Group (IWG) on Worldwide harmonized Light vehicles Test Procedure (WLTP EVAP) in line with Phase 1B of its mandate (ECE/TRANS/132 and Corr.1)



UNITED NATIONS



# GTR-19 INFORMATION

#3 PURGE CYCLE

Compromised proposal

Japan proposes LML/L for class 1 vehicles

Lower average speed than LML/L. From 41.3kmh to 33.3kmh

Larger distance than LML/L. From 13.0km to 22.3km

Parameter	Unit	Value	Unit	Value	Unit	Value	Unit	Value
Speed	km/h	41.3	km/h	33.3	km/h	41.3	km/h	33.3
Distance	km	13.0	km	22.3	km	13.0	km	22.3

Purge cycle for class 1 vehicles

Japan suggests LML/L or LML/2 for purge cycle for class 1 vehicles

Similar distance to Class 3 purge cycle. Either to be determined after the purge cycle for class 3 decided.

Class	Low	Mid-High	High	LMHM	LMML	LML/2
Class 1	-	-	-	-	-	-
Class 2	-	-	-	-	-	-
Class 3	-	-	-	-	-	-
Class 4	-	-	-	-	-	-
Class 5	-	-	-	-	-	-
Class 6	-	-	-	-	-	-
Class 7	-	-	-	-	-	-

Cycle characteristic

Parameter	Value	Unit
EVAP	1.00	
CO	0.00	
HC	0.00	
NOx	0.00	
PM	0.00	
SOx	0.00	
TP	0.00	
WCO	0.00	
WCO2	0.00	
WCO3	0.00	
WCO4	0.00	
WCO5	0.00	
WCO6	0.00	
WCO7	0.00	
WCO8	0.00	
WCO9	0.00	
WCO10	0.00	
WCO11	0.00	
WCO12	0.00	
WCO13	0.00	
WCO14	0.00	
WCO15	0.00	
WCO16	0.00	
WCO17	0.00	
WCO18	0.00	
WCO19	0.00	
WCO20	0.00	

Cycle characteristic

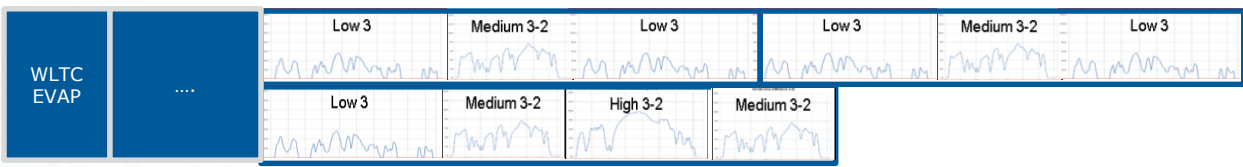
Parameter	Value	Unit
EVAP	1.00	
CO	0.00	
HC	0.00	
NOx	0.00	
PM	0.00	
SOx	0.00	
TP	0.00	
WCO	0.00	
WCO2	0.00	
WCO3	0.00	
WCO4	0.00	
WCO5	0.00	
WCO6	0.00	
WCO7	0.00	
WCO8	0.00	
WCO9	0.00	
WCO10	0.00	
WCO11	0.00	
WCO12	0.00	
WCO13	0.00	
WCO14	0.00	
WCO15	0.00	
WCO16	0.00	
WCO17	0.00	
WCO18	0.00	
WCO19	0.00	
WCO20	0.00	

Cycle characteristic

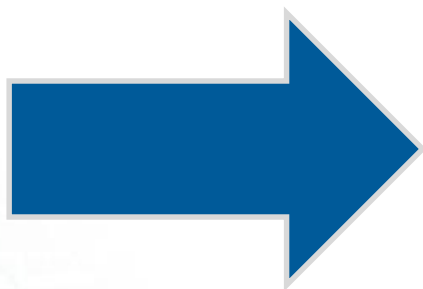
Parameter	Value	Unit
EVAP	1.00	
CO	0.00	
HC	0.00	
NOx	0.00	
PM	0.00	
SOx	0.00	
TP	0.00	
WCO	0.00	
WCO2	0.00	
WCO3	0.00	
WCO4	0.00	
WCO5	0.00	
WCO6	0.00	
WCO7	0.00	
WCO8	0.00	
WCO9	0.00	
WCO10	0.00	
WCO11	0.00	
WCO12	0.00	
WCO13	0.00	
WCO14	0.00	
WCO15	0.00	
WCO16	0.00	
WCO17	0.00	
WCO18	0.00	
WCO19	0.00	
WCO20	0.00	

Japanese statistical data

AVL statistical data shows that average FTP per day (purge unit day) (average) is approximately 10.0.



WLTC basierte AKF-Spülzyklen (Prep. Fahrzyklen) LMHM und LML x2  
 → EVAP spezifisch!



## RESTRICTIVE CANISTER PURGE REQUIREMENTS

**HOW TO CONTROL PURGE AIR LIMITS?**

Solution → PURGE AIR CONDITIONING UNIT 100

- Temperature range: 20 - 30 °C
- Humidity range: 25 - 75 % rF
- Flow range: 0 - 100 l/min

- Dynamic Purge Air Conditioning continuously adjustable set points
- Related to RDE testing
- Integrated water and pressurized air conditioning unit
- Operates via LAN interface with up to 4 CAN/LIN/LIN2 CAN/LIN
- Optional interface for a "dry" air supply

### Purge Air Requirements

Actual Limits

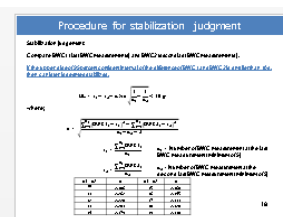
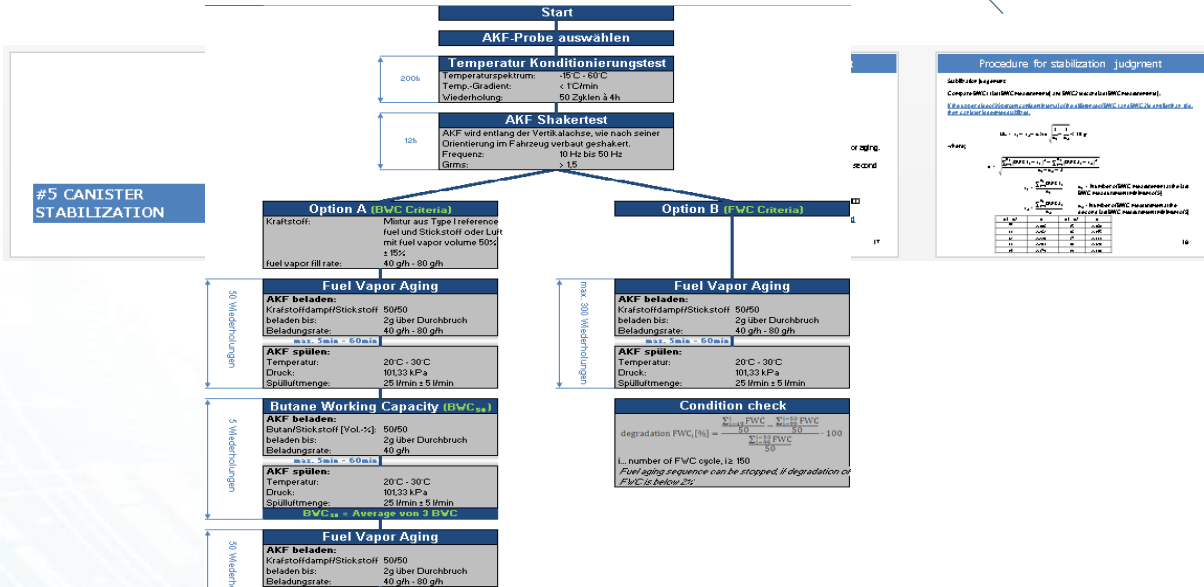
Relative Humidity: 50 ± 25 % rF

Temperature: 20 – 30 °C

GTR-15 with stricter limits for vehicle soak (23 ± 5°C)

Canister working capacity have a strong dependency to purge air temperature and humidity

# GTR-19 INFORMATION

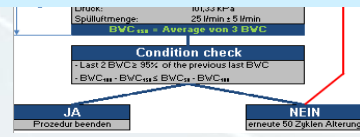


Zusammenfassend:  
 AKF Alterung / Stabilisierung mit Kraftstoffdampf (300 Zyklen GWC)  
 Abschliessend 5 Zyklen BWC5  
 → BWC Ermittlung basierend auf statistischer Berechnung



Vorstellung der neuen CANLOAD xL-BF Variante

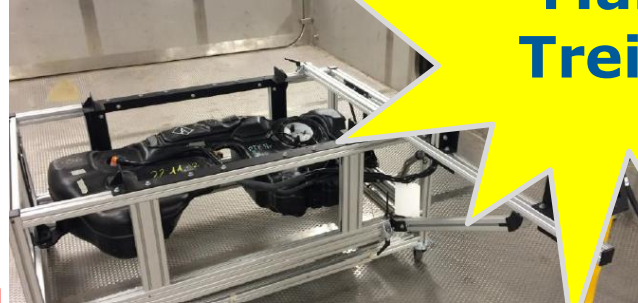
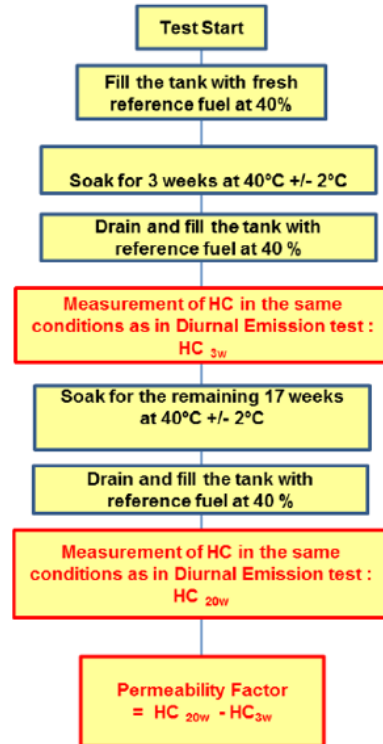
Kombination von Butan / Kraftstoff / Stickstoff



# GTR-19 INFORMATION

## Determination of PF

Figure 4 : Determination of the Permeability Factor



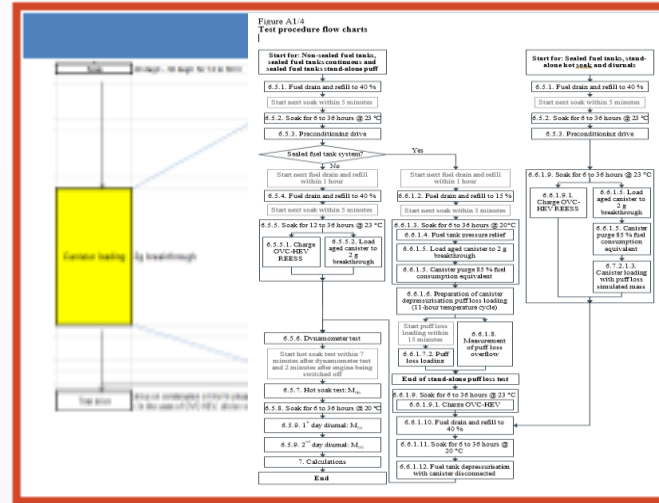
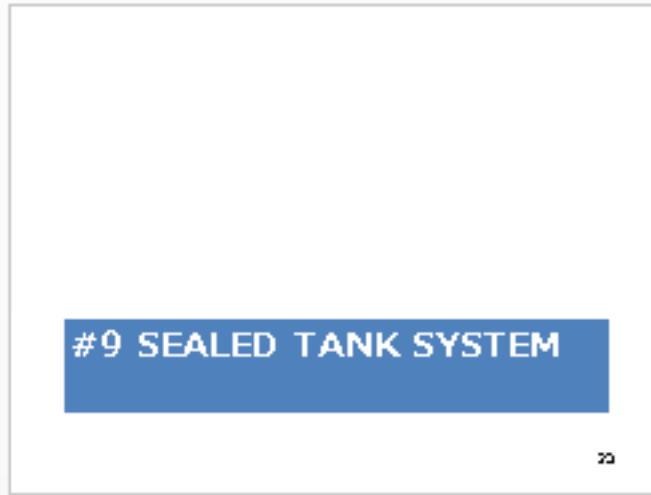
**Markt Treiber**



### PF - Permeability Factor

- Zusätzliche VV/VT-SHED's (Midi/Mini) zum Testen der Tanksysteme
- Zusätzliche Temperier-Kammern zum stationären Konditionieren bzw. Altern (40°C) – Containerlösung
- Basiswert (120mg/d) oder Testergebnis
- $PF = HC_{20w} - HC_{3w}$

# GTR-19 INFORMATION



**Puff-Loss Test**, spezielle Prüfung von Drucktanksystemen



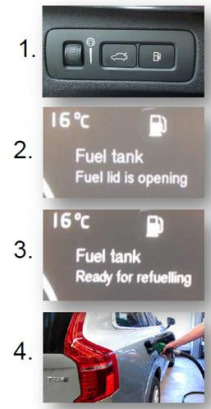
AVL CANLOAD Funktion zur Simulation sehr hohen AKF-Beladeraten verfügbar



SHED, SHEDCon Automatisierung mit neuer Testprozedur, Berechnung und Protokoll notwendig

# DRUCKTANKSYSTEME - INFORMATION

## TECHNOLOGY – PRESSURIZED TANK SYSTEMS

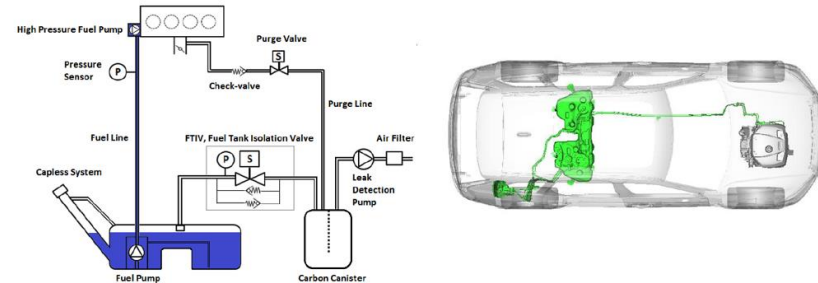


- Pressurized systems between up to -150 hPa up to +350 hPa (+500 hPa)
- Requires a specific refueling procedure (left)
- Required a fast pressure release over the canister – high flow rates
- Impact of fuel system design
- OBD requirements
- Etc.

**Shouldn't that be the future target to eliminate diurnal evaporative emissions?**

Gaggenau, P. Ulmerich, ETS ProductsSAM-Folder, 14.01.2016

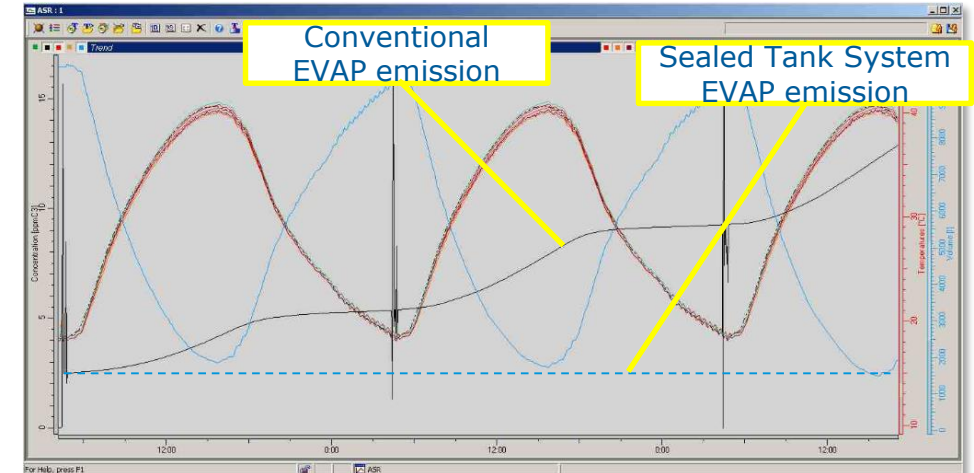
## TECHNOLOGY – PRESSURIZED TANK SYSTEMS



- Technology is available and actually standardized for small volume vehicles
- Eliminating long-term breathing losses – safe the environment
- High leak detection awareness
- Cost issue
- **Trend** - not just for Hybrid vehicles also conventional vehicle will get this technology

Gaggenau, P. Ulmerich, ETS ProductsSAM-Folder, 14.01.2016

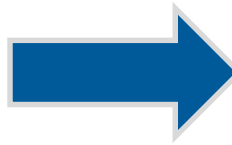
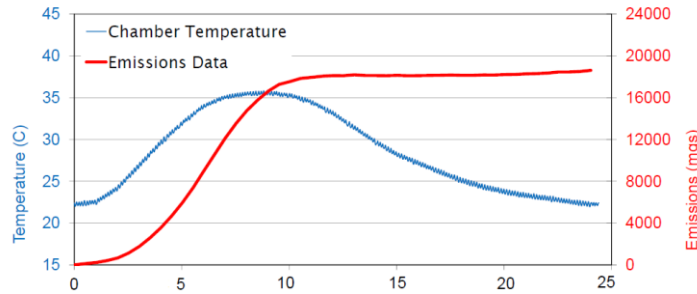
- Bei konventionellen Fahrzeugen basiert das Tankkonzept auf der regelmässigen AKF-Spülung (Motor läuft)
- Hybrid Fahrzeuge haben einen deutlich geringeren AKF-Spülanteil (e-Motor Anteil)
- Drucktanksysteme als wünschenswerte Zukunftslösung → keinerlei Langzeit-Tankatmungsverluste in die Umwelt



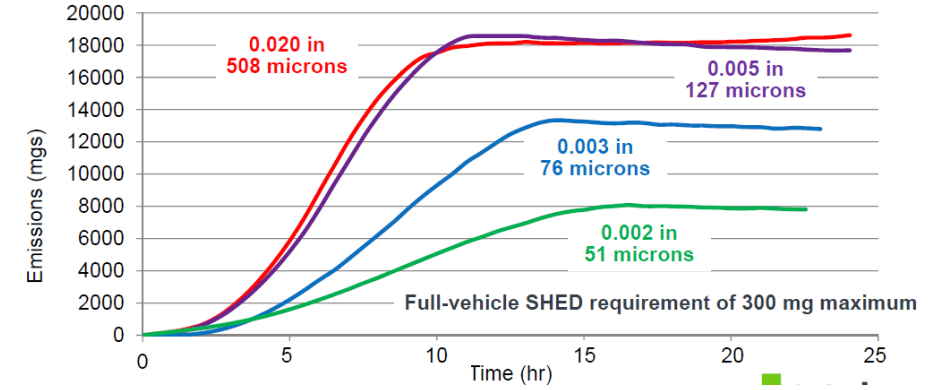
# In-Service Conformity Tests

- (12) In-service conformity checks currently cover only pollutant emissions measured through the Type 1 test. However, in order to ensure that the requirements of Regulation (EC) No 715/2007 are met, they should be extended to tailpipe and evaporative emissions. Therefore, Type 4 and Type 6 tests should be introduced for the purposes of in-service conformity tests. Due to the cost and complexity of such tests, they should remain optional.
- (13) A review of the current in-service conformity campaigns and other voluntary actions were problems related to emissions. There is a need for more transparency and control in the in-service conformity process.
- (14) In order to control the in-service conformity process, authorities should be responsible for performing the approved vehicle types each year.

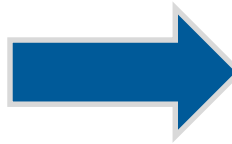
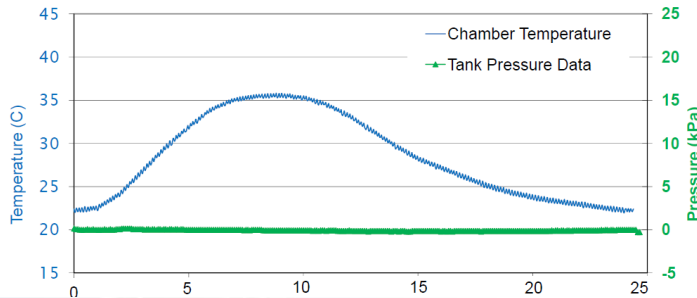
**Emissions During Diurnal With 0.020 inch (508 microns) Leak in Sealed Tank**



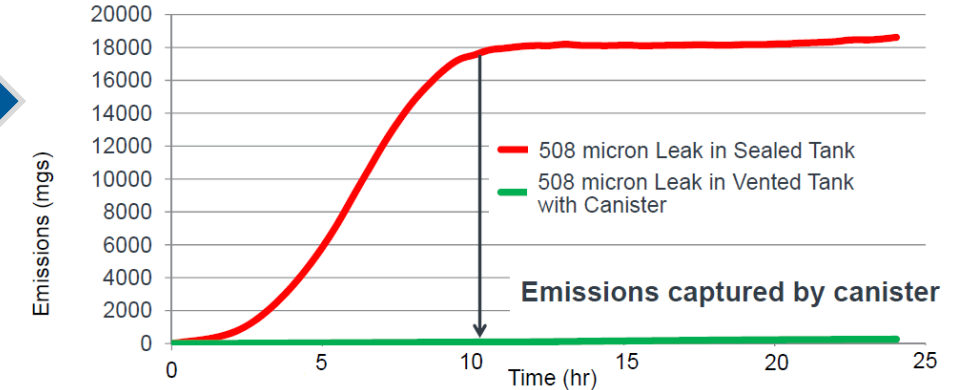
**Emissions During Diurnal With Leak in Sealed Tank**



**Pressure Build During Diurnal With 0.020 inch (508 microns) Leak in Sealed Tank**

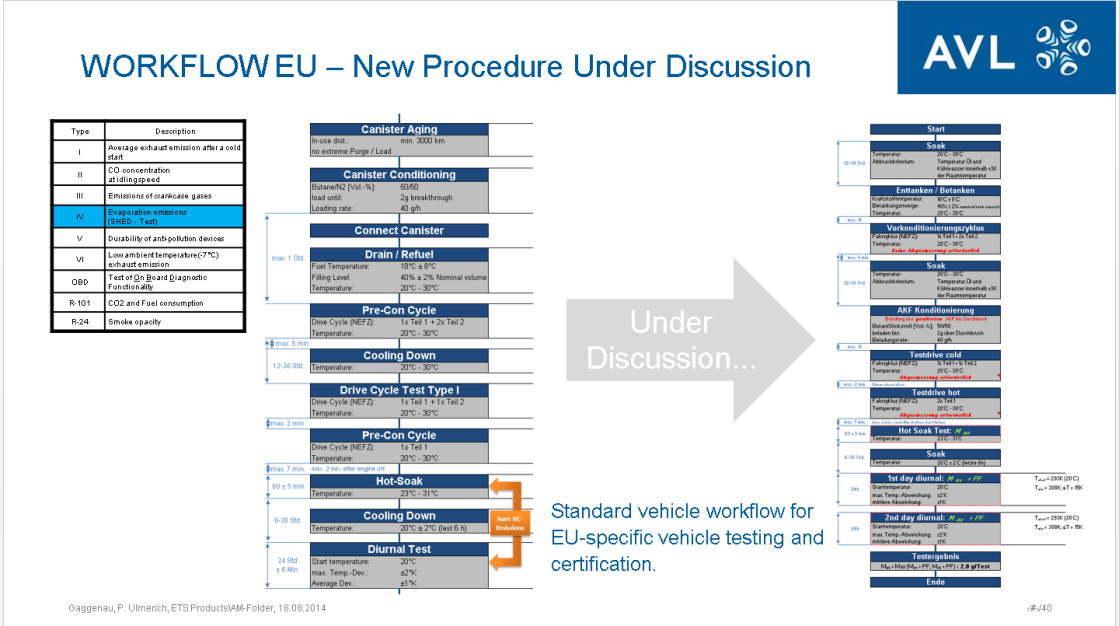
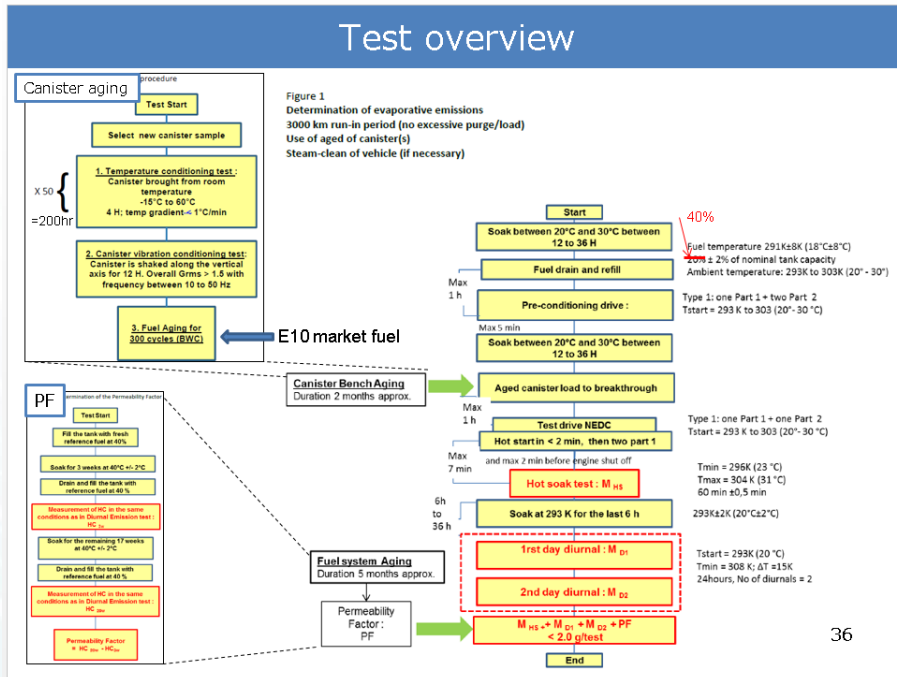


**Emissions During Diurnal With Leak in Sealed Tank versus Leak in Vented Tank with Canister**



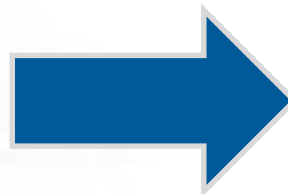
Bei Drucktankssystemen ist das Risiko einer Fehlfunktion durch Undichtigkeit deutlich höher und der Umwelteinfluss am größten!

# GTR-19 INFORMATION



Aktuelle Berechnung:

$$M_{HS} + M_{D1} < 2g \text{ (Total)}$$



Aktualisierter Workflow mit Verdopplung der Tankatmungprüfung von 24h → 48h  
Neue Berechnung:

$$M_{HS} + M_{D1} + M_{D2} + PF + PF < 2g \text{ (Total)}$$

(Anstelle einer Grenzveränderung wurde die Berechnungsvorschrift angepasst → gleicher Effekt)

AVL



THC

PN

CH<sub>4</sub>

N<sub>2</sub>O

PM

NH<sub>3</sub>

NO

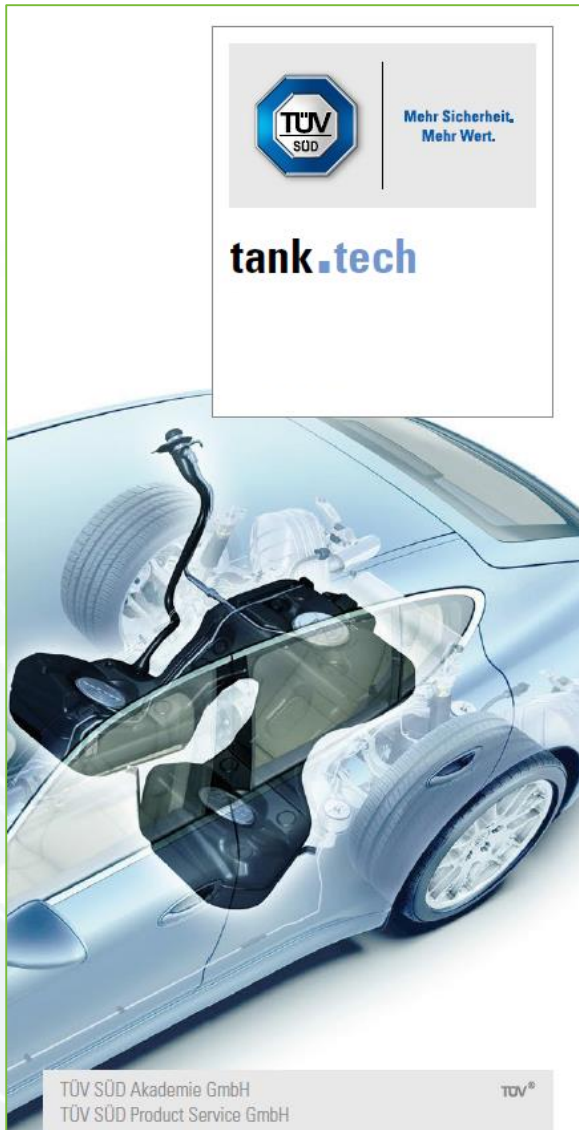
CO<sub>2</sub>

NO<sub>2</sub>

WEITERE MARKTANFORDERUNGEN



# TANK TECH 2017 - ZUSAMMENFASSUNG



München,  
Deutschland  
02.-03.11.2017

Wichtigste und wertvollste technische Konferenz mit dem Thema der Tanksysteme, Kraftstoffe und Technologien

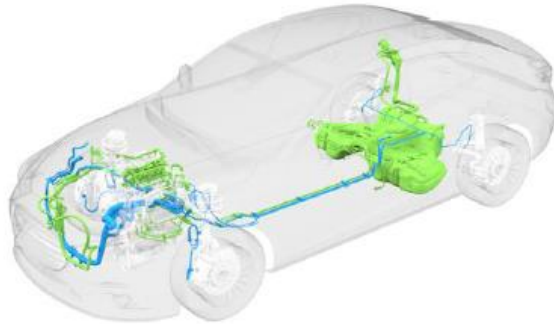
Mehr als 560 Teilnehmer aus 25 Ländern auf der 2-Tages-Konferenz...

# FAHRZEUG Typen, Varianten und Versionen

## Powertrain

### Conventional

- FWD
- RWD
- AWD

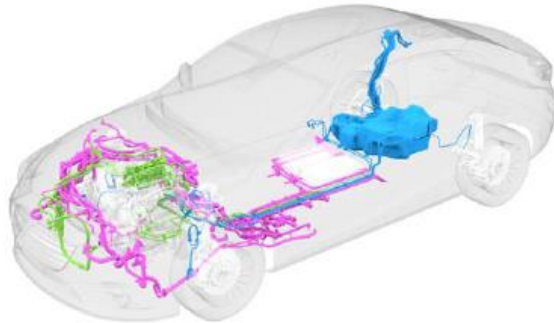


### Main challenges on conv. tank systems

- Emission
- Weight

### PHEV

- FWD
- RWD
- AWD



### Additional challenges on PHEV tank systems

- Pressure resistance
- Reduced tank height

**1 vehicle platform**

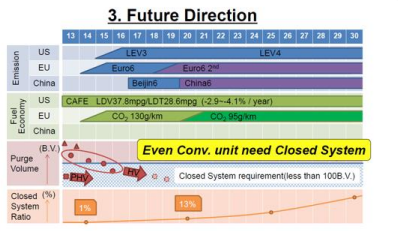
→ up to 10 tank variants

→ up to 50 fuel system variants

Noch nie gab es so eine große Anzahl an unterschiedlichen Kraftstoffsystemvarianten. Dieser Trend wird sich auch in Zukunft so fortsetzen.

# ZUKÜNFTIGE TECHNOLOGIEN & TRENDS

## VEHICLE CONCEPT FUTURE - TOYOTA



**3. Future Direction**

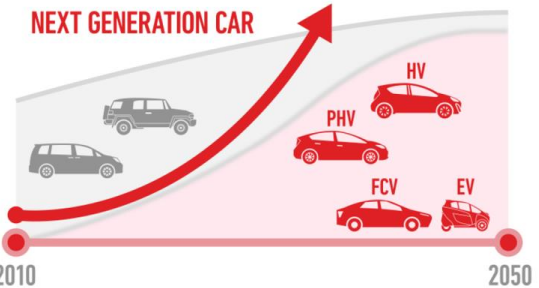
Year	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
US Emission	LEV2	LEV2	LEV2	LEV2	LEV2	LEV2	LEV2	LEV2	LEV2	LEV2	LEV2	LEV2	LEV2	LEV2	LEV2	LEV2	LEV2	LEV2
EU Emission	Europe	Europe	Europe	Europe	Europe	Europe	Europe	Europe	Europe	Europe	Europe	Europe	Europe	Europe	Europe	Europe	Europe	Europe
China Emission	China	China	China	China	China	China	China	China	China	China	China	China	China	China	China	China	China	China
US Fuel Economy	CAFE	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg
EU Fuel Economy	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg
China Fuel Economy	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg	LDV37.8mpg

**Even Conv. unit need Closed System**

➢ Emission Regulation is more Severe, in Future and Globally  
 ➢ Fuel Economy Improvement Makes Decreasing Purge Volume

**TOYOTA**

## NEXT GENERATION CAR



2010

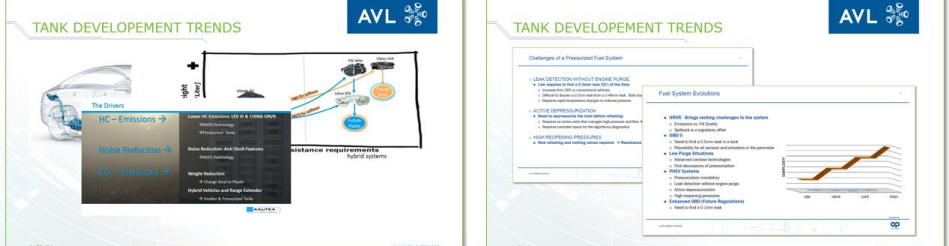
2050

General future concept will be the sealed tank system. It will be optimized for fuel temperature stability

- Insulated
- Low internal energy (fuel pump operation and technology (brush-less))
- Tank & pump design
- CO2, low fuel consumption results in low energy modules
- ECU control

Confidential | 11 March 2018 | 33

## TANK DEVELOPEMENT TRENDS - KAUTEX



**TANK DEVELOPEMENT TRENDS**

**Challenges of a Pressurized Fuel System**

- 1. LEAK DETECTION WITHOUT ENGINE PURGE
- 2. Low temperature stability
- 3. Weight reduction
- 4. Fuel economy improvement

**Fuel System Evolutions**

- HWV: Bring testing challenges to the system
- HWV: Bring testing challenges to the system
- HWV: Bring testing challenges to the system
- HWV: Bring testing challenges to the system
- HWV: Bring testing challenges to the system

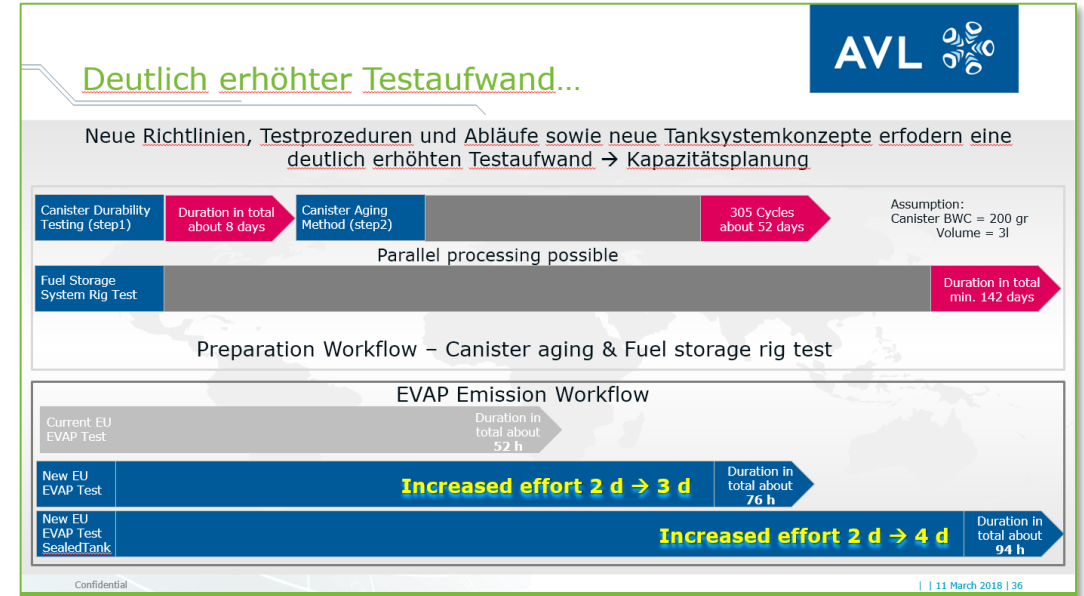
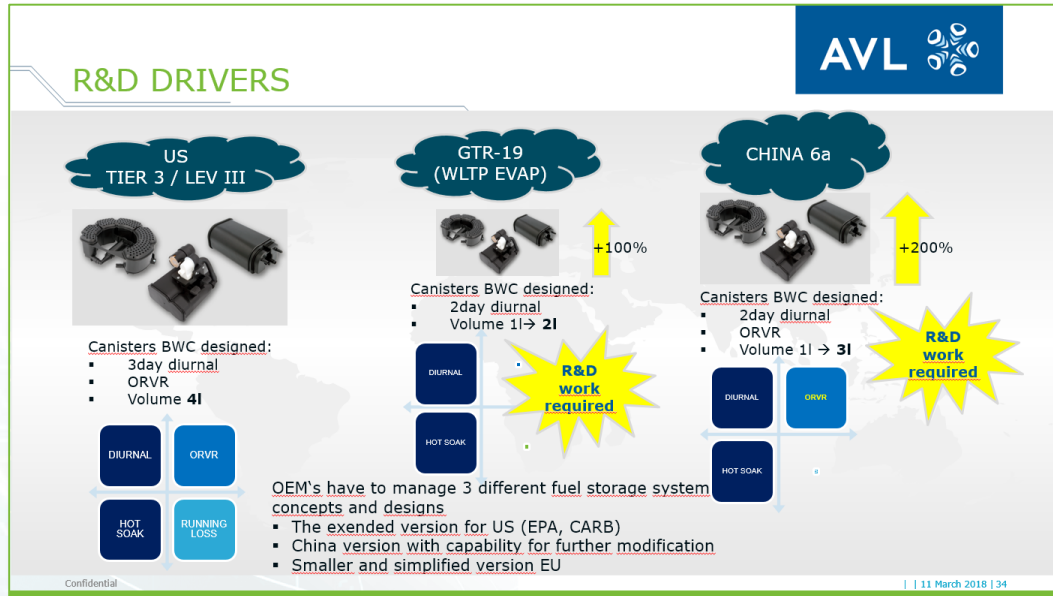
Main topics are pushing the tank system manufacturers

- HC-Emission, ORVR, PHEV
- CO2-Emission
- OBD II, Enhanced OBD (outlook)
- Noise, Anti Slosh Features

Confidential | 11 March 2018 | 34

- Trend Elektrifizierung / Hybridisierung hält an
- Auch für konventionelle Fahrzeuge werden Drucktanksysteme entwickelt
- HC-Emission – Einhaltung der Grenzwerte, neue Anforderungen ORVR und PHEV
- Anforderung – Reduzierung CO2-Emission durch z.B. neue Pumpen, Gewichtseinsparung, etc.
- OBD II, Enhanced OBD (Ausblick)
- Geräusentwicklungen, Anti-Schwapp-Module
- Isolierte Tanksysteme

# TESTAUFWENDUNGEN GENERELL



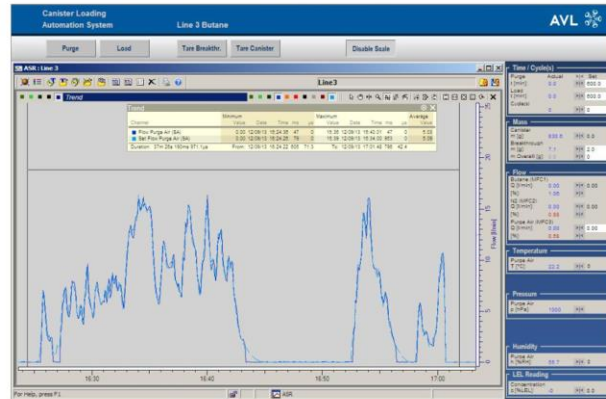
Neue Richtlinien, Testprozeduren und Abläufe sowie neue Tanksystemkonzepte erfordern einen deutlich höheren Testaufwand → Kapazitätsplanung

Durch unterschiedliche lokale Anforderungen und Richtlinien werden verschiedene Lösungskonzepte realisiert → Individualisierung

# US ANFORDERUNGEN & TRENDS



## DRIVE CYCLE PURGE FLOW SIMULATION



Online data quality evaluation set flow vs. real flow:

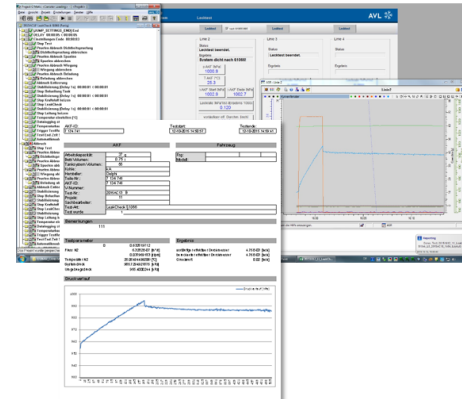
Maximum flows comparison  
 set flow 16.39 l/min  
 real flow 16.36 l/min  
 → difference -0.03 l/min

Average flow result (37 min.)  
 set flow 5.03 l/min  
 real flow 5.09 l/min  
 → difference +0.06 l/min

©aggenau, P. Ulmerich, EEM2016, 05.07.2016

/40

## FUEL STORAGE LEAK CHECK PROCEDURE



Fuel storage leak check procedure acc. eCFR §1066.985 implemented in AVL CANLOAD system

- Manual control panel and automation interface (for test sequence)
- Extended check parameter interface (V, t, Q, p)
- Automatic Leakage rate calculation / validation for flow estimation
- Leak diameter calculation (Limit validation)
- Online trend data information
- Online 1Hz data ASCII export
- Combined MS Excel report

©aggenau, P. Ulmerich, EEM2016, 05.07.2016

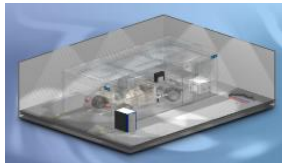
/40

## CANLOAD Funktion

## HOW TO ANALYZE BLEED EMISSIONS ?



➢ Bleed Test Requirements: EPA is proposing a new testing requirement referred to as the bleed emission test. The bleed emissions test standard for light-duty and medium-duty passenger vehicles is 0.020 g/test without averaging. The standard for onroad gasoline-powered heavy-duty vehicles is 0.030 g/test without averaging.



### TECHNICAL SOLUTIONS

- PASSIVE SHED

Canister outlet connected to an external SHED-chamber (Passive SHED) including integrated sensors, volume compensation bag, sample probe module with gas return, internal circulation fan, etc.

©aggenau, P. Ulmerich, EEM2016, 05.07.2016

/40

## HOW TO MEASURE ETHANOL ?



### VEHICLE EVAPORATIVE EMISSIONS (SHED), ETHANOL



Filter	filter/bank	Gas	Calibration Range
UA0036	A1	Methanol, CH <sub>3</sub> OH	0... 12 ppm
UA0074	B1	Ethanol, C <sub>2</sub> H <sub>5</sub> OH	0... 10 ppm
UA0081	C1	Toluene, C <sub>7</sub> H <sub>8</sub>	0... 10 ppm
UA0083	D1	CO <sub>2</sub>	0... 400 ppm
UA0071	E1	R134a	0... 10 ppm

### Features:

- Fully integrated into a standard AMAi60 Stand Alone Unit
- Ethanol specific emission measurements, online (cycle-based)
- Supports automatic test run configuration
- Ethanol based retention check procedure

©aggenau, P. Ulmerich, EEM2016, 05.07.2016

/40



## SHED Funktion

# EMISSIONS-GRENZWERTE

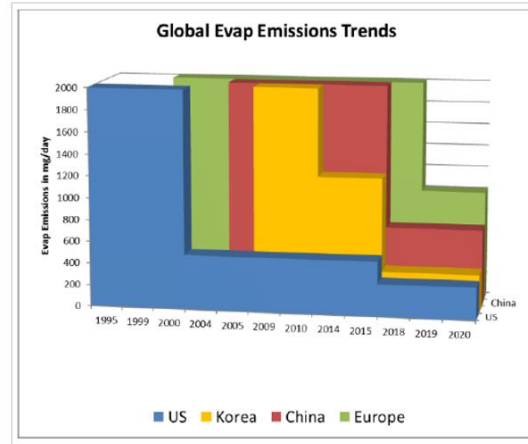
## EVAPORATIVE EMISSION LIMIT TRENDS



	CARB LEV 3	EPA Tier 3	KOREA LEV III	Euro 6c	CHINA 6
Phase-in	2015-2022	2018-2022	2018-2022	2019	2018-2022
Diurnal	2/3 day	2day	2day	2day	2 day
Whole Vehicle Evap Emissions limit (mg/day)	300mg/day (or 350mg/day with rig demonstration)	350	2g/2 days	700	
ORVR	Yes	NO	NO	Yes	
OBD	Yes	Yes	NO	Yes	
Test fuel	7RVP E10	9RVP E10	E0	E10	2.7% Oxygen
Canister Bleed Test	Yes, or rig demonstration	NO	NO	NO	

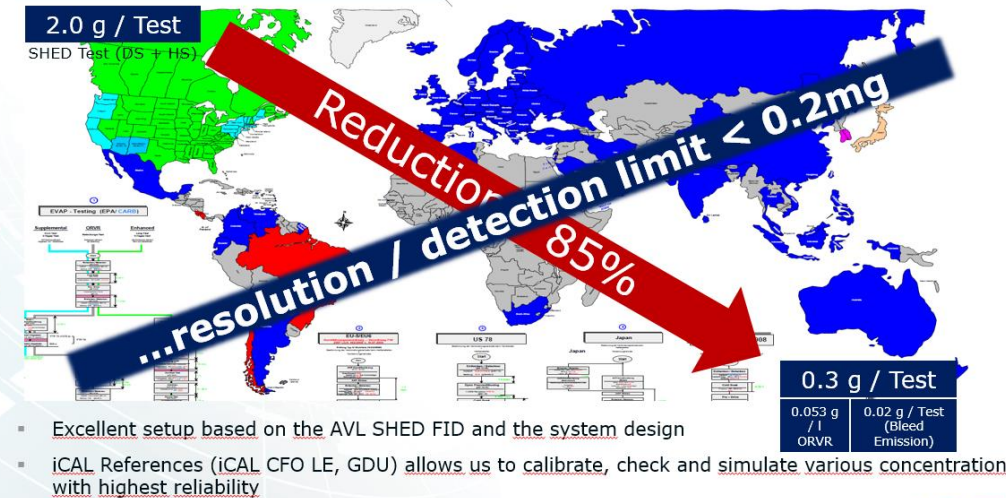
Global trend of emission limit reduction with the consequence of a modified focus in:

- Higher importance of detection limits
- Data reliability
- Workflow management
- Testing process accuracy



| 11 March 2018 | 39

## EVAP EMISSION LIMITS OVERVIEW



| 11 March 2018 | 40

## Konsequenzen der deutlich reduzierten Grenzwerte

- Höher Anforderung der Testsystem bzgl. Nachweisgrenze
- Kalibrier- und Systemtests müssen exakter und reproduzierbarer werden → AVL iCAL CFO LE
- Datenqualität und Reproduzierbarkeit wird wichtiger
- Workflow-Management und Prozess-Genauigkeit rückt in den Fokus

# WEITERE TESTANFORDERUNGEN

### COMPONENT TESTING

**TECHNICAL SOLUTIONS**

- PASSIVE SHED
  - Canister outlet connected to an external SHED-chamber (Passive SHED) including integrated sensors, volume compensation bag, sample probe module with gas return, internal circulation fan, etc.
  - For hoses, fuel tubing and further fuel system components
  - Determination of individual Bleed and Permeation Losses

Confidential | 11 March 2018 | 43

### HYBRID TESTING – NEW CHALLENGES

Reduced purge flows through the canister may require specific techn. solutions e.g.

- Sealed tank systems
- Boost pump modules
- Integrated canister heater for higher purge efficiency
- Etc.

Confidential | 11 March 2018 | 43

### RDE TESTING – NEW DEMANDS ?

- Tracking of online „purge flow“ through the canister during vehicle drive
- Saved data used as source for ASCII-file conversion
- CANLOAD automation module is using the ASCII flow data as dynamic set point curve for real flow simulation and test procedure

→ RDE Purge Flow Simulation

- RDE pushes the entire test simulation (e.g. affecting thermal response, dynamic vehicle condition, etc.)
- Evaporative emissions are basically a “function” of temperature and fuel (bleed emission, permeation)

Confidential | 11 March 2018 | 45

- Individuelle Komponenten-Tests z.B. Verschlauchung, Adapter, Pumpen, Ventile, etc.
- Spezifische R&D Anforderungen in Bezug auf Haltbarkeit oder alternative Materialien
- Simulationen und Messung für AKF-Durchflüssen (RDE) in Verbindung mit unterschiedlichen Höhen
- Erweiterungspaket für spezielle Applikationen MC, SORE, etc.

# AVL – SOAK BEREICH - LÖSUNGEN

### Soak Area

#### iGEM Charge Meter

### DATA LOGGER

T, rF, p\_baro

### DATA LOGGER

For vehicle data (T\_oil, T\_coolant)

### Soak Area

#### CANLOAD System

## Hybrid vehicles require both !



# PROJEKT-BESCHREIBUNG (CRS)



## Project description

The project description includes links to reference documents and information based on the RFQ or customer specifications and requirements.


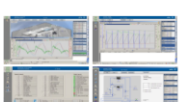
It includes specific interface descriptions and specific project information e.g. schedule, scope of supply, special services, deviations lists, etc.

The document also includes safety concept description and safety matrix information for final TÜV certification (on demand).

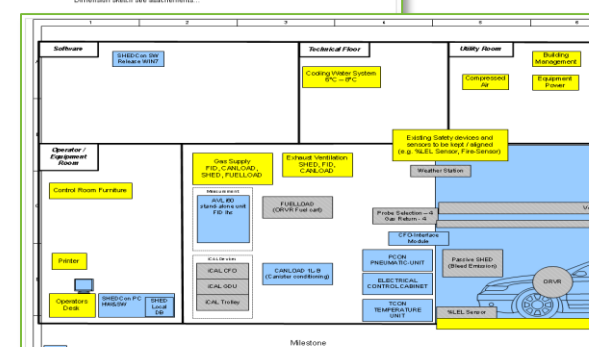
Dear customer, we thank you for the interest in our products and solution services. We always try to fulfill your requirements and expectations.


The AVL equipment complies with all the latest regulations, as follows:  
**US EPA:** [http://www.epa.gov/epaospp/030613.pdf](#)


**General Introduction**  
 AVL EVAPORATIVE  
 The AVL Evaporator performs automatic generation.  
 It is focused on core hybrid technology selection and adaptation.  
 This includes stand testing and device development.  
 Operating jointly we can tailor condition test procedure to be evaluation.  
 Automation wherever compatibility allows.  
 The AVL VTRV-SH continuous basis acquisition system.


**Customer Project**  
**System Description**  
 The initial evaporative SHED system setup offers a flexible usage with the possibility of an easy upgrade for advanced functions and options e.g. integration of DRIVE testing devices (AVL FUELCAD) or interacting GDB vehicle databases supporting and tracking the entire evaporative testing workflow.  
  
 The simplified test procedure and temperature curve editor, supports future demands and system flexibility for certification, COP and advanced RSD testing.  
 The MS Excel based reporting tools includes a report layout editor, statistical functions and customized RSD reports based on actual standards.  
 The look & feel visualization guides the system operator in an easy and intuitive way. The system also provides clear system status and alarm messaging for further diagnostics or annual services and sensor calibrations.  
  
 The CANLOAD 1L-B for standard canister conditioning can be also upgraded with a fuel vapor unit to be prepared for long-term testing, durability checks and stabilization procedures.


**Advanced Technical Information**  
 The general system concept is designed to fulfill the demands based on the various vehicle types and dimensions.  
 Dimension sketch see attachments.

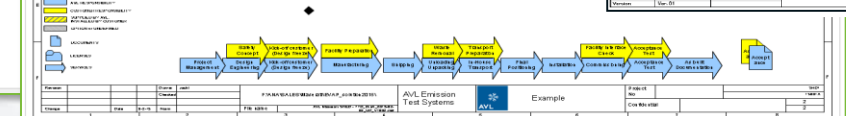
**Technical Floor Plan**  


**Construction**  


**Utility**  


**Test Cell**  



**Additional scope**  


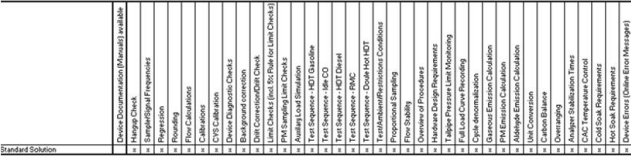
**Milestone**  


AVL Emission Test Systems

# SYSTEM KALIBRIERUNG & DOKUMENTATION




**FINAL VEHICLE DOCUMENTATION AND REFERENCES** 

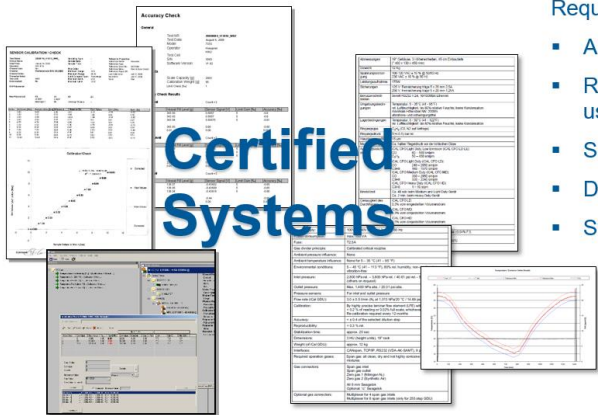


**Market is sensitized !**

- General vehicle data
- Workflow data
- Testing data
- Component documentation
- Vehicle "life" documentation
- Reference & calibration data

Gaggenau, P. Ulmerich, ETS Products\AM-Folder, 14.03.2017

**SYSTEM VERIFICATION & DOCUMENTATION** 



**Certified Systems**

Required documentation

- Annual services recommended
- References (ICAL devices, tools, usage, etc.)
- Sensor calibration (SMC)
- Device Checks (AMAi60, FID)
- System checks
  - Background
  - Retention
  - Performance
  - Distribution, Response

Gaggenau, P. Ulmerich, ETS Products\AM-Folder, 14.03.2017

## Market is sensitized !

- Is the system compliant according to the actual regulation?
- How can I prove and argue the compliance? Is the calibration and annual service documented and stored?
- How about ISO 17025? Solutions & Concepts available?
- Dakks Calibration? Ready for regulation audits?

# EVAP WORKFLOW / GEBÄUDE-INTEGRATION

### EVAPORATIVE EMISSION TEST TYPES

Test Requirements	ORVR Test	Fuel Spk-Back	Point Source	Running - Loss	Hot Soak	Diurnal	Bleed Emission
Onboard refueling vapor recovery (ORVR) test determines the fuel vapor coming out of the tank when a car is refueled.	Measures the liquid fuel spilt-back from the fuel nozzle during refueling the car.	Measures fuel vapor at potential refueling points during driving on a chassis dynamometer, which is built into a climatic chamber.	Measures fuel vapor during driving on a chassis dynamometer, which is built into a climatic chamber.	Measures fuel vapor during driving on a chassis dynamometer, which is built into a climatic chamber.	Measures fuel vapor emissions in a SHED during parking for 24 h, 48 h or 72 h.	Measures fuel vapor emissions in a SHED during parking for 24 h, 48 h or 72 h.	Like the diurnal test, but the bleed emissions are sampled by separate small SHED boxes.

Legislation in place

### AVL – Test Facility - Solution

**AVL iGEM Lab Scheduler**  
is an emission test system lab scheduler application to organize all your regular calibration, diagnostic and maintenance activities for an emission measurement laboratory facility.

- Dyno Warm up
- Leak checks
- Total system verification (CFO)
- ...

### AVL EVAPORATIVE EMISSION TEST SYSTEMS

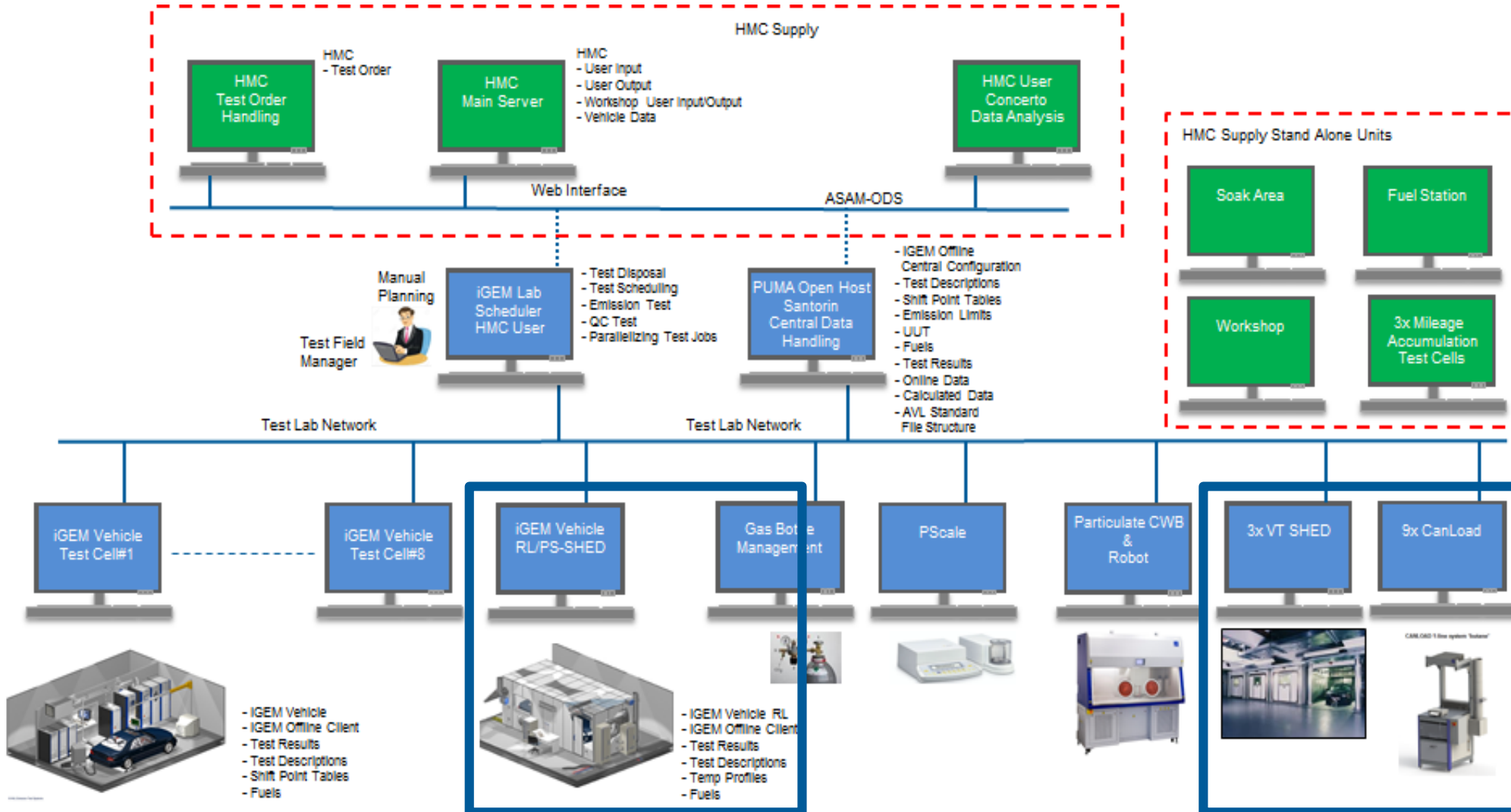
→ Optimized workflows, device networking, facility interfaces, data links (pre- and post data)

### AVL EVAPORATIVE EMISSION TEST SYSTEMS

### WORKFLOW – Overview of Standard Gasoline Vehicle

### WORKFLOW - Process

# iGEM VITA - OVERVIEW



AVL



# Verdunstungsemissionen

- Markttrends  
Gesetzgebung & Neuigkeiten
- **Technologie**  
AKF-Konditionierung Kraftstoff
- RL-Testing
- Resümee

# ANFORDERUNGEN DER GASMISCHUNG



## Regulated Standards for vapor mix

- ARB Bleed Emission Test Procedure
- §III.D.12.1.2. Carbon Canister System Purge/Load Cycling with Fuel Vapor. The carbon canister system shall be cycle aged no less than 10 cycles using the gasoline referenced in section III.D.12.1.1 by **loading the canister system to 2-gram breakthrough with either a mixture of fuel vapor and nitrogen ( $50 \pm 15$  percent fuel vapor by volume)** or a mixture of fuel vapor and air ( $50 \pm 15$  percent fuel vapor by volume), at a **fuel vapor fill rate of 40 to 80 grams per hour**. Each loading is followed by purging the canister system with 300 canister bed volume exchanges at 0.8 cfm.

Confidential

| 11 March 2018 |

## Regulated Standards for vapor mix

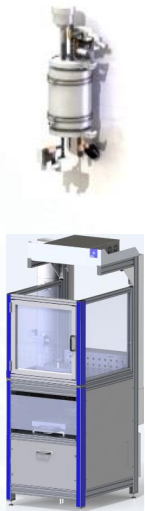
- WLTP EVAP Task Force GTR Draft Procedure
- §5.1.3.1.1 After the temperature conditioning test and vibration test, the canister shall be aged with a mixture of Type 1 E10 market fuel as specified in paragraph 5.1.3.1.1.1. of this annex and nitrogen or air with a  **$50 \pm 15$  percent fuel vapour volume. The fuel vapour fill rate shall be kept between  $60 \pm 20$  g/h.** The canister shall be loaded to the corresponding breakthrough. Breakthrough shall be considered accomplished when the cumulative quantity of hydrocarbons emitted equals 2 grams.

Confidential


| 11 March 2018 | 56

- **What is required to verify the  $50 \pm 15\%$  (vol.) fuel vapor concentration in the mixture?**
  - Direct measurement is difficult due to variation in vapor properties caused by fuel weathering.
    - $\rho_{\text{vapor}} = f(\text{temperature, mass lost})$
  - Mass concentration is a more direct measurement but does not satisfy §III.D.12.1.2.

# ZUSAMMENFASSUNG DER ERGEBNISSE



- Use of Fuel Vapor requires heating of “Loading Components” to prevent condensation
  - Heated evaporator, heated transfer line, heated enclosure



### Future Activities

- Optimization of Fuel Refresh/Refill for efficient use of fuel
  - Certification fuel is expensive!
- Publication of test results focusing on direct validation of Fuel Vapor Concentration
  - Existing literature is mostly outdated
  - SAE paper in 2019
  - Coordinating Research Council (CRC) presentation in 2019
- Patent application on use of fuel weathering parameters to determine concentration in lieu of using GDM
  - GDM could be used as a calibration or quality control device

Confidential | 11 March 2018 | 46

- Incorporation of Gas Density Meter (GDM) allows for direct validation of  $50 \pm 15\%$  volumetric Fuel Vapor Concentration
  - Quality checks during purge of canister ( $N_2$ , Air, Butane)
- AVL has developed the only (?) commercially available canister loading system that is able to validate Fuel Vapor Concentration regulatory requirement
  - Can be used with multiple fuel types

AVL

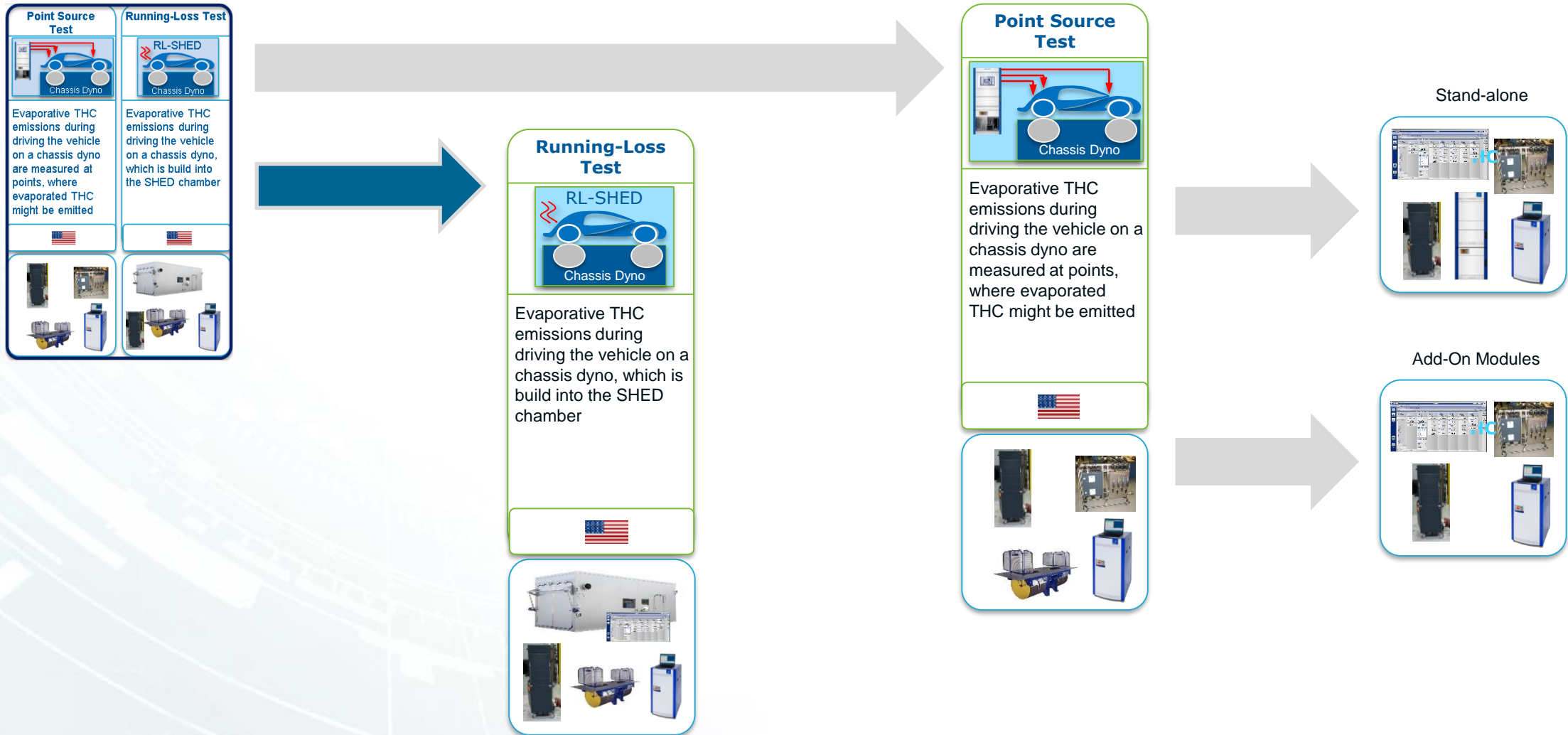


# Verdunstungsemissionen

- Markttrends  
Gesetzgebung & Neuigkeiten
- Technologie  
AKF-Konditionierung Kraftstoff
- **RL-Testing**
- Resümee



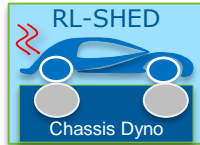
# RL-TESTING



# PRO's & CON's

# RL-SHED

## Running-Loss Test



Evaporative THC emissions during driving the vehicle on a chassis dyno, which is build into the SHED chamber



## Pro's:

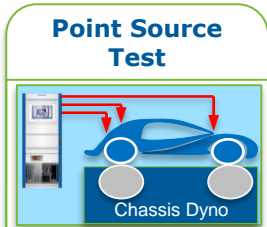
- AVL's recommended solution concerning analytical response
- Analytical reliability level is high
- Temperature conditioning is approved and designed for RL-Testing
- Optimized analytical setup inside
- Test sequence possible to include Hot Soak after the RL-Test
- Analytical and device installation outside the enclosure
- New TC concepts are allowing standard CD operation

## CON's:

- Investment costs
- Facility needs to be capable

# PRO's & CON's

# POINT-SOURCE



Evaporative THC emissions during driving the vehicle on a chassis dyno are measured at points, where evaporated THC might be emitted



## Pro's:

- Can be used inside an existing climate CD test cell
- Reduced budget required

## CON's:

- Installation and TC integration requires specific engineering
- Mobile solutions with impact of reliability
- Facility needs to be capable
- Installation inside the TC (mostly for existing TC's)
- Analytical trend measurement
- Usable for future seal tank systems?

# ZUSAMMENFASSUNG RL-TESTING

## RL-SHED ENGINEERING

SOAK AREA (20 to 30°C)

RL-SHED  
Internal Enclosure Height - 3000mm  
Operation range 15°C - 30°C  
Advanced Concept  
ZWD for FWD & RWD operation  
V\_RL-SHED about 178 m³

HEAT MANAGEMENT:  
Max. HEAT input = 113 kW  
Average out. HEAT input = 45 kW

Energy management  
Future drive cycles estimation

Confidential | 11 March 2018 172

## RL-SHED BASEMENT & CD INTEGRATION

- Basement facility interface, static, vibration, etc.
- Halfen rails for vehicle fixture definition
- Mounting and service concept description
- Floor structure definition
- Grounding concept
- etc.

Confidential | 11 March 2018 173

## CD INTERFACES AND DUCTS

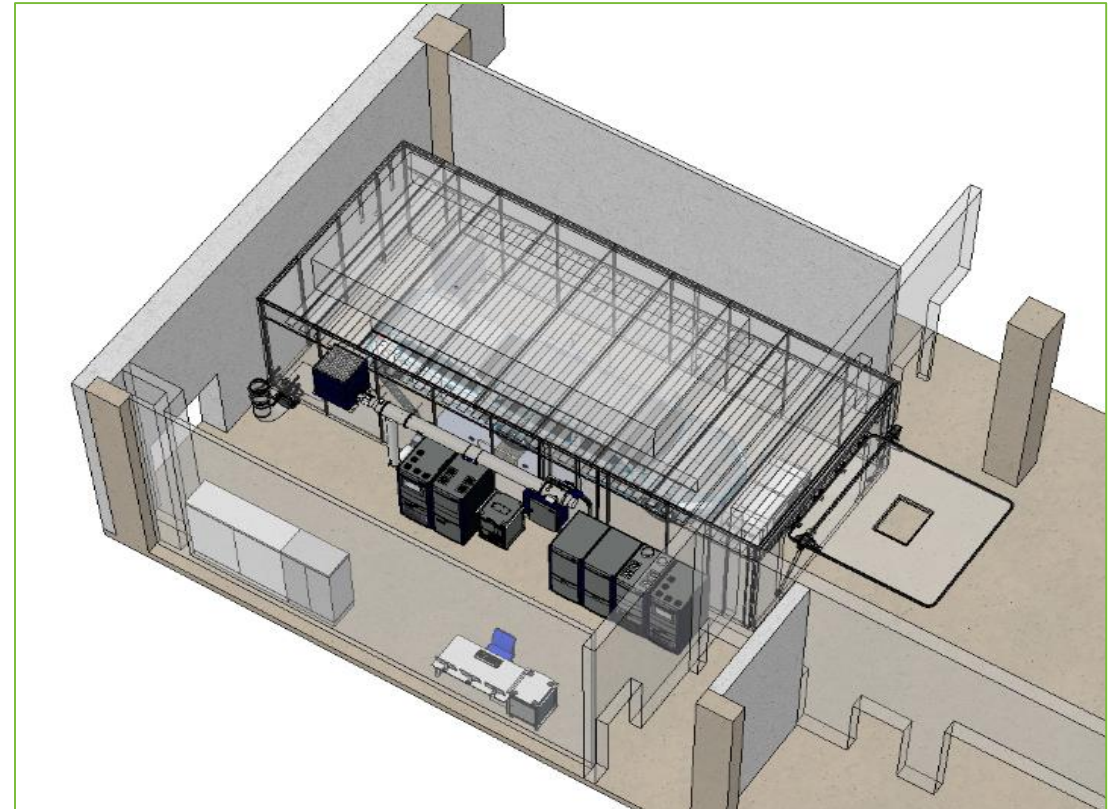
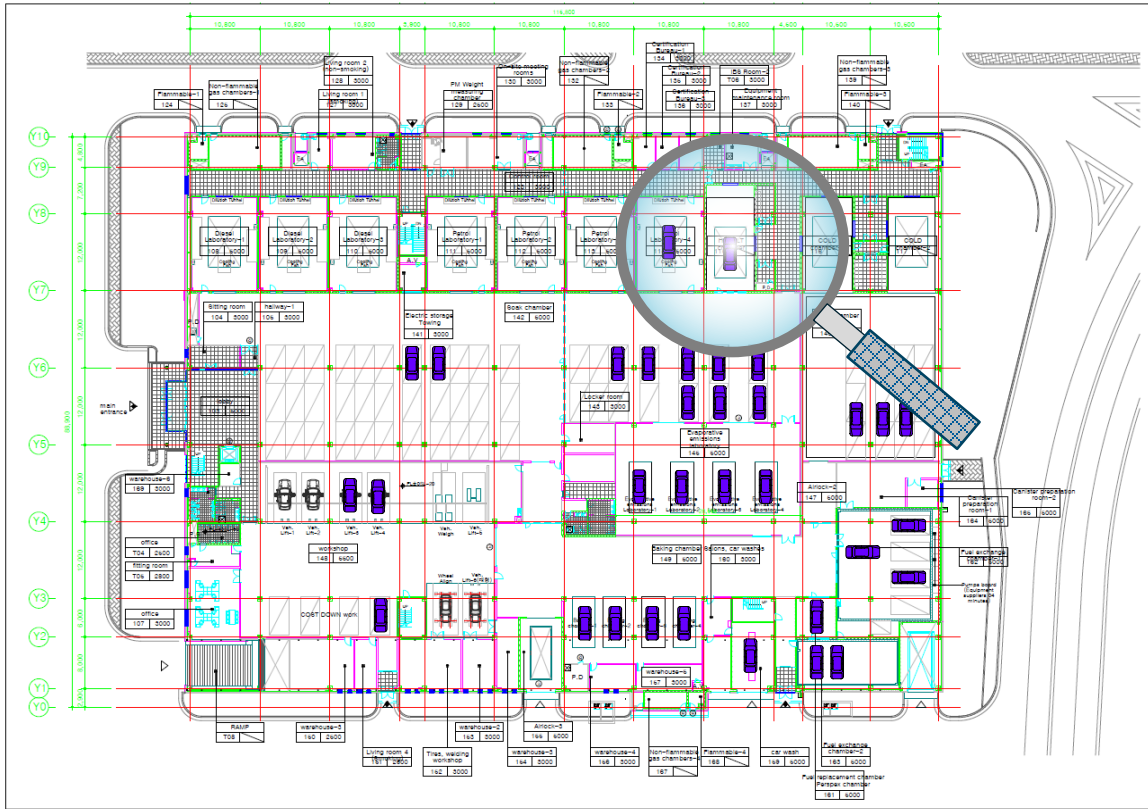
Cable ducts

- Definition of cable bundles and groups for installation
- Basement modification for cable trays

Confidential | 11 March 2018 174

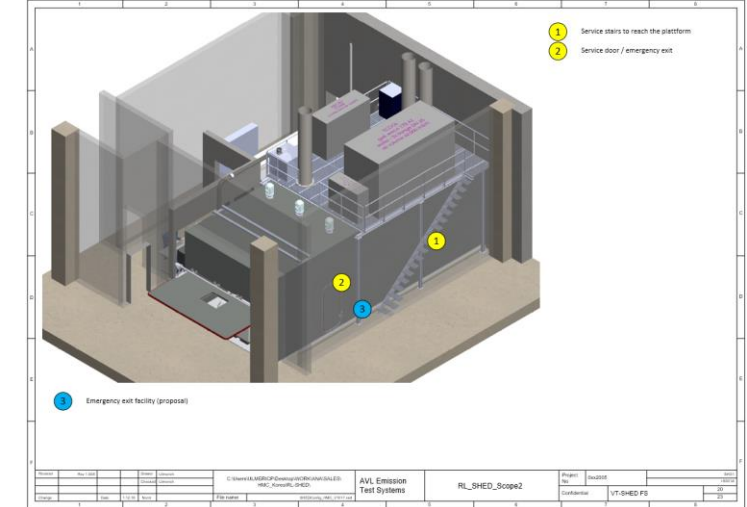
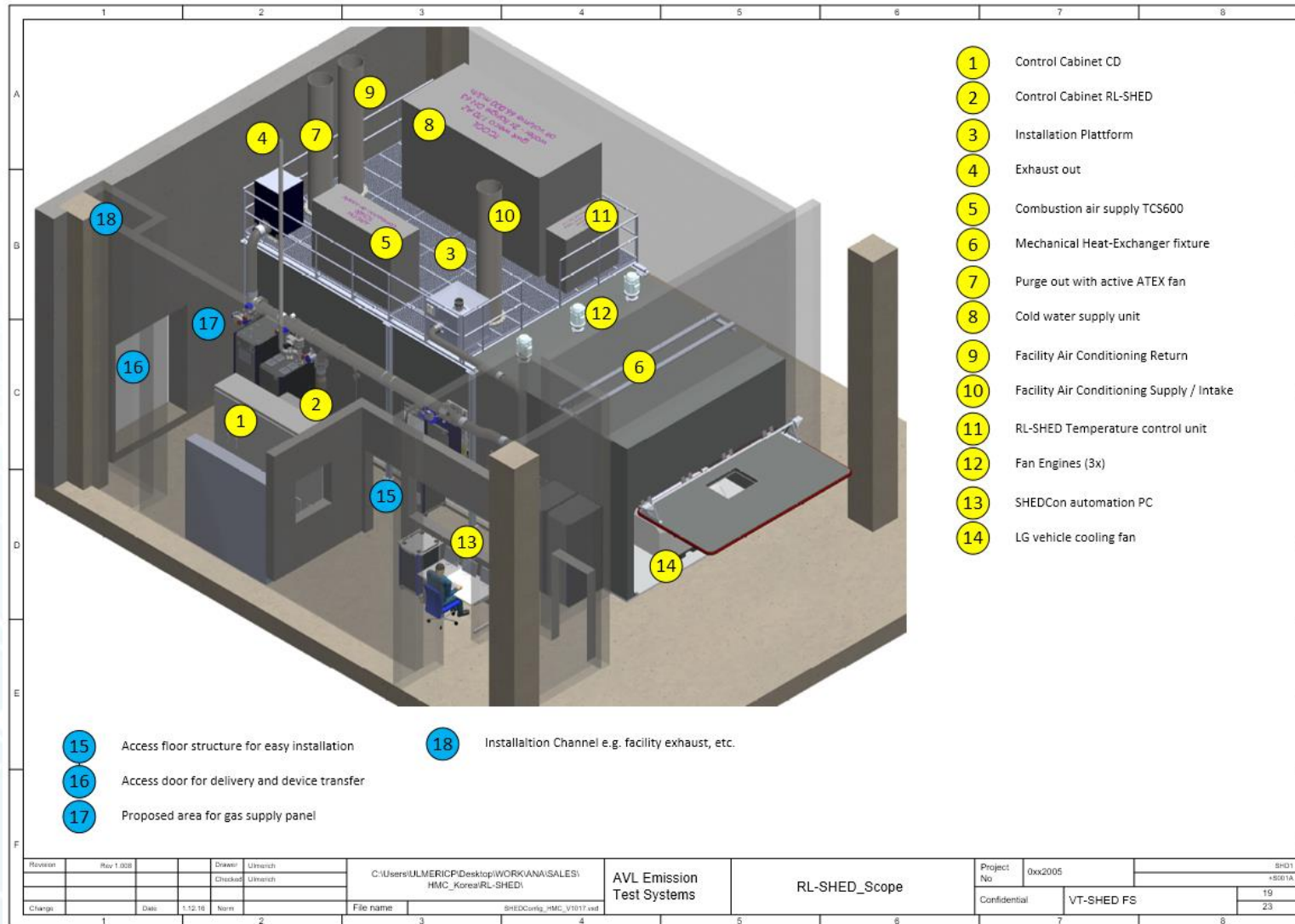
- AVL's Empfehlung für die Messung im RL-SHED System
  - Aufgrund der aktuellen Diskussionen und Marktbeobachtung in China sinnvoll
  - Techn. deutlich besseres Konzept
  - Nutzbar für die neuen Tanksysteme – Drucktanksystem
  - Flexible Nutzung durch das modernen Gesamtkonzept
  - Emissionsoptimierte Komponenten in den Einbauten sorgen für ideale analytische Resultate

# RL-TESTING – INNOVATION / KONZEPT



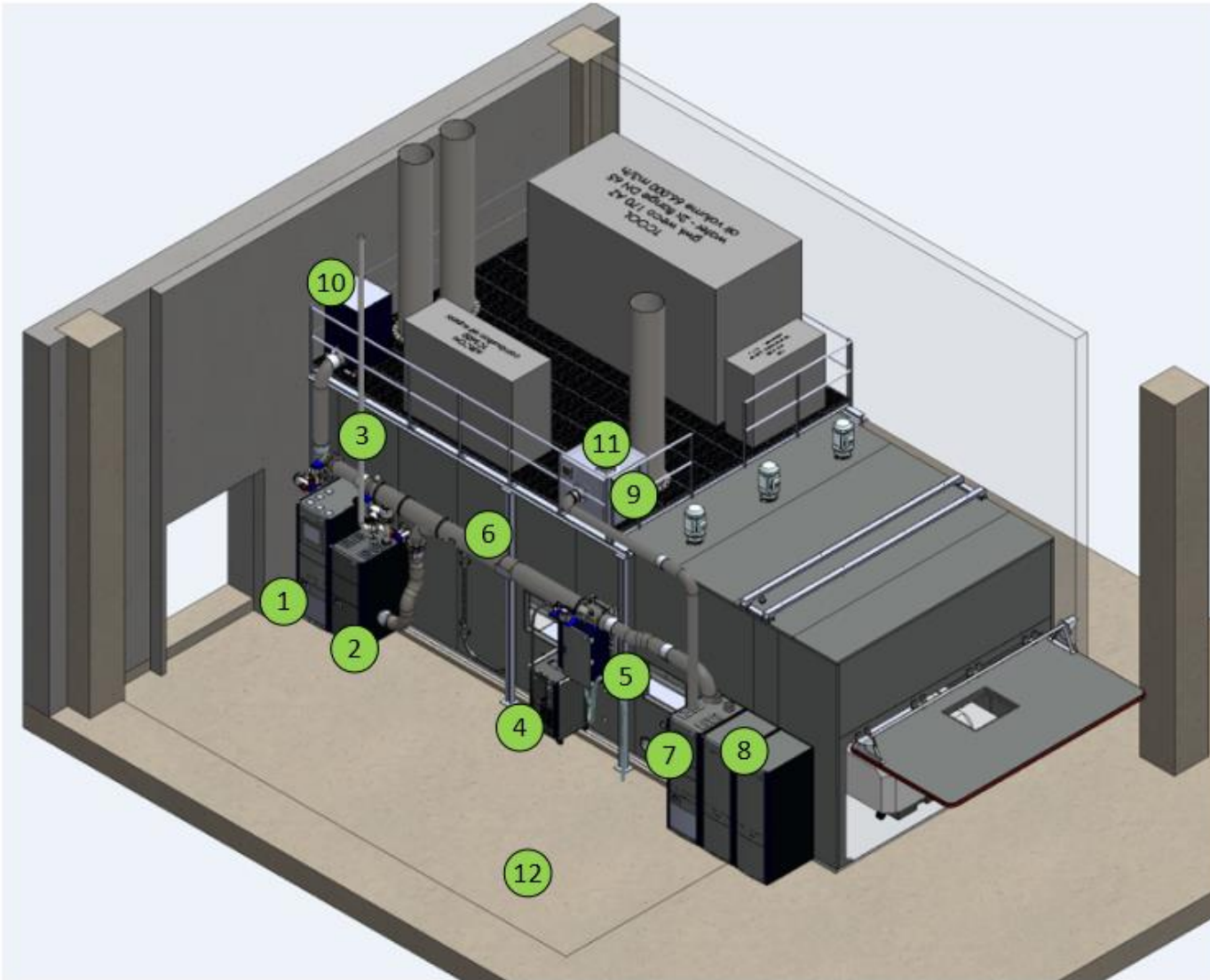
- AVL's test cell concept is supporting standard emission CD testing, vehicle conditioning and RL-SHED operation (incl. Hot-Soak SHED procedure)
- Multiple test cell operation modes

# RL-SHED MODULE LAYOUT CONCEPT



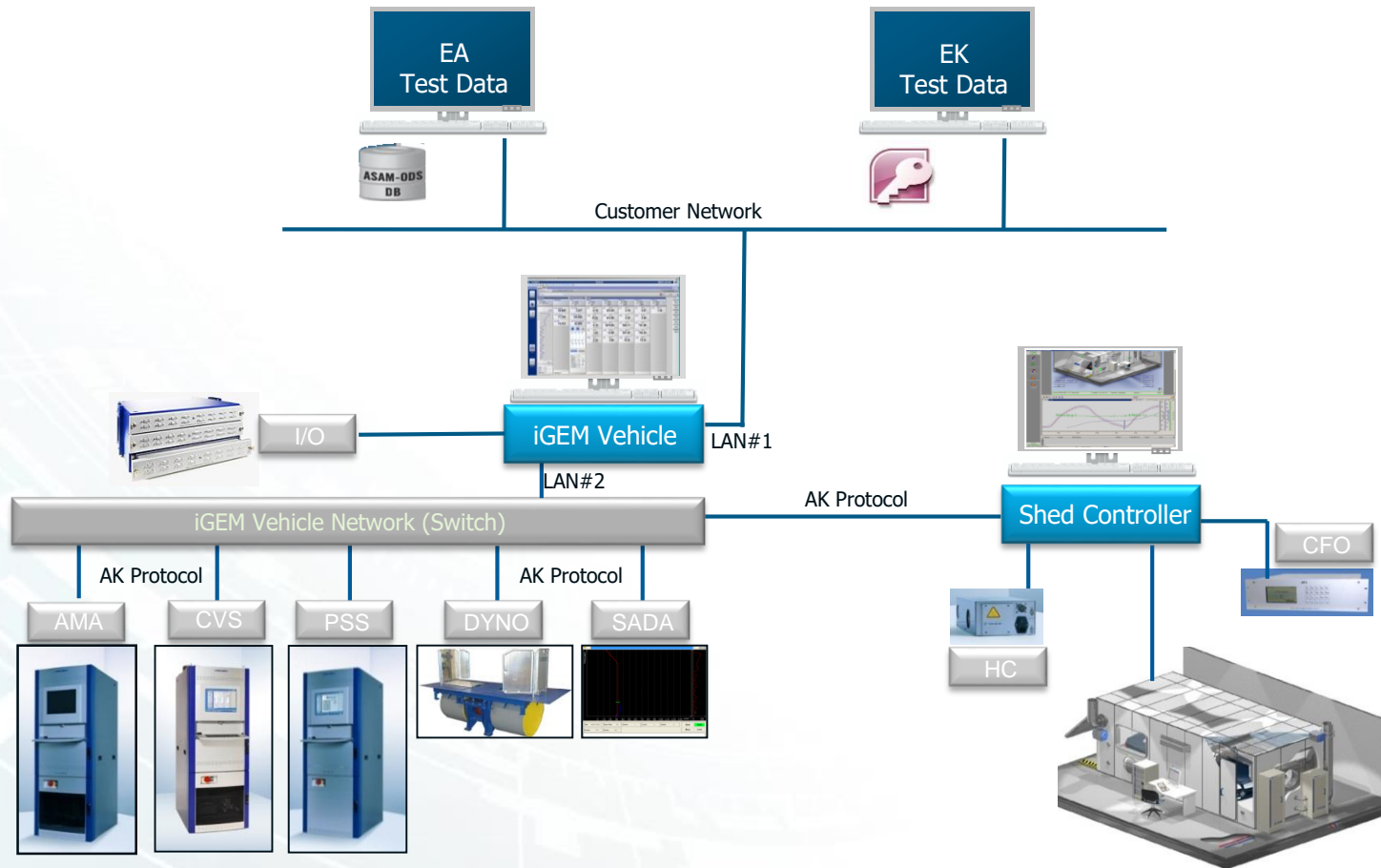
- Gesamtprüfstand aus 100% AVL
- Modulare Struktur von Einzelgeräten z.B. THU, TCS, TCON, HE, etc.

# RL-SHED – EXHAUST EMISSION PACKAGE



- 1 AMA, diluted
- 2 HFID, Particulate cabinet
- 3 Exhaust tubing
- 4 APC
- 5 PM Filters
- 6 Dilution Tunnel
- 7 CVS Control Cabinet
- 8 CVS Bag Cabinets
- 9 CVS Bower
- 10 CVS Dilution Air Filter Unit
- 11 CVS Blower Silencer
- 12 iGEM Vehicle Host System

# RL-SHED HOST INTEGRATION



### RL-TESTING HOST INTEGRATION

AVL

### REFUELING & TESTING - RL SIMULATION

Workflow specific management required

- Refueling (filling level, tank system, fuel type, etc.)
- Vehicle preparation, SOAK
- Prep-drive cycles (Vehicle parameters, dyno coefficients, etc.)
- SoC of the vehicle
- Temperature profile source
- TC interface type (type J, K)
- I/O calibration (THU)
- THU air distribution setup, documentation
- Etc.

AVL

### SIMULATION SERVICE

Special Information & Services

Test cell air flow and temperature simulation projects for Chassis Dyno Test Cells, RL-SHED or SHED enclosures.

Simulation of thermal management and vehicle responses - fuel temperature simulation

-> "Hot Hot Soak" and Fuel temperature simulation

AVL



AVL



# Verdunstungsemissionen

- Markttrends  
Gesetzgebung & Neuigkeiten
- Technologie  
AKF-Konditionierung Kraftstoff
- RL-Testing
- **Resümee**

# SHED TESTING - NEUHEITEN

**BAKING**  
Advanced Procedure

Diurnal

**SOAK 14°C**  
Advanced Procedure

**PUFF-LOSS**  
Advanced Procedure

Bleed

RL-Test

ORVR

**SOAK 20°C**  
Advanced Procedure

**LEAK CHECK**  
Advanced Procedure

DBLT

**SOAK 38°C**  
Advanced Procedure

Hot Soak



# SHED TESTING SOLUTIONS & TRENDS

Since the initial start of evaporative emission rules 1970 in California, the regulation trends and demands did not change much in the last decades. In the last 2-3 years, the awareness of the entire evaporative testing capabilities changed.

Various reasons e.g. new test sequences, stricter emission limits, additional CO2 targets, bio-fuels and new vehicle drive technologies forces the OEM's and component manufacturers to invest into new equipment and testing solutions. Know-how, long-term experience and a complete product and solution portfolio is key to achieve best test data quality, reliability and global correlation targets.

Traditional Standard Testing Setup	Newest Testing Solutions & Trends
Single device supplier	Global solution partner providing a complete product and application portfolio
System design on demand of OEM or homemade solution	Industrialized standard products fulfilling global demands in terms of safety and operation standards
Local supplier	Global accountable partners for sales, service and application support
Supplier trained by customer	Development partnership with specific testing expertise between supplier and customer
Development try & error	Simulation services and R&D partner for e.g. flow and temperature simulation for vehicle and UUT
Single test report	Vehicle testing and certification workbook → Entire workflow data and test results including information of soaking, fueling, canister conditioning, prep-cycles, Hot-Soak + Diurnal testing, etc.
Manual single test operation and data handling	Centralized data and workflow management
Hard-coded test sequence	Flexible and dynamic test configuration with multiple template and stencil database
Fixed volume SHED	VV/VT-SHED including an additional volume reduction BAG for improvement of the analytical response up to 25%
Manual refueling operation	Remote controlled automatic ORVR test procedure with online-data validation
Supplier of environmental chambers	Expert in analytical emission testing, long-term experience in FID technologies with clear understanding of the relationship and dependencies between exhaust emission and evaporative emission testing (thermal management of vehicle - depends on CD test cell design)
Personnel attention during test runs required	Unmanned operation 24/7, un-limited days (long-term diurnal testing)

**Trends**

**EVAPORATIVE EMISSION TEST TYPES**

EVAP Test Preparation	Canister Conditioning & Testing	CANLOAD SYSTEMS	or	Component Testing
<b>Diurnal Test</b>  Evaporative THC emissions over the day while the vehicle is parked 24h, 48h, 72h.	<b>Bleed Emission Test</b>  Like Diurnal test, but the bleed emissions (capacities of the fuel systems) are analyzed separately by a separate small Passive SHED within the VV/VT-SHED chamber.	<b>Hot Soak Test</b>  Evaporative THC-Emissions after a vehicle was driven (engine is left hot) and soaked. Transfer timing chassis dyno TC → VV/VT-SHED required.	<b>ORVR Test / Split back</b>  Onboard Refueling Vapor Recovery test determines fuel vapor THC emissions coming out of the tank by new fuel being pumped into it.	<b>Point Source Test</b>  Evaporative THC emissions during driving the vehicle on a chassis dyno are measured at points, where evaporated THC might be emitted.
<b>Running-Loss Test</b>  Evaporative THC emissions during driving the vehicle on a chassis dyno, which is built into the SHED chamber.	<b>Canload Testing</b>  Testing of Components of OEM Choppers such as Fuel Tanks or Canisters.			

**EVAPORATIVE PRODUCT PORTFOLIO**

**RL-SHED FLOW SIMULATION – THERMAL MANAGEMENT**

Velocity (m·s<sup>-1</sup>): 35.000, 32.348, 29.610, 26.927, 24.231, 21.588, 18.940, 16.154, 13.462, 10.769, 8.077, 5.385, 2.692, 0.000

**WHY AVL?**

AVL is the only manufacturer with analytical and emission background worldwide  
 AVL is the only manufacturer worldwide - designing, developing and manufacturing all testing modules itself  
 Customer have trust in our product portfolio and technology.  
 AVL is the only manufacturer providing solutions in all areas of evaporative testing – having an entire product portfolio

- Enclosure design based on analytical experience
- Minimized 3<sup>rd</sup>-Party Dependencies
- Continuous & Seamless System Design
- Alignment with AVL product philosophy
- Excellent Application Know-how
- Global Sales & Service Organization

# CANISTER TESTING SOLUTIONS & TRENDS

Beside the general various market trends(see SHED Testing Solutions & Trends), the RDE (Real Drive Emissions) discussion “being more realistic” are pushing the entire testing and simulation environment to higher level of flexibility and functionality to fulfill future demands of - vehicle and device testing, certification and development.

Local emission levels and problems are forcing governments to modify or create their individual legal emission regulation targets (e.g. China, Beijing) with possible consequences like:

- ✓ Extended temperature and humidity simulation (canister purge air)
- ✓ Dynamic (acc. Drive cycles) canister purge procedures (not just stationary)
- ✓ Dynamic load simulation (not just stationary)
- ✓ Combined canister stabilization and conditioning procedures
- ✓ Real vapor conditioning (instead of synthetic gas conditioning - C4H10 / N2)
- ✓ Improved accuracy, repeatability and control modes, Adv. PID loading control f(RVP, T, Q, m)
- ✓ Additional COP demands
- ✓ Advanced module testing e.g. fuel storage leak check procedure (acc. EPA §1066.985)
- ✓ OBD validation and simulation functions
- ✓ Long-term durability testing and in-use test cases
- ✓ Online data calculation and validation(not just cyclic results)
- ✓ Specific R&D tools and functions for example
  - hybrid flow simulation
  - pressurized tank systems – puffer control
  - purge control simulation and test, boost pump interfaces
  - purge efficiency interface, pulsed inline heater control

**Actual testing setups covering most of the actual legal requirements but are they ready for future technologies, testing trends and emission visions?**

**INTRODUCTION & MOTIVATION**

Current trends and future demands concerning alternative fuels and various drive concepts require adequate and flexible test systems.

AVL CANLOAD systems constitute a state of the art test system by providing specific test solutions for a wide application range - supporting standard certification (acc. federal regulations EPA, CARB, EU, etc.), individual R&D and durability testing.

The AVL CANLOAD unit is designed for all standard applications based on butane / nitrogen, fuel vapor or fuel vapor / nitrogen handling.

It provides all required functions e.g.

- Canister aging / stabilization
- Canister working capacity evaluation
- Standard canister conditioning (see test procedure tree)
- Leak check procedure
- Individual loading and purging (dyn. purge)
- etc.

**AUTOMATION SOFTWARE**

- Standardized
- Easy
- Intuitive
- Flexible
- Smart
- Robust

**MULTIPLE DYNAMIC PURGE & FUEL VAPOR CONDITIONING**

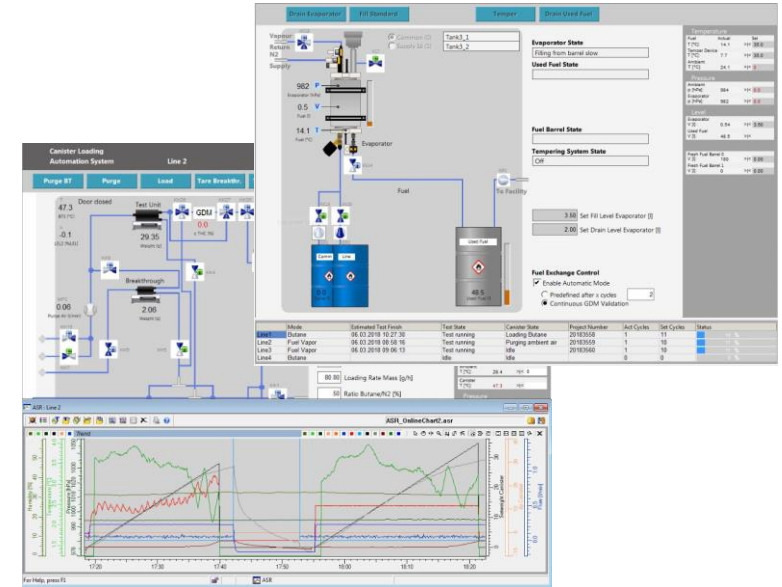
**EVAP REFERENCES – ARE YOU READY?**

The global references are a mixture of OEM's, TIER I / II suppliers, testing service and certification laboratories. Thank you for the confidence and partnership.

# REFERENCES CUSTOMERS & PARTNERS



# VERDUNSTUNGSEMISSIONEN - LÖSUNGEN



# Vielen Dank