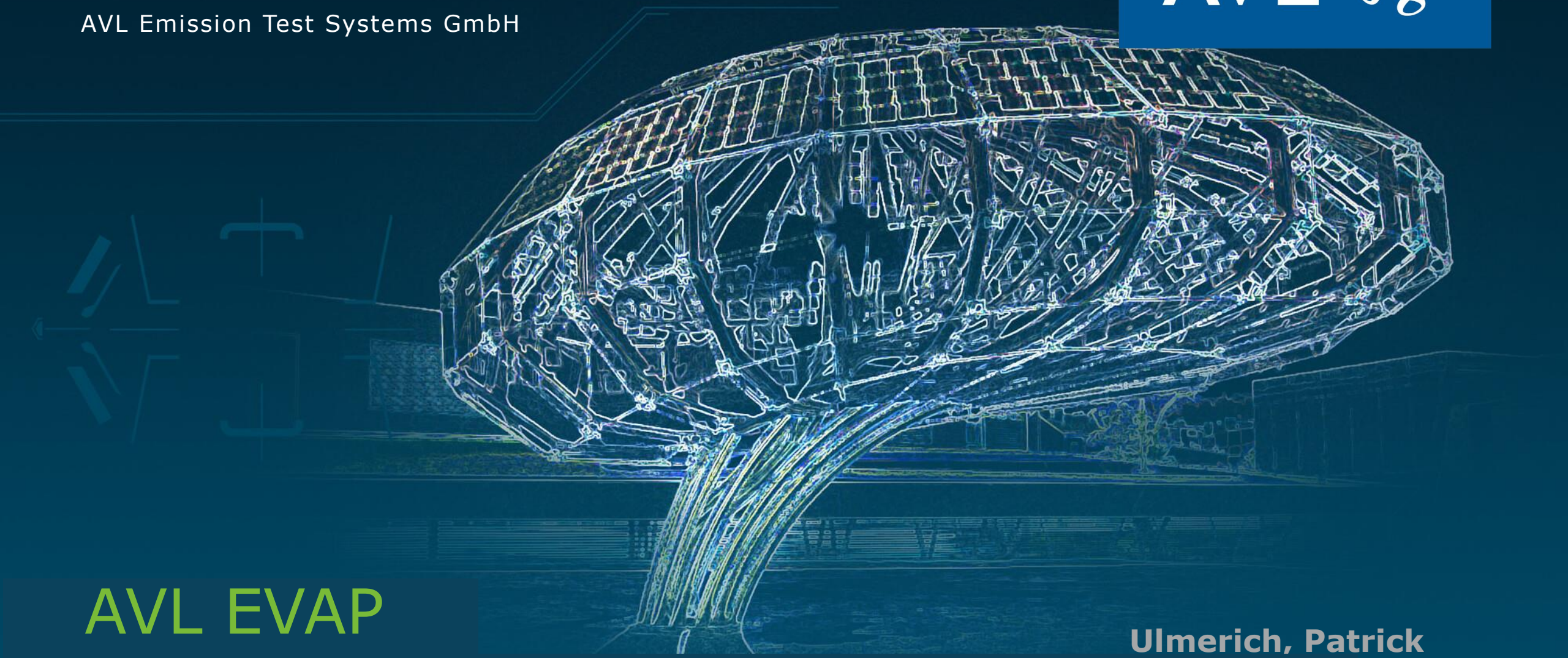
AVL Emission Test Systems GmbH

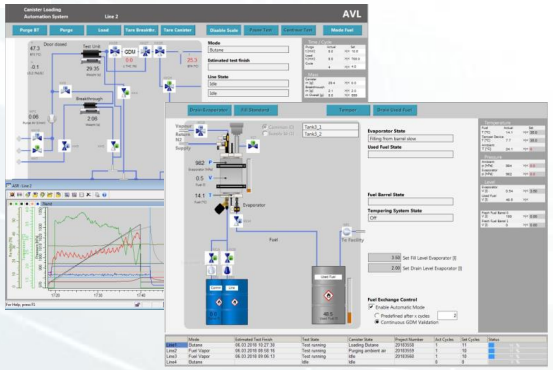


AVL EVAP

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

Verdunstungsemissionen

- **Markttrends**

  Gesetzgebung & Neuigkeiten

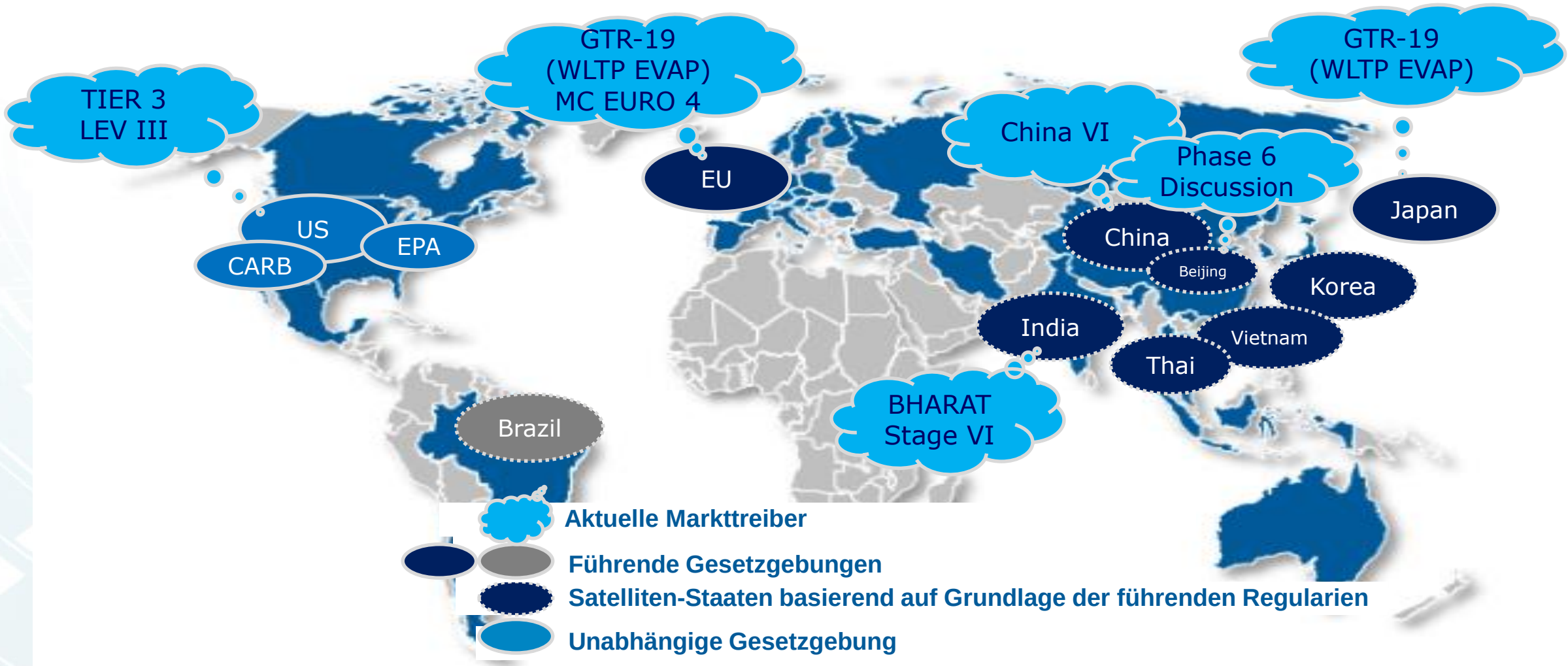
- Technologie

  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

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, bu
the bleed emission
(openings of the fu
system) are analyz
separately by a
separate small Pas
SHED within the
VV/VT-SHED cham

Puff-Loss Test

Sealed Tanks System Test based on 12h Diurnal Cycle

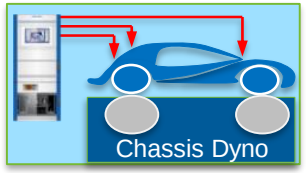
Hot-Soak Test

THC-Emissions after
s driven (engine is
tested
ng (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

Evaporativ
emissions
driving the
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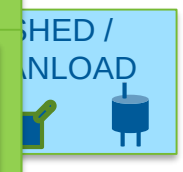
which is b
the SHED

Canister Aging

CANLOAD

Canister Aging 300 cycles GWC followed by 5 cycles of BWC

Component Testing



g of
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Suppliers
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or
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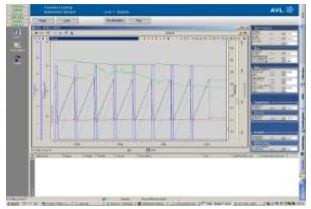
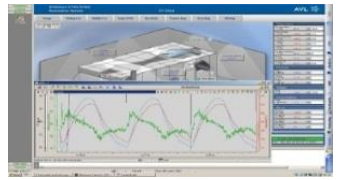
R&D

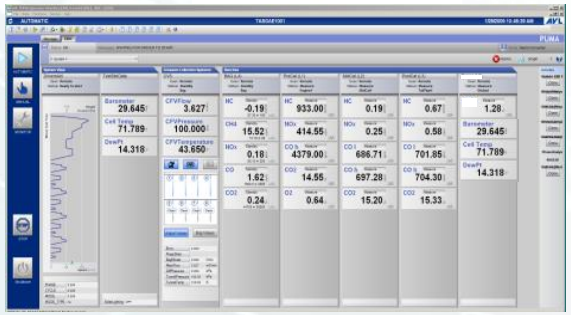
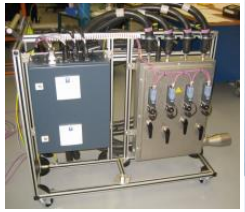
EVAP PRODUKT-PORTFOLIO

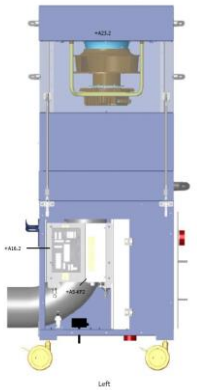




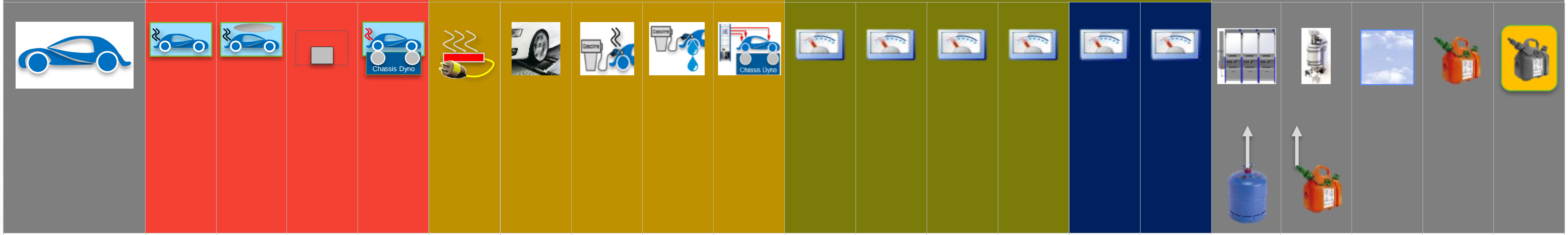







EVAP APPLIKATION: LD-FAHRZEUGE



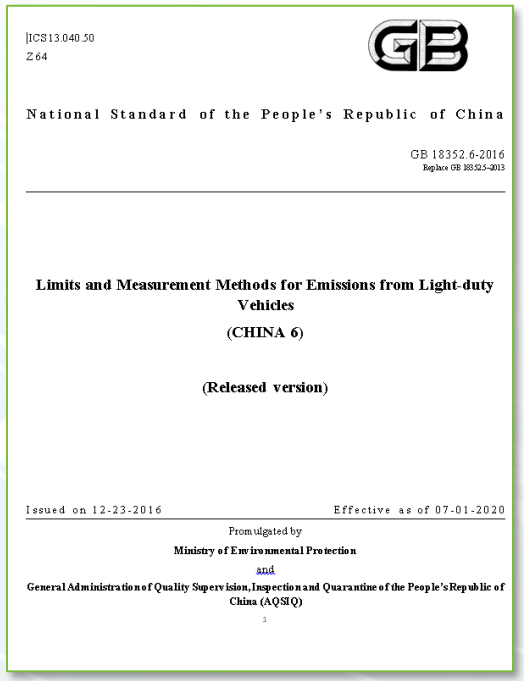
Testkandidat	SHED Kammer				Testgeräte und Zubehör					Analytik						Konditionierung				
UUT	SHED Chamber	Variable Vol. / Temp	Passive Chamber	Running Loss SHED	Heating Devices	Running Loss CD	ORVR Devices	Spit-Back Devices	Point Source	THC Analysis	CH4 Analysis	Ethanol Analysis	NH3 Analysis	iCal GDU	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



ICS 13.040.50
Z 64

National Standard of the People's Republic of China

GB 18352.6-2016
Replace GB 18352.5-2013

Limits and Measurement Methods for Emissions from Light-duty Vehicles
(CHINA 6)

(Released version)

Issued on 12-23-2016 Effective as of 07-01-2020

Promulgated by
Ministry of Environmental Protection
and
General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China (AQSIQ)

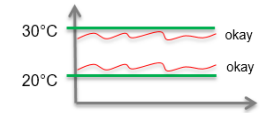
Index	Contents
Annex C	Type I test: Average tailpipe emissions after a cold start
Annex D	Type II test: RDE (Real Driving Emission)
Annex E	Type III test: Crankcase Gas Emission
Annex F	**Type IV test: Determination of evaporative emission**
Annex H	Type VI test: Verifying the average low ambient temperature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

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

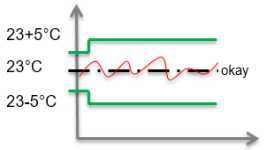
GB6 – ÜBERBLICK

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.

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

TYPE IV TEST- IMPACT TO EVAP SYSTEM

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

Deterioration Factor	0.06 (g/test)

- 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

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

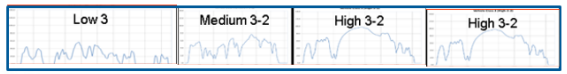
- Anlehnung an die GTR-15 Anforderungen z.B. Temperaturkonditionierung während der Prep-Fahrzyklen oder der Fahrzeugstabilisierung (SOAK)
- Neue und deutlich reduzierte Grenzwerte 0.7g/Test (HS+D, ORVR 0.05g/l)
- Neue, erhöhte Heissabstell (Hot-SOAK)-Temperatur → 38°C
- Hochtemperatur-Prep. Fahrzyklus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

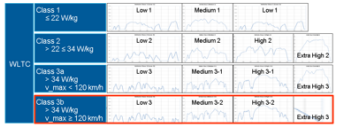
CHINA 6 – INFORMATION

TYPE IV TEST- IMPACT TO EVAP WORKFLOW

1 New pre-condition cycle in Chassis dyno

Driving cycle: low speed + medium speed + high speed + **high speed**; (WLTC 3b - EVAP)





2 High temperature chassis dyno driving cycle (38°C ± 2°C)

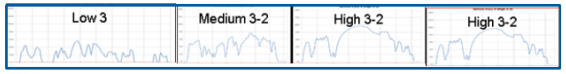
Driving cycle: low speed + 2 min idle + medium speed + 2 min idle + high speed + 2 min idle + **high speed** + 2 min idle; (WLTC 3b - EVAP)

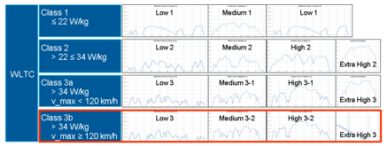
Confidential | | 11 March 2018 | 20

TYPE VII – ORVR IMPACT TO EVAP WORKFLOW

3 Vehicle pre-condition driving cycle

Driving cycle: For HEV vehicle, repeated (WLTCs-EVAP) until charge-sustaining mode





4 ORVR control system Vehicle pre-condition driving cycle

Driving cycle: low speed + low speed + medium speed + low speed; (WLTC 3b-EVAP)

iGEM Vehicle requirements – EVAP specific prep-cycles

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 - INFOMATION

workflow

Hoch-Temperatur Konditionierung (Soak)

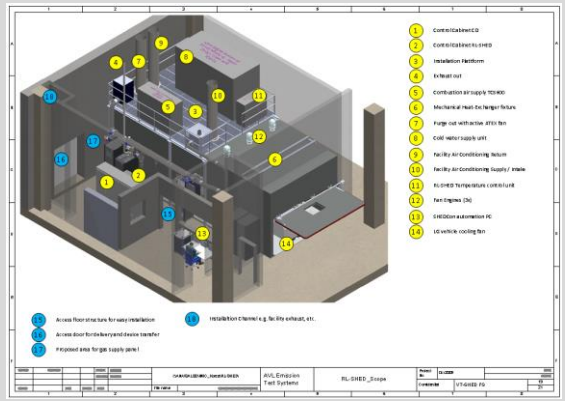
Temperatur-Sollwert: **38°C ± 2°C**

Relativ einfache Temperatur-Konditionierung
- In speziellen zusätzlichen Containern
- Im Standard-SHED

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

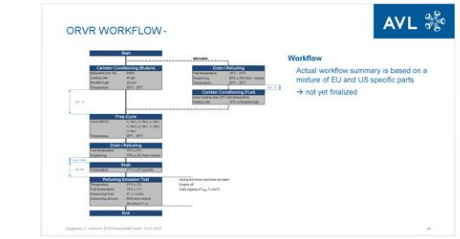
- Refer to US EPA ORVR test procedure
- Drive cycle refers to WLTC - EVAP

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

Deterioration Factor	0.01 (g/L)

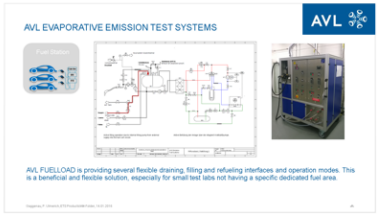
Test requirement

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



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

TYPE VII – ORVR IMPACT TO EVAP SYSTEM



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: → avai…, new settings

Enhanced ORVR …dules" (…ly)

Improved desig…

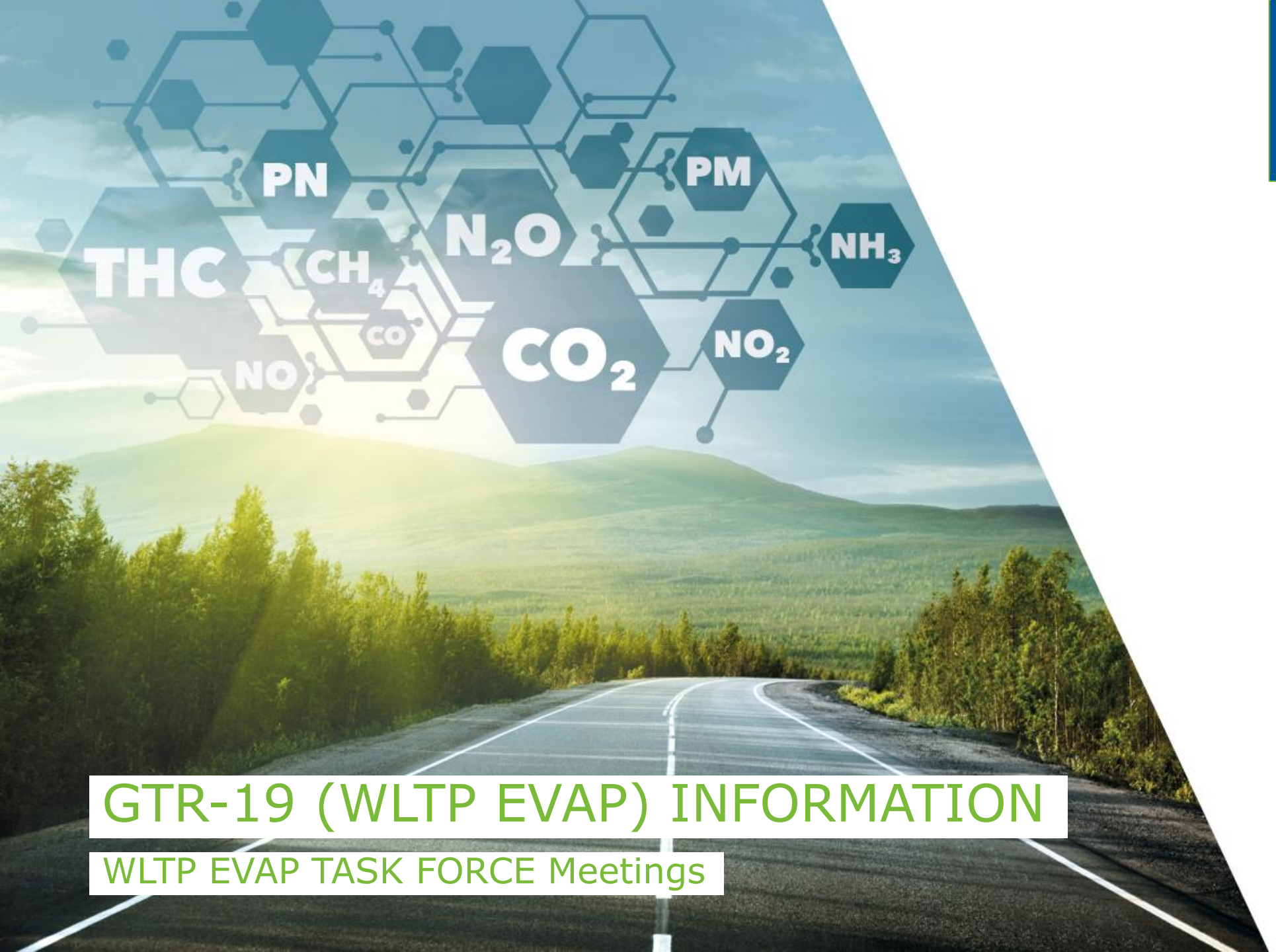
Additional …

Capacity o…

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

Markt Treiber

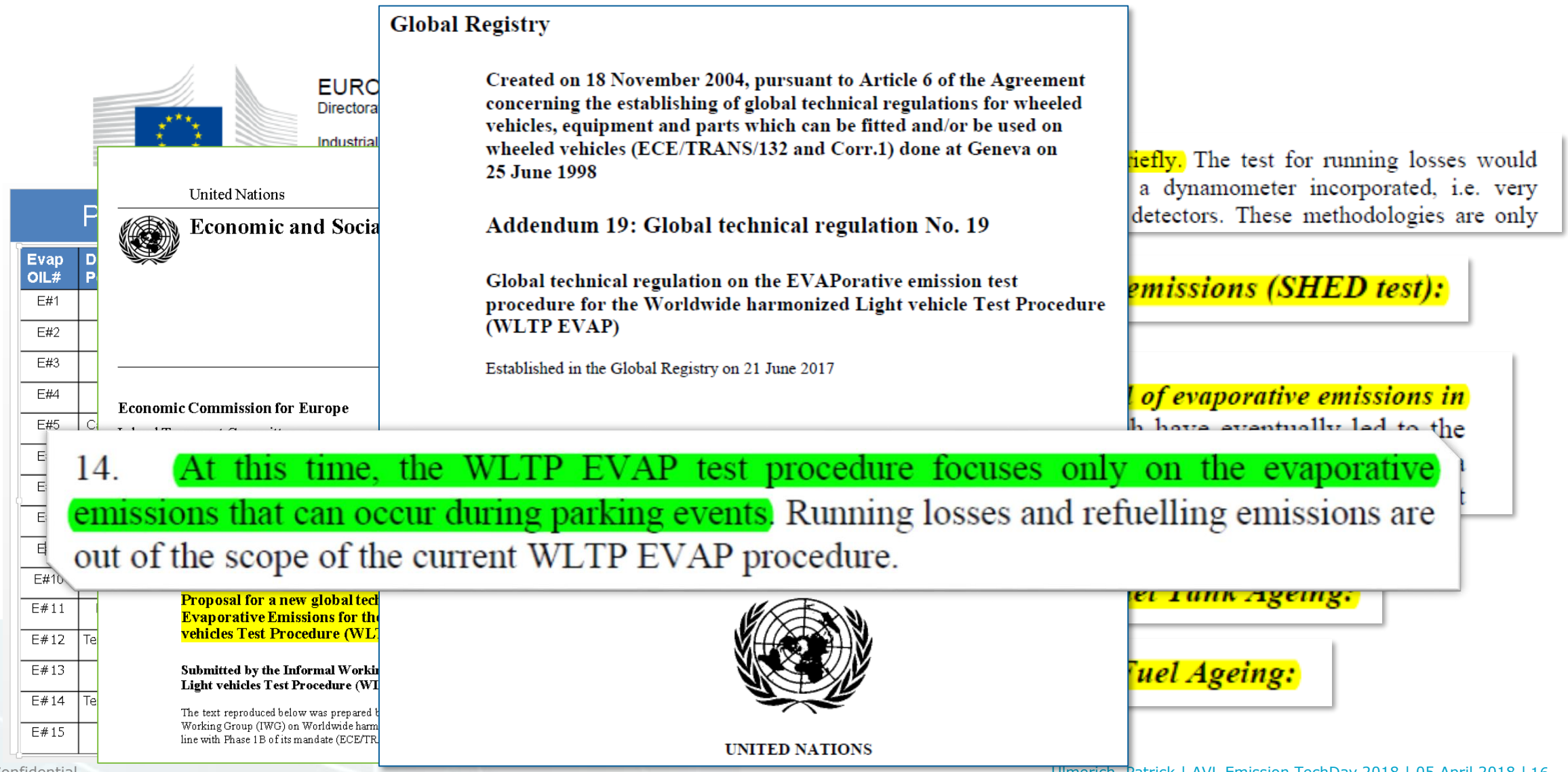
- Betankungsprozedur (ORVR) ähnelt sehr der bestehenden US Prozedur
- Vorstellung der 2. Generation des AVL FUELLOAD Betankungssystems
- Zusatz ORVR-Lüfter optimiert die Mischung und stellt das hohe analytische Ansprechverhalten sicher
- Neuer ORVR-Betankungsbeutel mit Abschlussadaptern und spezifischen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



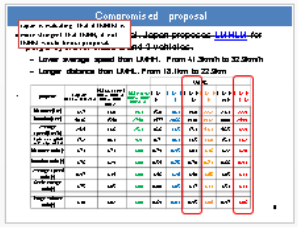
GTR-19 (WLTP EVAP) INFORMATION

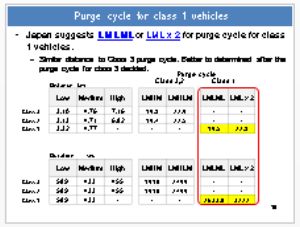
WLTP EVAP TASK FORCE Meetings

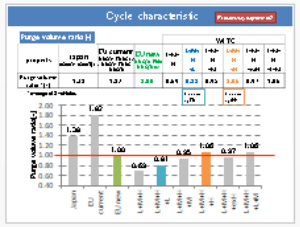
GTR-19 INFORMATION

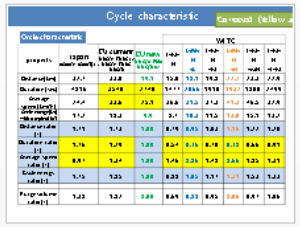


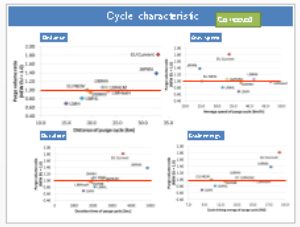
GTR-19 INFORMATION

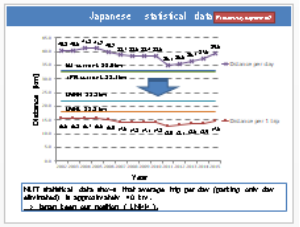


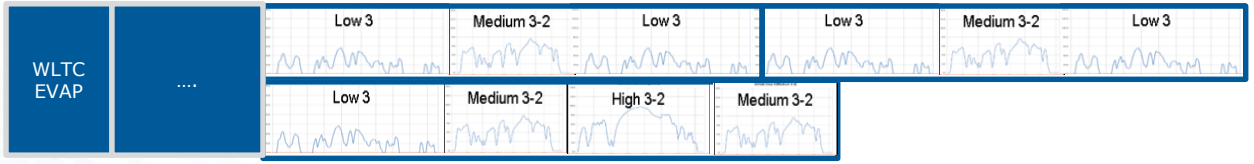






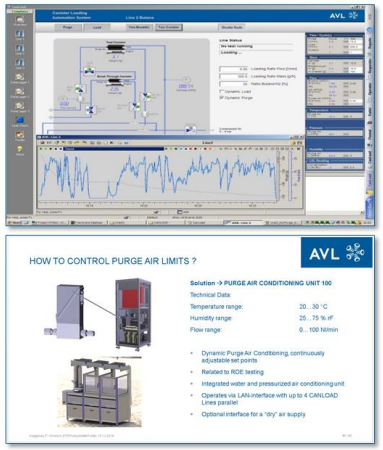






WLTC basierte AKF-Spülzyklen (Prep. Fahrzyklen)
LMHM und LML x2
→ EVAP spezifisch!

RESTRICTIVE CANISTER PURGE REQUIREMENTS



Purge Air Requirements

Actual Limits

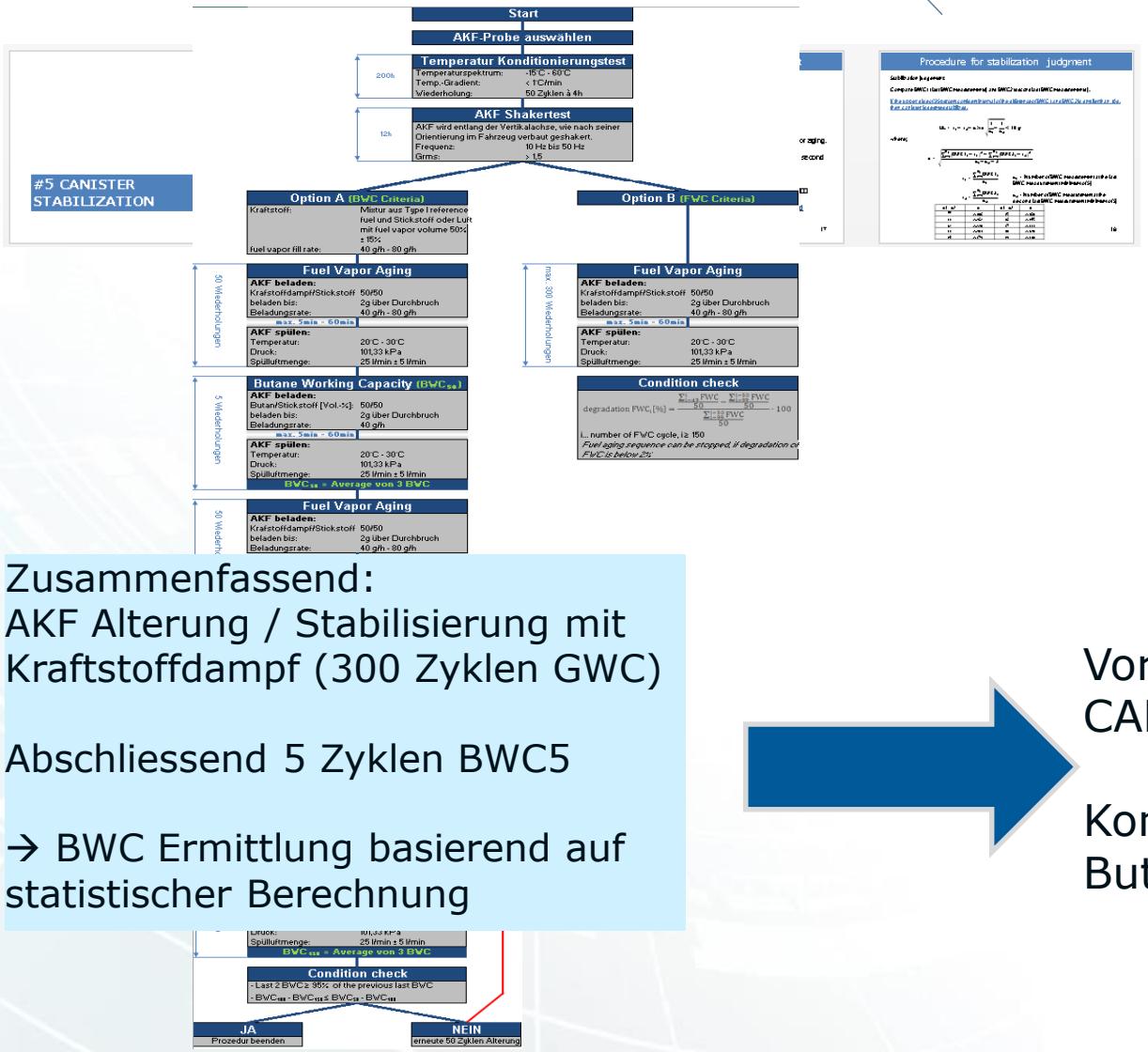
Relative Humidity:	50 ± 25 % rF
Temperature:	20 – 30 °C

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

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

Gaggenau, P. Ulmerich, ETS Products\AM-Folder, 10.12.2014

GTR-19 INFORMATION



Zusammenfassend:
AKF Alterung / Stabilisierung mit Kraftstoffdampf (300 Zyklen GWC)

Abschliessend 5 Zyklen BWC5

→ BWC Ermittlung basierend auf statistischer Berechnung

Markt Treiber

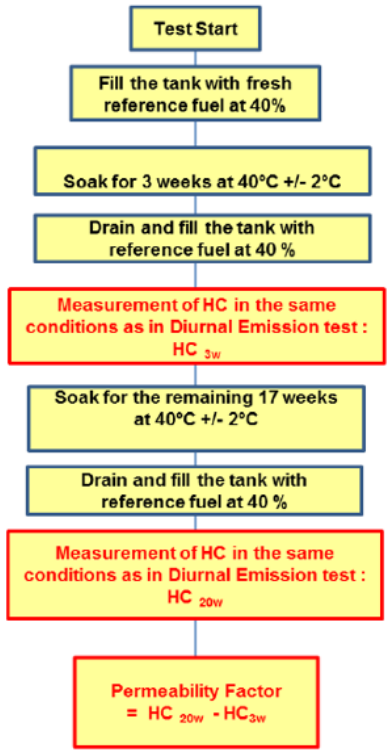
Vorstellung der neuen CANLOAD xL-BF Variante

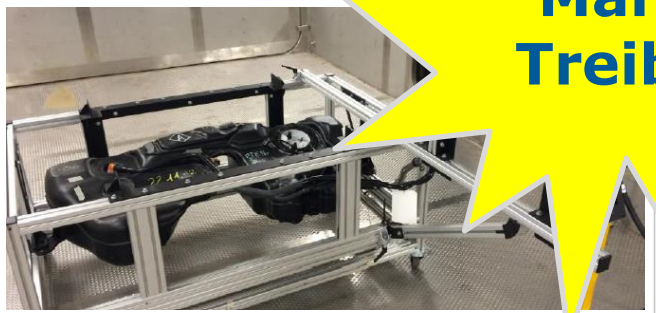
Kombination von
Butan / Kraftstoff / Stickstoff

GTR-19 INFORMATION

Determination of PF

Figure 4 : Determination of the Permeability Factor



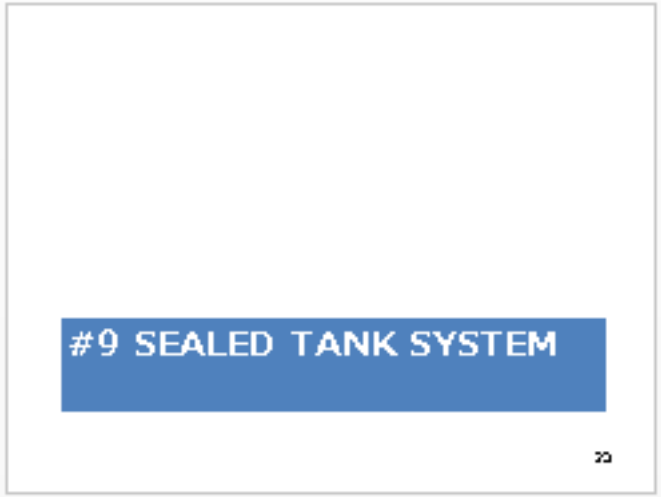


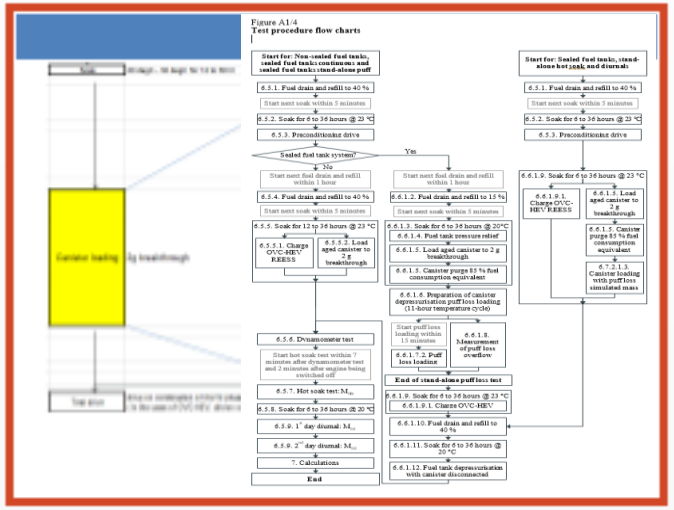
Markt Treiber

PF - **P**ermeability **F**actor

- 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



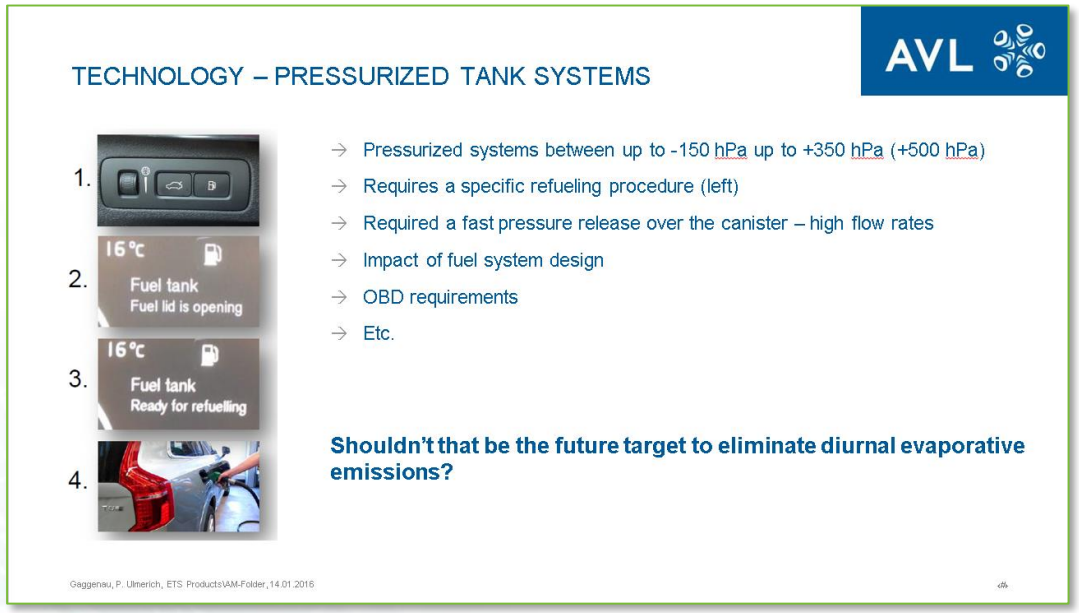


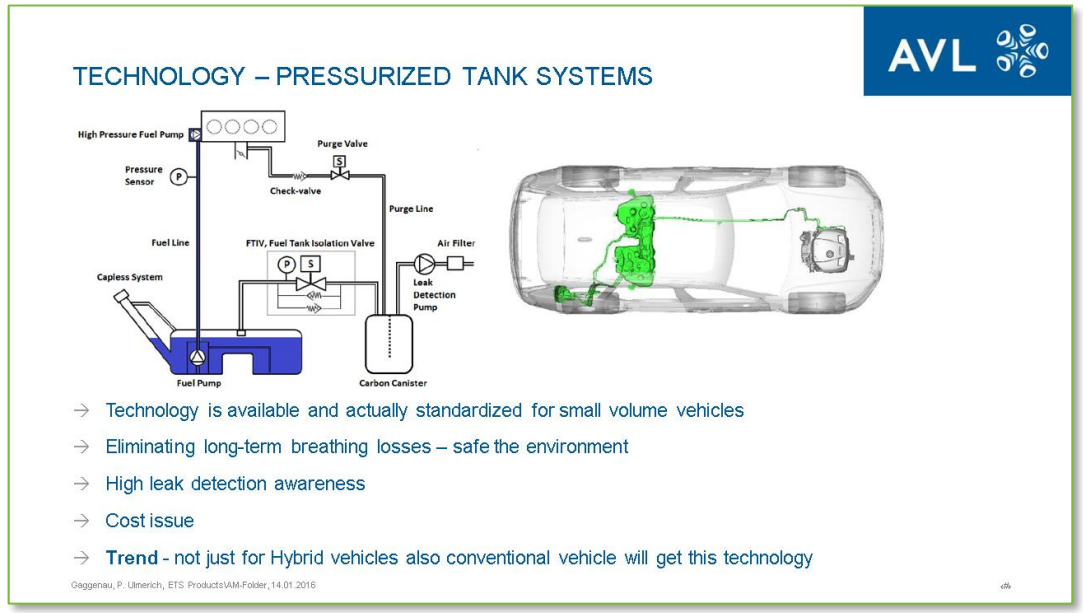
Neuer SHED TEST

Puff-Loss Test, spezielle Prüfung von Drucktanksystemen

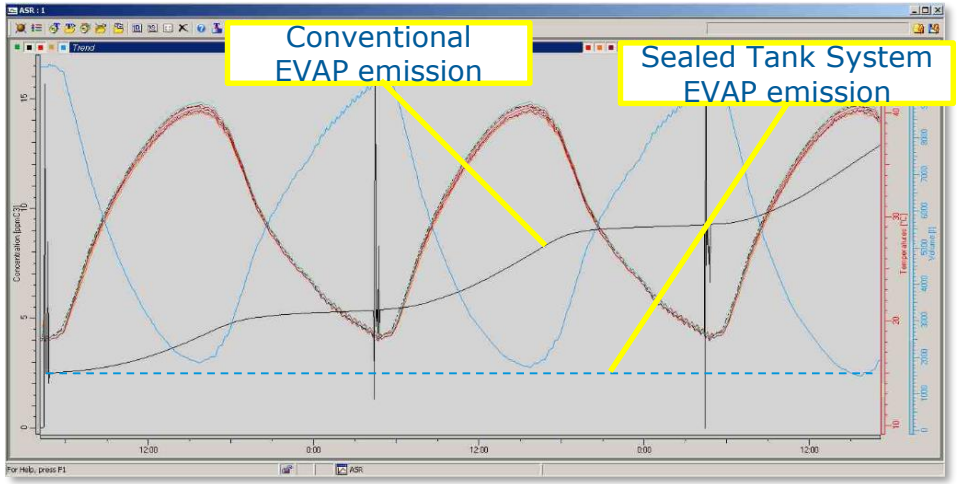
- AVL CANLOAD Funktion zur Simulation sehr hohen AKF-Beladeraten verfügbar
- SHED, SHEDCon Automatisierung mit neuer Testprozedur, Berechnung und Protokoll notwendig

DRUCKTANKSYSTEME - INFORMATION





- 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

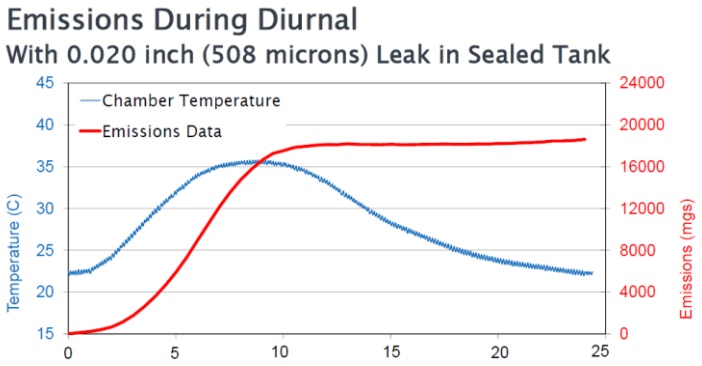


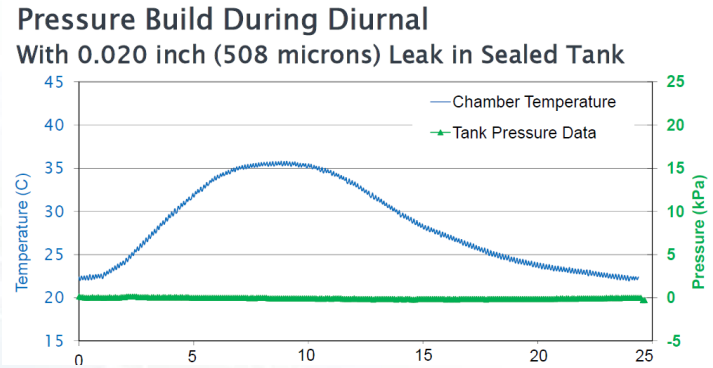
In-Service Conformity Tests

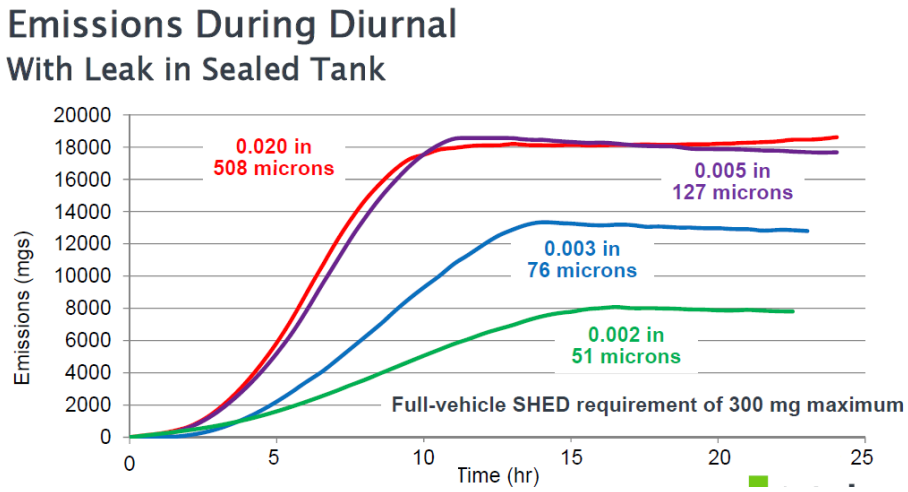
(12) In-service conformity checks currently cover only pollutant emissions measured through the Type 1 test. However, in order to ensure that the requirements of Regulation (EC) No 715/2007 are met, they should be extended to tailpipe and evaporative emissions. Therefore, Type 4 and Type 6 tests should be introduced for the purposes of in-service conformity tests. Due to the cost and complexity of such tests, they should remain optional.

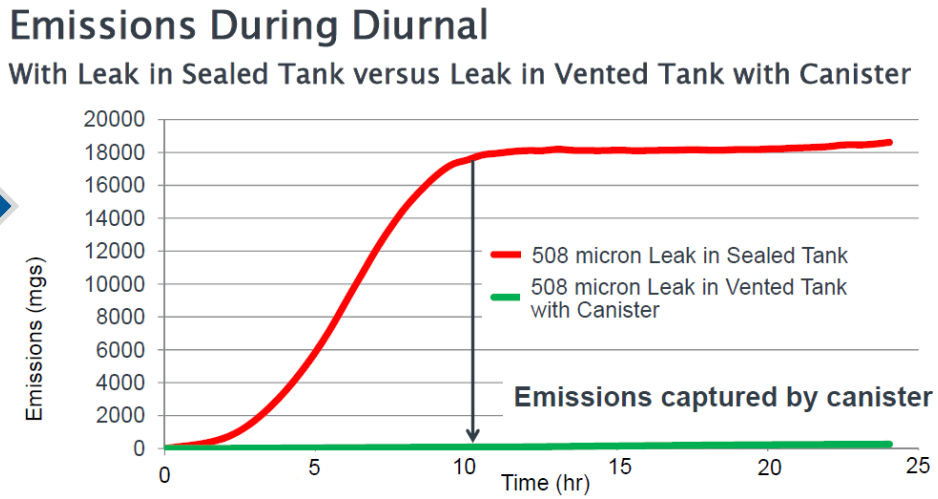
(13) A review of the current in-service confor revealed that very few fails were reported campaigns and other voluntary actions we problems related to emissions. There transparency and control in the in-service

(14) In order to control the in-service conform authorities should be responsible for perfo of the approved vehicle types each year.



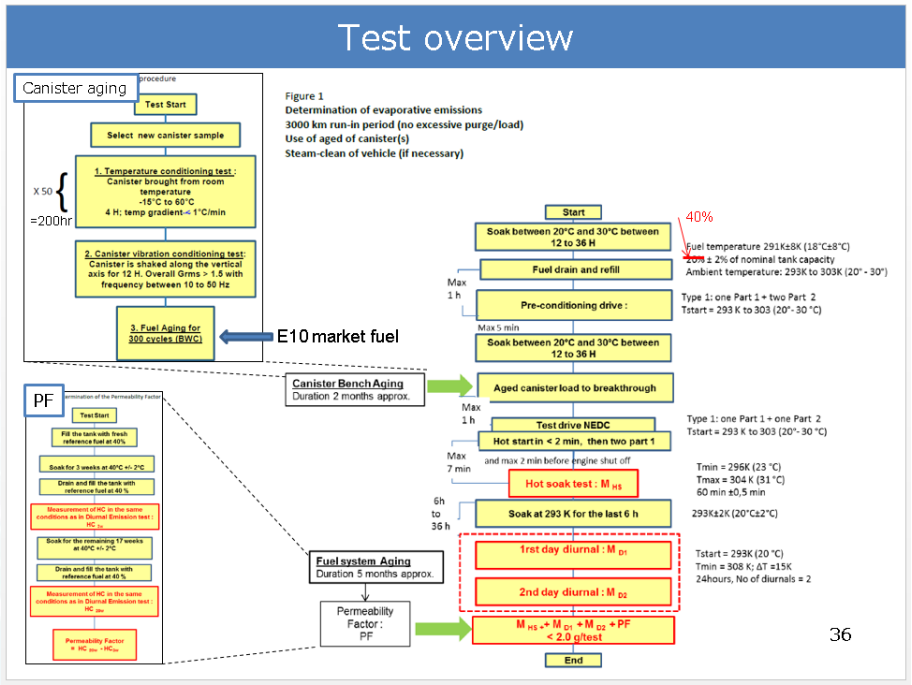






Bei Drucktanksystemen ist das Risiko einer Fehlfunktion durch Undichtigkeit deutlich höher und der Umwelteinfluss am größten!

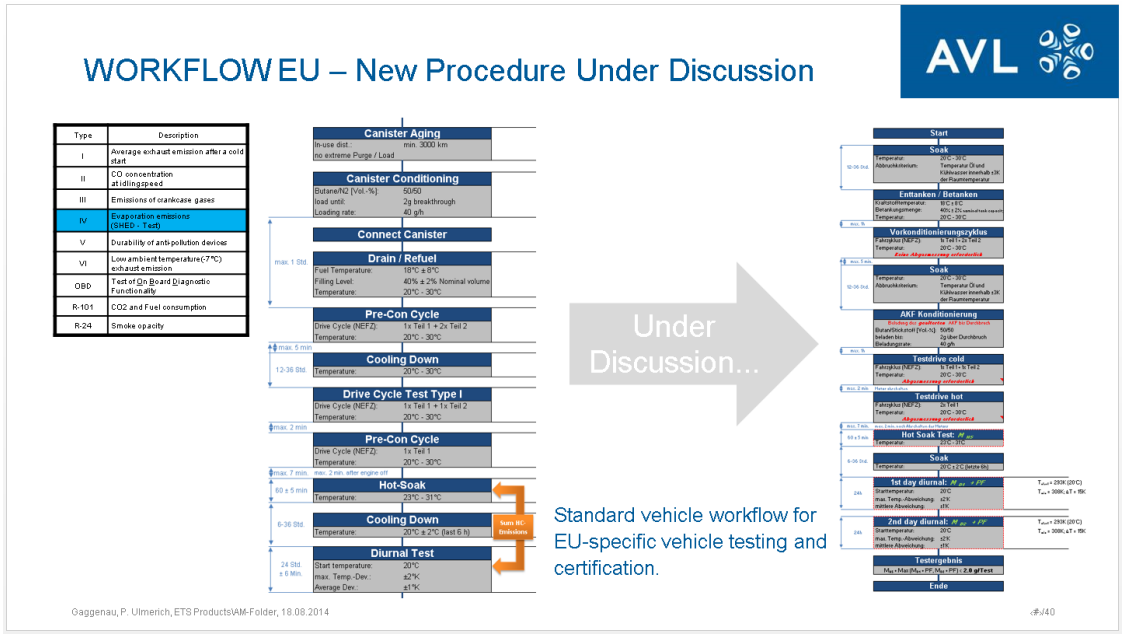
GTR-19 INFORMATION



Aktuelle Berechnung:

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

HS = Hot Soak
D = Diurnal



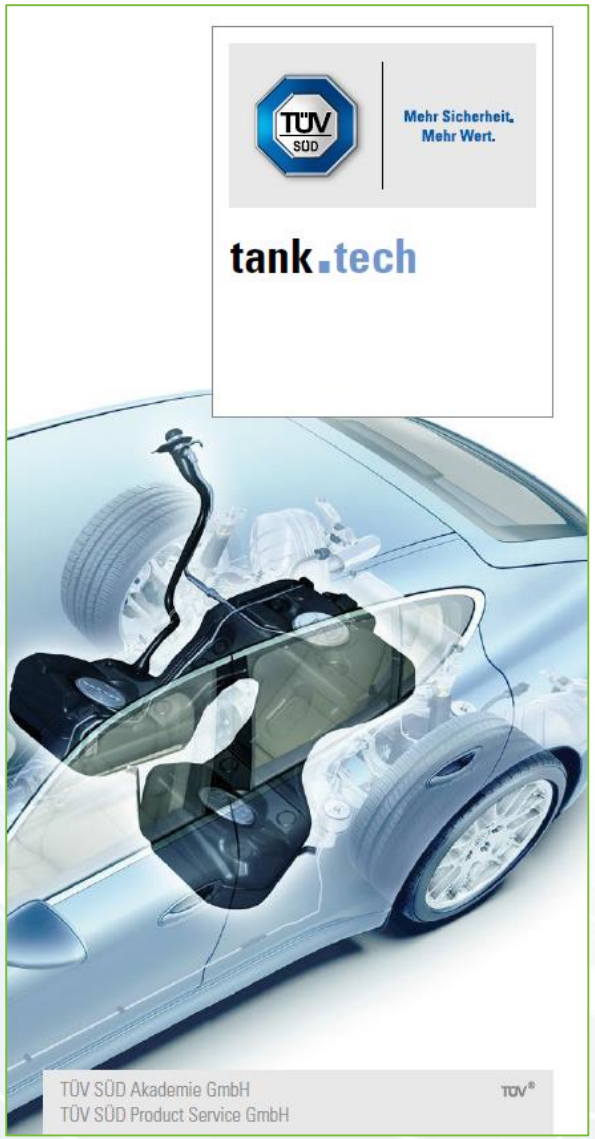
Aktualisierter Workflow mit Verdopplung der Tankatmungprüfung von 24h → 48h
Neue Berechnung:

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

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

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

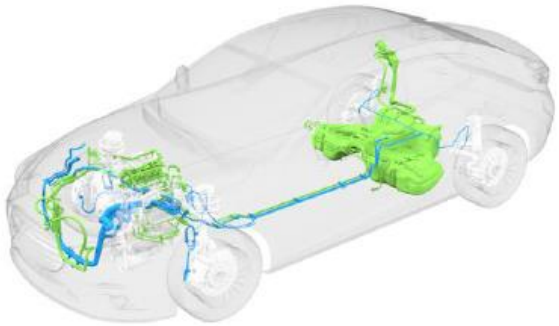
Mehr als 560 Teilnehmer aus 25 Ländern auf der 2-Tages-Konferenz…

FAHRZEUG Typen, Varianten und Versionen

Powertrain

Conventional

- FWD
- RWD
- AWD

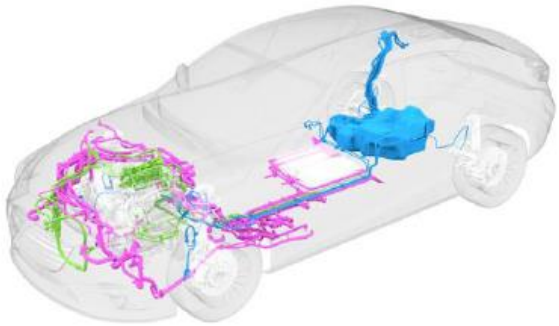


Main challenges on conv. tank systems

- Emission
- Weight

PHEV

- FWD
- RWD
- AWD



Additional challenges on PHEV tank systems

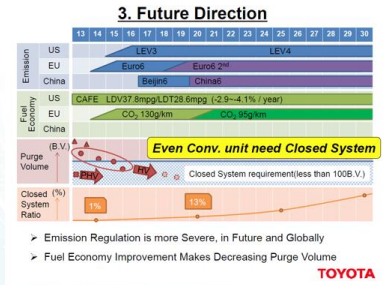
- Pressure resistance
- Reduced tank height

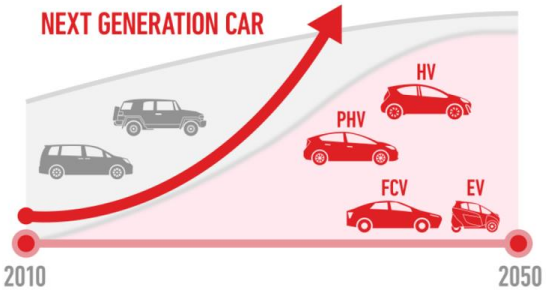
1 vehicle platform → **up to 10 tank variants**
→ **up to 50 fuel system variants**

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





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

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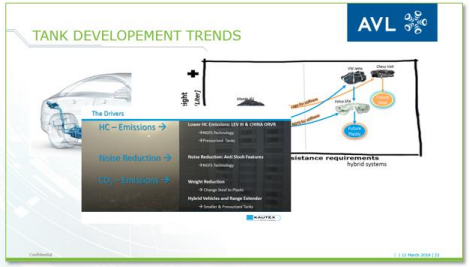
TANK DEVELOPEMENT TRENDS - KAUTEX



Main topics are pushing the tank system manufacturers

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

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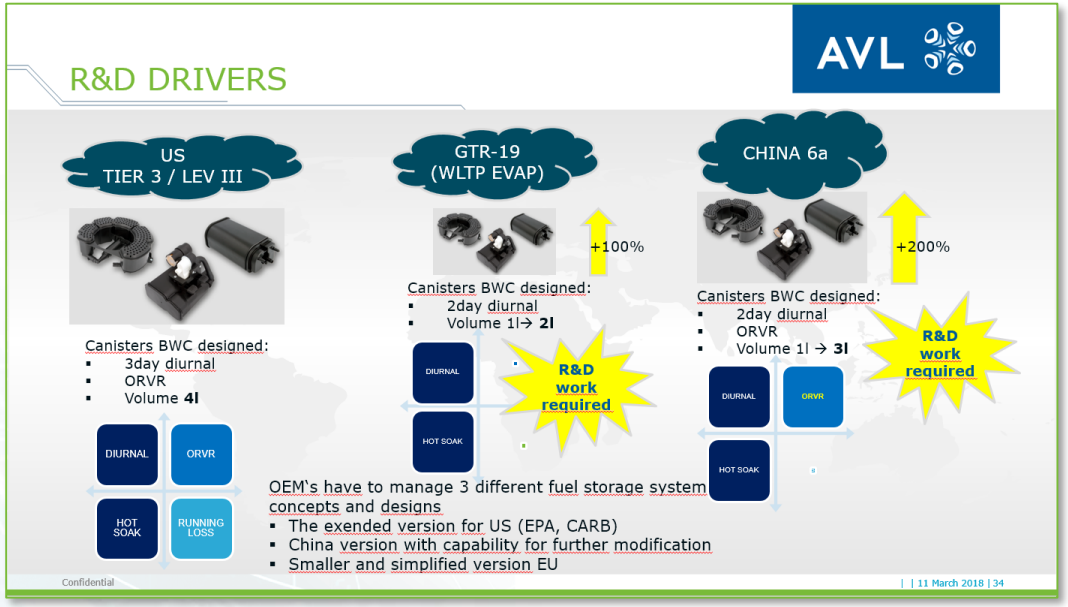
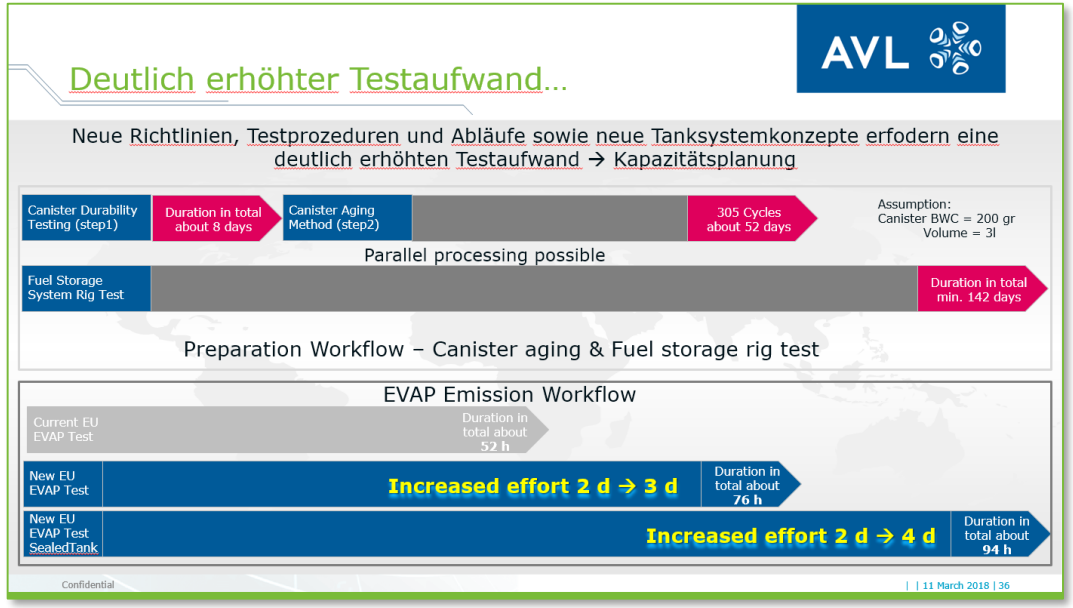
- Trend Elektrifizierung / Hybridisierung hält an
- Auch für konventionelle Fahrzeuge werden Drucktanksysteme entwickelt
- HC-Emission – Einhaltung der Grenzwerte, neue Anforderungen ORVR und PHEV
- Anforderung – Reduzierung CO2-Emission durch z.B. neue Pumpen, Gewichtseinsparung, etc.
- OBD II, Enhanced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

TESTAUFWENDUNGEN GENERELL



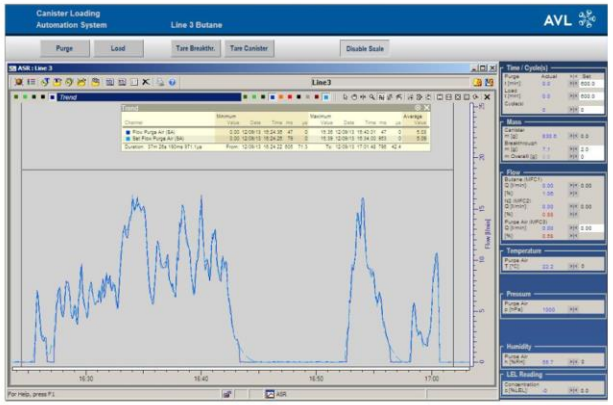


Neue Richtlinien, Testprozeduren und Abläufe sowie neue Tanksystemkonzepte erfordern einen deutlich höheren Testaufwand → Kapazitätsplanung

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

US ANFORDERUNGEN & TRENDS

DRIVE CYCLE PURGE FLOW SIMULATION

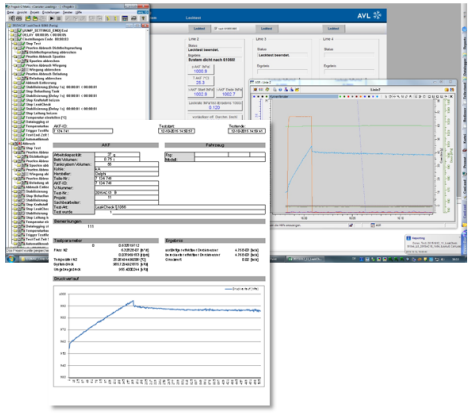


Online data quality evaluation
set flow vs. real flow:

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

FUEL STORAGE LEAK CHECK PROCEDURE



New Release

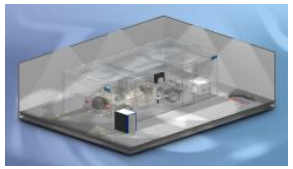
Fuel storage leak check procedure acc. eCFR §1066.985 implemented in AVL CANLOAD system

- 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

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

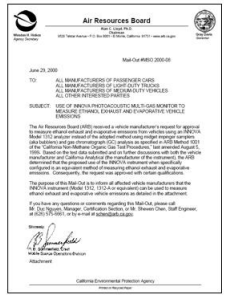
- PASSIVE SHED

  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.

HOW TO MEASURE ETHANOL ?

VEHICLE EVAPORATIVE EMISSIONS (SHED), ETHANOL

Filter	Filter bank	Gas	Calibration Range
UA0936	A1	Methanol, CH_3OH	0...12 ppm
UA0974	B1	Ethanol, C_2H_5OH	0...10 ppm
UA0981	C1	Toluene, C_7H_8	0...10 ppm
UA0983	D1	CO_2	0...400 ppm
UA0971	E1	R134a	0...10 ppm

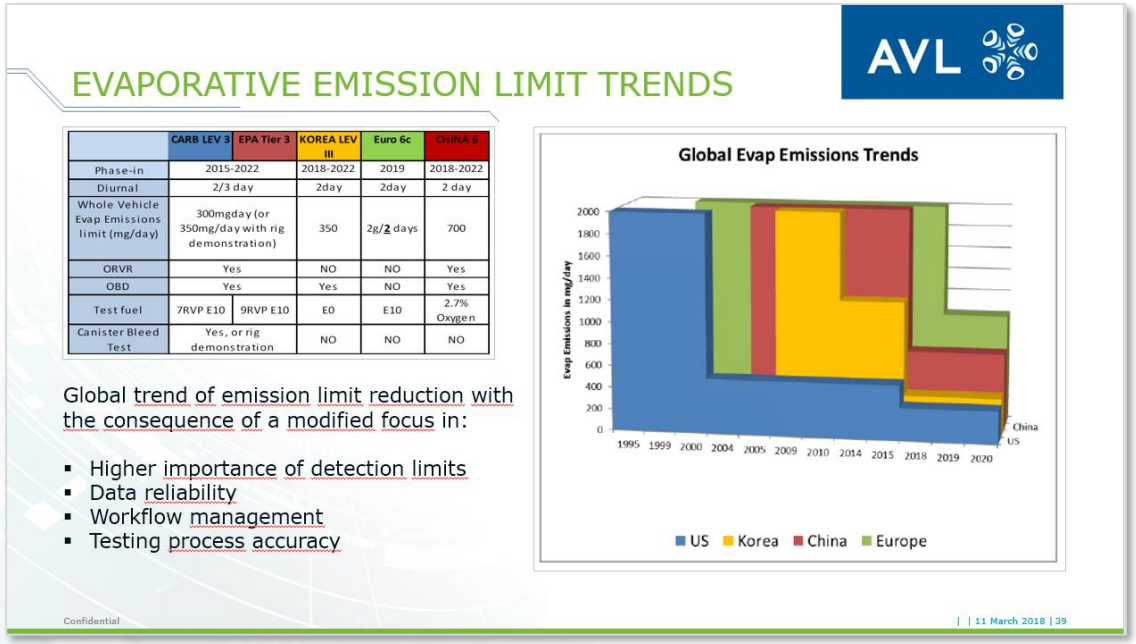


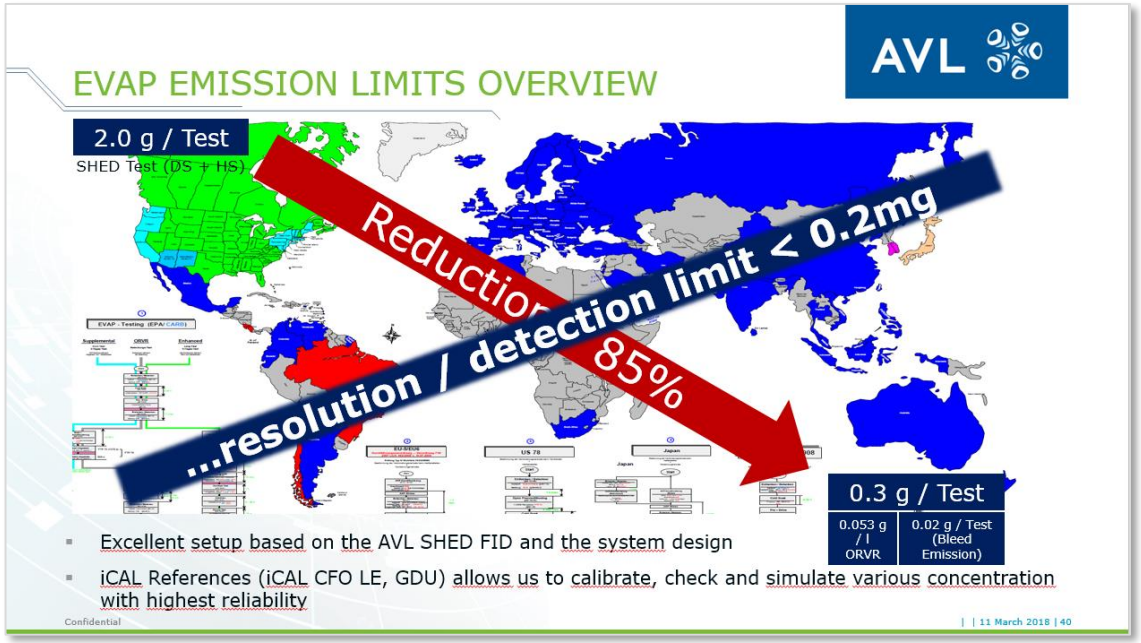
Features:

- 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

SHED Funktion

EMISSIONS-GRENZWERTE

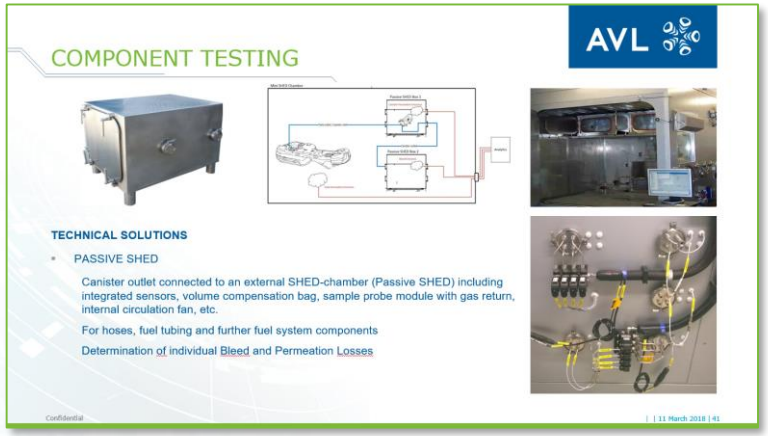


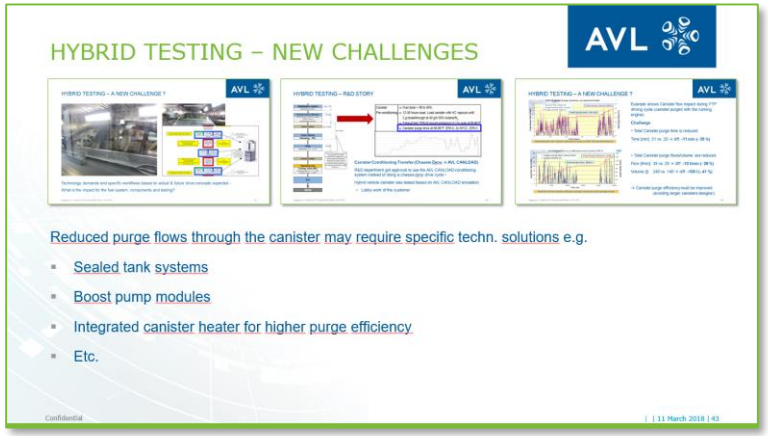


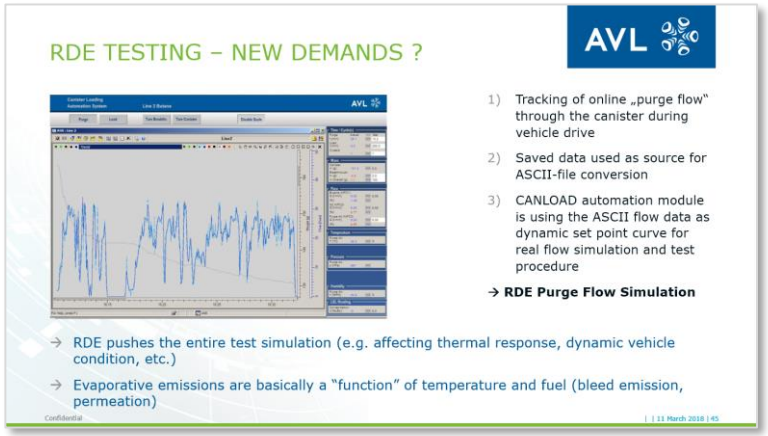
Konsequenzen der deutlich reduzierten Grenzwerte

- 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



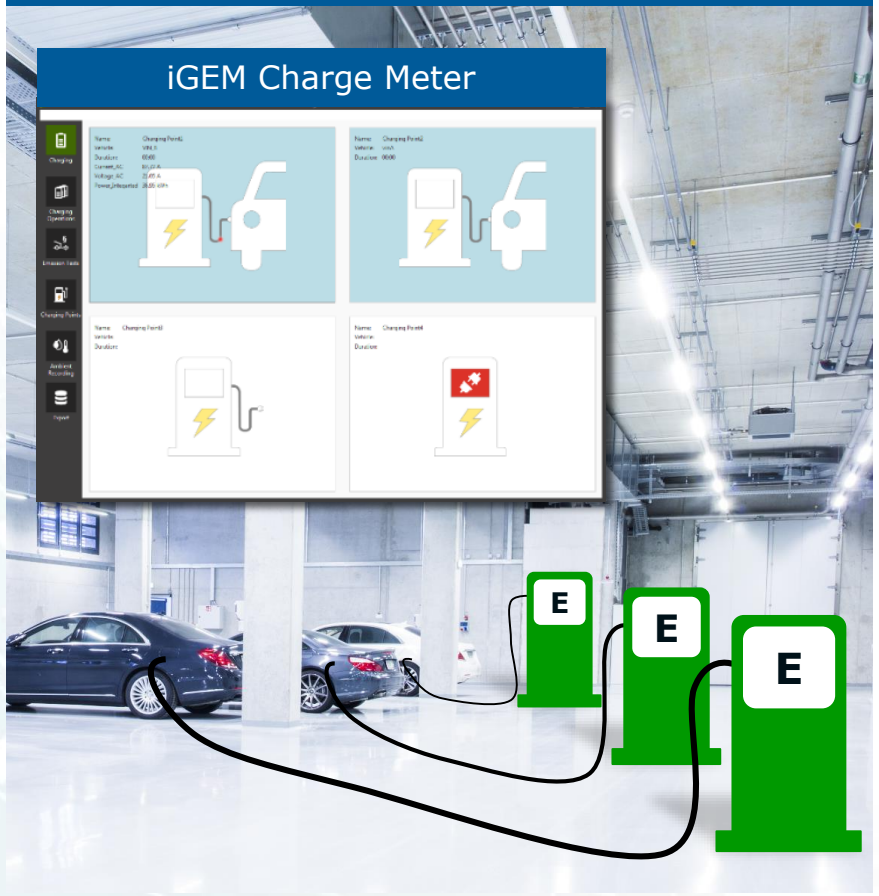




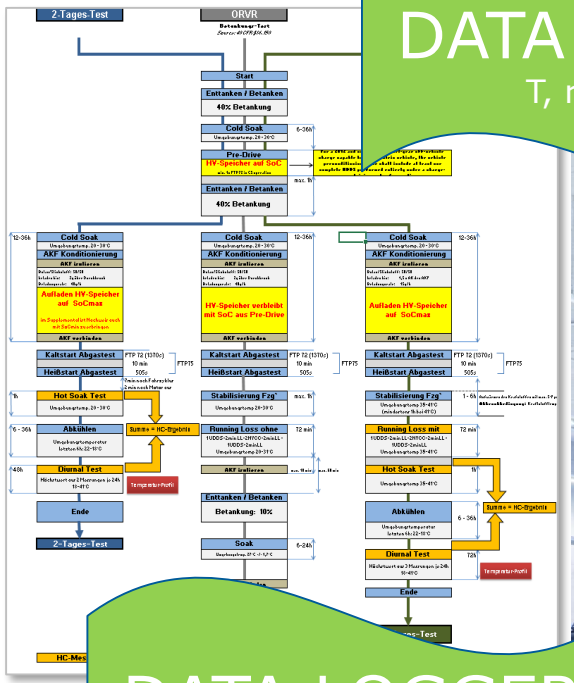
- Individuelle Komponenten-Tests z.B. Verschlauchung, Adapter, Pumpen, Ventile, etc.
- Spezifische R&D Anforderungen in Bezug auf Haltbarkeit oder alternative Materialien
- Simulationen und Messung für AKF-Durchflüssen (RDE) in Verbindung mit unterschiedlichen Höhen
- Erweiterungspaket für spezielle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

AVL – SOAK BEREICH - LÖSUNGEN

Soak Area

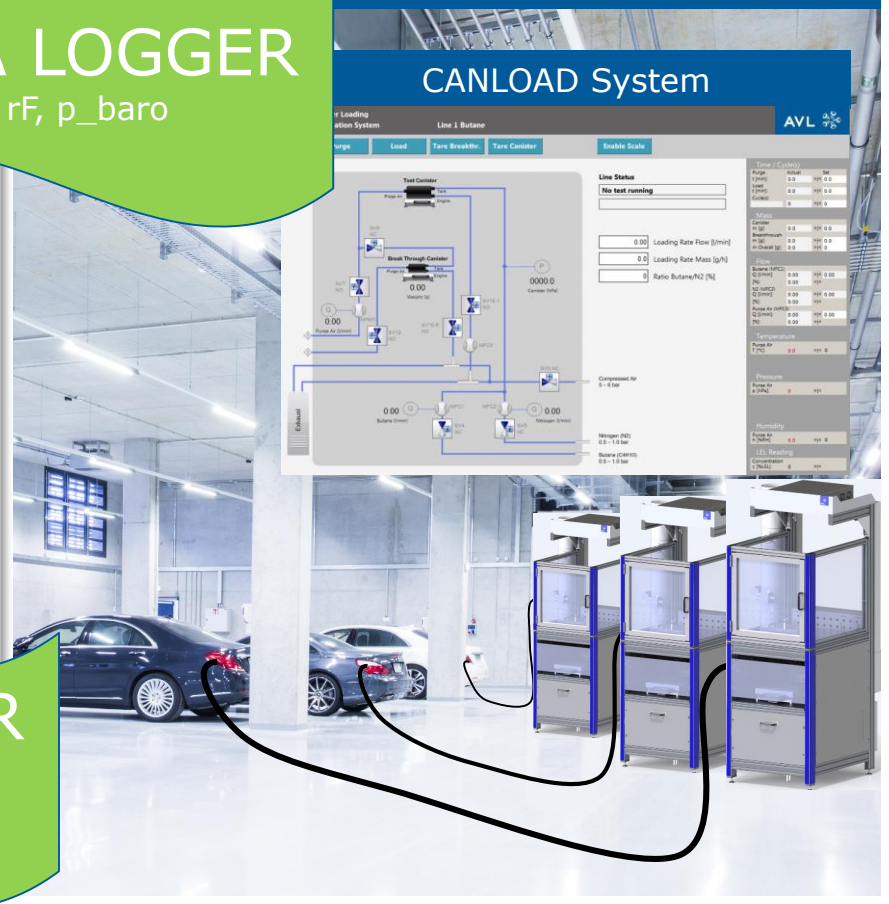


DATA LOGGER
T, rF, p_baro



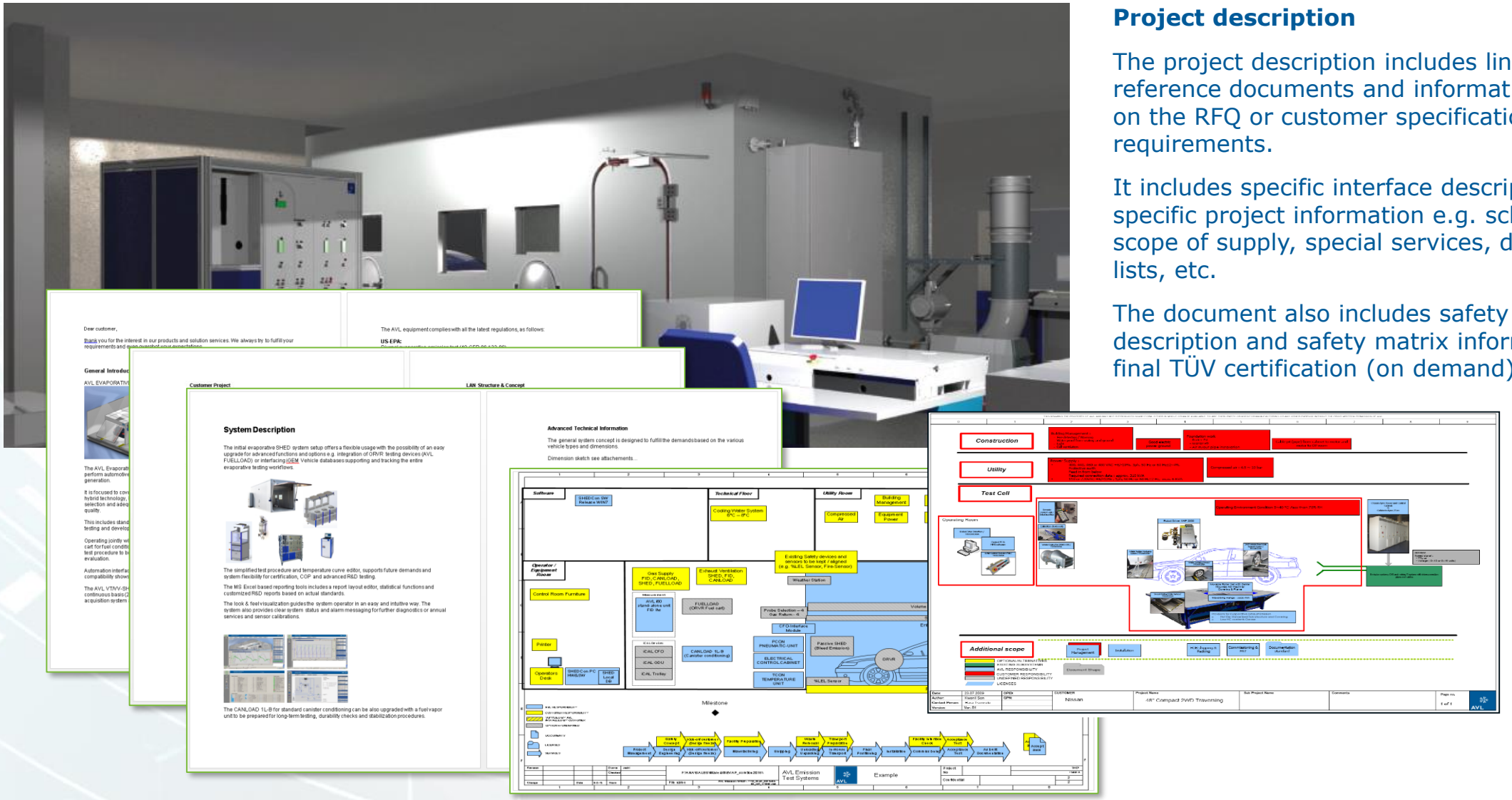
DATA LOGGER
For vehicle data
(T_oil, T_coolant)

Soak Area



Hybrid vehicles require both !

PROJEKT-BESCHREIBUNG (CRS)



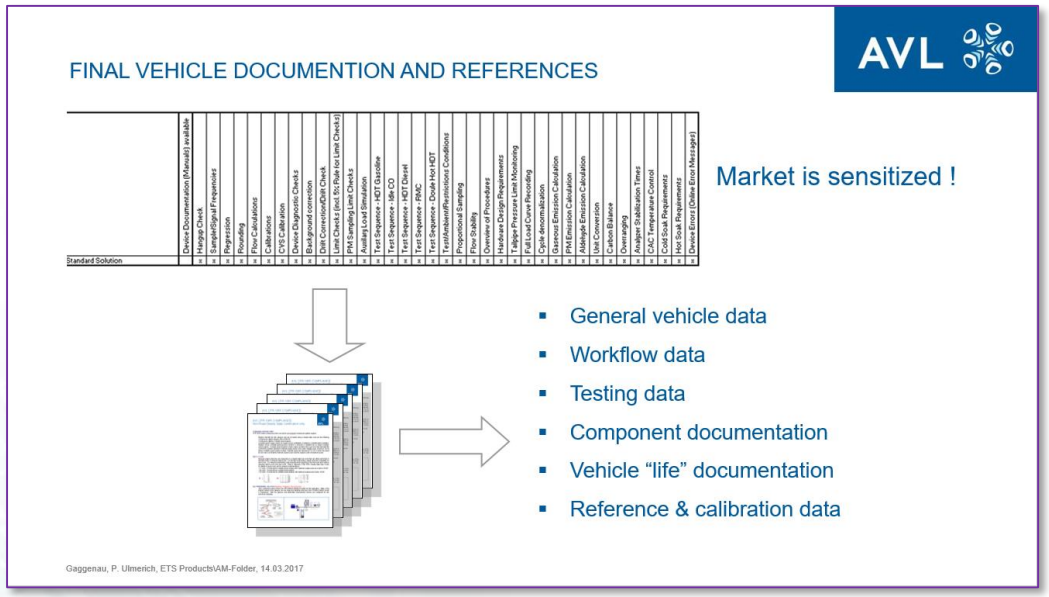
Project description

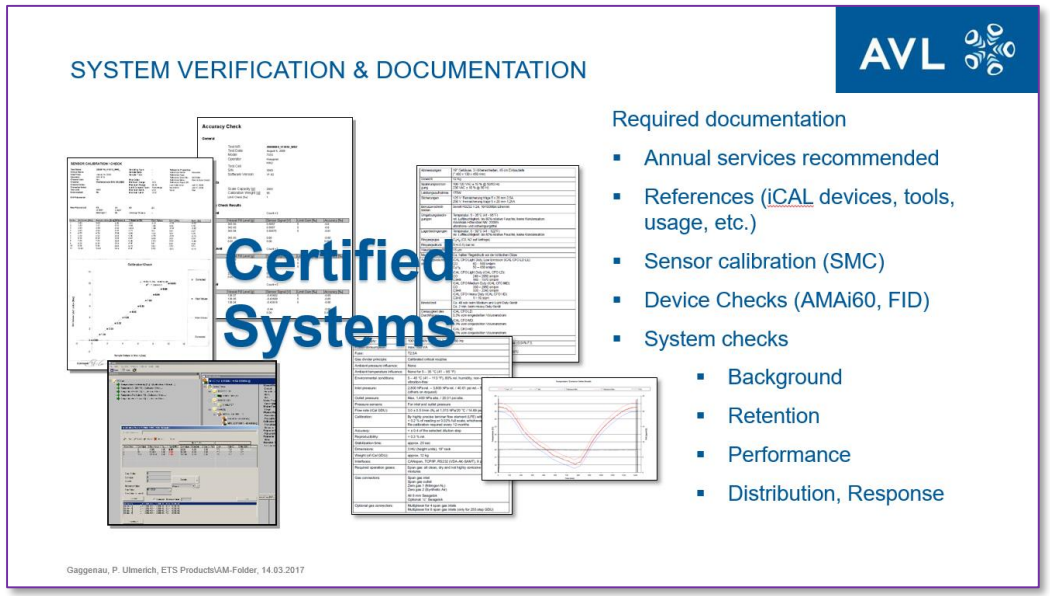
The project description includes links to reference documents and information based on the RFQ or customer specifications and requirements.

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).

SYSTEM KALIBRIERUNG & DOKUMENTATION





Market is sensitized !

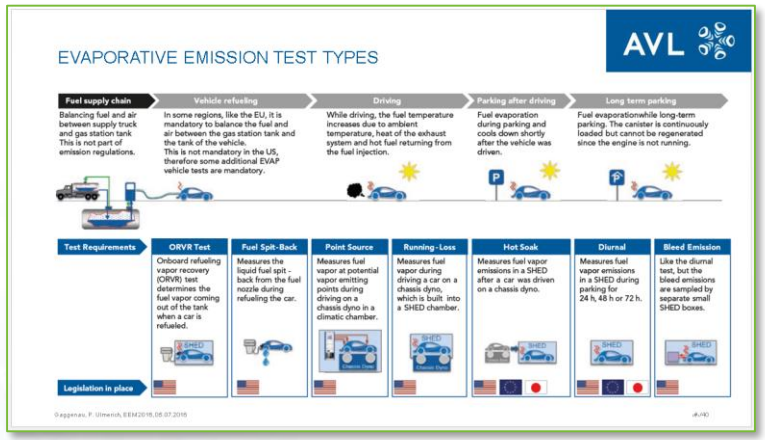
Is the system compliant according to the actual regulation?

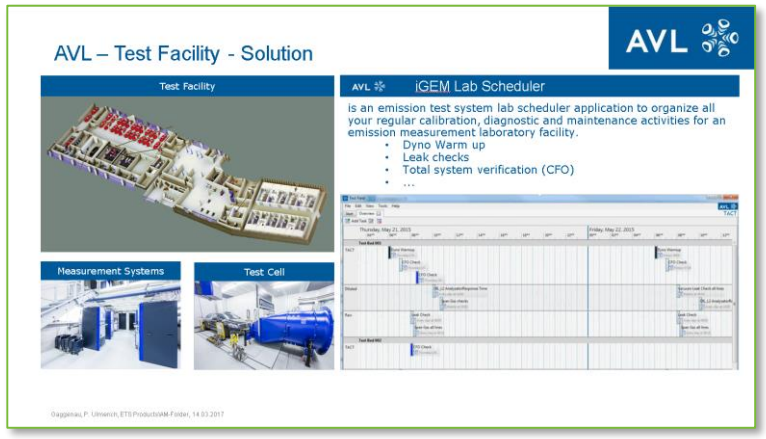
How can I prove and argue the compliance? Is the calibration and annual service documented and stored?

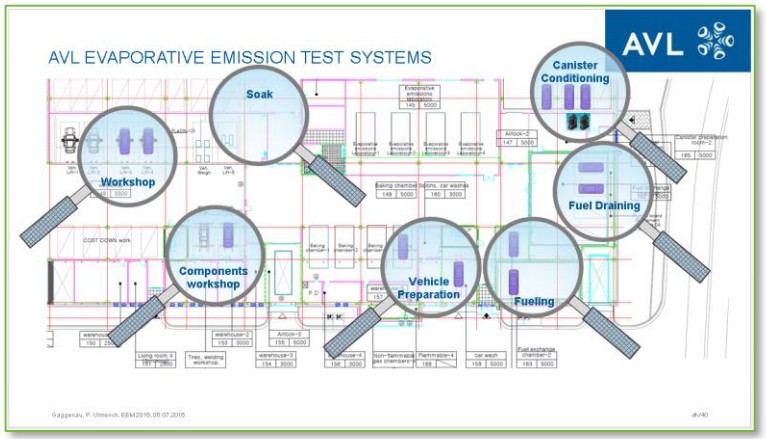
How about ISO 17025? Solutions & Concepts available?

Dakks Calibration? Ready for regulation audits?

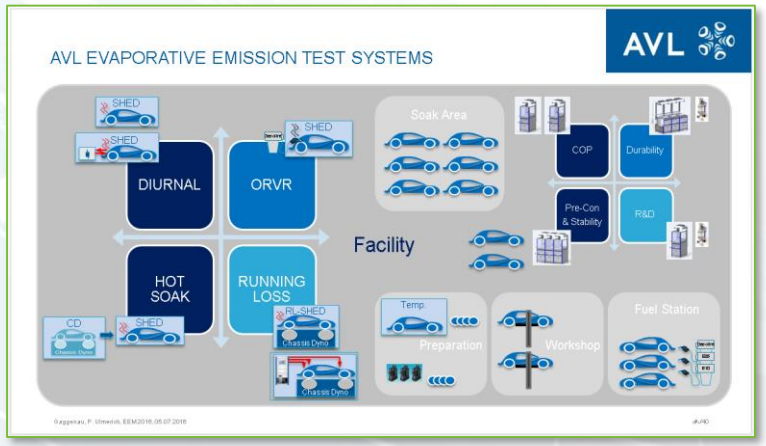
EVAP WORKFLOW / GEBÄUDE-INTEGRATION

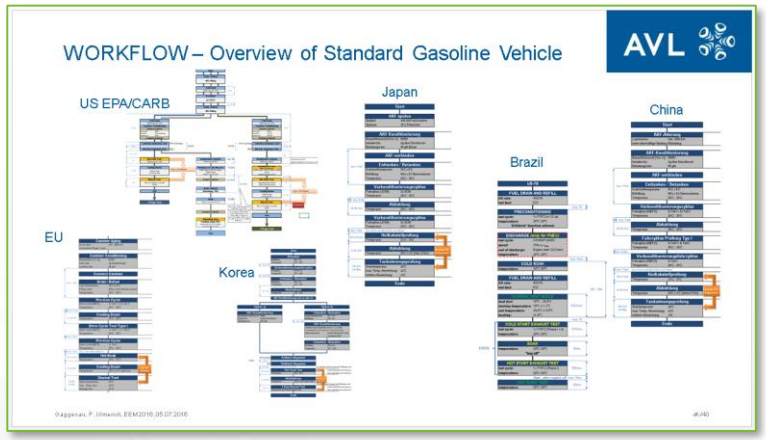


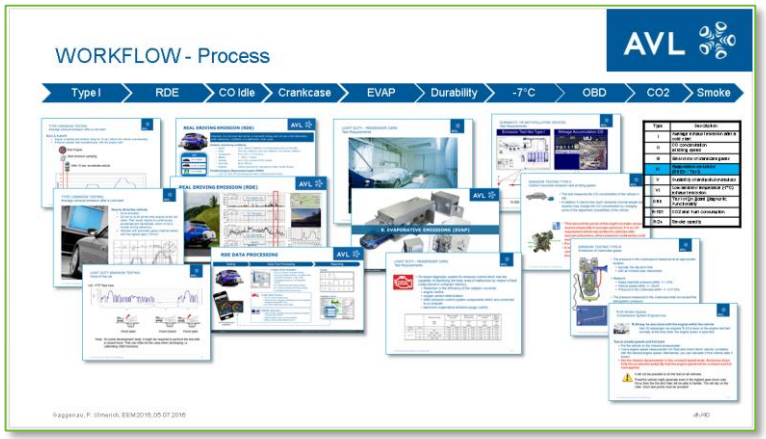




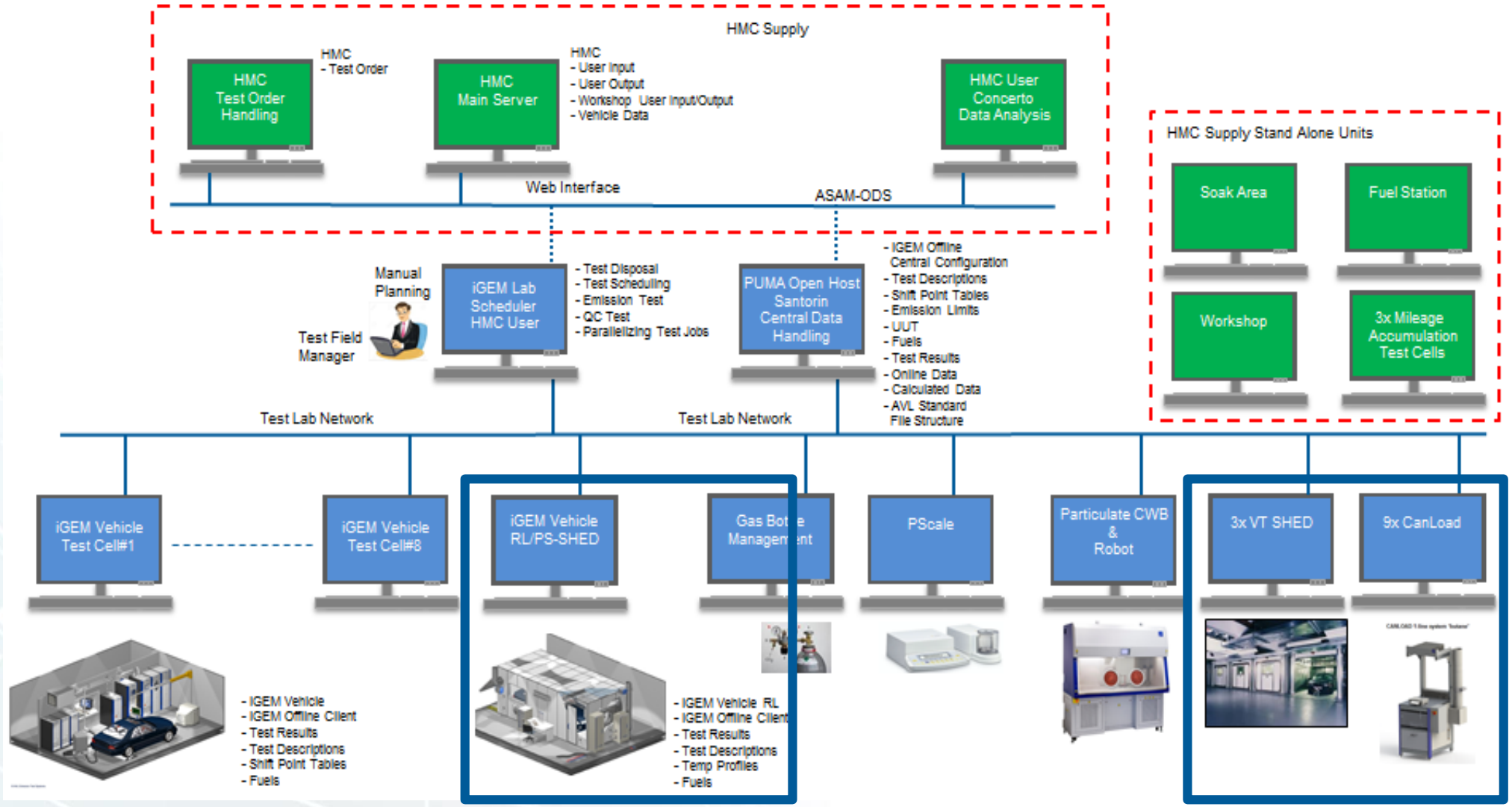
→ Optimized workflows, device networking, facility interfaces, data links (pre- and post data)







iGEM VITA - OVERVIEW



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 ± 15 percent fuel vapor by volume)** or a mixture of fuel vapor and air (50 ± 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.

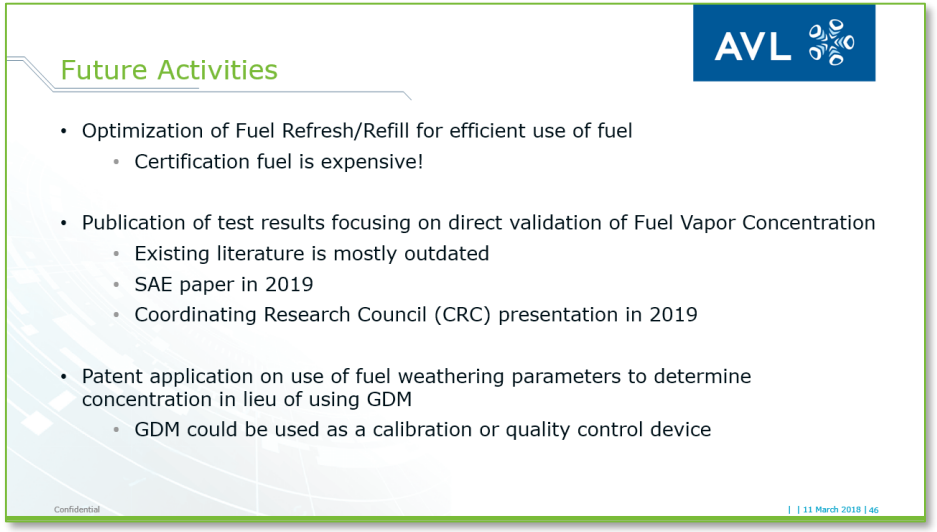
Regulated Standards for vapor mix

- 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 ± 15 percent fuel vapour volume. The fuel vapour fill rate shall be kept between 60 ± 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.

- **What is required to verify the 50±15% (vol.) fuel vapor concentration in the mixture?**
  - Direct measurement is difficult due to variation in vapor properties caused by fuel weathering.
    - ρ_{vapor}= f(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



- Incorporation of Gas Density Meter (GDM) allows for direct validation of 50 ± 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

Verdunstungsemissionen

- Markttrends

  Gesetzgebung & Neuigkeiten

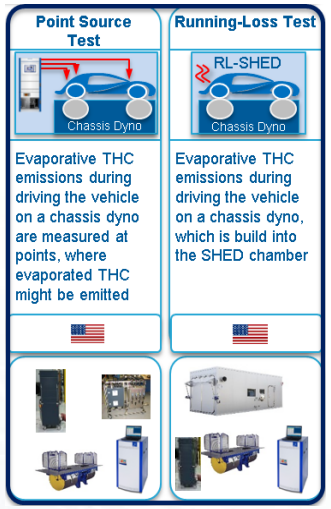
- Technologie

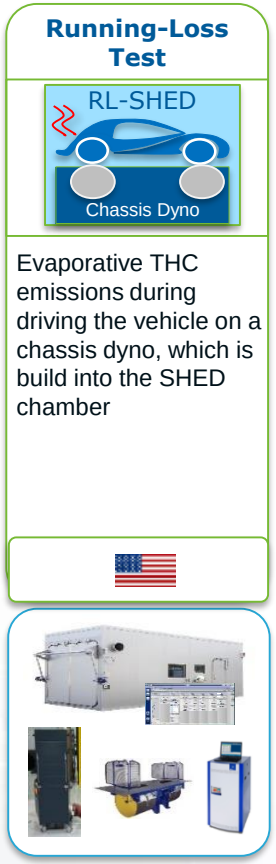
  AKF-Konditionierung Kraftstoff

- **RL-Testing**

- Resümee

RL-TESTING


Point Source Test
Chassis Dyno
Evaporative THC emissions during driving the vehicle on a chassis dyno are measured at points, where evaporated THC might be emitted
Running-Loss Test
RL-SHED
Chassis Dyno
Evaporative THC emissions during driving the vehicle on a chassis dyno, which is build into the SHED chamber


Running-Loss Test
RL-SHED
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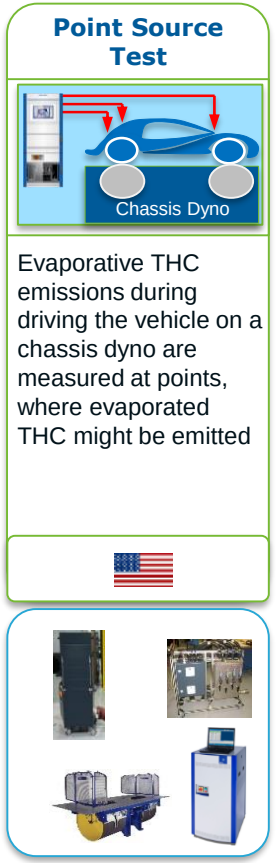
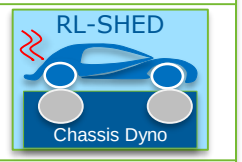

Point Source Test
Chassis Dyno
Evaporative THC emissions during driving the vehicle on a chassis dyno are measured at points, where evaporated THC might be emitted


Stand-alone


Add-On Modules

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:

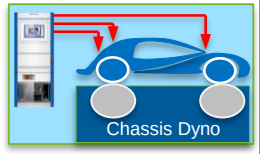
- AVL’s recommended solution concerning analytical response
- Analytical reliability level is high
- Temperature conditioning is approved and designed for RL-Testing
- Optimized analytical setup inside
- Test sequence possible to include Hot Soak after the RL-Test
- Analytical and device installation 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

Point Source Test



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

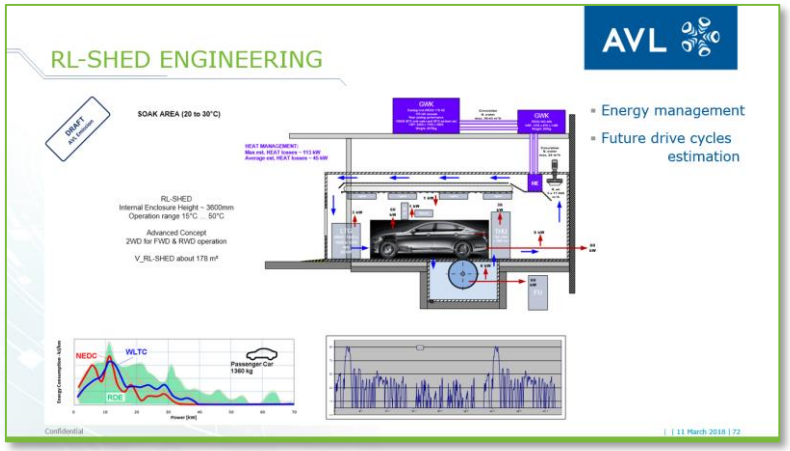
Pro’s:

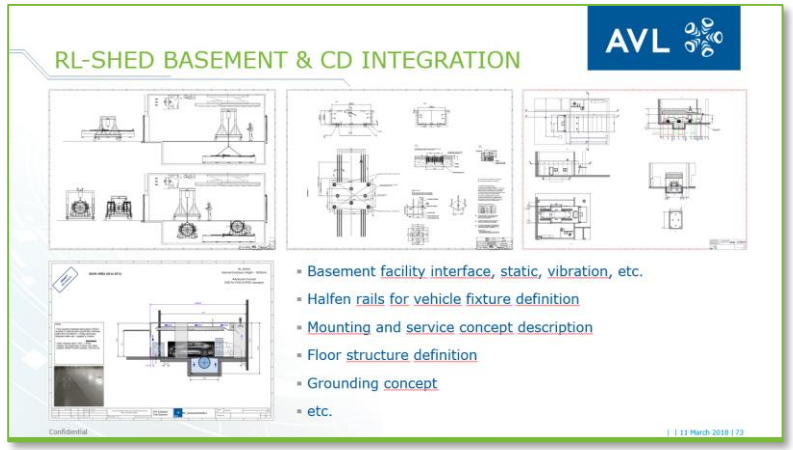
- Can be used inside an existing climate CD test cell
- Reduced budget required

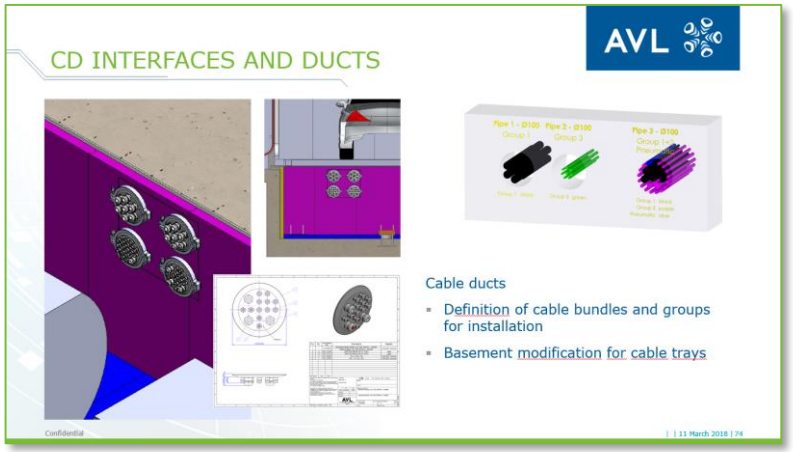
CON‘s:

- 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

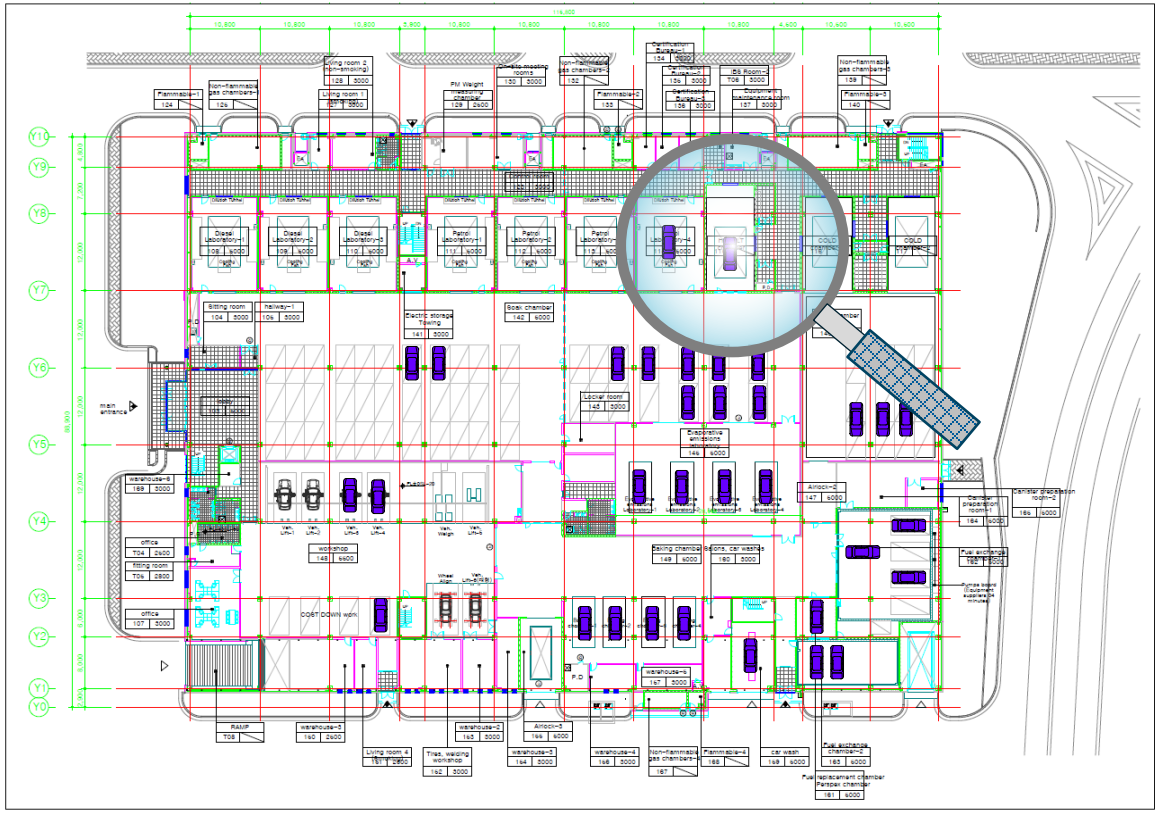


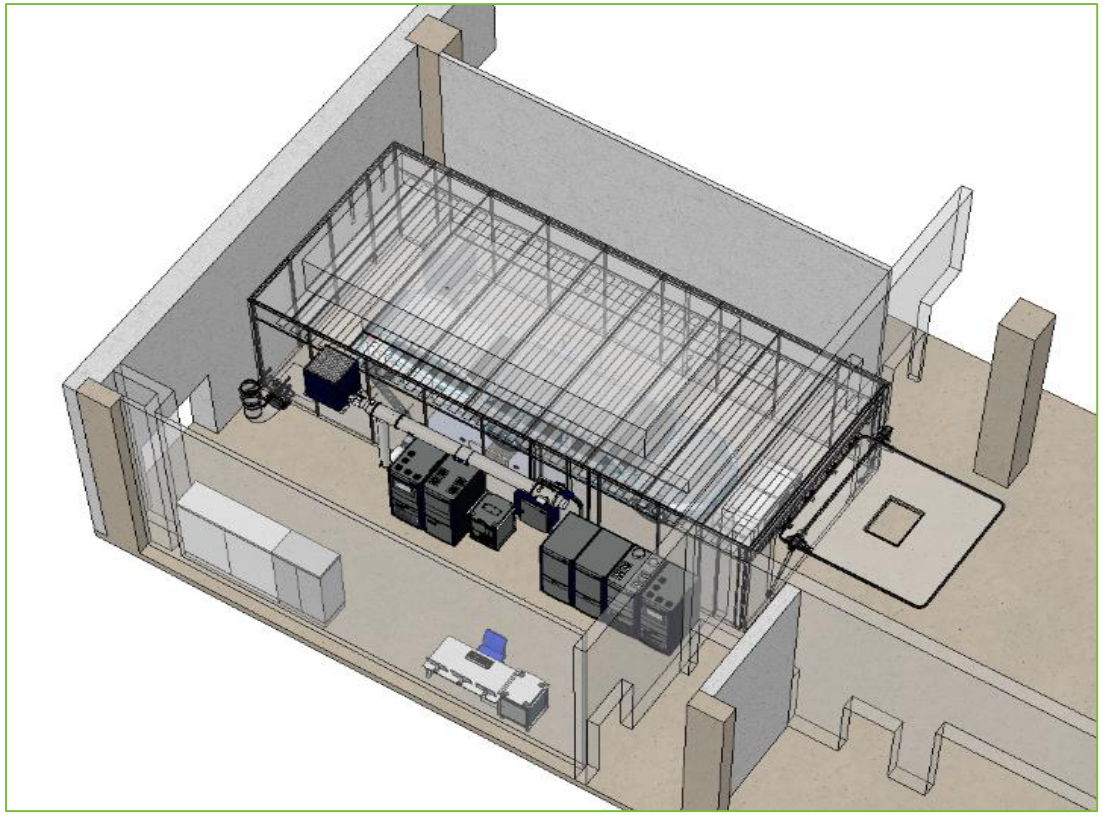




- AVL's Empfehlung für die Messung im RL-SHED System
  - Aufgrund der aktuellen Diskussionen und Marktbeobachtung in China sinnvoll
  - Techn. deutlich besseres Konzept
  - Nutzbar für die neuen Tanksysteme – Drucktanksystem
  - Flexible Nutzung durch das modernen Gesamtkonzept
  - Emissionsoptimierte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

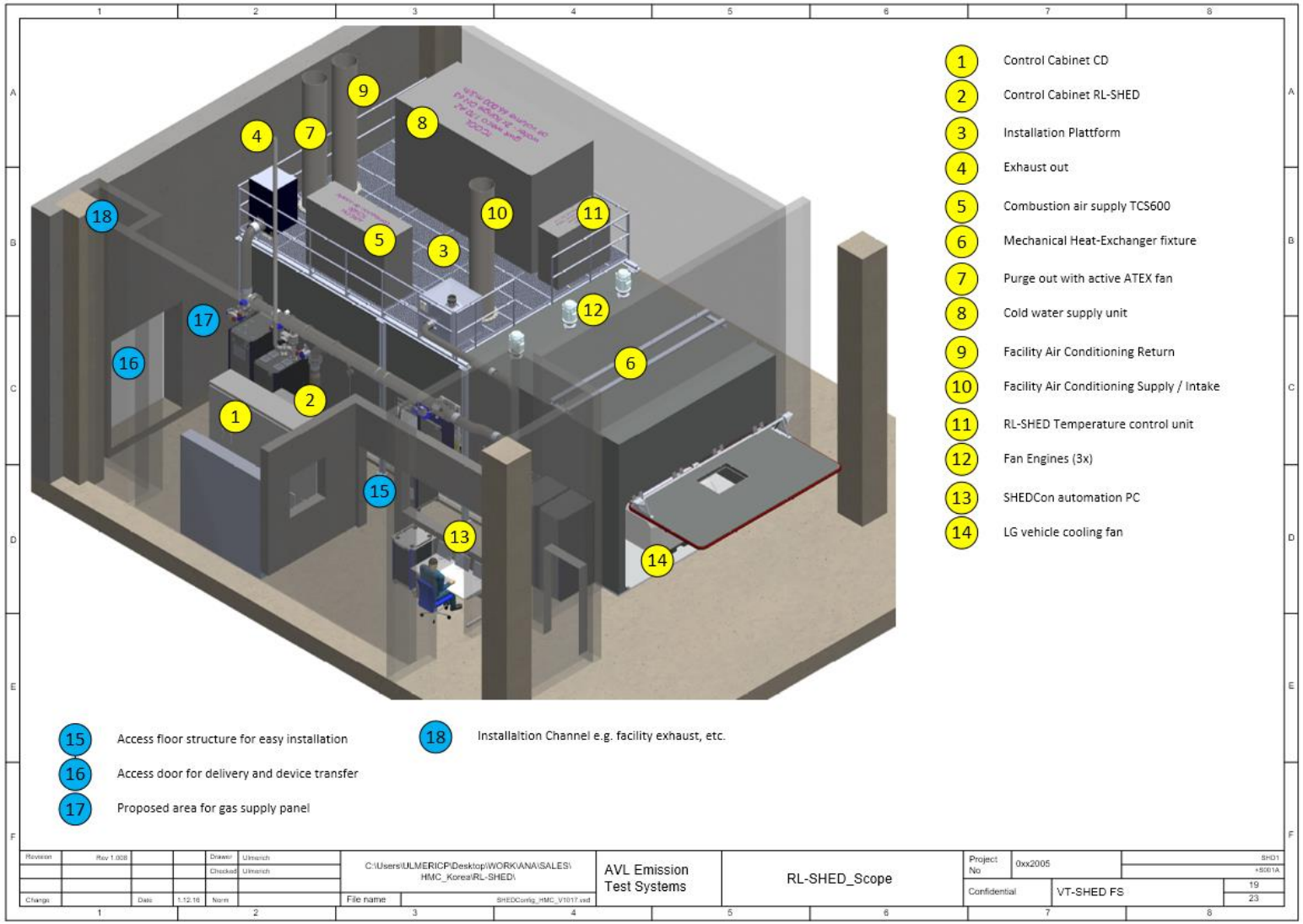
RL-TESTING – INNOVATION / KONZEPT

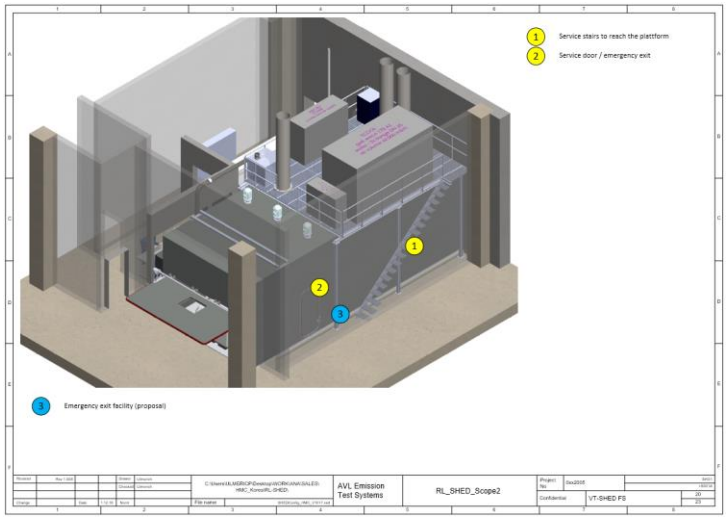




- AVL's test cell concept is supporting standard emission CD testing, vehicle conditioning and RL-SHED operation (incl. Hot-Soak SHED procedure)
- Multiple test cell operation modes

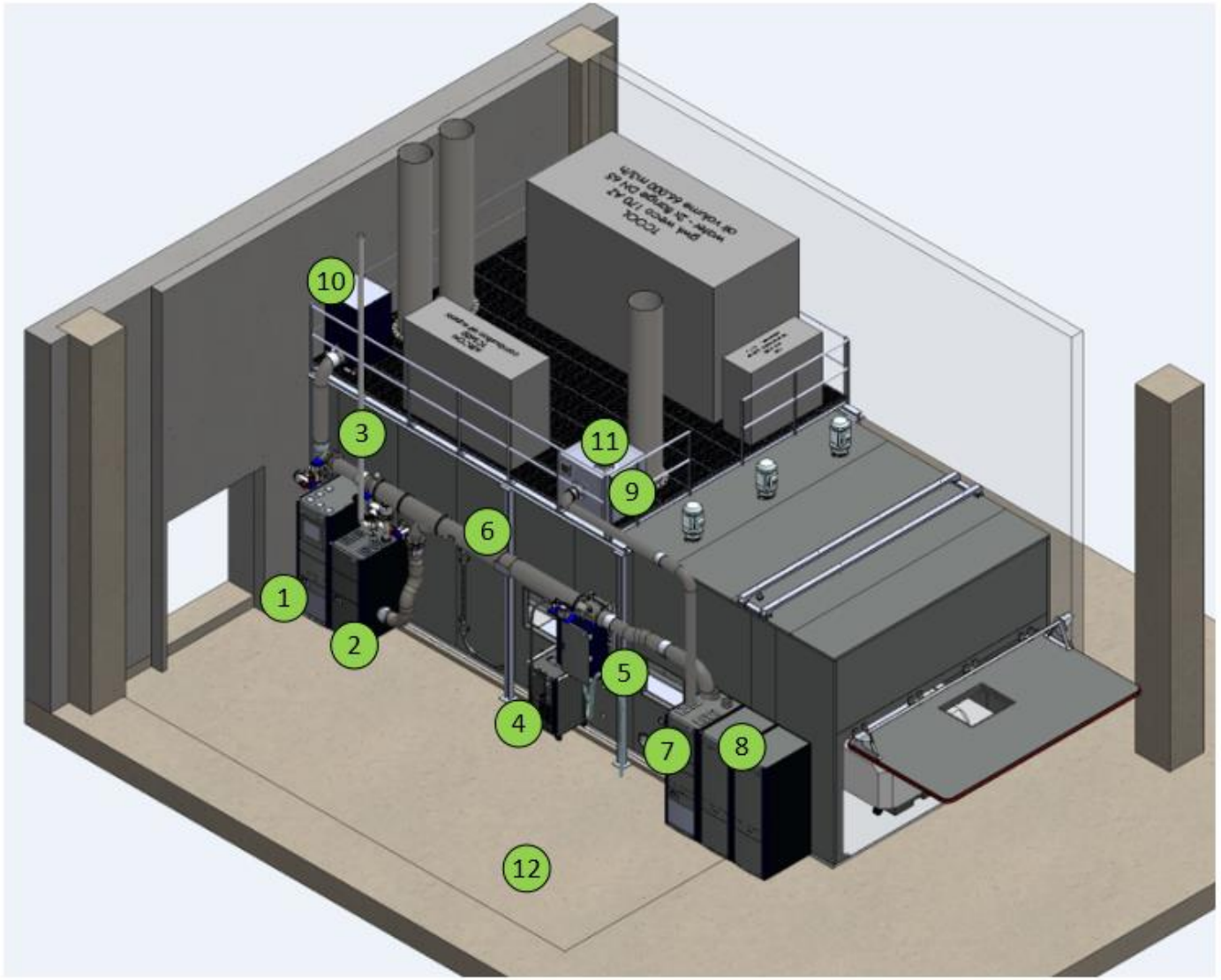
RL-SHED MODULE LAYOUT CONCEPT





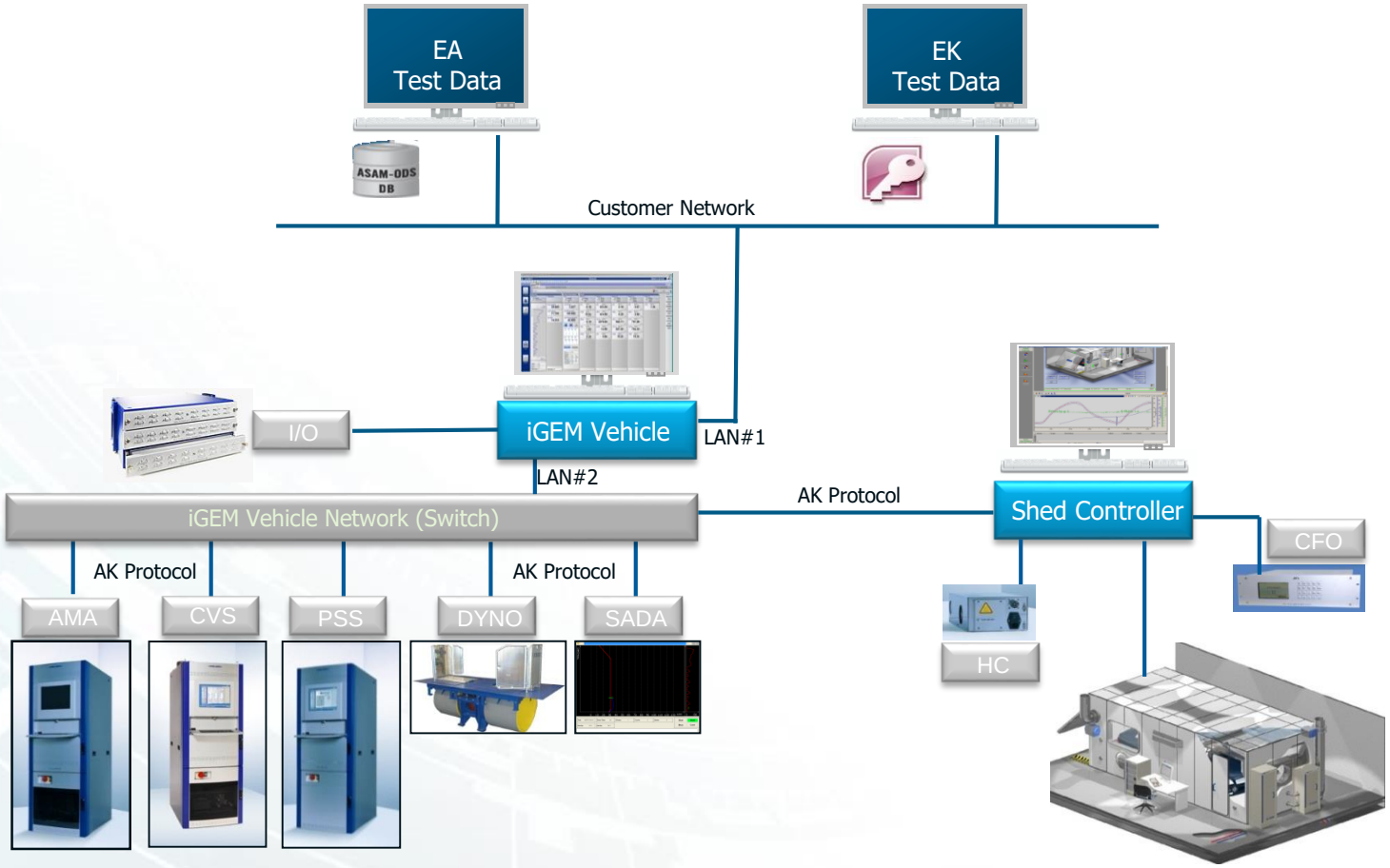
- Gesamtprüfstand aus 100% AVL
- Modulare Struktur von Einzelgeräten z.B. THU, TCS, TCON, HE, etc.

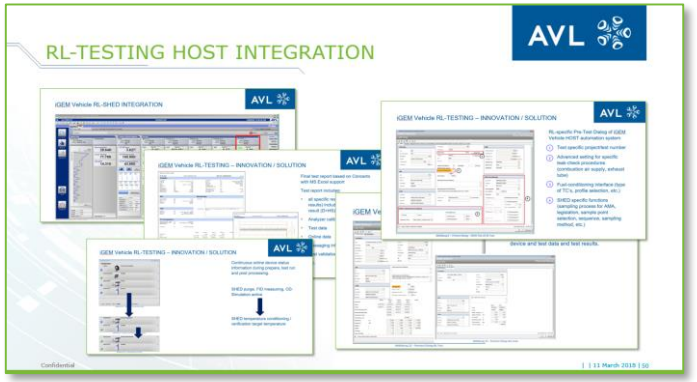
RL-SHED – EXHAUST EMISSION PACKAGE

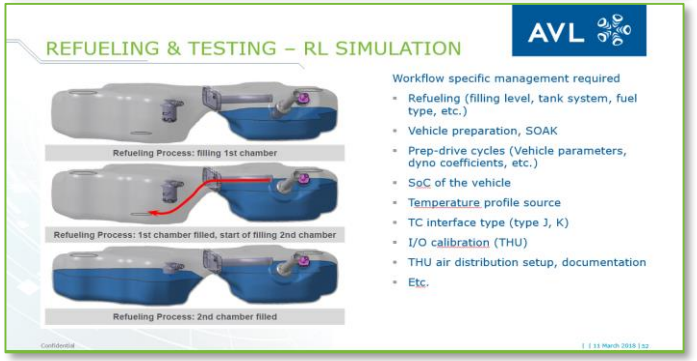


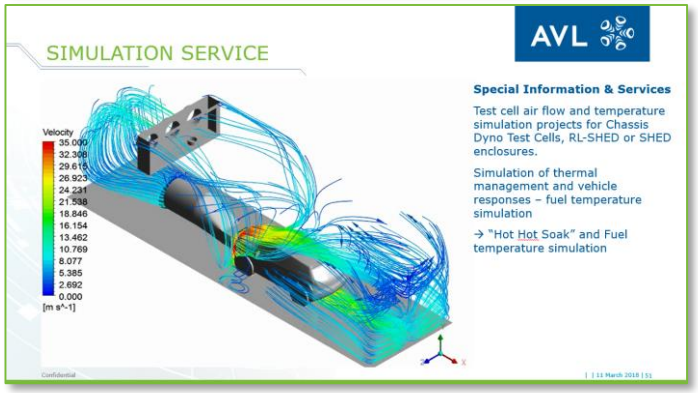
1. AMA, diluted
2. HFID, Particulate cabinet
3. Exhaust tubing
4. APC
5. PM Filters
6. Dilution Tunnel
7. CVS Control Cabinet
8. CVS Bag Cabinets
9. CVS Bower
10. CVS Dilution Air Filter Unit
11. CVS Blower Silencer
12. iGEM Vehicle Host System

RL-SHED HOST INTEGRATION









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

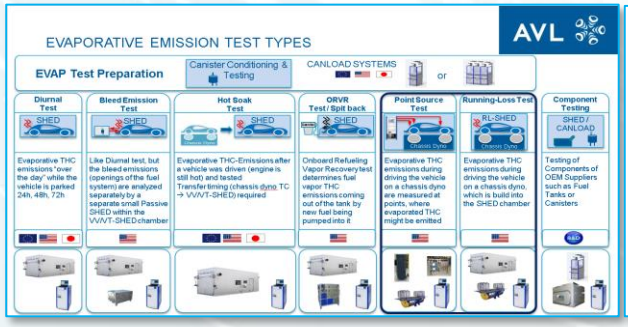
Hot Soak

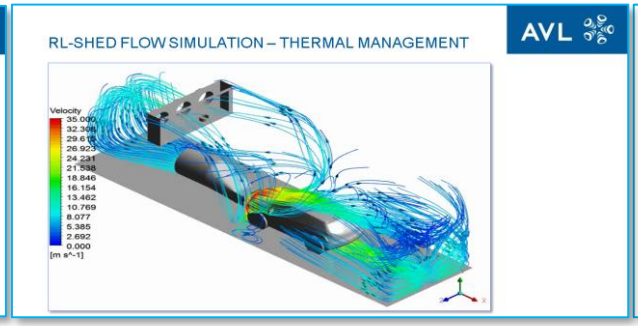
SHED TESTING SOLUTIONS & TRENDS

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 handli		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





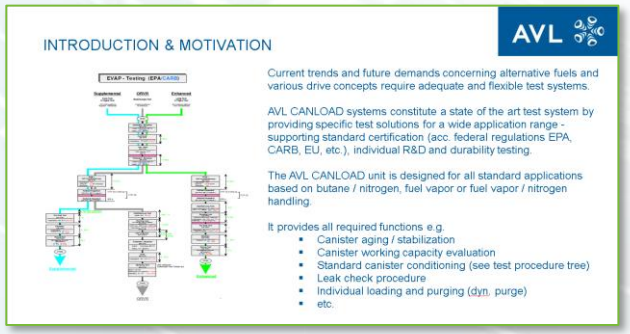
CANISTER TESTING SOLUTIONS & TRENDS

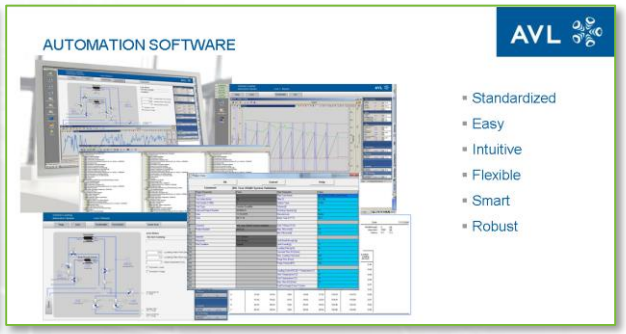
Beside the general various market trends(see SHED Testing Solutions & Trends), the RDE (Real Drive Emissions) discussion “being more realistic” are pushing the entire testing and simulation environment to higher level of flexibility and functionality to fulfill future demands of - vehicle and device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

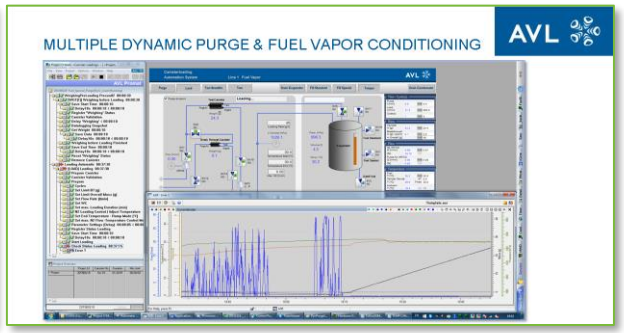
Local emission levels and problems are forcing governments to modify or create their individual legal emission regulation targets (e.g. China, Beijing) with possible consequences like:

- ✓ 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?

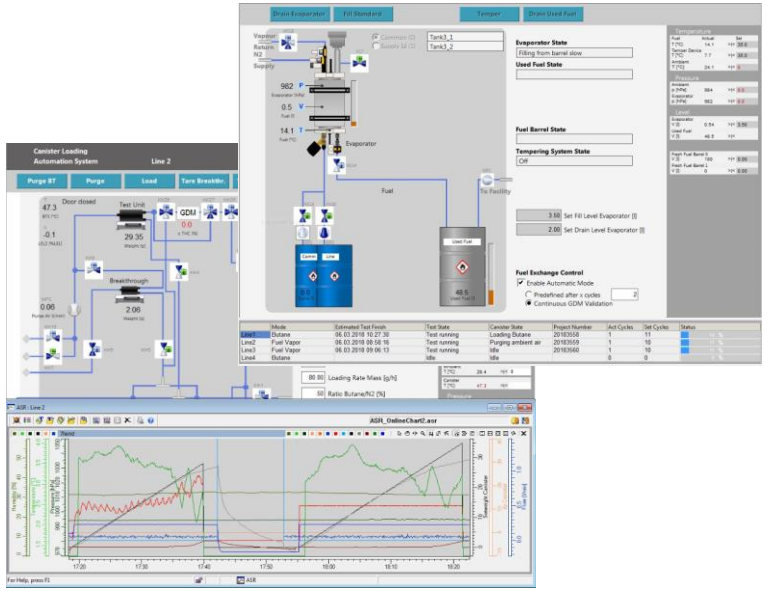






REFERENCES CUSTOMERS & PARTNERS

VERDUNSTUNGSEMISSIONEN - LÖSUNGEN



Vielen Dank