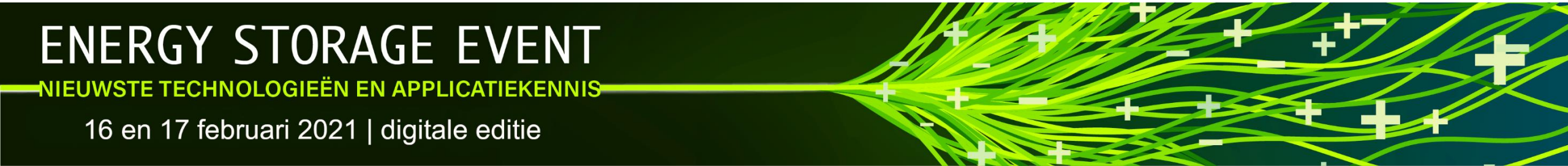
Customized battery testing – step by step

Weiss Technik - For a Safe Future



weisstechnik® – The world´s leading climate solutions

- **weiss**technik®
  - Environmental Simulation
    weisstechnik is one of the most innovative and significant manufacturers of environmental simulation systems.
  - Heat Technology
    vötschtechnik has a wide product portfolio in the field of heating technology.
  - Air-conditioning Technology
    weissklimatechnik is one of the leading providers of professional cleanroom and precise climate solutions.
  - Pharmaceutical Technology
    weisspharmatechnik is a competent provider of sophisticated clean room and containment solutions.
- Experts around the globe
  - 23 companies
  - In 15 countries
  - More than 2500 employees

weisstechnik®
a schunk company

ENERGY STORAGE EVENT

16 en 17 februari 2021
DIGITALE EDITIE

Future visions with Batteries

weisstechnik®
a schunk company
ENERGY STORAGE EVENT
16 en 17 februari 2021
DIGITALE EDITIE

Requirements on energy storages

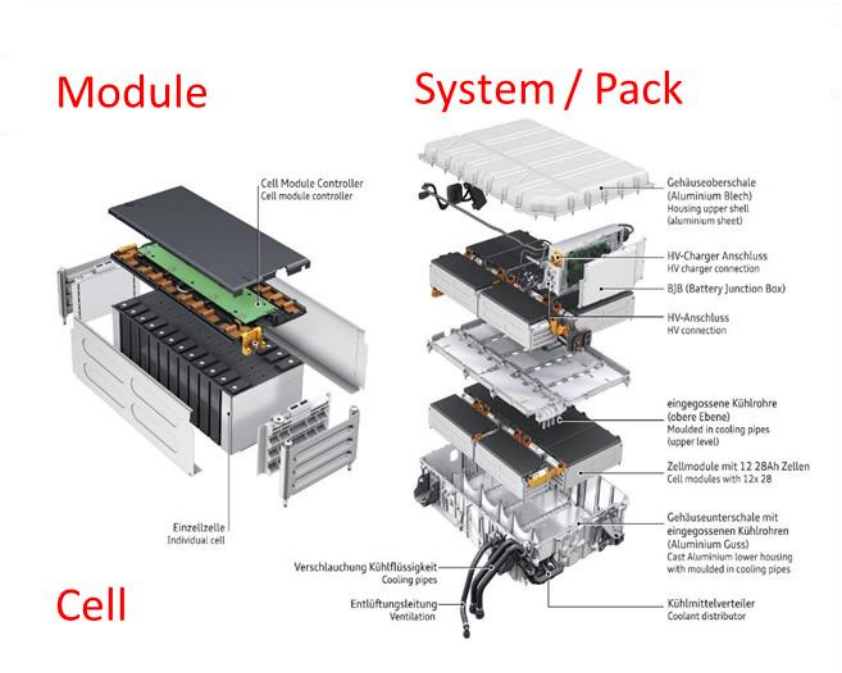
- ✓ Long duration.. Much power..
- ✓ Rechargeable
- ✓ Fast charging!
- ✓ Light
- ✓ Small
- ✓ Long Lifecyle / infinite number of rechargeability
- ✓ No heat development
- ✓ Long-term warehousing (with no further checks)
- ✓ Weather-resistant (Warm, Cold, moisture, …)
- ✓ Low price

weisstechnik®
a schunk company
ENERGY STORAGE EVENT
16 en 17 februari 2021
DIGITALE EDITIE

Li-Ion Batteries – Different Sizes - Appearances

- Lithium-Ion battery cells come
  - In different sizes
  - And shapes

- Traction battery systems
  - Are typically made of Cells which are combined in Modules
  - The System or Pack consists out of modules
  - In addition, the systems require:
    - Structural enclosures
    - Management
    - Electronics
    - Cabling and cooling.



CE

weisstechnik®
a schunk company
ENERGY STORAGE EVENT
16 en 17 februari 2021
DIGITALE EDITIE

Many different chemical combinations

Which one is the best?

It always depends on your application…

weisstechnik® a schunk company

ENERGY STORAGE EVENT

16 en 17 februari 2021
DIGITALE EDITIE

Li-ionMn – the perfect combination

weisstechnik®
a schunk company

ENERGY STORAGE EVENT

16 en 17 februari 2021
DIGITALE EDITIE

Mistakes and dangers with energy storages

- Top 3 most done mistakes with batteries:
- Too long in stock (with no control)
- Stock in wrong environmental conditions (Temperature, Humidity)
- Wrong charging (wrong charger, charging process, charging time)
- Top 3 most dangerous mistakes with batteries:
- Overload or wrong loading
- Mechanical damage
- Overheating

No chance for not testing...

(Only Li-Ion batteries have over 40 different test specifications)

weisstechnik®
a schunk company
ENERGY STORAGE EVENT
16 en 17 februari 2021
DIGITALE EDITIE

Step by step process flow

1 Requirement analysis

In joint workshops with our customers, we specify the required test standards, test capacities and other requirements of the planned testing laboratory.

2 Definition of scope of supply

A project team, consisting of weisstechnik experts and customers, defines the technical specifications for all relevant subsections. We then quote a non-binding budget price.

3 Technical definition of subsections of the project

A project team, consisting of weisstechnik experts and customers, defines the technical specifications for all relevant subsections. We then quote a non-binding budget price.

4 Binding quotation

After finalizing and consolidating all subsections, we prepare a binding quotation. Within the framework of final agreements, changes can still be made if necessary.

5 Production of the test systems

After receiving an order, we plan and realize the test systems ordered. Depending on the requirements, we either modify proven standard systems or build completely new customer-specific units.

6 Installation and commissioning

After shipment, our experienced service technicians will install the test systems on site and commission them professionally.

7 Training of employees

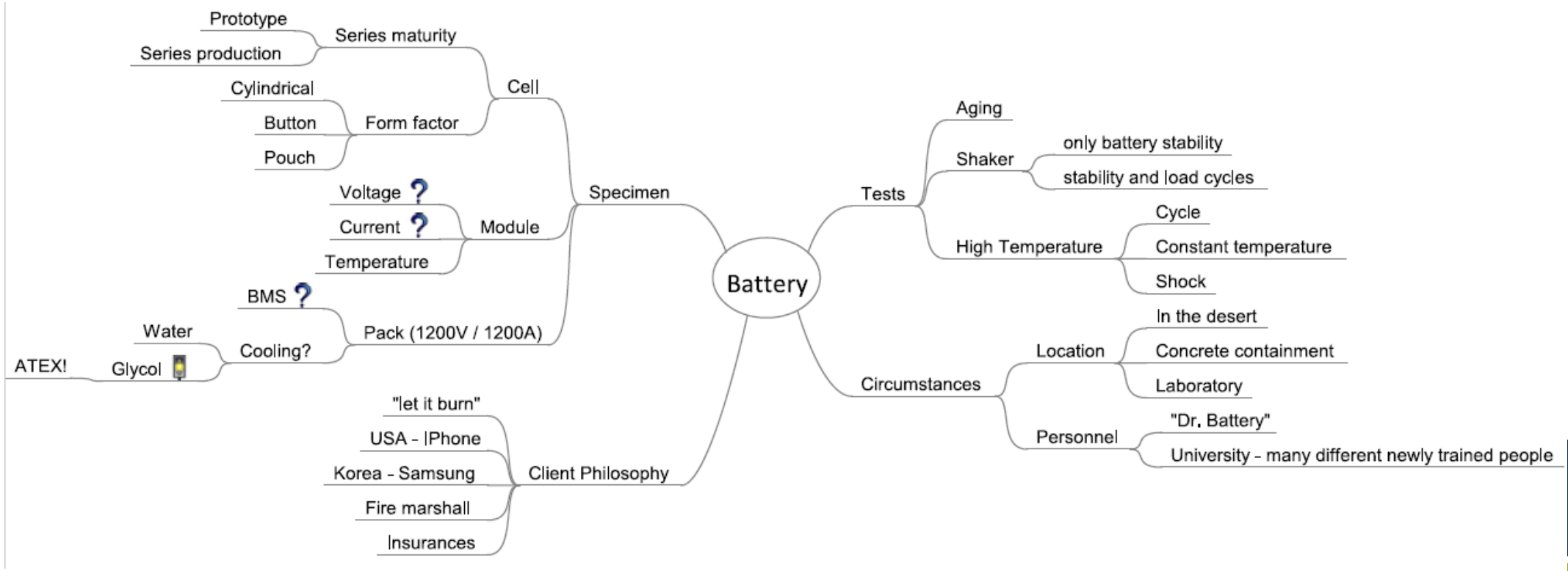
In the initial stage, we support our customers with personnel trainings for their employees. weisstechnik Academy also offers online and classroom trainings.

8 After sales service

Customer service is the focus of our thinking and acting. We offer a comprehensive service network with short response times, reliable support by qualified service technicians, preventive maintenance and reliable spare parts supply.

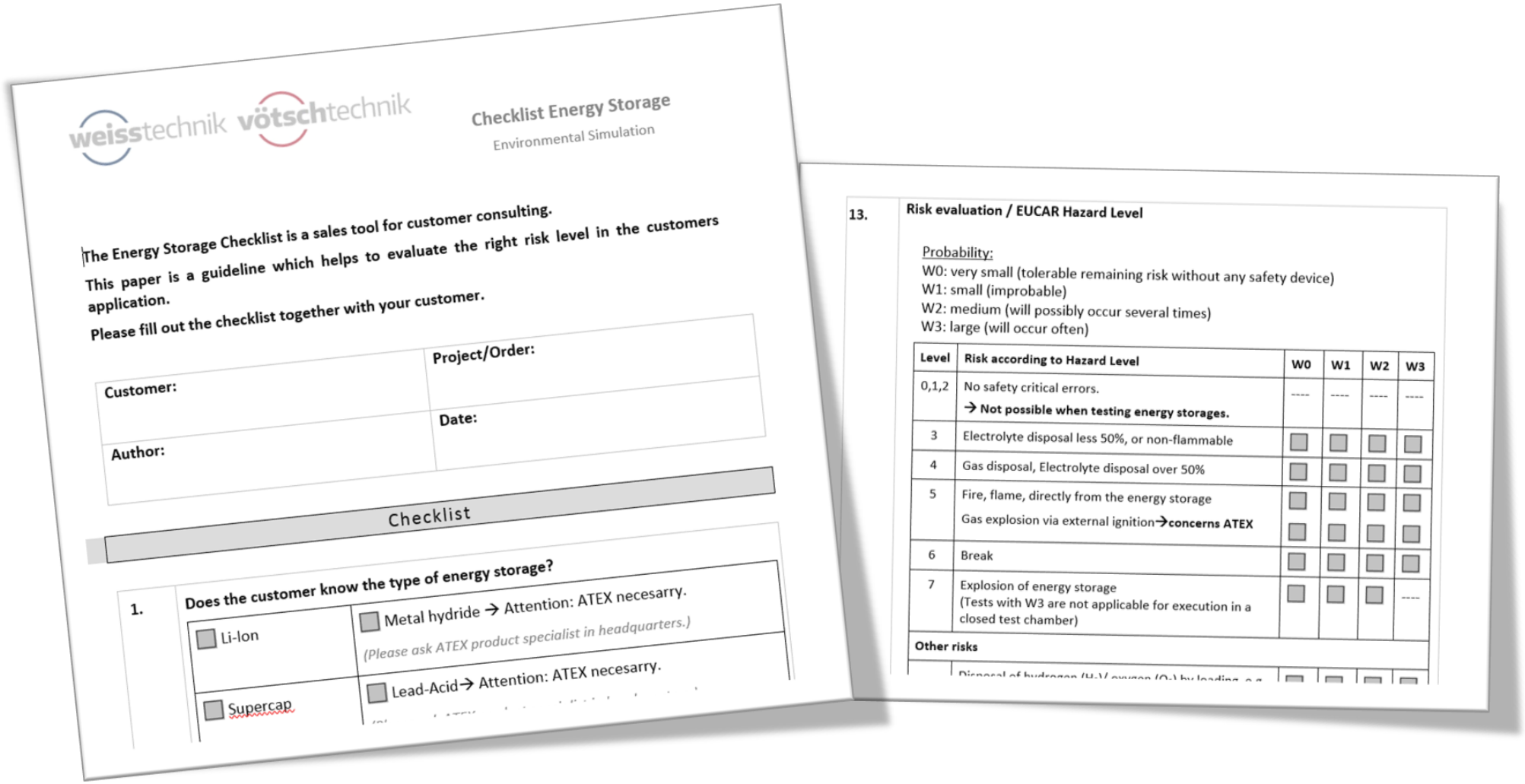
weisstechnik® a schunk company
ENERGY STORAGE EVENT
16 en 17 februari 2021
DIGITALE EDITIE

Brainstorming with customer



weisstechnik®
a schunk company
ENERGY STORAGE EVENT
16 en 17 februari 2021
DIGITALE EDITIE

Energy Storage Checklist



weisstechnik vötschtechnik

Checklist Energy Storage

Environmental Simulation

The Energy Storage Checklist is a sales tool for customer consulting.

This paper is a guideline which helps to evaluate the right risk level in the customers application.

Please fill out the checklist together with your customer.

Customer:	**Project/Order:**
Author:	**Date:**

Checklist

1. Does the customer know the type of energy storage?

☐ Li-Ion	☐ Metal hydride → Attention: ATEX necesarry. *(Please ask ATEX product specialist in headquarters.)*
☐ Supercap	☐ Lead-Acid→ Attention: ATEX necesarry.

13. Risk evaluation / EUCAR Hazard Level

Probability:

W0: very small (tolerable remaining risk without any safety device)
W1: small (improbable)
W2: medium (will possibly occur several times)
W3: large (will occur often)

Level	Risk according to Hazard Level	W0	W1	W2	W3
0,1,2	No safety critical errors. → **Not possible when testing energy storages.**	----	----	----	----
3	Electrolyte disposal less 50%, or non-flammable	☐	☐	☐	☐
4	Gas disposal, Electrolyte disposal over 50%	☐	☐	☐	☐
5	Fire, flame, directly from the energy storage Gas explosion via external ignition→**concerns ATEX**	☐ ☐	☐ ☐	☐ ☐	☐ ☐
6	Break	☐	☐	☐	☐
7	Explosion of energy storage (Tests with W3 are not applicable for execution in a closed test chamber)	☐	☐	☐	----
Other risks					

weisstechnik® a schunk company

ENERGY STORAGE EVENT

16 en 17 februari 2021

DIGITALE EDITIE

Which standard to apply?

Tests	Standards	Cabinets and Walk-Ins
Temperature Cycles	IEC 62660, IEC 62281, ISO 12405, ISO 16750, UL 2580, UL 2271, UL 1973, UL 1642, UL 2054, SAE J2929, SAE J2464, FreedomCAR, GB/T 31467.3, GB/T 31485 LV-124, UN 38.3, Telcordia GR-3150-CORE, UN ECE R100	TempEvent ShockEvent Temperature Walk-In
Constant Temperatures	UL 2580, LV-124, BATSO 01, UL 2271, ISO 16750, IEC 62660, IEC 62620, IEC 61960, ISO 12405, QC/T 743, Telcordia GR-3150-CORE, DOE-INL/EXT-15-34184	TempEvent HeatEvent Temperature Walk-In
IP Tests	BATSO 02, LV-124, ISO 16750	Dust Test Device ST Spray and Splash Water SWT
Corrosion Tests	UL 2580, UL 19973, LV-124, ISO 16750, Telcordia GR-3150-CORE	SaltEvent Corrosion Walk-In AirEvent
Mechanical Shock/ Vibration	IEC 62660, IEC 62281, IEC 62133, IEC 61960, ISO 12405, ISO/FDIS 6469, SAE J2929, SAE J2464, UL 2580, UL 1642, UL 2271, UL 1973, UL 2054, UN 38.3, LV-124, BATSO 01, BATSO 02, FreedomCAR, UN ECE R100, Telcordia GR-3150-CORE, GB/T 31467.3, QC/T 743	ShakeEvent
Altitude Simulation	UN 38.3, IEC 62281, GB/T 31485, UL 1642, BATSO 01, Telcordia GR-3150-CORE	SkyEvent
Damp Air/ Dewing	ISO 12405, ISO 16750, GB/T 31467.3, LV-124, SAE J2929, UL 1973, Telcordia GR-3150-CORE	ClimeEvent ClimeEvent Walk-In

weisstechnik®
a schunk company
ENERGY STORAGE EVENT
16 en 17 februari 2021
DIGITALE EDITIE

Fe LV 124 – often used in car industry

14 Climatic requirements and tests

14.1 K-01 High/low temperature storage

14.1.1 Purpose

This test simulates the thermal exposure of the component during storage and transport.
The test is intended to verify the resistance to storage at high or low temperatures, e.g. during the transport of the component (plane, ship container).
If the test is carried out at the beginning of a test sequence, it is also intended to adjust all components to the same initial conditions.

14.1.2 Test

Table 64: Test parameters K-01 High/low temperature storage

Operating mode of the DUT	Operating mode I.a
Test duration and test temperature	2 cycles of 24 h (consisting of 12 h storage at T_{min} and 12 h storage at T_{max})
Number of DUTs	As specified in the test sequence plan in the Component Requirement Specification.

14.1.3 Requirement

The DUT shall be fully functional before and after the test and all parameters shall meet the specifications. Verification is done by means of a parameter test (large) as per Section 10.4.

2.5.1.1 Betriebsart I.a

Der Prüfling ist unbestromt, ohne Stecker und Leitungssatz.

14.2 K-02 Temperature step test

14.2.1 Purpose

This test simulates the operation of the component at different ambient temperatures. The test is intended to verify the resistance of the component to malfunctions that may occur within a small interval of the operating temperature range.

14.2.2 Test

Table 65: Test parameters K-02 Temperature step test

Operating mode of the DUT	During the parameter test (function test) operating mode II.c, otherwise operating mode II.a
Test temperature	The DUTs shall be subjected to the temperature profile shown in Figure 32. Temperature change of 5 °C for each step.
Test sequence	The DUT shall be maintained at each temperature step until the specified temperature is attained throughout (see Section 10.4). This shall be followed by a parameter test (function test) as per Section "Parameter test" (see Section 10.4).
Number of DUTs	6

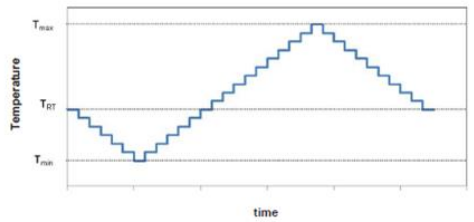


Figure 32: Temperature profile for temperature step test

For components attached to a coolant circuit the coolant temperature shall follow the relevant test temperature between $T_{cool,min}$ and $T_{cool,max}$. Outside the coolant temperature limits, only the ambient temperature shall be varied.

14.2.3 Requirement

All parameters of the DUT shall lie within the specification during each parameter test (function test).

10.2.3 Operating mode II – DUT electrically connected

10.2.3.1 Operating mode II.a

The DUT shall be operated without operating load.
Any existing coolant circuit shall be filled, and the coolant hoses shall be connected. If required, the flow rate and temperature of the coolant shall be adjusted - as specified in the Component Requirement Specifications.

10.2.3.3 Operating mode II.c

The DUT shall be operated with maximum operating load (power user, but no misuse).
The DUT shall be operated such that maximum self-heating occurs (for example by means of a realistic maximization of a continuous output power or frequent activation of external loads).
Any existing coolant circuit shall be filled, and the coolant hoses shall be connected. If required, the flow rate and temperature of the coolant shall be adjusted - as specified in the Component Requirement Specifications.

10.4 Parameter test

A set of sensitive parameters, so-called key parameters, e.g. closed-circuit current consumption, operating currents, output voltages, contact resistances, input impedances, signal rates (rise/fall times) and bus specifications, shall be defined in the Component Requirement Specifications. These parameters shall be checked for their compliance with the specifications before the start and after the end of each test.
For components connected to the coolant circuit parameter tests shall be carried out at T_{RT} with $T_{cool,nom}$, at T_{max} with $T_{cool,max}$ and at T_{min} with $T_{cool,min}$.
If not specified otherwise in the Component Requirement Specifications, for components with HV supply the parameter tests shall be carried out at U_{Bmin} with $U_{Bmin,HV}$, at U_B with $U_{B,HV}$ and at U_{Bmax} with $U_{Bmax,HV}$.

10.4.1 Parameter test (small)

The key parameters shall be measured and the functional behavior of the components checked at T_{RT} and U_B. For components with fault memory, the fault memory shall be read out. The components shall be checked for external damage/changes such as cracks, chipping/peeling, discoloration, deformation etc. by visual testing according to DIN EN 13018, without opening the DUT.
Changes in the values of the key parameters, the functional behavior or the fault memory entries as well as irregularities found during the visual test shall be evaluated against the new condition with regard to the previous test exposures.

All results shall be documented in the test report.

10.4.2 Parameter test (large)

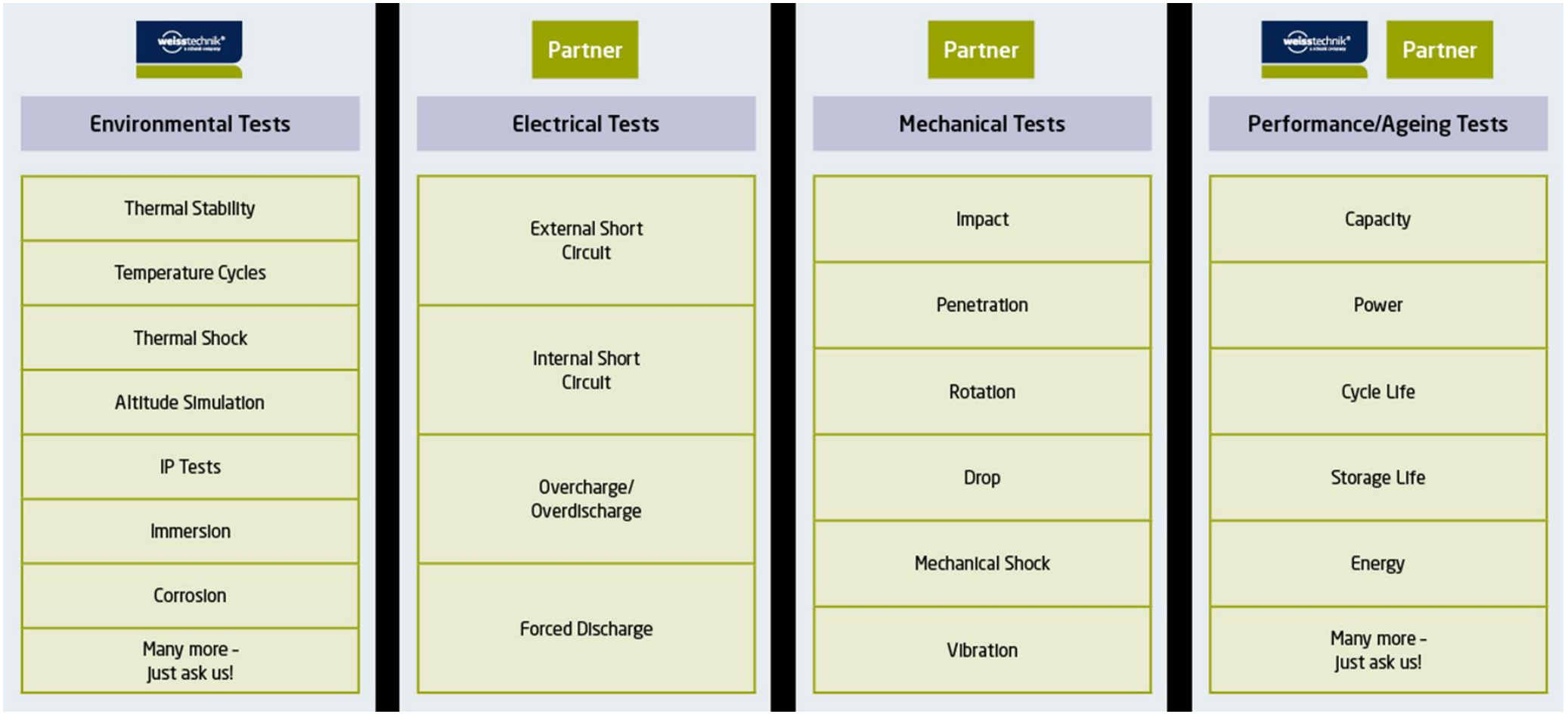
The key parameters shall be measured and the functional behavior of the components measured at temperatures T_{max}, T_{RT} and T_{min} at each of the voltages U_{Bmin}, U_B and U_{Bmax}.
For components with fault memory, the content of the fault memory shall be read out. The components shall be checked for external damage/changes such as cracks, chipping/peeling, discoloration, deformation etc. by visual testing according to DIN EN 13018.

Changes in the values of the key parameters, the functional behavior or the fault memory entries as well as irregularities found during the visual test shall be evaluated against the new condition with regard to the previous test exposures.

All results shall be documented in the test report.

weisstechnik® a schunk company
ENERGY STORAGE EVENT
16 en 17 februari 2021
DIGITALE EDITIE

Several Test Categories for Li-Ion Batteries



weisstechnik®
a schunk company
ENERGY STORAGE EVENT
16 en 17 februari 2021
DIGITALE EDITIE

EUCAR – European Council for Automotive R&D

Members

EUCAR was established on 27 May 1994, evolving from the previous Joint Research Committee (JRC) of the European motor vehicle manufacturers. Following on from the scientific cooperation carried out by the JRC, EUCAR has begun to foster strategic cooperation in research & technological development (R&TD) activities.

The objective of this common approach is progressively to achieve technologies for the optimisation of the motor vehicle of the future. This continuous process will also provide intermediate solutions for substantial improvements in the short and medium term.

The 15 members of EUCAR represent the major European vehicle manufacturers.

weisstechnik®
a schunk company
ENERGY STORAGE EVENT
16 en 17 februari 2021
DIGITALE EDITIE

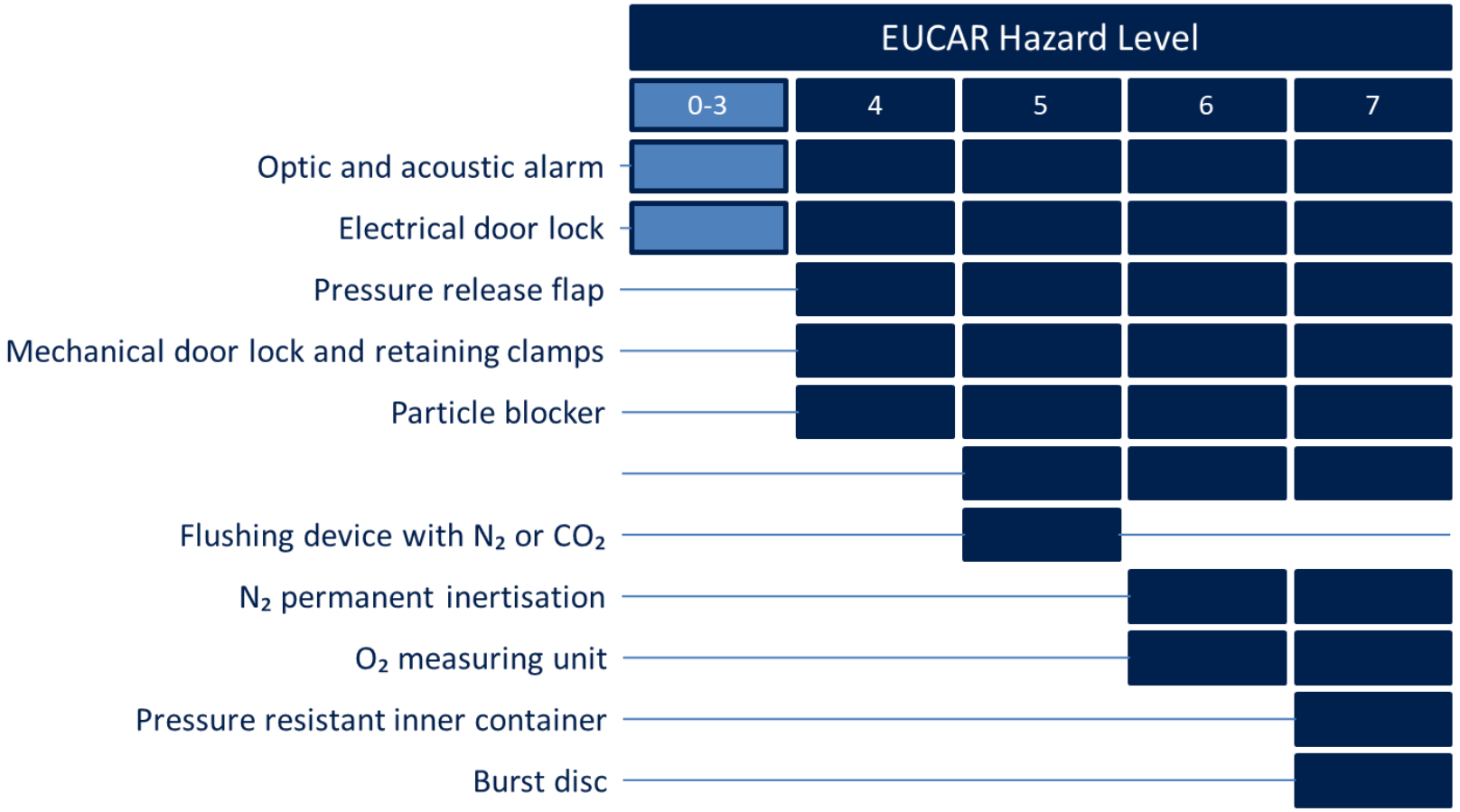
With Security Installations: EUCAR Hazard Level

External influences, internal topics with results on the Li-Ion battery

Hazard Level	Description	Security Level and results
0	No effects.	No effect, no functional limitation
1	Start of passive security system.	No damage, no leakage, no gas leak, no fire, no explosion, no reaction, no thermal runaway. **Cell broken reversible, repairs of security installations necessary.**
2	Damage	No leakage, no gas leak, no fire, no explosion, no reaction, no thermal runaway. **Cell broken irreversible, repairs of security installations necessary.**
3	Leakage (Weight loss < 50%)	No gas leak, no fire, no explosion. Leakage of electrolyte <50%.
4	Gas leakage (Weight loss > 50%)	No fire, no explosion. Leakage of electrolyte >50%.
5	Fire	No explosion, no flying parts.
6	Fraction	No explosion, but flying parts of the active mass.
7	Explosion	Decomposition of battery cell.

weisstechnik® a schunk company
ENERGY STORAGE EVENT
16 en 17 februari 2021
DIGITALE EDITIE

Modular Approach – Li-Ion Safety Equipment



BESCHEINIGUNG ■ CERTIFICATION ■ ATTESTATION ■ COMPROBANTE ■ ZAŚWIADCZENIE ■ СПРАВКА

TÜV SÜD Industrie Service

Attestation

N° IS-EG1-14 - 1469959

for

Vötsch Industrietechnik GmbH
Beethovenstr. 34
72336 Balingen

and

Weiss Umwelttechnik GmbH
Greizer Str. 41-49
35447 Reiskirchen-Lindenstruth

Products: Temperature and climatic test-equipment for specified environment conditions for testing Lithium-Ion-Batteries

Specification: Safety concept, risk-assessment, evaluation list and safety matrix of the manufacturer

Reference of evaluation: TÜV SÜD Industrie Service GmbH
Only valid with the related test report N° 1469959

Herewith is confirmed, that the risk reduction as demonstrated in the safety concept for temperature and climatic test-equipment is adequate for the potential hazards during testing cells/ modules/ systems of Lithium-Ion-Batteries up to EUCAR Hazard Level 7 (explosion)

Conditions: Each temperature and climatic test-equipment must be inspected according to the safety specification before putting into service and integration in the test-system

Filderstadt, 23. January 2014

Günter Steinsträter
head of department electrical engineering

Klaus Gohlke
electrical engineering

TÜV SÜD Industrie Service GmbH • Elektrotechnik • Gottlieb-Daimler Straße 7 • 70794 Filderstadt

weisstechnik® a schunk company

ENERGY STORAGE EVENT

16 en 17 februari 2021
DIGITALE EDITIE

With Security Installations: EUCAR Hazard Level

Hazard Level 0-3	Hazard Level 4	Hazard Level 5-6		Hazard Level 7
Status display	Reversible pressure release flap	Permanent inertization using nitrogen or argon	Fire alarm system	Tolerable residual risk without further safety test
				
Electrical door lock	Mechanical door lock	Oxygen measurement	Fire detection via temperature measurement	
				
	Sealing plug with retaining clamp	Burst disc	Flushing device for inertization in case of fire	
				

weisstechnik® a schunk company

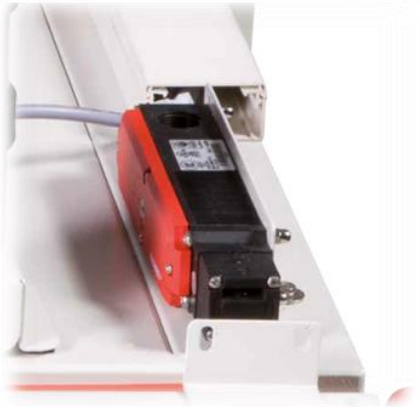
ENERGY STORAGE EVENT

16 en 17 februari 2021
DIGITALE EDITIE

With Security Installations: EUCAR Hazard Level

Package Hazard Level 0 – 3.

Optic and acoustic alarm



Electrical door lock

Installed Safety Equipment:

weisstechnik®
a schunk company
ENERGY STORAGE EVENT
16 en 17 februari 2021
DIGITALE EDITIE

With Security Installations: EUCAR Hazard Level

Package Hazard Level 4.

Ø 80 mm
gas outlet per cell: max. 200 l/s
Ø 125 mm
gas outlet per cell: max. 500 l/s
Ø 150 mm
gas outlet per cell: max. 750 l/s

Pressure release flap

Mechanical door lock and retaining clamps

Particle blocker

Installed Safety Equipment:

weisstechnik®
a schunk company
ENERGY STORAGE EVENT
16 en 17 februari 2021
DIGITALE EDITIE

With Security Installations: EUCAR Hazard Level

Package Hazard Level 5.

Fire detection via CO gas or temperature sensor

Flushing device with N_2 or CO_2

Installed Safety Equipment:

weisstechnik®
a schunk company
ENERGY STORAGE EVENT
16 en 17 februari 2021
DIGITALE EDITIE

With Security Installations: EUCAR Hazard Level

Package Hazard Level 6.

N_2 permanent inertisation

O_2 measuring unit

Installed Safety Equipment:

weisstechnik® a schunk company

ENERGY STORAGE EVENT

16 en 17 februari 2021
DIGITALE EDITIE

With Security Installations: EUCAR Hazard Level

Package Hazard Level 7.

Pressure resistant inner container

Burst disc

Installed Safety Equipment:

weisstechnik®
a schunk company

ENERGY STORAGE EVENT
16 en 17 februari 2021
DIGITALE EDITIE

Additional safety equipment

H_2 measuring unit

Additional LEL monitoring H_2

Alternative to N_2 or CO_2: inertisation with Argon

CO_2 Bottles

Sealing plugs: there are special sealing plugs available

weisstechnik®
a schunk company
ENERGY STORAGE EVENT
16 en 17 februari 2021
DIGITALE EDITIE

Integration partner

- Weiss has plenty experience working with partners like:
  - Chroma
  - Kratzer
  - AVL
  - Moehwald (Bosch)
  - OEM’s like
    - Audi
    - Daimler
    - Volvo
    - VW
    - BMW
    - ….

weisstechnik®
a schunk company
ENERGY STORAGE EVENT
16 en 17 februari 2021
DIGITALE EDITIE

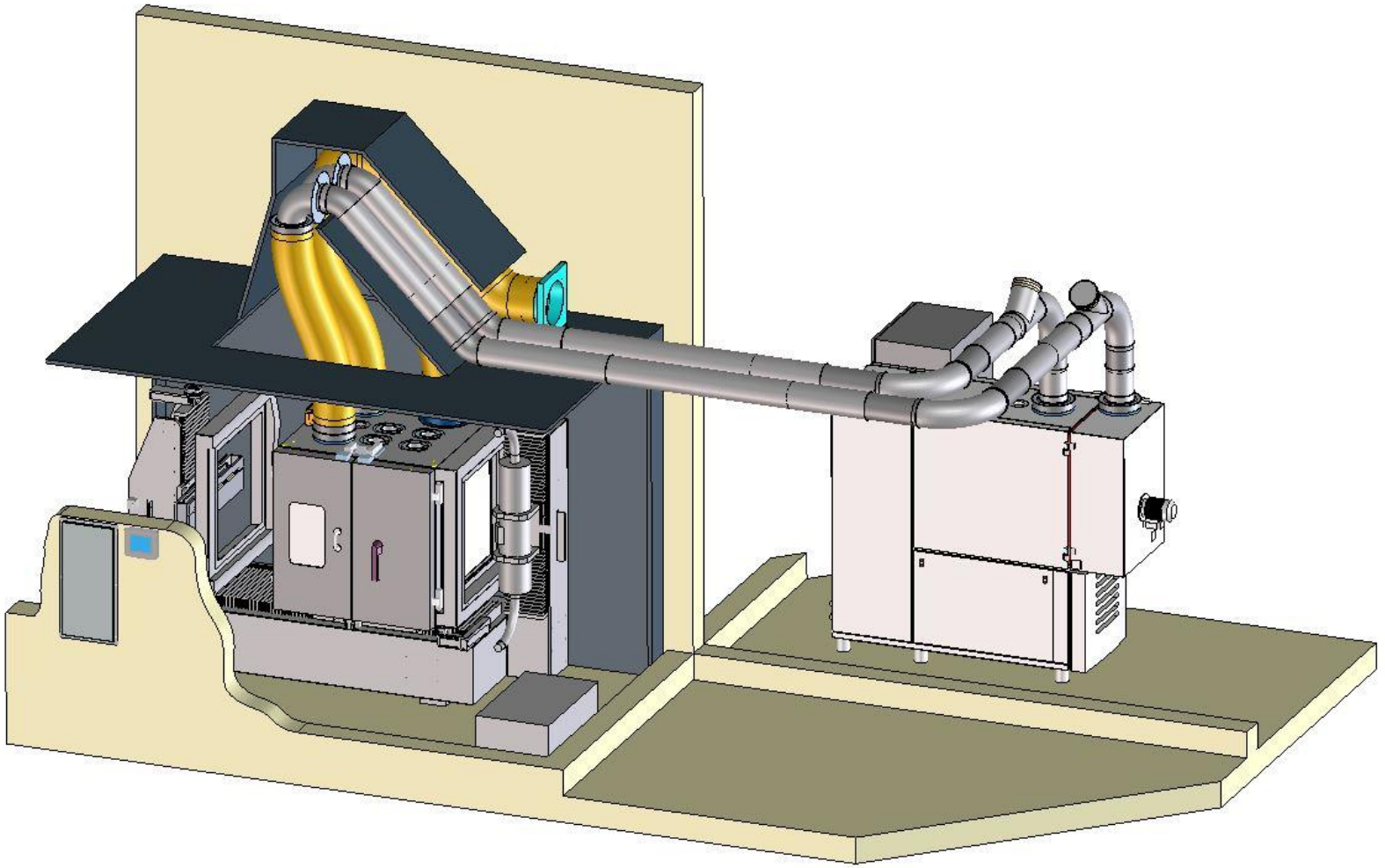
Reference at Dutch customer

weisstechnik®
a schunk company
ENERGY STORAGE EVENT
16 en 17 februari 2021
DIGITALE EDITIE

Examples: 3-Axis Vibration – Splash water

weisstechnik®
a schunk company
ENERGY STORAGE EVENT
16 en 17 februari 2021
DIGITALE EDITIE

X-RAY imaging during battery cycling in a test chamber

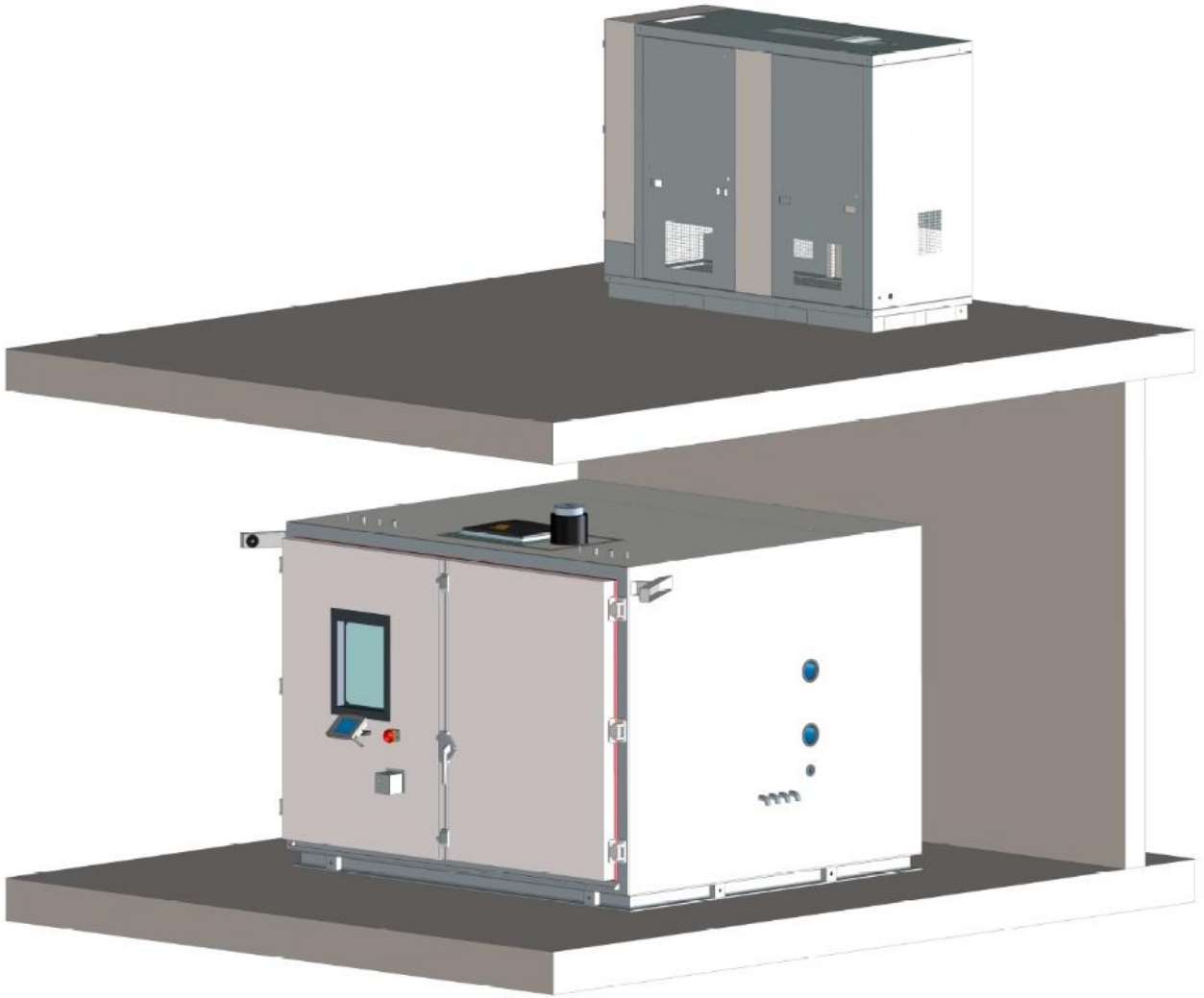


weisstechnik®
a schunk company

ENERGY STORAGE EVENT

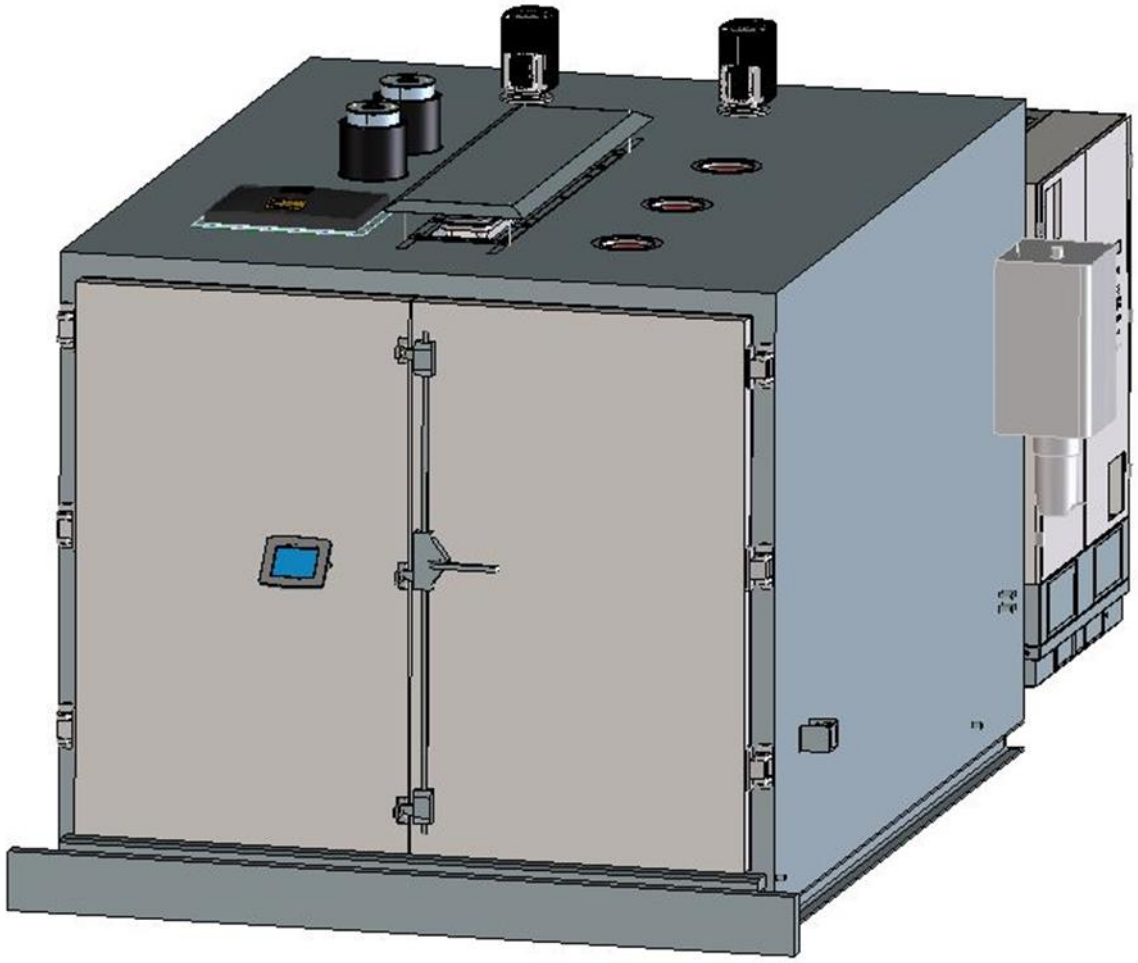
16 en 17 februari 2021
DIGITALE EDITIE

Volvo 17 m3 chamber in split design



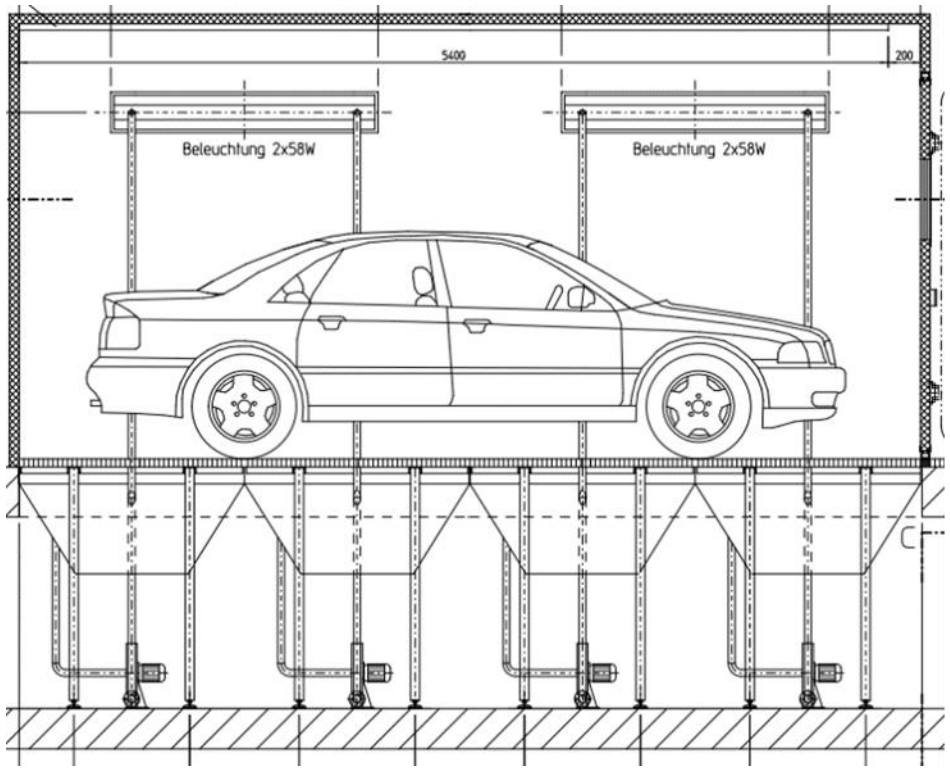
weisstechnik®
a schunk company
ENERGY STORAGE EVENT
16 en 17 februari 2021
DIGITALE EDITIE

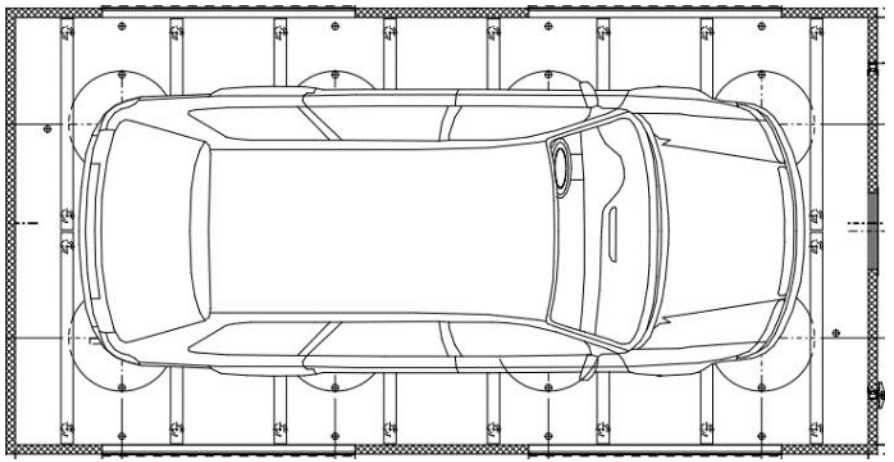
Audi 17 m3 chamber on frame



weisstechnik®
a schunk company
ENERGY STORAGE EVENT
16 en 17 februari 2021
DIGITALE EDITIE

Dust Test Chamber – LV124 – M-03

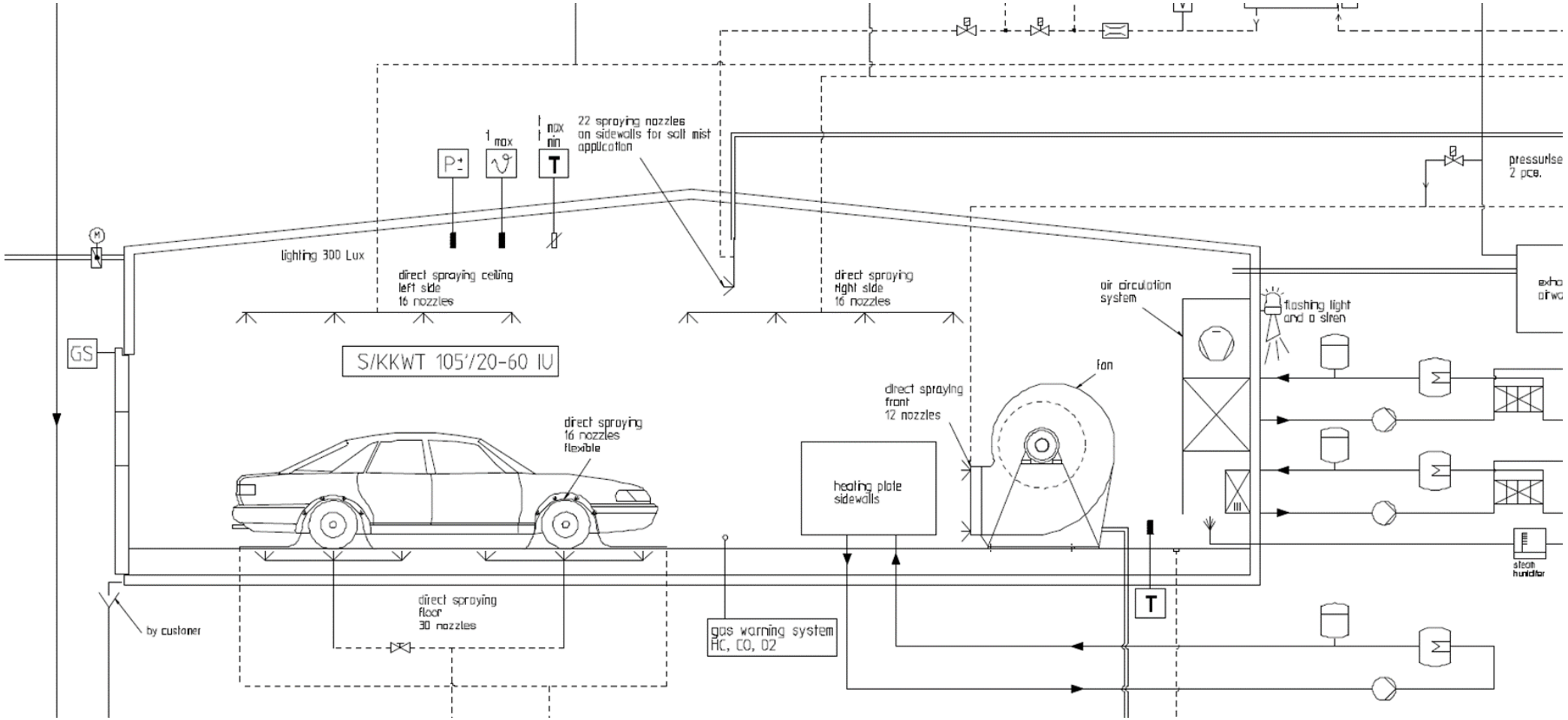




„Drive in“ chamber with machine unit
part at the level below. A pit for a cellar is needed.
The nett test space will be about 3m*2m*1m (w*d*h)

weisstechnik®
a schunk company
ENERGY STORAGE EVENT
16 en 17 februari 2021
DIGITALE EDITIE

Saltspray & Saltmist – LV124



weisstechnik®
a schunk company
ENERGY STORAGE EVENT
16 en 17 februari 2021
DIGITALE EDITIE

Proven experience

weisstechnik®
a schunk company

ENERGY STORAGE EVENT

16 en 17 februari 2021
DIGITALE EDITIE

Matchmaking

GET IN TOUCH

- Meer informatie?
- Kom rechtstreeks in contact!

- Vraag een vrijblijvend gesprek aan
  - Kan tijdens of na het event!

Weiss Technik Nederland B.V.

Newtonstraat 5

4004 KD Tiel – The Netherlands

Tel +31 344 670400

Info.nl@weiss-technik.com

www.weiss-technik.nl

ENERGY STORAGE EVENT

NIEUWSTE TECHNOLOGIEËN EN APPLICATIEKENNIS

16 en 17 februari 2021 | digitale editie