

Safety measures when testing lithium-ion batteries

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Agenda

- Key figures Schunk / Weiss Technik
- Introduction to our modular safety approach
- Introduction to abuse testing
- Plug & Play Test Lab
- More battery testing solutions

Key figures Schunk / Weiss Technik





- Founded in 1913 by Ludwig Schunk
- No shareholders. Foundation based.
- 2 Divisions: Materials Science and Mechanical Engineering (incl. **weisstechnik**)

Revenue 2021



Countries



Locations



Employees





Environmental Simulations



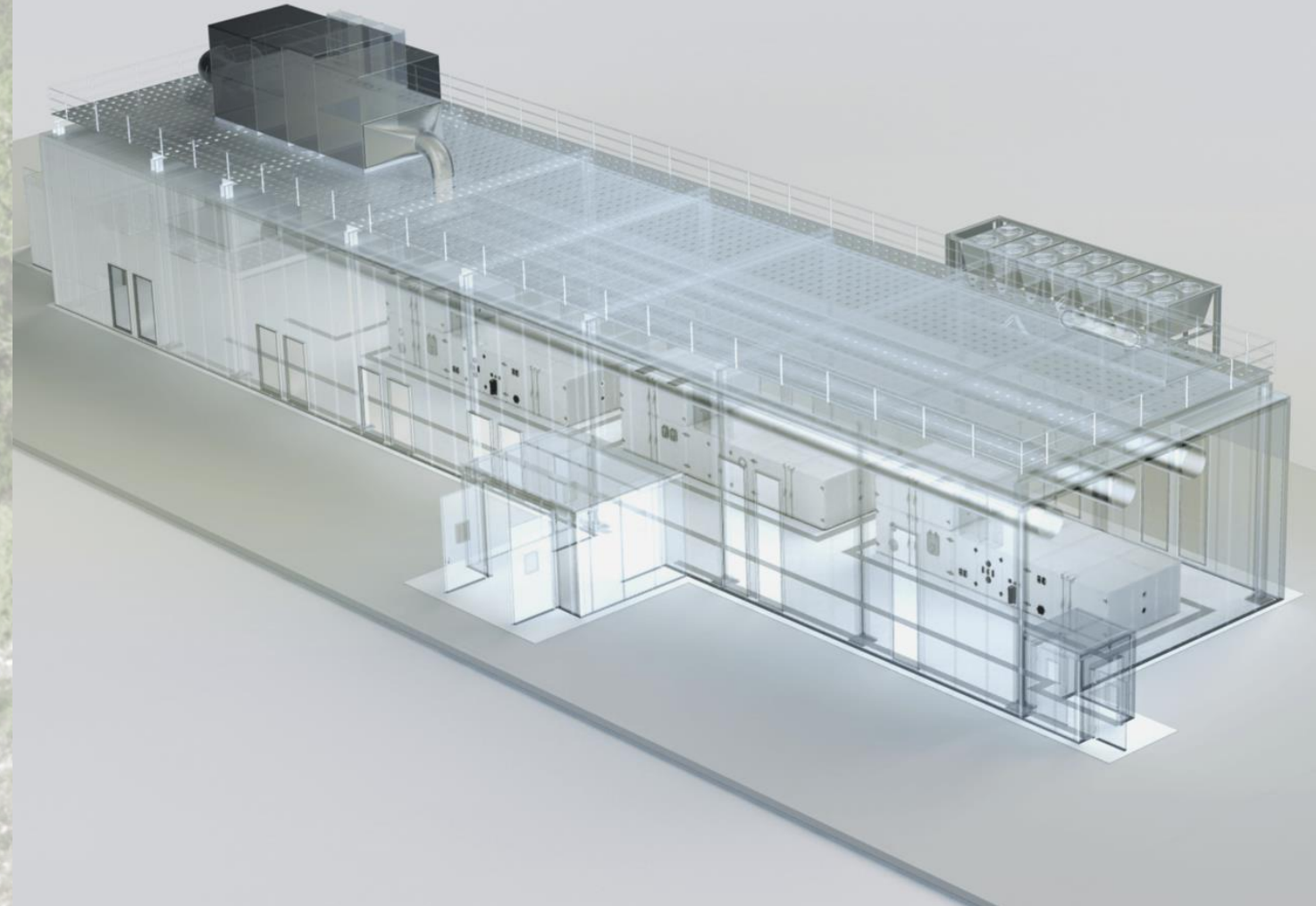
Heat Technology



Air Solutions



Pharma



Consulting > Engineering > Production > Installation > Training > Service



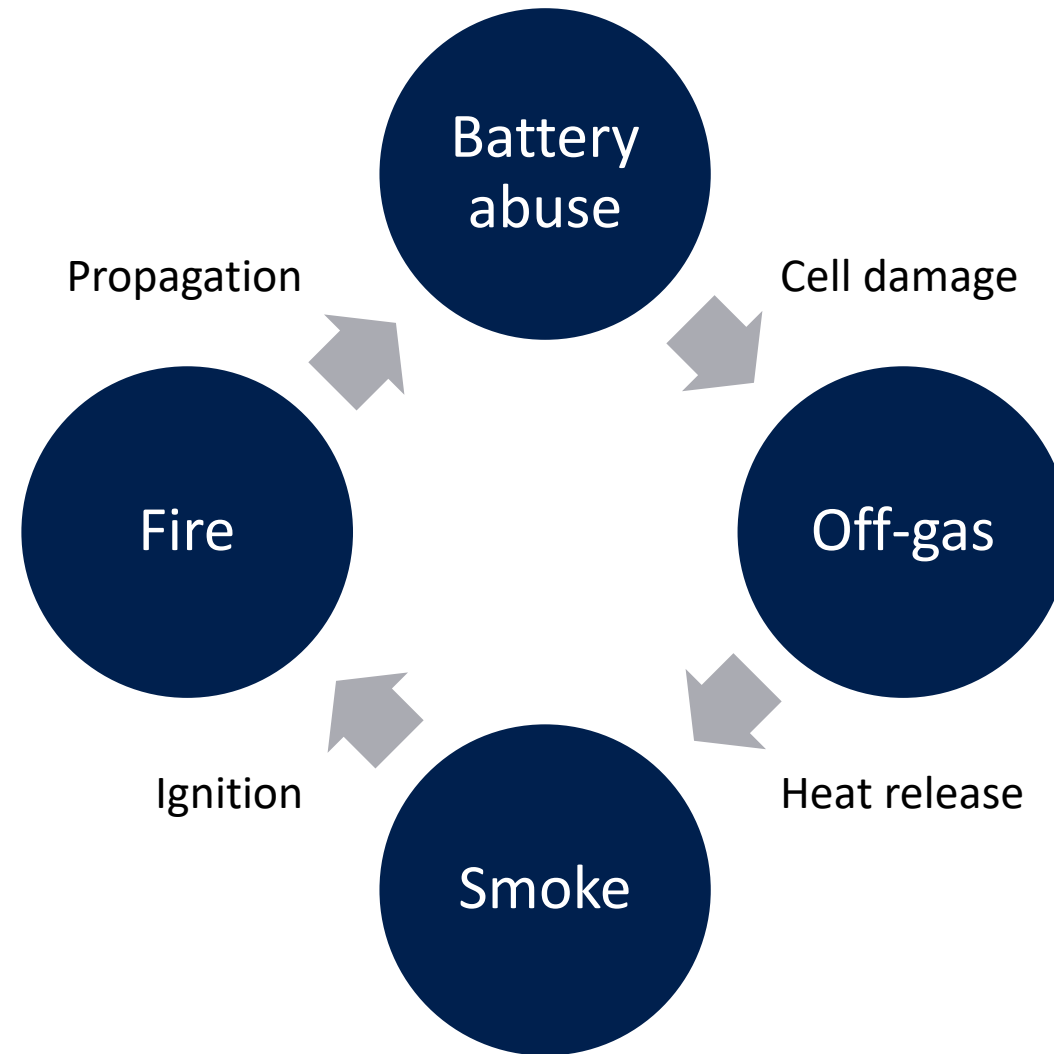
There for you. Worldwide.

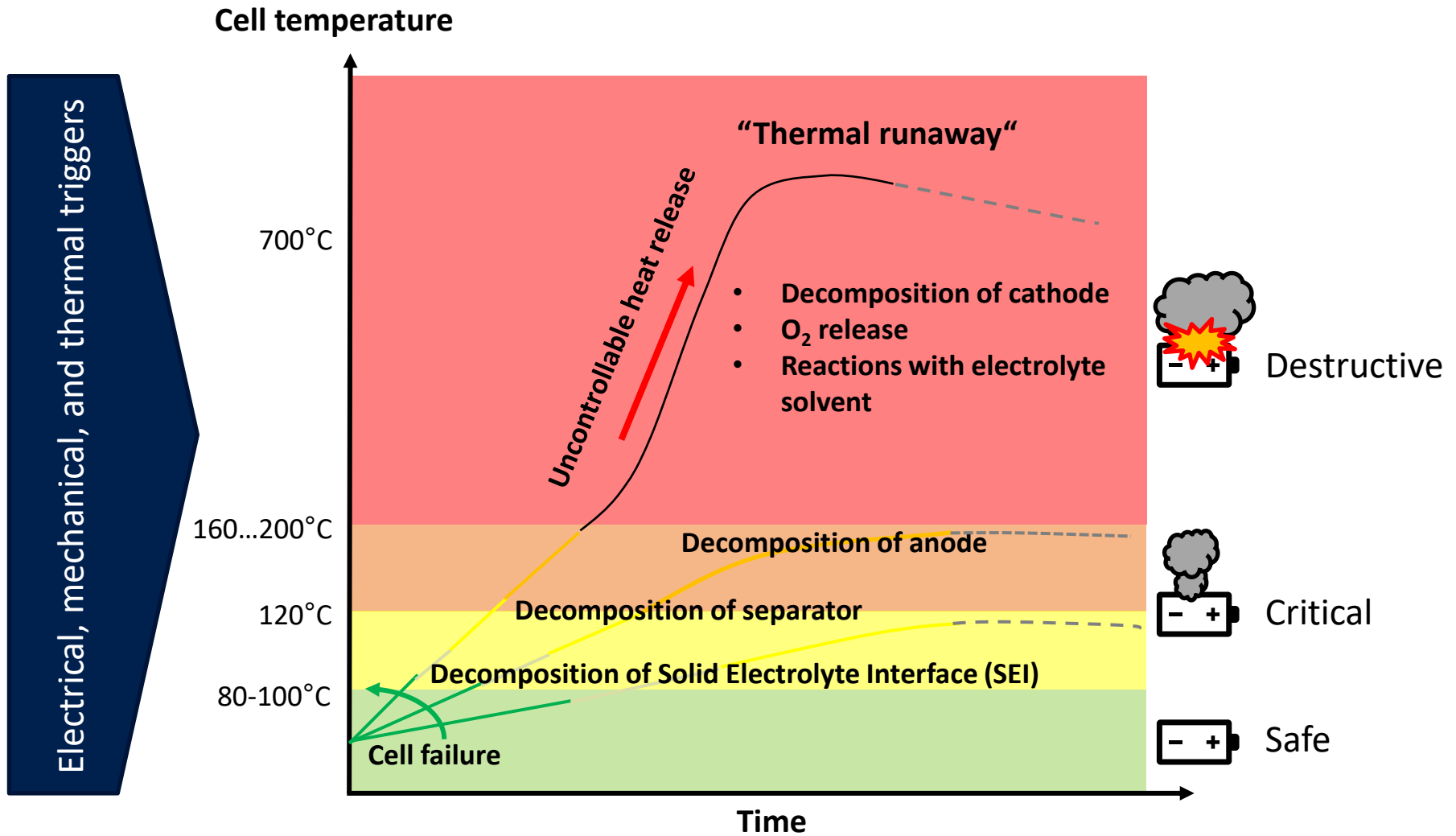
- Service centers in Europe, Asia, and America
- Shorter response times
- High qualified employees
- Qualification / Re-qualification



Introduction to our safety approaches







- EUCAR Hazard Levels define criteria and effects of lithium-ion battery failure
- Used in our checklist to determine possible risks
- Does not take battery design and size into consideration

Hazard Level	Description	Classification criteria & effect
0	No effect	No effect. No loss of functionality.
1	Passive protection activated	No defect; no leakage; no venting, fire or flame; no rupture; no explosion; no exothermic reaction or thermal runaway. Cell reversibly damaged. Repair of protection device needed.
2	Defect/Damage	No leakage; no venting, fire or flame; no rupture; no explosion; no exothermic reaction or thermal runaway. Cell irreversibly damaged. Repair needed.
3	Leakage Δ mass <50%	No venting, fire or flame; no rupture; no explosion. Weight loss <50% of electrolyte weight (electrolyte = solvent + salt).
4	Venting Δ mass \geq 50%	No fire or flame; no rupture; no explosion. Weight loss \geq 50% of electrolyte weight (electrolyte = solvent + salt).
5	Fire or flame	No rupture; no explosion (i.e. no flying parts).
6	Rupture	No explosion, but flying parts of the active mass.
7	Explosion	Explosion (i.e. disintegration of the cell).

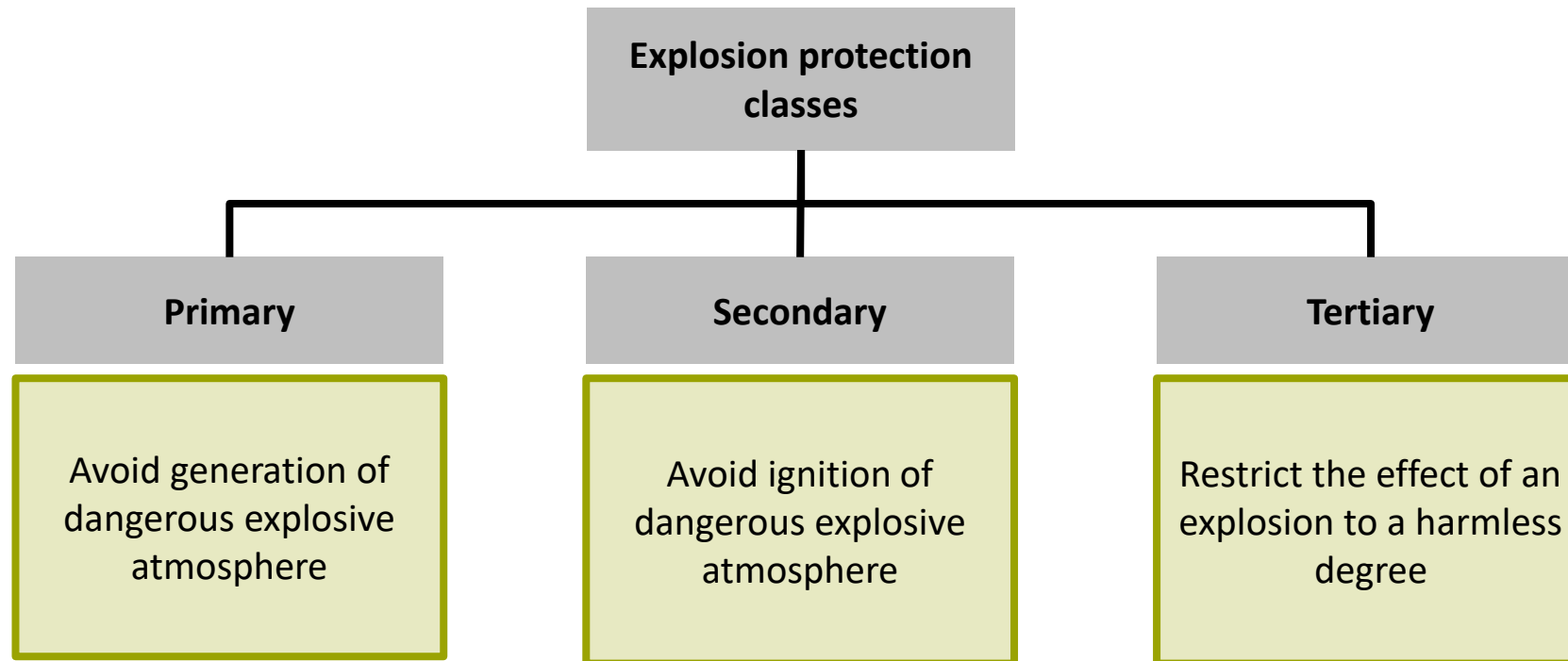
- Commonly used liquid electrolytes are flammable / explosive
- Potential risk of explosion in confined spaces


Substance	Composition	Flash point	Ignition	LEL Lower Explosion Limit	UEL Upper Explosion Limit
Ethylene carbonate (EC)	$C_3H_4O_3$	145°C	465°C	3.6 Vol.%	16.1 Vol.%
Diethyl carbonate (DEC)	$C_5H_{10}O_3$	25°C	445°C	1.4 Vol.%	11.7 Vol.%
Dimethyl carbonate (DMC)	$C_3H_6O_3$	18°C	458°C	4.2 Vol.%	12.8 Vol.%
Ethyl methyl carbonate (EMC)	$C_4H_8O_3$	25°C	440°C	2.0 Vol.%	-
Propylene carbonate (PC)	$C_4H_6O_3$	135°C	455°C	1.9 Vol.%	14.3 Vol.%

Decomposition products: C_2H_4 , C_2H_6 , CH_4 , H_2 , CO , CO_2

With **weisstechnik** you reliably meet the required Directives

Name	EUCAR	Machinery Directive	ATEX Directive
Directive	Guideline only	2006/42/EC	2014/34/EU
Legal situation	Not legally binding	Mandatory for CE certification	
Classification	Hazard Level 0-7	< LEL No explosive atmosphere	> LEL Explosive atmosphere





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?

<input type="checkbox"/> Li-Ion	<input type="checkbox"/> Metal hydride → Attention: ATEX necessary. <small>(Please ask ATEX product specialist in headquarters.)</small>
<input type="checkbox"/> Supercap	<input type="checkbox"/> Lead-Acid → Attention: ATEX necessary. <small>(Please ask ATEX product specialist in headquarters.)</small>
<input type="checkbox"/> _____	

2. Is the battery a prototype or (almost) series product?

<input type="checkbox"/> Prototype	<input type="checkbox"/> (Almost) series product
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- Used for customer projects
- Considers qualitative battery aspects
- Evaluation of the EUCAR Hazard Level
- Evaluation of ATEX

EUCAR Hazard Level 0-3
Hazard: general hazards



Electrical door lock



Interfaces for alarm signals



Status indicator

EUCAR Hazard Level ≥ 4
Hazard: overpressure



Mechanical door lock, retaining clamps, particle blocker



Reversible pressure release flap
- lower pressure level -



Certified burst disc
- higher pressure level -



Reinforced inner container and door

EUCAR Hazard Level 5
Hazard: fire or flame



Temperature sensor



Smoke detector



CO sensor

EUCAR Hazard Level 5
Hazard: fire or flame



Flushing with N₂/CO₂

Forced cooling with refrigeration unit

Water flushing system

Low pressure water sprinkler system

High pressure water mist system

Explosion protection (ATEX)

Hazard: release of flammable / explosive gases



HC sensor with LEL monitoring

H2 sensor with LEL monitoring

Ventilation
- primary Ex protection -

Nitrogen inertisation incl. O2 sensor
- primary Ex protection -

Limitation of the heater's surface temperature
- secondary Ex protection -

Introduction to our modular safety approach Combination with various chamber designs



Introduction to abuse testing



Test standards 



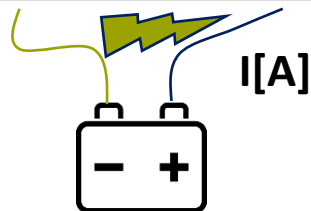
UN 38.3 – Transport standard



UN ECE R100 – Battery electric vehicle safety

Stress

Electrical

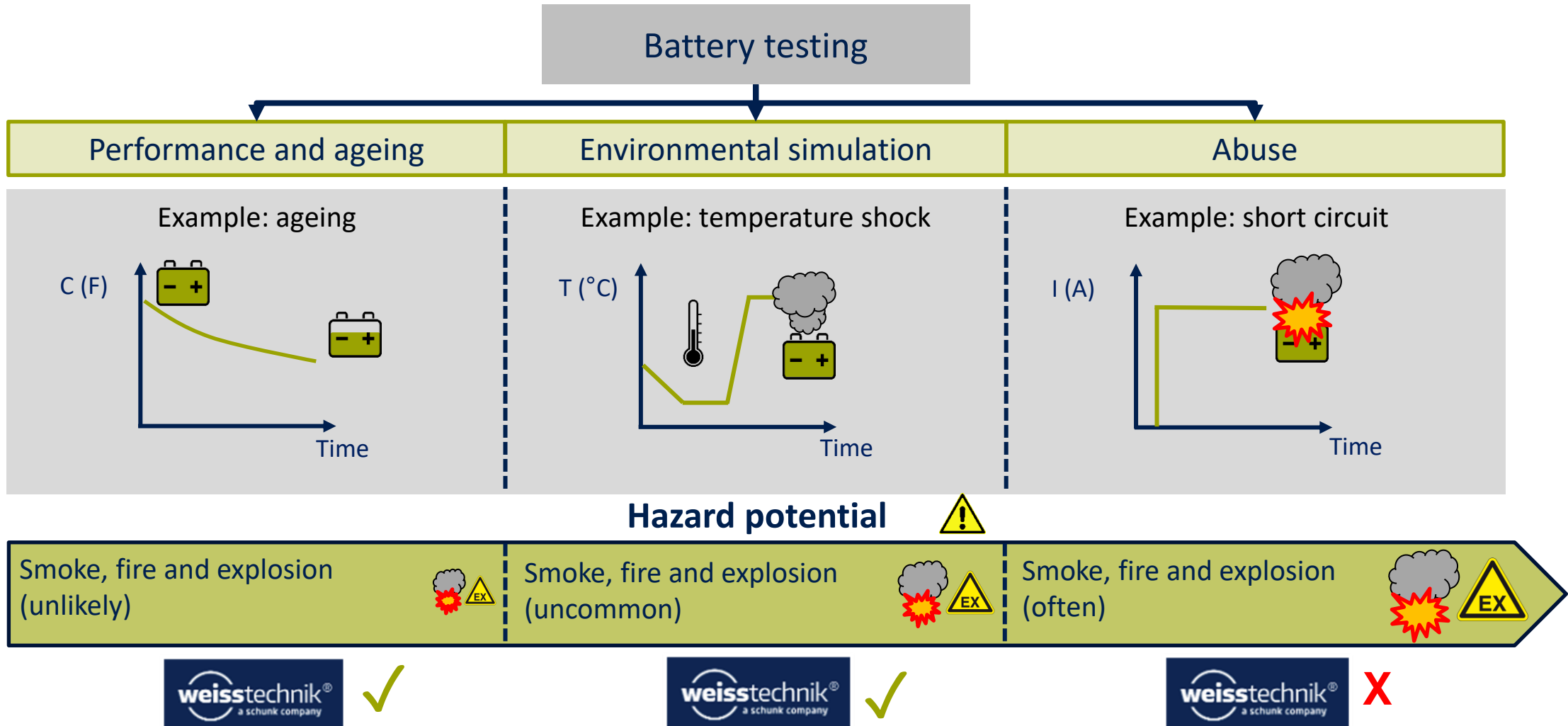


Mechanical



Thermal





Design



Box design

- Pressure and temperature resistance
- Materials selection
- Contamination issues
- Explosion flap
- Ventilation concept

Exhaust gas purification

- Pressure management
- Adsorption scrubber and filtering

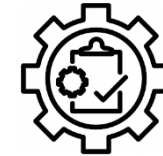
Simulation



Air flow simulation

- Air distribution
- Combustion and explosion
- Pressure estimation
- Temperature gradients
- Resistance

Testing



Explosion tests

- Safety tests
- Issue certificate
- Validation



Video

Plug & Play Test Lab



Video

- **weisstechnik**: walk-in chamber and container
- DSA: software / electric
- ZF: cyclers type VES 1000V/1000A
- Lauda: media cooling and chiller
- Callies / Systeex: high pressure water mist system

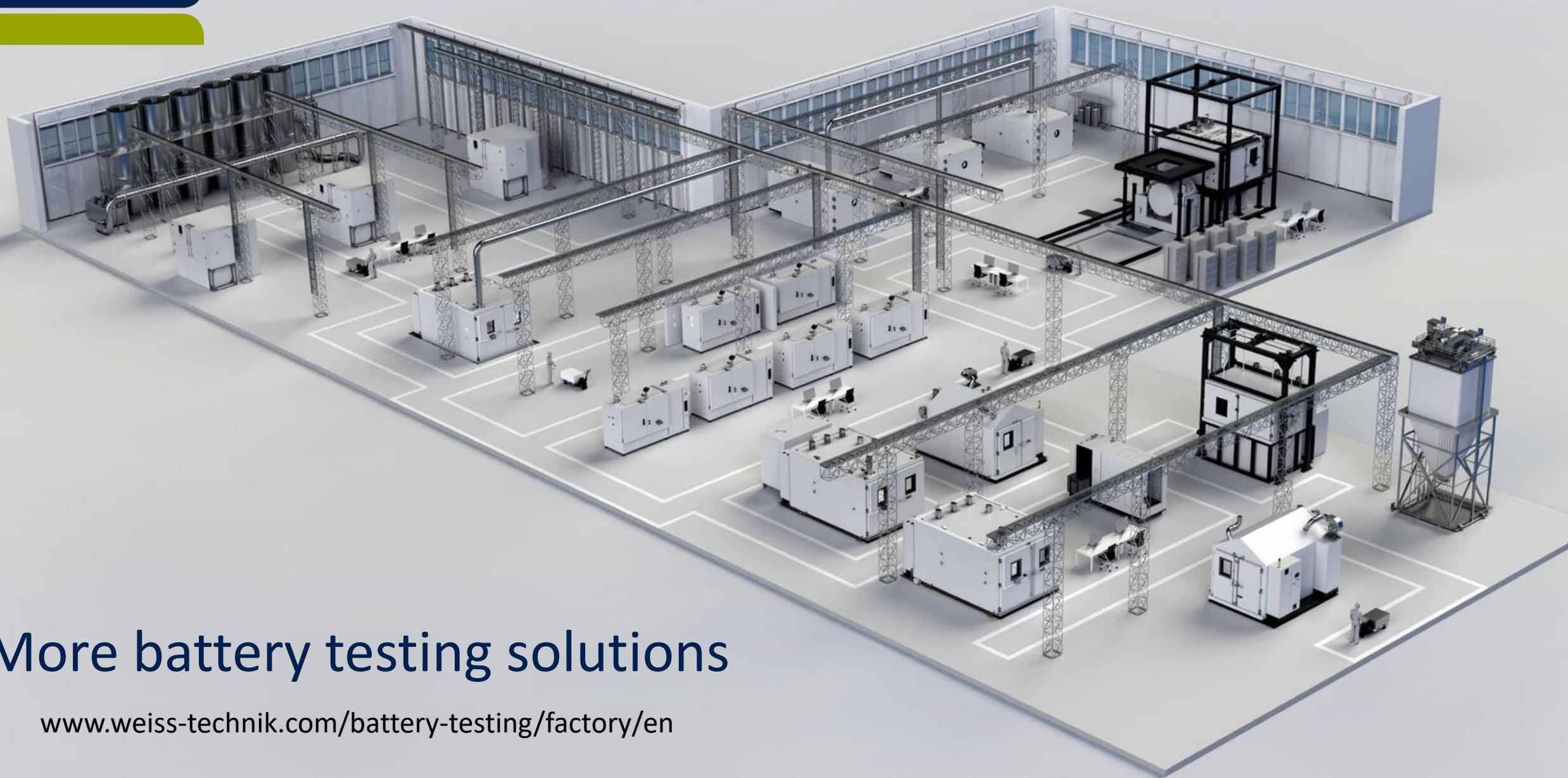


- Standardized plug & play solution, easy to install
- All from one single source
- **weisstechnik** clarifies all interfaces for all necessary equipment and suppliers
- Training of employees in our **weisstechnik** Academy
- Factory acceptance test at **weisstechnik**
- Fast start of first tests

- Containers from 3 to 18 meters in length can be manufactured
- Depending on the application, containers can be connected to create large rooms
- Containers can be placed side by side or on top of each other
- The Plug & Play Test Lab can be equipped with small cabinets or a walk-in chamber
- Different applications are possible like temperature tests, climate tests, corrosion tests, dust tests, etc.



- The Plug & Test Lab is delivered by truck
- All that is required is an available parking space or a strip foundation
- Electricity, water and sewage are the connection points



More battery testing solutions

www.weiss-technik.com/battery-testing/factory/en













Thank you for your attention!

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