

# SAFE TESTING OF BATTERIES: THE POWER TO KNOW

Determining Your Custom  
Safety Solution

What You Need to Know Before Safely Testing  
Lithium Ion Batteries



**Tenney**  
ENVIRONMENTAL

[www.tenney.com](http://www.tenney.com)

# CONTENTS

Published Specifications .....	1
Hazards Associated with Battery Testing .....	1
Partners in Safety .....	2
Assessing the Risks .....	2
Which Safety Features are Right for You .....	4
Improving Your Risk Equation with SafeTest™ .....	7



## PUBLISHED SPECIFICATIONS

Battery testing must meet published specifications as set forth by multiple industry organizations.

Examples include:

- IEC 62660-2 for abuse testing of automotive batteries
- SAE J2464 for automotive rechargeable batteries (RESS systems)
- IEC 60086-4 safety of lithium batteries
- UL 1642 for lithium ion batteries
- UN/DOT 38.3 for testing lithium ion batteries
- IEC 61960 for portable battery cells
- UL 2054 for consumer and commercial batteries
- IEEE 1625 laptop rechargeable batteries
- IEEE 1725 phone rechargeable batteries



**Whether your company serves the automotive, computer, telecommunications, defense, or alternative-energy industries, you need a safe, effective, and reliable way to test batteries.**



## HAZARDS ASSOCIATED WITH BATTERY TESTING

Battery testing involves unique hazards that must be anticipated, evaluated, and mitigated prior to testing, not only for the safety and protection of the end user but also for the safety and protection of your employees, systems, facilities, and equipment.

Risks vary with the types of battery products you want to test and the conditions under which you need to test them. It's important that you choose not only the right environmental testing chamber to meet your battery testing needs but also that you select the right custom safety features as well.

# PARTNERS IN SAFETY

TPS works hard to be your trusted source for information and products relating to the safe and reliable testing of batteries. In developing the SafeTest™ Battery Testing system, our engineers worked closely with experts from a top-rated, independent safety laboratory to develop the most comprehensive offering of standard and optional safety equipment available in the industry.

## ASSESSING THE RISKS

Your most important role in this partnership involves identifying the **maximum expected hazard level** for each battery type you plan to test as well as the **likelihood that a hazard will occur**.

### 1. DETERMINE THE HIGHEST POTENTIAL EUCAR HAZARD LEVEL FOR THE BATTERIES YOU TEST

#### SEVERITY

The customer must identify the maximum expected EUCAR Hazard Level

#### EUCAR Hazard Levels and Descriptions

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 $\Delta$ mass < 50%	No venting, fire or flame; no rupture; no explosion. Weight loss < 50% of electrolyte weight (electrolyte = solvent + salt).
4	Venting $\Delta$ 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).

## 2. ASSESS THE LIKELIHOOD OF THE HAZARD OCCURRING

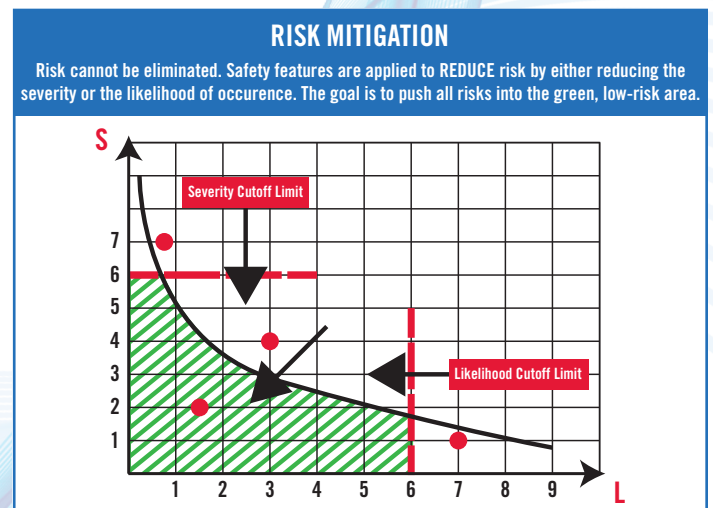
LIKELIHOOD OF OCCURENCE			
The customer must estimate the likelihood of occurrence for each hazard			
Likelihood (L)	Estimated Occurrence		Description
	1/x	(%)	
10	1/ 10	10%	Extremely High
9	1/ 20	5%	Very High
8	1/ 50	2%	High
7	1/ 100	1%	Above Average
6	1/ 200	0.5%	Average
5	1/ 500	0.2%	Below Average
4	1/ 1,000	0.1%	Fairly Low
3	1/ 2,000	0.05%	Low
2	1/ 10,000	0.01%	Very Low
1	1/ 100,000	0.001%	Extremely Low

## 3. THE ADDITION OF SAFETY FEATURES MINIMIZES RISK

By selecting the right safety features for your environmental testing chambers, you can mitigate risk by reducing both the severity of an anticipated hazard and the likelihood of an occurrence.

Once you've accurately assessed the risks, you are well on your way to determining the customized safety solution to meet your battery testing needs.

RISK MITIGATION	
Safety features contribute an additional factor (Hazard Control Number) which reduces the risk:	
<b>Risk = Severity x Likelihood x HCN</b>	
HCN	Description
0.9	Modest Risk Reduction
0.8	
0.7	
0.6	Above Average Risk Reduction
0.5	
0.4	
0.3	Notable Risk Reduction
0.2	
0.1	Significant Risk Reduction
0.0	Prevention



# WHICH SAFETY FEATURES ARE RIGHT FOR YOU?

## EUCAR Hazard Severity Classifications and Possible Mitigation Options

### EUCAR LEVELS 0-2: ANY DAMAGE IS CONFINED TO THE INSIDE OF THE BATTERY CELL

HAZARD SEVERITY CLASSIFICATION & MITIGATION OPTIONS		
Hazard Level	Hazard	Possible Mitigation Options
0	No Damage - No Leakage	Redundant High Link Pressure Relief Port
1	Reversible Damage - No Leakage	Alarms - visual, audible, dry contacts Chamber
2	Irrversible Damage - No Leakage	Pressure Alarm

**Any damage is confined to the inside of the cell**  
No leakage; no venting, fire, or flame; no rupture; no explosion; no exothermic reaction or thermal runaway.

**Standard safety options ("good insurance"):**

High Limit Controller	— TempGuard, etc.
Pressure Relief Port	— Strataflo check valve
Explosion Venting	— Gasketed explosion vent panel
Pressure alarm	— Differential pressure switch

### EUCAR LEVEL 3: LEAKAGE OF FLAMMABLE ELECTROLYTES

HAZARD SEVERITY CLASSIFICATION & MITIGATION OPTIONS		
Hazard Level	Hazard	Possible Mitigation Options
3	Leakage (ignition of flammable electrolytes)	(A) Class A Ventilation (B) Intrinsically Safe (C) Inert Atmosphere Solvent Monitor Rapid Purge System

**Leakage of flammable electrolytes**  
No venting, fire or flame; no rupture; no explosion.  
Weight loss < 50% of electrolyte weight (electrolyte = solvent + salt).

**Safety options address the three sides of the fire triangle:**

(A) Class A Ventilation	— Dilute vapors below LFL
(B) Intrinsically Safe	— Eliminate ignition sources
(C) Inert Atmosphere	— Eliminate oxygen

# EUCAR LEVEL 4: VENTING OF FLAMMABLE GASES AND/OR ELECTROLYTES

HAZARD SEVERITY CLASSIFICATION & MITIGATION OPTIONS		
Hazard Level	Hazard	Possible Mitigation Options
4	Venting (pressure, smoke, fumes, ignition of electrolytes)	Solvent Monitor Product monitoring thermocouples Automatic Door Lock Rapid Purge System Remote Shutdown Explosion Vent Inert Atmosphere
<p><b>Venting of flammable gases and/or electrolytes</b> No fire or flame; no rupture; no explosion. Weight loss <math>\geq</math> 50% of electrolyte weight (electrolyte = solvent + salt).</p>		

Venting implies pressure, smoke, toxic fumes and thermal runaway.

Thermal runaway frequently causes auto-ignition of vented gases and vapors.

<p><b>Safety options address the three sides of the fire triangle:</b></p> <p>Detection — Pressure switch, high limit, gas monitors, product TC's          Containment — Automatic door lock, rapid purge system          Pressure Relief — Vent valve, explosion venting, chamber reinforcement          Ignition — Options from Hazard Level 3 to prevent ignition</p>
--

# EUCAR LEVEL 5: FIRE

HAZARD SEVERITY CLASSIFICATION & MITIGATION OPTIONS		
Hazard Level	Hazard	Possible Mitigation Options
5	Fire (heat, pressure, smoke, toxic fumes)	(A) Fire Suppression System (B) Cryogenic Cooling Rapid purge system Automatic door lock Reinforced Liner, Explosion Venting Fire Suppression system Gas Analyzer (CO2)
<p><b>Fire</b> No rupture; no explosion (i.e. no flying parts).</p>		

<p><b>Safety options address detection, suppression, containment:</b></p> <p>Detection — Pressure switch, high limit, gas monitors, thermal plug          Suppression — Fire suppression system, inert gas, cryogenic cooling          Containment — Explosion vent, door locks, rapid purge, dry contacts</p>
--

## EUCAR LEVEL 6: RUPTURE

HAZARD SEVERITY CLASSIFICATION & MITIGATION OPTIONS		
Hazard Level	Hazard	Possible Mitigation Options
6	Rupture ( pressure, low velocity fragments)	Pressure Relief Port Reinforced Liner, Explosion Venting Rapid purge system
<b>Rupture</b> No explosion, but flying parts of the active mass. Implies low velocity fragmentation.		

**Safety options address detection, containment:**

- Detection — Pressure switch, gas monitors
- Containment — Vent port, explosion vent, door locks, rapid purge

## EUCAR LEVEL 7: EXPLOSION

HAZARD SEVERITY CLASSIFICATION & MITIGATION OPTIONS		
Hazard Level	Hazard	Possible Mitigation Options
7	Explosion ( pressure, high velocity fragments)	Pressure Relief Port Reinforced Liner, Explosion Venting Rapid purge system
<b>Explosion</b> Disintegration of the cell, implies high velocity fragmentation.		

**Safety options address detection, containment:**

- Detection — Pressure switch, gas monitors
- Containment — Explosion venting, reinforced liner, locks, purge



## IMPROVING YOUR RISK EQUATION WITH SafeTest™

Our SafeTest™ Battery Testing system offers a comprehensive line of standard and optional safety features that are designed to help you mitigate the risks associated with battery testing. This system is available on the following models:



Tenney C-EVO Temperature Humidity Test Chamber

Link: <https://www.tenney.com/products/reach-in-test-chambers/tenney-c-evo-temperaturehumidity-test-chamber>



Tenney Benchmaster Temperature and Humidity Test Chamber

Link: <https://www.tenney.com/products/benchtopy-test-chambers/tenney-benchmaster-test-chamber>



Tenney UTC Upright Test Chamber

Link: <https://www.tenney.com/products/reach-in-test-chambers/tenney-utc-upright-environmental-chambers>



Tenney TC Series Cycling Test Chambers (available in 10, 20, or 30 cubic feet.)

Link: <https://www.tenney.com/products/reach-in-test-chambers/tenney-tc-series-cycling-test-chambers>



Tenney Environmental Walk In Room (available in 288, 512, 800 and 1,152 cubic feet.)

Link: <https://www.tenney.com/products/walk-in-temperature-humidity-test-rooms>

Contact [www.tenney.com](http://www.tenney.com) for more information.

# SafeTest™ Battery Testing System

## Standard Safety Features:

- Redundant High-Limit Temperature Controller
- Pressure-Relief Port
- Chamber-Pressure Alarm
- Explosion Venting
- Reinforced chamber liner

## Optional Safety Features:

- Alarm Package – visual, audible, dry contacts
- Product-Monitoring Thermocouples
- Rapid-Purge System
- Emergency Stop Switch
- NFPA Class “A” Ventilation System
- INS – Intrinsically Safe Chamber
- Inert Atmosphere (fully inert or O2 level control)
- Solvent Monitor (hydrocarbons, solvents)
- Gas Analyzers (H2, O2, CO2, CO)
- Remote Shutdown (customer contacts)
- Automatic Door Locks
- Rapid Cryogenic Cooling (CO2 or LN2)
- Fire-Suppression System (CO2 or LN2)

## Baseline Chamber Capabilities:

- Temperatures range from -68°C to 180°C (-90°F to 356°F)
- Humidity range from 20% to 95%
- Wide variety of internal dimensions to accommodate your testing needs
- Easy to use, touchscreen-control system
- **NFPA compliant systems** tailored to your specific requirements

**Safely Test to All Major Standards, including IEC, SAE, UL, UN/DOT & IEEE**  
Safety options are available to help mitigate events associated with all **EUCAR** hazard levels.

## Determining Your Custom Safety Solution

TPS has the experts and tools – including a proprietary, comprehensive questionnaire – to help you determine the customized safety solution that’s right for you. Contact a member of our Battery Test Team today to begin your evaluation.



Contact [www.tenney.com](http://www.tenney.com) for more information.