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OF

**ECA**

**ELECTRICAL CONTRACTORS' ASSOCIATION (SA)**

**YOUR TRUSTED ELECTRICAL CONTRACTORS**

# *Batteries and the Unseen Risks*

*A session exploring current incidents, pre-emptive measures and failures experienced in battery installations.*

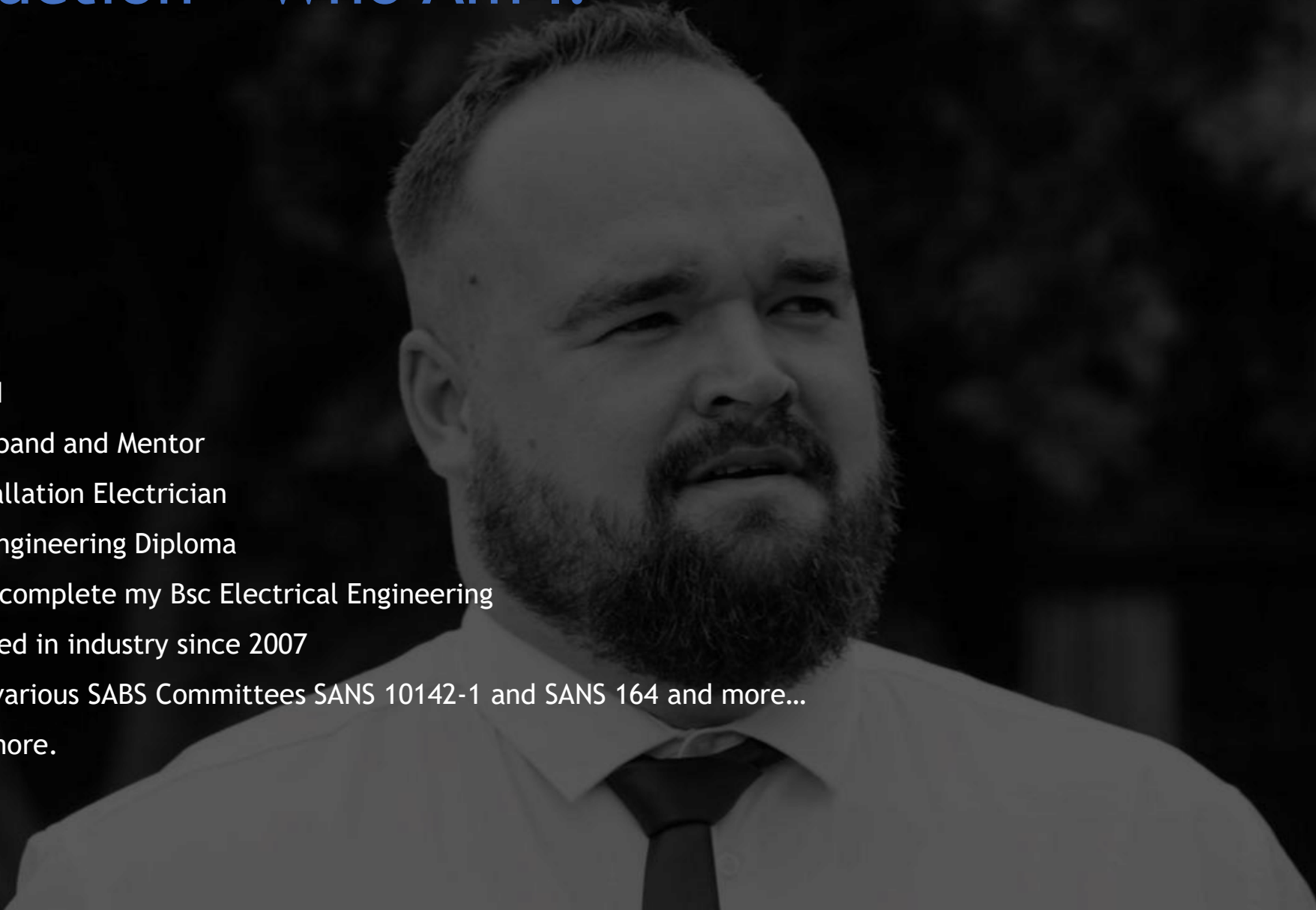
*Anthony Schewitz - ECA(SA)*

# Contents

- ▶ Introduction
- ▶ Current Industry Occurrences
- ▶ Batteries Science
- ▶ Requirements, Recommendations and Guidelines
- ▶ Challenge to industry

# Introduction - Who Am I?

- ▶ 37 Years old
- ▶ Father, Husband and Mentor
- ▶ Master Installation Electrician
- ▶ Electrical Engineering Diploma
- ▶ Enrolled to complete my Bsc Electrical Engineering
- ▶ Been involved in industry since 2007
- ▶ Serving on various SABS Committees SANS 10142-1 and SANS 164 and more...
- ▶ And many more.



# About the ECA(SA)

## Electrical Contractors' Association of SA

- Established in 1948 (78 years)
- An association for electrical contractors
- Organisation not centered on profit
- 40+ fulltime members of staff
- Around 3 500 members
  - Representing 75% of electrical industry
  - Seven regional offices and 22 branches countrywide
  - Assists electrical contractors with DoEL registration – keeps records
  - Sells CoCs to all electrical contractors



**Technical Support and Advice**

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**Labour and Industrial Relations**

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**Contractual Support and Advice**

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**Special Training Rates**

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**SABS Documents at a discounted rate**

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**CoC and Related Documents at reduced rates**

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**eCoC Platform**

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**Workmanship Guarantee Scheme**

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**NBCEI Representation**

# What the ECA(SA) does?

## Services provided to members

- **Advice on and assistance with:**
  - Labour
  - Contractual matters
  - Legislation
  - Wiring Code and practices
  - Training
  - Committees
  - Workmanship Guarantee
  - Disciplinary code

# Current Industry Occurrences

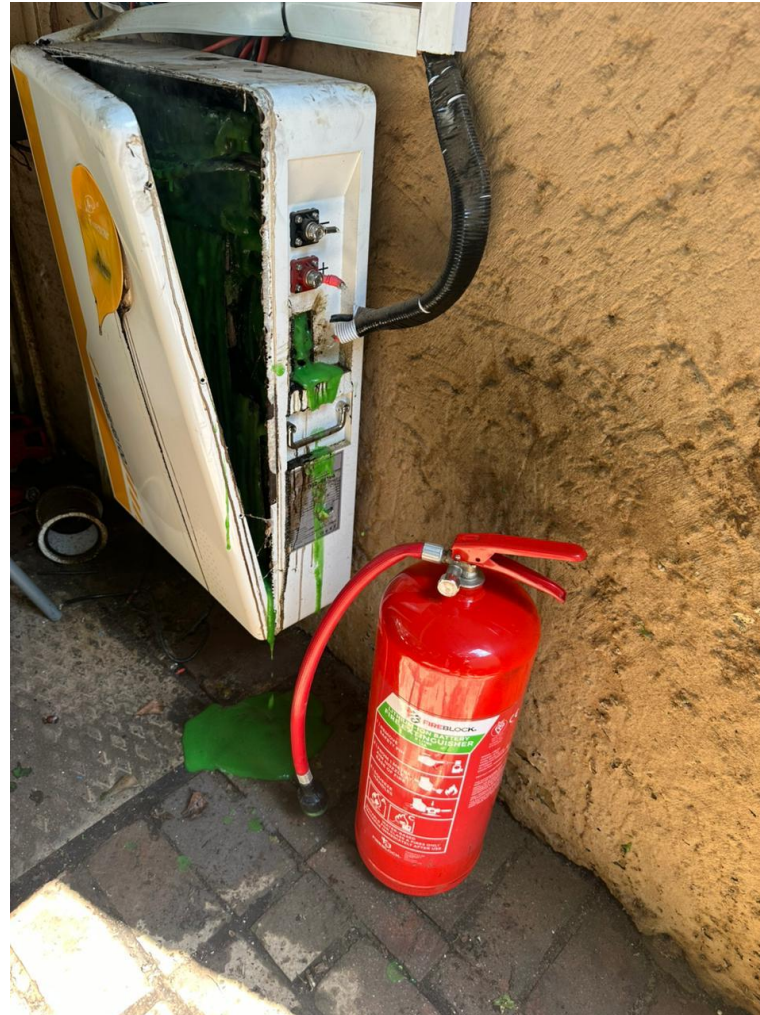


# Current Industry Occurrences



1. Battery was replaced and there was a connection issue.
2. Battery proceeded to enter thermal runaway.
3. Electrician disconnected and made safe
4. Fire department extracted batteries
5. Electrician went to hospital for check up

# Current Industry Occurrences



# Current Industry Occurrences



# Current Industry Occurrences

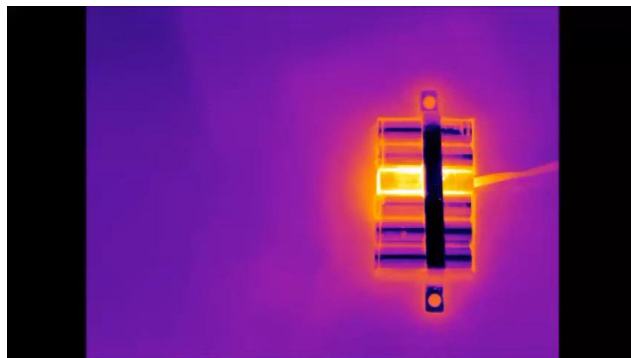


# Current Industry Occurrences



# Batteries - Thermal Runaway

It is a phenomenon in which the lithium-ion cell enters an uncontrollable, **self-heating state**.

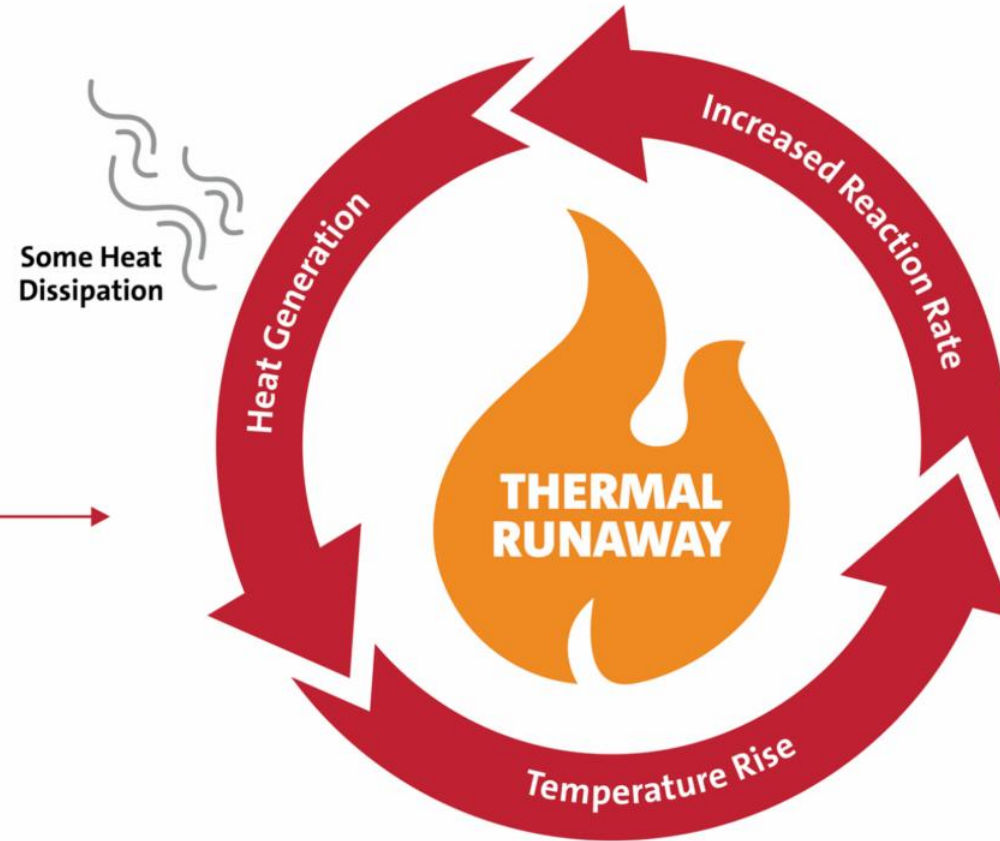


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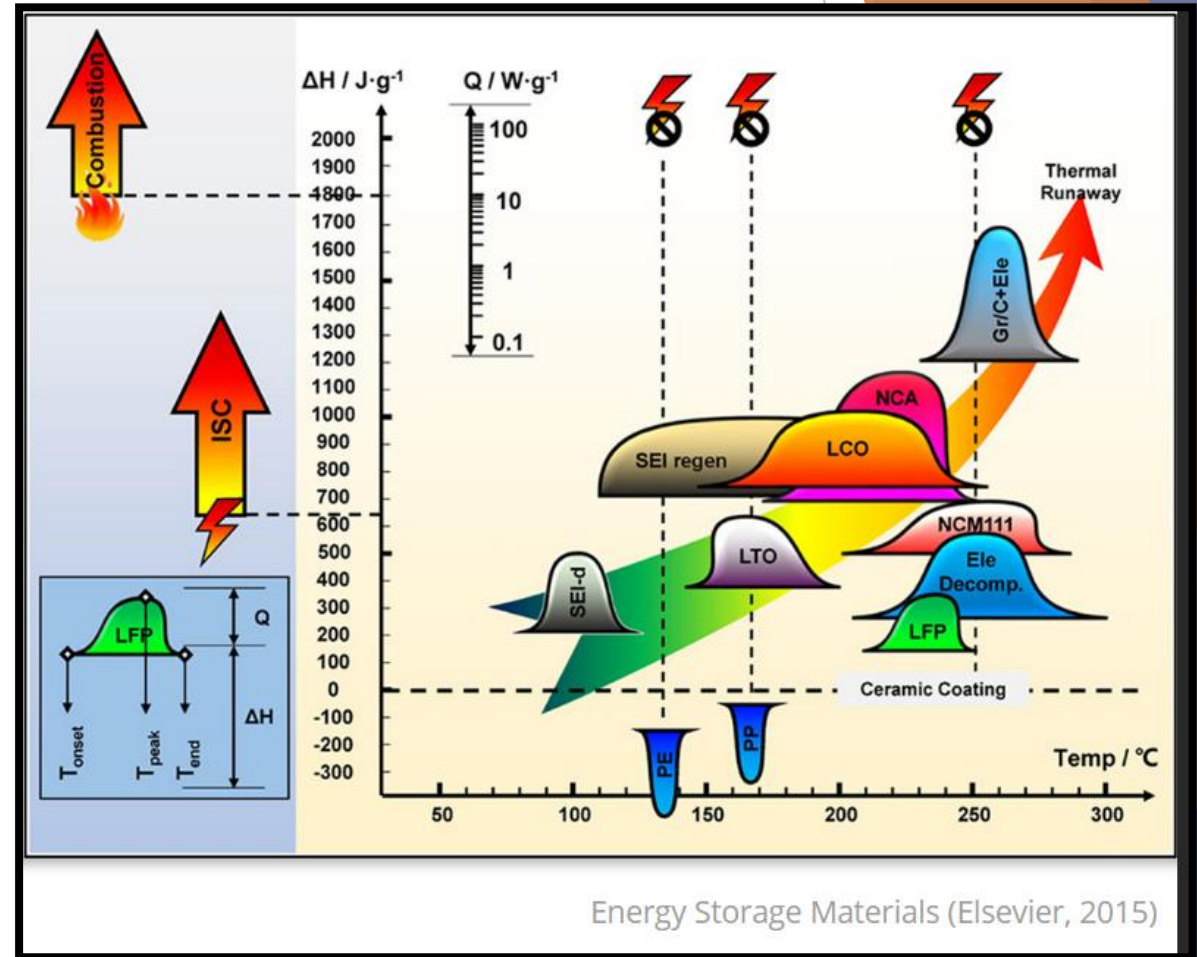
# Thermal Runaway



Courtesy of FSRI

# Thermal Runaway

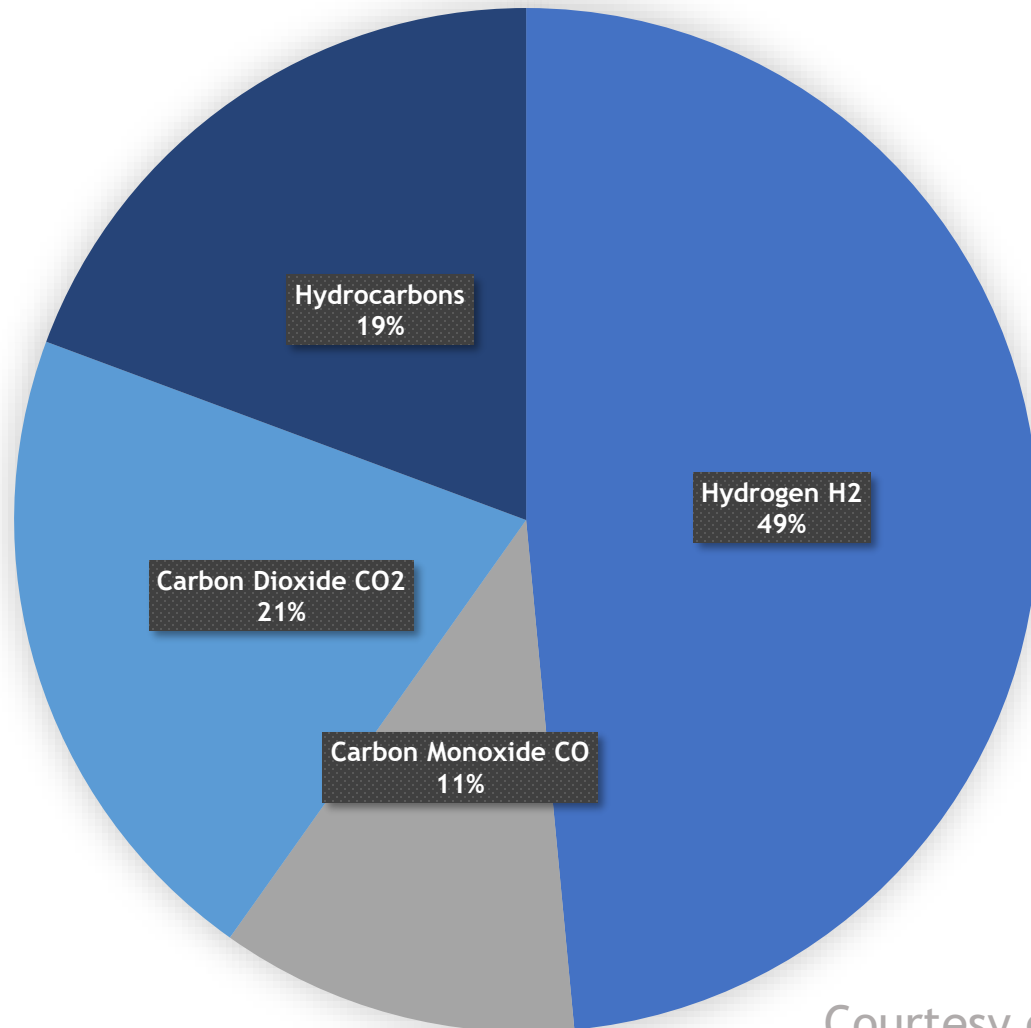
- ▶ ENVIRONMENTAL
- ▶ MECHANICAL
- ▶ ELECTRICAL OVERCHARGE
- ▶ ELECTRICAL OVER-DISCHARGE
- ▶ EXTERNAL SHORT CIRCUIT
- ▶ DESIGN AND MANUFACTURING
- ▶ AGING



Courtesy of FSRI

# Thermal Runaway

## Gas Release LFP



- Hydrogen H2
- Carbon Monoxide CO
- Carbon Dioxide CO2
- Hydrocarbons

Courtesy of FSRI

# Why LiFPo4 is considered safer?

**Lithium Nickel Cobalt Aluminum Oxide:** LiNiCoAlO<sub>2</sub> cathode (~9% Co), graphite anode  
Short form: NCA or Li-aluminum. Since 1999

<b>Voltages</b>	3.60V nominal; typical operating range 3.0–4.2V/cell
<b>Specific energy (capacity)</b>	200-260Wh/kg; 300Wh/kg predictable
<b>Charge (C-rate)</b>	0.7C, charges to 4.20V (most cells), 3h charge typical, fast charge possible with some cells
<b>Discharge (C-rate)</b>	1C typical; 3.00V cut-off; high discharge rate shortens battery life
<b>Cycle life</b>	500 (related to depth of discharge, temperature)
<b>Thermal runaway</b>	150°C (302°F) typical, High charge promotes thermal runaway
<b>Cost</b>	~\$350 per kWh <sup>[1]</sup>
<b>Applications</b>	Medical devices, industrial, electric powertrain (Tesla)
<b>Comments</b>	Shares similarities with Li-cobalt. Serves as Energy Cell.
<b>2019 Update:</b>	Mainly used by Panasonic and Tesla; growth potential.

Courtesy of Battery University

# Why LiFPo4 is considered safer?

<b>Lithium Iron Phosphate:</b> LiFePO <sub>4</sub> cathode, graphite anode Short form: LFP or Li-phosphate Since 1996	
<b>Voltages</b>	3.20, 3.30V nominal; typical operating range 2.5–3.65V/cell
<b>Specific energy (capacity)</b>	90–120Wh/kg
<b>Charge (C-rate)</b>	1C typical, charges to 3.65V; 3h charge time typical
<b>Discharge (C-rate)</b>	1C, 25C on some cells; 40A pulse (2s); 2.50V cut-off (lower than 2V causes damage)
<b>Cycle life</b>	2000 and higher (related to depth of discharge, temperature)
<b>Thermal runaway</b>	270°C (518°F) Very safe battery even if fully charged
<b>Cost</b>	~\$580 per kWh <sup>[1]</sup>
<b>Applications</b>	Portable and stationary needing high load currents and endurance
<b>Comments</b> <b>2019 Update:</b>	Very flat voltage discharge curve but low capacity. One of safest Li-ions. Used for special markets. Elevated self-discharge. Used primarily for energy storage, moderate growth.

Table 10: Characteristics of Lithium Iron Phosphate

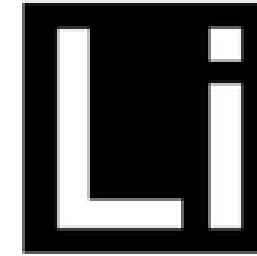
Courtesy of Battery University

# What could change our outcomes?

- ▶ Routine Maintenance.
- ▶ Manufacturer-Specific Training.
- ▶ Integrated Fire Protection.
- ▶ Quality Assurance.
- ▶ Specialized PPE.
- ▶ Correct Suppression.
- ▶ Industry Standardization.



# Battery Manufacturers Investing in Protection



BATTERIES  
**THIUM**  
SOUTH AFRICA



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# Locally Developed Fire Protection



**FIREBLOCK®**



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# Ensuring batteries are dealt with safely after an incident.



# Local Specifications Guiding around Batteries

- ▶ SANS 10142-1
- ▶ SANS 10108
- ▶ SANS 10400?

# Local Specifications Guiding around Batteries

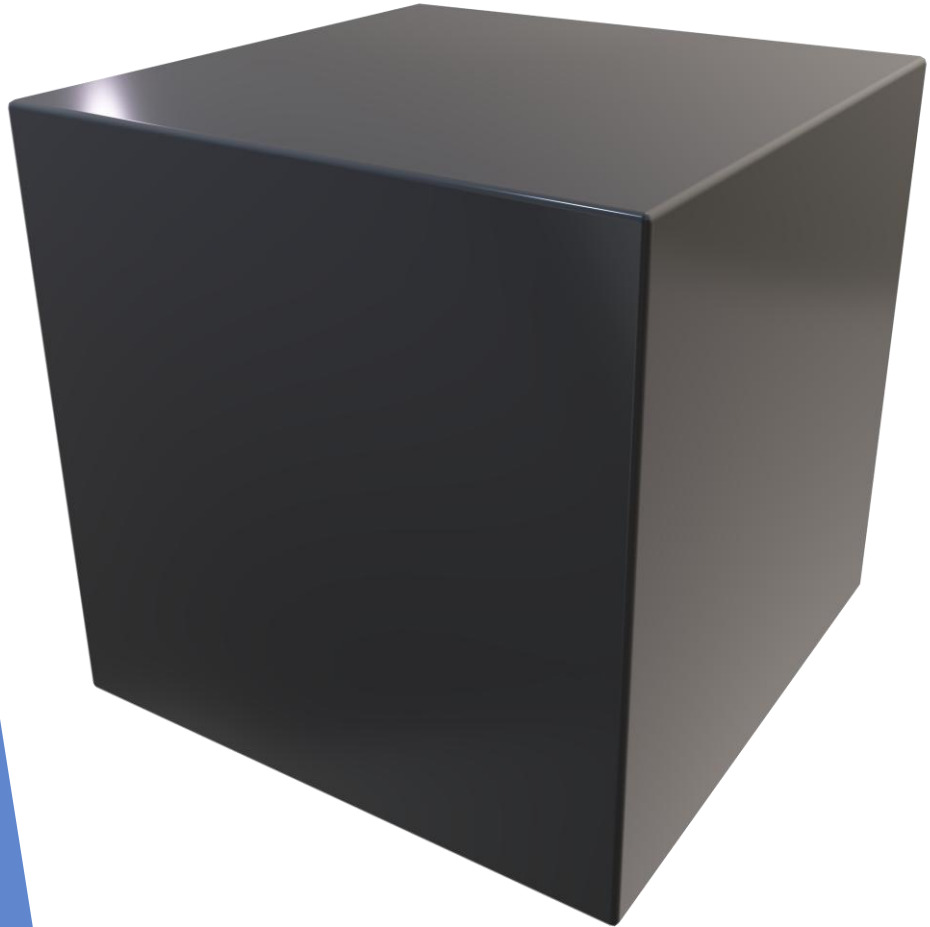
## ▶ SANS 10108

*3.3.6 zone 2 an area in which an explosive gas atmosphere is not likely to occur in normal operation but, if it does occur, it will exist for a short period only*

*Note 1 to entry: Indications of the frequency of the occurrence and duration may be taken from codes relating to specific industries or applications.*

Courtesy of SANS 60079-10-1

# Thermal Runaway



$$3\text{m} \times 3\text{m} \times 3\text{m} = 27\text{m}^3$$

*Hydrogen:*

$$\text{LEL } 4\% = 1,08 \text{ m}^3$$

$$\text{UEL } 70 \% = 18,9 \text{ m}^3$$

# Local Specifications Guiding around Batteries

## ► SANS 10400?

Table 1 — Occupancy or Building Classification

1	2
Class of occupancy of building	Occupancy
A1	<b>Entertainment and public assembly</b> Occupancy where persons gather to eat, drink, dance or participate in other recreation.
A2	<b>Theatrical and indoor sport</b> Occupancy where persons gather for the viewing of theatrical, operatic, orchestral, choral, cinematographical or sport performances.
A3	<b>Places of instruction</b> Occupancy where school children, students or other persons assemble for the purpose of tuition or learning.
A4	<b>Worship</b> Occupancy where persons assemble for the purpose of worshipping.
A5	<b>Outdoor sport</b> Occupancy where persons view outdoor sports events.
B1	<b>High risk commercial service</b> Occupancy where a non-industrial process is carried out and where either the material handled or the process carried out is liable, in the event of fire, to cause combustion with extreme rapidity or give rise to poisonous fumes, or cause explosions.
B2	<b>Moderate risk commercial service</b> Occupancy where a non-industrial process is carried out and where either the material handled or the process carried out is liable, in the event of fire, to cause combustion with moderate rapidity but is not likely to give rise to poisonous fumes, or cause explosions.
B3	<b>Low risk commercial service</b> Occupancy where a non-industrial process is carried out and where neither the material handled nor the process carried out falls into the high or moderate risk category.
C1	<b>Exhibition hall</b> Occupancy where goods are displayed primarily for viewing by the public.
C2	<b>Museum</b> Occupancy comprising a museum, art gallery or library.
D1	<b>High risk industrial</b> Occupancy where an industrial process is carried out and where either the material handled or the process carried out is liable, in the event of fire, to cause combustion with extreme rapidity or give rise to poisonous fumes, or cause explosions.
D2	<b>Moderate risk industrial</b> Occupancy where an industrial process is carried out and where either the material handled or the process carried out is liable, in the event of fire, to cause combustion with moderate rapidity but is not likely to give rise to poisonous fumes, or cause explosions.
D3	<b>Low risk industrial</b> Occupancy where an industrial process is carried out and where neither the material handled nor the process carried out falls into the high or moderate risk category.
D4	<b>Plant room</b> Occupancy comprising usually unattended mechanical or electrical services necessary for the running of a building.
E1	<b>Place of detention</b> Occupancy where people are detained for punitive or corrective reasons or because of their mental condition.
E2	<b>Hospital</b> Occupancy where people are cared for or treated because of physical or mental disabilities and where they are generally bedridden.
E3	<b>Other institutional (residential)</b> Occupancy where groups of people who either are not fully fit, or who are restricted in their movements or their ability to make decisions, reside and are cared for.

Table 1 (concluded)

1	2
Class of occupancy of building	Occupancy
E4	<b>Health care</b> Occupancy which is a common place of long term or transient living for a number of unrelated persons consisting of a single unit on its own site who, due to varying degrees of incapacity, are provided with personal care services or are undergoing medical treatment.
F1	<b>Large shop</b> Occupancy where merchandise is displayed and offered for sale to the public and the floor area exceeds 250 m <sup>2</sup> .
F2	<b>Small shop</b> Occupancy where merchandise is displayed and offered for sale to the public and the floor area does not exceed 250 m <sup>2</sup> .
F3	<b>Wholesalers' store</b> Occupancy where goods are displayed and stored and where only a limited selected group of persons is present at any one time.
G1	<b>Offices</b> Occupancy comprising offices, banks, consulting rooms and other similar usage.
H1	<b>Hotel</b> Occupancy where persons rent furnished rooms, not being dwelling units.
H2	<b>Dormitory</b> Occupancy where groups of people are accommodated in one room.
H3	<b>Domestic residence</b> Occupancy consisting of two or more dwelling units on a single site.
H4	<b>Dwelling house</b> Occupancy consisting of a dwelling unit on its own site, including a garage and other domestic outbuildings, if any.
H5	<b>Hospitality</b> Occupancy where unrelated persons rent furnished rooms on a transient basis within a dwelling house or domestic residence with sleeping accommodation for not more than 10 persons within a dwelling unit.
J1	<b>High risk storage</b> Occupancy where material is stored and where the stored material is liable, in the event of fire, to cause combustion with extreme rapidity or give rise to poisonous fumes, or cause explosions.
J2	<b>Moderate risk storage</b> Occupancy where material is stored and where the stored material is liable, in the event of fire, to cause combustion with moderate rapidity but is not likely to give rise to poisonous fumes, or cause explosions.
J3	<b>Low risk storage</b> Occupancy where the material stored does not fall into the high or moderate risk category.
J4	<b>Parking garage</b> Occupancy used for storing or parking of more than 10 motor vehicles.

Table 4 — Fire resistance of occupancy-separating elements

Occupancy groups	Fire resistance																	
	min																	
	B1 D1	B2 D2	J1	A1 A2 A4 F1	F3	D4	E1 E2 E3 E4	A3	J2	F2	G1	J3	J4	H1 H2 H3 H4 H5	A5	C1 C2	B3 D3	
B1, D1	-	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
B2, D2	120	-	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
J1	120	120	-	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
A1, A2, A4, F1	120	120	120	-	120	120	120	120	120	120	120	120	120	120	120	120	120	120
F3	120	120	120	120	-	120	120	120	120	120	120	120	120	120	120	120	120	120
D4	120	120	120	120	120	-	120	120	120	120	120	120	120	120	120	120	120	120
E1, E2, E3, E4	120	120	120	120	120	120	-	90	90	90	90	90	90	90	90	90	90	90
A3	120	120	120	120	120	120	90	-	90	90	60	60	60	60	60	60	60	60
J2	120	120	120	120	120	120	90	90	-	90	60	60	60	60	60	60	60	60
F2	120	120	120	120	120	120	90	90	90	-	60	60	60	60	60	60	60	60
G1	120	120	120	120	120	120	90	60	60	60	-	60	60	60	60	60	60	60
J3	120	120	120	120	120	120	90	60	60	60	60	-	60	60	60	60	60	60
J4	120	120	120	120	120	120	90	60	60	60	60	60	-	60	60	60	60	60
H1, H2, H3, H4, H5	120	120	120	120	120	120	90	60	60	60	60	60	60	-	60	60	60	60
A5	120	120	120	120	120	120	90	60	60	60	60	60	60	60	-	60	60	60
C1, C2	120	120	120	120	120	120	90	60	60	60	60	60	60	60	60	-	60	60
B3, D3	120	120	120	120	120	120	90	60	60	60	60	60	60	60	60	60	60	-

# Local Specifications Guiding around Batteries

OHS Act

**‘Safe’** Free from any **Hazard**.

**‘Hazard’** A source of or exposure to **Danger**.

**‘Danger’** Anything which may cause injury or damage to persons or property.

# Local Specifications Guiding around Batteries

OHS Act

**“reasonably practicable”**

means practicable having regard to-

- a) the **severity** and scope of the hazard or risk concerned;
- b) the state of **knowledge** reasonably available concerning that hazard or risk and of any means of removing or mitigating that hazard or risk;
- c) the ***availability and suitability*** of **means** to remove or mitigate that hazard or risk; and
- d) the **cost** of removing or mitigating that hazard or risk in **relation** to the benefits deriving there from

# International Specifications

- ▶ Australia/New Zealand

## AS 5139:2019

- ▶ Batteries shouldn't be installed where you can expect damage from external influences.
- ▶ Hazardous areas as defined by the AS 3000 shouldn't be used for battery installation.
- ▶ Batteries shouldn't be installed within 600mm horizontally or 900mm below a window or vent leading to a habitable room.
- ▶ Passageways, walkway exits or evacuation routes should not contain a battery.
- ▶ Batteries should not be installed below entrance or exit walkways, staircases, escape routes or passageways internal or external to a building.
- ▶ Roofs, ceiling spaces and wall cavities should not contain a solar battery.
- ▶ Non-combustible barriers should be installed between solar batteries and any walls within 300mm that have habitable rooms on the other side.
- ▶ Manufacturers prohibit battery installation in specific locations.

Courtesy of Plico

# International Specifications

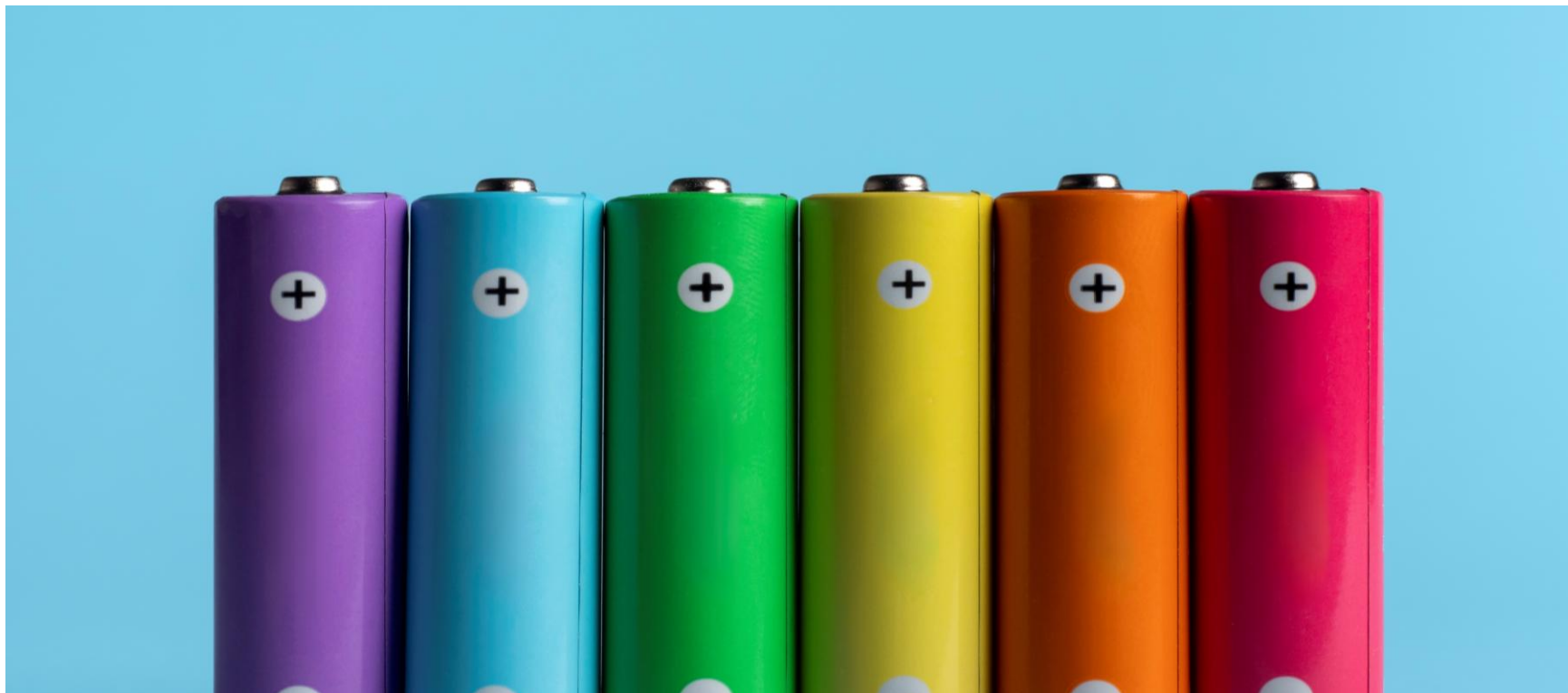
▶ America

Chapter 15 of NFPA 855

Area	Maximum Stored Energy
Utility closets, storage or utility spaces	40 kWh
Garages and detached structures	80 kWh
Exterior walls	80kWh
Outdoor installations	80kWh

# Challenge to Industry

- ▶ Complacency Doesn't help
- ▶ Advocate safety
- ▶ Drive change



# Thank You-Dankie-Ngiyabonga

Please feel free to ask any questions on [anthony@ecasa.co.za](mailto:anthony@ecasa.co.za) or give us a call on 011 392 0000