BT6 Decommissioning and Sustainable Reutilisation of Batteries

BY THE FARADAY INSTITUTION AS A DELIVERY PARTNER OF THE FARADAY BATTERY CHALLENGE BY INNOVATE UK

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BT6 Decommissioning and Sustainable Reutilisation of Batteries

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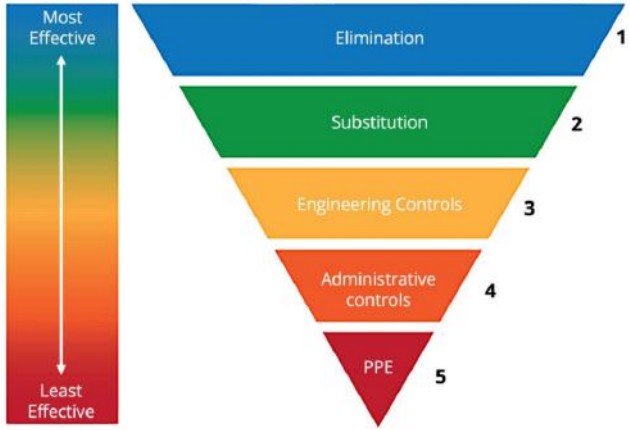

Risk Chart

At work, Personal Protective Equipment (PPE) is considered as the least effective defence against risk.

However, in electrification activities it is our first line of defence, ultimately the most important factor that will keep you alive when carrying out activities on High Voltage (HV)

Notes:

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PPE for Working on HV Battery Packs – Removal Process

Class zero (0) or double zero (00) rubber gloves, which you have checked for damage before wearing

A cotton inner glove and a protective outer glove

Non-conductive face shield.

Overalls made from natural materials (e.g. cotton).

Non-conductive footwear, with Electrical Hazards (EH) protection.

Notes:

IMPORTANT: Use a rubber (electrical) mat at all times.

PPE – Filtering Devices

Class zero (0) or double zero (00) rubber gloves, which you have checked for damage before wearing

Notes:

A cotton inner glove and a protective outer glove

Antistatic/Cleanroom coveralls

Air-fed full-face helmet

Safety Issues Relating to Tools & Equipment

Make sure the equipment you are using:

- Has the correct CAT rating for the vehicle you are working on.
- Has a CAT III rating of 1000 V DC and leads rated at 1000 V DC these would be suitable for most electric vehicles.
- Has a CAT III rating of 600V DC and leads rated at 600 V DC this equipment would not be suitable for a system delivering at 720V DC.
- Are fully insulated tools (1000 V DC) - spanners, screwdrivers, pliers, cutters and socket sets etc.

IMPORTANT: Do not rely on the CAT rating alone, please check the safety voltages of the equipment and the output voltage of the HV system.

Notes:

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Civilian Protection Equipment (CPE)

Protection equipment to protect civilians when working on high voltage batteries includes:

- Barriers
- Signage
- Fire extinguishers
- Electrical safety hook
- AED
- Burns kit
- First aid kit
- Spill kit

Notes:

Conforming to Health & Safety and Legislation

There are a number of legislations which are relevant to battery preparation and disposal. These include:

- (UN) ECE – R100 Rev 2
  https://www.unece.org/fileadmin/DAM/trans/main/wp29/wp29regs/2013/R100r2e.pdf
- Electricity at Work Regulations (EAWR-89)
  https://www.hse.gov.uk/pubns/books/hsr25.htm
- (HSE) Electric and Hybrid Vehicles
  https://www.hse.gov.uk/mvr/topics/electric-hybrid.htm
- (HSE) Using Electric Storage Batteries Safely
  https://www.hse.gov.uk/pubns/indg139.pdf
- GS38 (Electrical Test Equipment)
  https://www.hse.gov.uk/pubns/books/gs38.htm
- Health & Safety at Work Act
  https://www.hse.gov.uk/legislation/hswa.htm
- (HSE) Managing for Health & Safety
  https://www.hse.gov.uk/pubns/priced/hsg65.pdf
- Reporting of Injuries, Diseases and Dangerous Occurrences (RIDDOR)
  https://www.hse.gov.uk/pubns/indg453.pdf
- Control of Substances Hazardous to Health (COSHH)
  https://www.hse.gov.uk/coshh
- Personal Protective Equipment (PPE)
  https://www.hse.gov.uk/pubns/indg174.pdf

Notes:

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Notes:

Working Practices

- Employers must carry out a Risk Assessment for each task or operation.
- SOPs: Standard Operating Procedures / Safe Operation Practices must be adhered to.
- When the hazards and risks are identified Safe Schemes of Work (SSW) must be introduced.
- SSWs may include: No lone working or handling of machinery, calibration of test equipment, protective methods and protective equipment.

Notes:

Health & Safety Toolbox

The health and safety toolbox is a comprehensive guide from the HSE on ‘how to control risks at work’.

It contains guidance on how small to medium-sized businesses can put measures in place to control the risks and includes:

- Case studies
- Simplified advice
- Helpful lists/do’s and don’ts
- Updates on legal changes
- Detail information / sources of advice

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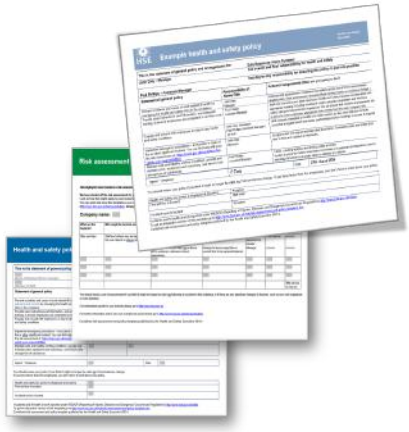
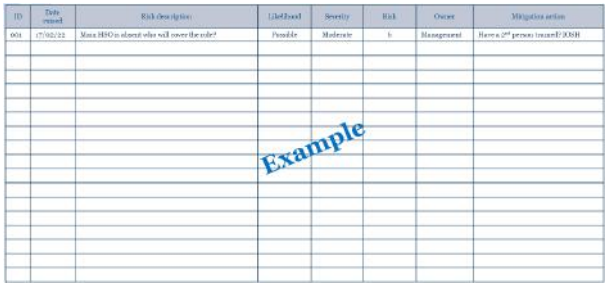


Health & Safety Policy Documents

- Workplace General Policy documents
- Safe Schemes of Work (SSW)
- Health and Safety Policy documents
- Risk Assessment / Risk Management documents
- Electrical / PAT / Gas Safe testing records
- Standard Operating Procedures (SOPs)
- Staff training / CPD records
- Accident book - records
- Incident or near miss reporting forms
- Layout map of fire evacuation / escape route plans

Notes:



ID	Date raised	Risk description	Likelihood	Severity	Risk	Owner	Mitigation action
001	17/02/22	Main HSO is absent who will cover the role?	Possible	Moderate	6	Management	Have a 2nd person trained/EIOSH

Example

Health & Safety Workplace Training

Who is needed and what are their titles?

- The Health and Safety Officer (HSO)
- Fire Wardens
- Fire Marshalls
- Anti-terrorism - trained personnel
- First Aiders

Additional to staffing:

- H&S Communications / Bulletins
- H&S Risk Management

Notes:

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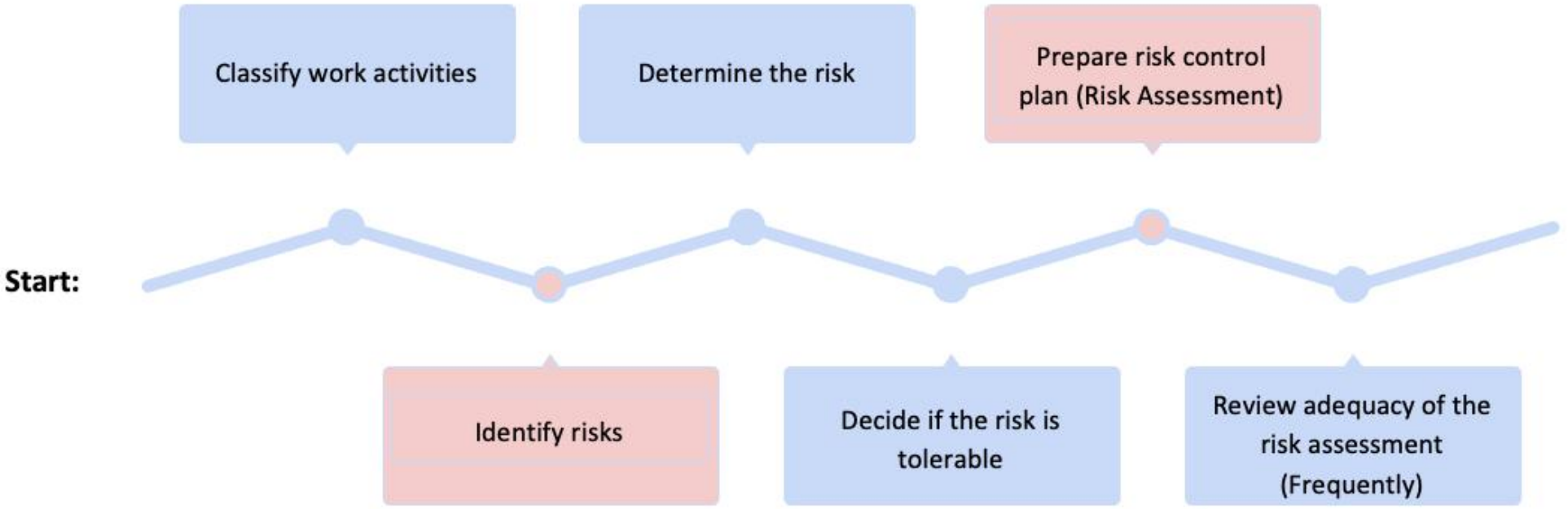
Risk Identification



Notes:

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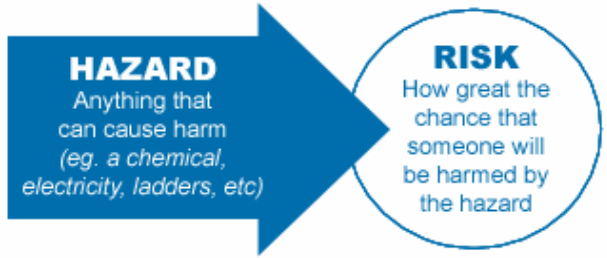
High Voltage Workplace Observations

Additional safety measures must be taken when working with HV components / parts and assemblies.

Measures should be in place to identify:

- The space around a HV designated component / part or assemblies
- The cleanliness of the area
- All tools, equipment and PPE

Notes:



Hazard vs Risk

A Hazard is something that can cause harm, e.g. electricity, chemicals, working up a ladder, noise, a keyboard, a bully at work, stress, etc.

A Risk is the chance, high or low, that any hazard will actually cause somebody harm. For example, working alone away from your office can be a hazard.

Notes:

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Types of Hazard

There are six major types of hazard:

- **Physical** Noise, vibration, lighting, electrical, heat and cold, nuisance dust, fire/explosion, machine grinding, working space.
- **Chemical** Gases, dusts, fumes, vapours, liquids.
- **Ergonomic**
- **Radiation**
- **Psychological**
- **Biological**

Notes:

Hazards cont.

Safety hazards are the most common workplace hazards. They include anything that can cause spills or tripping such as cords running across the floor or ice.

Anything that can cause falls such as working from heights, including ladders, scaffolds, roofs, or any raised work area.

Notes:

Risk Assessment

Identify hazards and risk factors that have the potential to cause harm (hazard identification). Determine appropriate ways to eliminate the hazard or control the risk when the hazard cannot be eliminated (risk control).

Notes:

Identify the Hazard

- Check manufacturers' instructions or data sheets / SDS sheets / battery passports for chemicals and equipment as they can be very helpful in spelling out the hazards and putting them in their true perspective.
- Look back at your accident and ill-health records - these often help to identify the less obvious hazards.
- Take account of non-routine operations (e.g. maintenance, cleaning operations or changes in production cycles).
- Remember to think about long-term hazards to health (e.g. high levels of noise or exposure to harmful substances).

Notes:

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Notes:

The 5 Steps to Risk Assessment

- Step 1 – Identify the hazard
- Step 2 – Decide who might be harmed and how
- Step 3 – Evaluate the risks and decide on precautions
- Step 4 – Record your findings and implement them
- Step 5 – Review your risk assessment and update if necessary

Notes:

Risk Assessment – Static vs Dynamic

A risk assessment can be Static or Dynamic.

Static – planned in advanced, would happen before the action/process takes place and would then be reflected upon after the process is completed.

Dynamic – planed in advance but constantly happening during the action/process. The risk assessment is constantly happening and being reflected upon. This takes into account any changes in situation / people / process / environment and is a more accurate representation of that moment in time.

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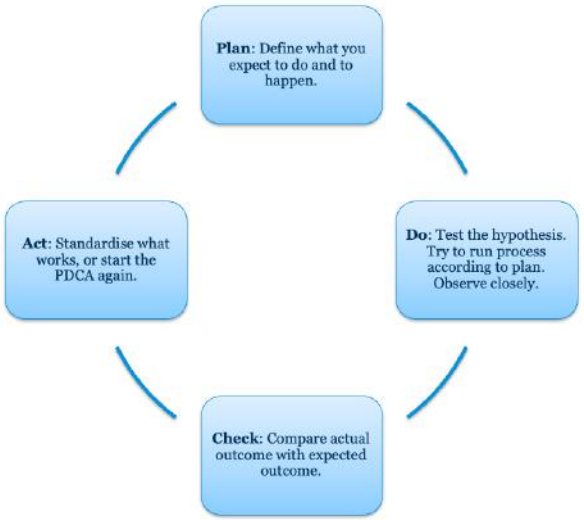

Dynamic Risk Assessment

This methodology is known as **PDCA**:

- **P**lan
- **D**o
- **C**heck
- **A**ct

It is a continually repeated process, that is used at each review process until risks or failures are reduced to zero.

Notes:

Risk Assessment Example

CENTRE:	ISSUE DATE:
VERSION: 001	REVIEW DATE:
AUTHOR:	APPROVED BY:
SIGNATURE:	SIGNATURE:

Risk Assessment

Department: Section: Battery Pack - Checking / Preparation Area	**Overview – A risk assessment on general workshop activities, passing through the workshop and taught sessions**	
Name of assessor and position:	**Date Completed:**	**Review Date:**

What are the significant Hazards?	Who might be harmed and how?	What are you doing already? (Controls)	What further action, is needed?	Risk Rating L	S	R	Comments: by HSO.
Slips trips and falls	Employees, contractors, visitors and other personnel. Slips and trips can cause cuts, bruises, broken bones, sprains and strains from poorly maintained floor surfaces, poor housekeeping and contaminated floor areas.	Adequate training, information, instruction and supervision, Good house-keeping and 5s, Spill kits situated in the area, Rubber matting fitted to reduce the risk of slips and fatigue, Safety inspections on a daily and monthly cycle, Marked walkways, adequate lighting and barriers.	Employees to conduct a visual pre use environmental safety check of their training environment at the beginning of each working day.	1	2	2	All spillages and trip hazards must be removed as soon as possible to prevent injury and ill health to staff and students. Good housekeeping must be maintained at all times. All trailing cables must be covered when in use.
Projectiles and ejection of parts or materials	Employees, contractors, visitors and other personnel. Projectiles can cause bruising, cuts, abrasions, serious damage to eyes and skin which can lead to infections and loss of sight.	Personal protective equipment has been provided; E-boots and safety glasses, Protective faceshields are also provided, adequate guarding is in place on equipment, Regular maintenance and safety checks are conducted on all equipment in the area.	N/A	1	2	2	All visitors to the area must wear the required PPE and be supervised at all times.

Notes:

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Calculating the Risk Rating

LIKELIHOOD		
1	Unlikely	Where harm will rarely occur
2	Possible	Where harm will occur frequently
3	Likely	Where it is certain or near certain that harm will occur

SEVERITY		
1	Minor	Superficial injury. Minor damage
2	Significant	Where a person may be off work for more than 3 days. Significant property damage
3	Major	Death, major injury. Major property damage
RISK RATING		
1-3	Low	Ensure controls are maintained. Reduce so far as reasonably practicable
4	Medium	Look to improve within a specified time scale. Aim to reduce to a Low-risk rating if this is not possible contact the health and safety department for further advice and guidance –
6-9	High	Stop activity and contact the health and safety department for further advice and guidance -

Likelihood X Severity =
Risk Rating

LIKELIHOOD				
	3	LOW	HIGH	HIGH
	2	LOW	MEDIUM	HIGH
	1	LOW	LOW	LOW
		1	2	3
		SEVERITY		

Notes:

Unknown Risks/Changing Situations

Whilst Risk Assessment are specific to a site, environment, task or specific piece of equipment / product.

You cannot anticipate for everything or prevent every accident.

If a risk assessment/management activity has been carried out, plus a site assessment has been done and there are still a lot of unknowns, then an activity should cease and not go ahead until all the identified risks are mitigated against.

Notes:

Lithium-ion Battery Hazards - Leakage

- Damage or abuse leads to leaking electrolyte (potentially toxic chemicals).
- Potential for HF (Hydrofluoric Acid) to be present.
- Hydrofluoric acid is a serious systemic poison. It is highly corrosive. Its severe and sometimes delayed health effects are due to deep tissue penetration by the fluoride ion.

Notes:

Lithium-ion Battery Hazards – Thermal Runaway

Thermal runaway can be caused by:

- Abuse / Stress leads to thermal runaway / fire.
- Rapid exothermic reaction – catastrophic decomposition and fragmentation (flying debris)
- Very high temperature (1300°C+)
- Very high gas flow rates (100's litres/second)
- Toxic gases and particulates.

Notes:

Lithium-ion Battery Hazards – Cell Venting

- Abuse or Stress leads to gas build up and venting.
- Potential for flammable gas build up, leading to explosive atmosphere.

Notes:

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Battery Safety Issues – Cell Degradation

When Li-ion cells charge and discharge over a long time, deposits form around the anode. Cell manufacturing is normally done in a cleanroom to stop additional materials being added to the anode and cathode layers.

If these materials are allowed to become embedded in the layers then puncturing of the separator becomes inevitable which leads to a direct short between the anode and cathode.

Notes:

Battery Safety Issues – Cell Pressuring/Venting

Charging above 4.2 V or the failure of the cell charging system leads to increased heat and swelling of the Li-ion cell.

If the pressure is too high depending on the cell structure, a release valve is incorporated into the cell casing, however this pressure release can also lead to thermal incidents inside the battery housing.

Notes:

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Battery Safety Issues – Overcharging

The sole purpose of a battery/cell is to store energy and release this energy at the desired time. The energy batteries supply stay high during most of its charge and then drops away rapidly as the charge depletes. If the discharge is allowed to continue (as the charge is rapidly depleting) then irreversible damage is caused to the battery.

Notes:

Battery Safety Issues – Overcharging cont.

This may cause the electrolyte to dry up and the separator to breakdown. Battery life and stability is directly related to the amount and length of stress the battery is subjected too. The stressing of the battery is directly related to charge and discharge rate along with temperature.

Notes:

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Battery Safety Issues – Impact/Puncture Damage

Impact damage is one of the main causes of extreme temperature leading to a fire of the battery and case.

Impact damage that penetrates the cell module housing but not the cell modules leads to the ingress of water. This leads to overheating or shorts in the battery housing.

Impact damage that penetrates the cell modules generally leads to damage to the separator allowing a direct short between the anode and cathode.

Notes:

Battery Safety Issues – Potential Injuries

Potential injuries from batteries include:

- **B**urns
- **S**hocks
- **A**rc
- **F**ire
- **E**xplosion

BSAFE – Keep safe and know how to control electrical hazards.

Notes:

Know How to Protect Against Electric Shock

Direct contact - This occurs when you touch something you would expect to be live.

Indirect contact - This occurs when you come into contact with something you would not expect to be live because there is a fault.

EAWR-89 deals with the three ways in which protection against electric shock is carried out

- ✓Protection against both direct and indirect contact
- ✓Protection against direct contact
- ✓Protection against indirect contact

- **+ EN 50110** - 1 / -2

Notes:

The Golden Rule

There is one way to make sure that you never experience an electric shock or burns:

Don't touch anything live

It sounds simple enough, but how do we make sure you cannot be injured by contact with live parts?

There are two ways:

Basic protection – which **prevents direct contact.** Fault protection systems - which **indirectly protect.**

Notes:

Safety Issues – HV Battery Packs

When removing and storing any HV system components, it is vital that all safety precautions and recommendations are followed.
You must have the required qualification and licence to work on an EV and remove the High Voltage battery pack.
Some of the safety precautions and recommendations are:

- Cutting corners
- High voltages
- Risking lives
- PPE

Notes:

AC and DC – The Effect of Current (Ref IEC 60479-2)

DC current will make a single continuous contraction of the muscles compared to AC current, which will make a series of contractions depending on the frequency it is supplied at.

In terms of fatalities, both kill but more milliamps are required of DC current than AC current at the same voltage.

The severity of the electric shock depends on the following factors: body resistance, circuit voltage, amplitude of current, path of the current, area of contact, and duration of contact.

Notes:

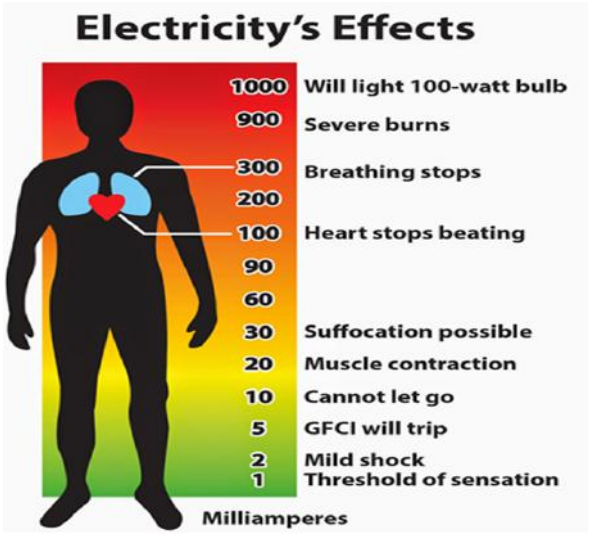
AC and DC – The Effect of Current (Ref IEC 60479-2)

Though both AC and DC currents and shock are lethal, more DC current is required to have the same effect as AC current.

For example:
If you are being electrocuted or shocked 0.5 to 1.5 milliamps of AC 60 Hz current is required and up to 4 mA of DC current is required.

For the let-go threshold in AC a current of 3 - 22 mA is required, against 15 - 88 mA of DC current.

Notes:



AC current (mA) @230V	Effect on Human body
1mA	Slight tingling sensation
1-3mA	Small shock
3-22mA (15-88mA DC)	Muscles contract, causing you to freeze. Known as the Let go threshold.
22-40mA	Respiratory muscles can become paralysed; pain; exit burns often visible
40-100mA	Usually fatal; ventricular fibrillation; entry & exit wounds visible
>100mA	Death almost certain; if survive will have badly burnt organs and probably require amputations

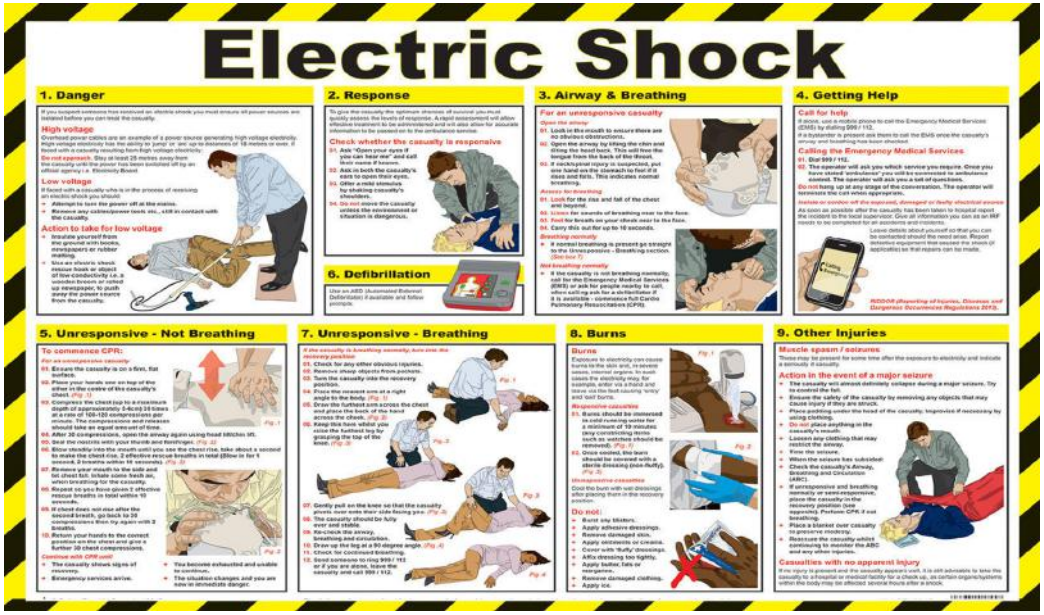
Notes:

Emergency Procedures - The Effect of Current (Ref IEC 60479-2)

The best way you can help somebody is to disconnect them from the power.
If 15-88mA (DC) or above they may be unable to free themselves.

If the power cannot be disconnected try and remove the person from the power source with a non-conducting item (Electrical Safety Hook).
Once the situation is safe administer First Aid and wait for the ambulance / paramedic.

Notes:



Notes:

Reporting Electrical Incidents

Report all electrical shocks and near misses
RIDDOR:2013 legal responsibility to report to the HSE

- Electricity is invisible – this in itself makes it dangerous
- It has great potential to seriously injure or kill
- Every company has a duty of care to its employees and contractors
- Everyone is exposed to electrical hazards, not just electricians

All employees can be exposed to electrical hazards. They should receive electrical hazard training at the commencement of their employment and regular refresher training.

Notes:

Compliance – Labelling and Packaging

A hazard statement is a phrase that describes the nature of the hazard in the substance or mixture. A hazard statement will be determined by the application of the classification criteria.

Examples of battery hazard statements include:

- Hazardous voltage inside - A battery may have several protective layers
- Toxic if swallowed - Common sense isn't always common
- Corrosive, if the battery is leaking - Care in handling required
- Explosive, risk of explosion if damaged, punctured or pierced

Notes:

Control of Substances Hazardous to Health (COSHH) cont.

The Control of Substances Hazardous to Health Regulations (COSHH) requires the employer to consider:

- Preventing exposure to hazardous substances
- Replacing with a safer alternative
- Changing the process to limit exposure

If this cannot be achieved then assess the risk from the substance.

Notes:

Battery Safety Issues – Hydrogen Fluoride (HF) Electrolyte Burns

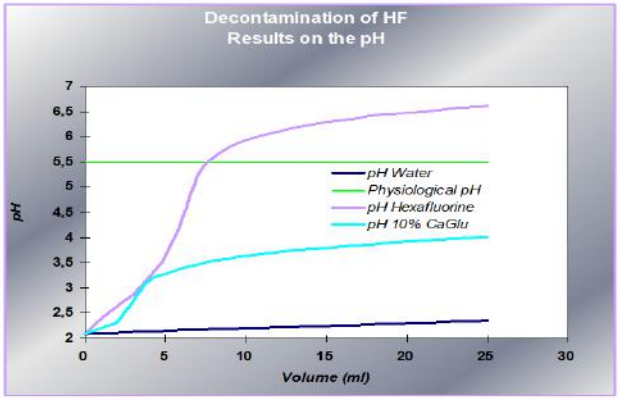
Some materials are vulnerable to moisture due to their chemical properties.

$LiPF_6$ (Lithium Hexafluorophosphate) is contained in the electrolyte of a lithium-ion battery.

When hydrolysed, $LiPF_6$ releases HF (Hydrogen Fluoride) that causes serious damage to a human body when in contact with the skin, eyes or if ingested.

Hydrogen Fluoride causes necrosis from within the skin and must be treated immediately.

Notes:



Battery Safety Issues – Hydrogen Fluoride (HF) Electrolyte Burns

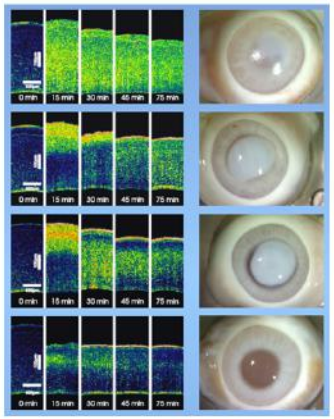
- Liquid: retains the mechanical effect.
- Absorption capacity:
  - Stops the corrosive action of H^+ ions *(3 ions fixed by each molecule)*
  - Stops the toxic action of F^- ions *(6 ions fixed by each molecule)*
- Hypertonicity: stops the penetration.

Application: on the eye and the skin

Notes:

Influence of different washing solutions on HF penetration through the cornea.

- 20s of contact,
- 25ml of 2.5% HF,
- 15 minutes of washing



Without washing

Using water

1% Calcium Gluconate Solution (C-Gel)

HEXAFLORINE® No Burn

Source: *Schrage F, Frentz M, Spöler F, Först M, Kurz H. Accepted for publication in Burns*

Notes:

DGSA – Battery Safety

Employers are required to carry out the following:

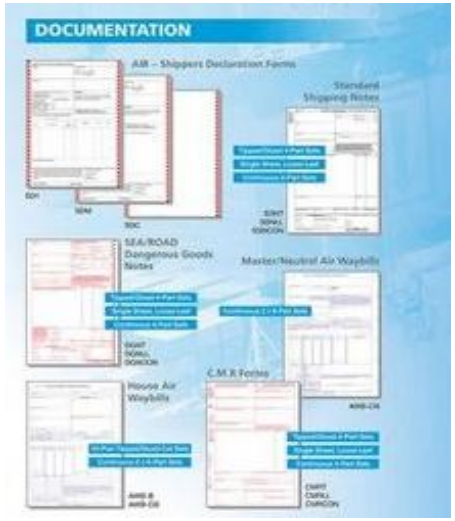
- Ensure that any employees involved in any way with the transport of dangerous goods have been appropriately trained before any involvement and that they have received appropriate refresher training.
- For air transport, refresher training is mandatory within 24 months.
- Keep a record of any training given and, if requested, make a copy available to the employee.

Notes:

DGSA – Battery Safety cont.

If involved in the carriage or the related packing, loading, unloading of significant quantities of dangerous goods by road or rail, appoint a vocationally trained and certified Dangerous Goods Safety Adviser (DGSA).

Notes:



Notes:

DGSA – Documents Required

The employer is required to ensure that when any dangerous goods (lithium batteries) are transported, they are carried in full compliance with the appropriate regulatory provision or provisions (if more than one mode is involved).

Documentation required includes:

- Shipping declaration forms
- Shipping notes
- Dangerous goods notes
- C.M.R forms

Notes:

DGSA – CMR

A CMR is **Convention relative au Contrat de Transport International de Marchandises par Route**. It is the document prepared by the company delivering the product to you, i.e. the external transport company.

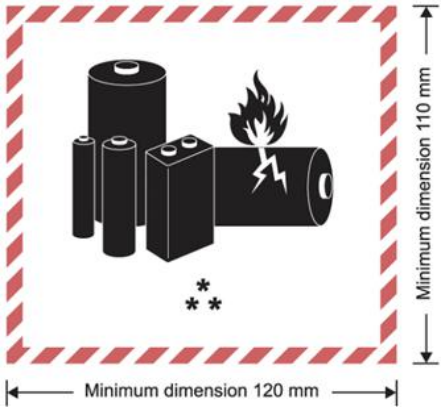
You need to sign the document to prove you received the product.

Lithium-ion Battery Transportation

Lithium-ion battery transportation in large amounts falls under the following regulations:

- **For road -** the Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR).
- **For rail -** the International Carriage of Dangerous Goods by Rail (RID).
- **For air -** the International Civil Aviation Organization (ICAO) Technical Instructions (TI) for the Safe Transport of Dangerous Goods by Air and the International Air Transport Association (IATA) Dangerous Goods Regulations (DGR).

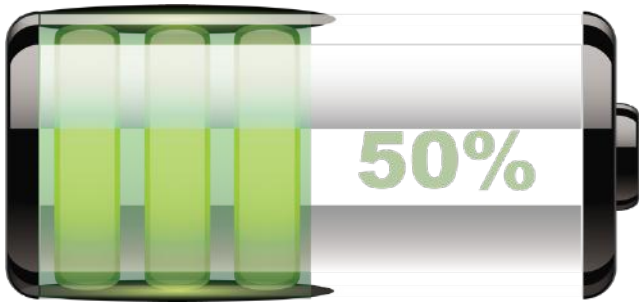
Notes:



Lithium-ion Battery Transportation cont.

- **For sea -** the International Maritime Dangerous Goods Code (IMDG).
- **For inland waterways** - the European Agreement Concerning the International Carriage of Dangerous Goods by Inland Waterways (ADN).

Notes:



Lithium-ion Battery Transportation cont.

State of Charge (SOC) of high voltage batteries should be between 28% and 50% for transportation.

High voltage batteries should be stored dry between 14ºc and 40ºc (ideal conditions)

Notes:

Identification and Classification

Due to the hazards associated with lithium batteries, there have been a number of changes to transport legislation over the past few years. Lithium batteries are articles and are now assigned their own UN numbers:

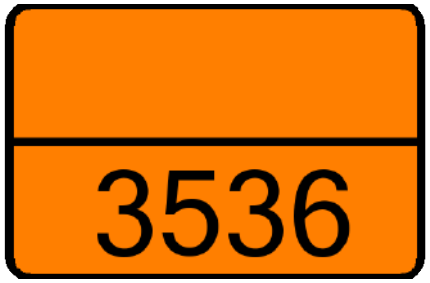
- UN 3090 — lithium metal batteries (including lithium alloy batteries)

Notes:

Identification and Classification cont.

Notes:

- UN 3091 — lithium metal batteries contained in equipment, or lithium metal batteries packed with equipment (including lithium alloy batteries)
- UN 3480 — lithium-ion batteries (including lithium-ion polymer batteries)
- UN 3481 — lithium-ion batteries contained in equipment, or lithium-ion batteries packed with equipment (including lithium ion polymer batteries)



Identification and Classification

Notes:

- UN 3536 — lithium batteries installed in cargo transport unit lithium-ion batteries or lithium metal batteries.

All lithium batteries are Class 9 — miscellaneous dangerous substances and articles. All batteries must be tested and meet the criteria as stated in the UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria Part III subsection 38.3.

BT6 Decommissioning and Sustainable Reutilisation of Batteries

UK Regulations

Each transport mode and dangerous cargo carries its own inherent risk. There are international rules for transport by land, sea, inland waterway and air, which are co-ordinated by the UN. **Directive 2008/68/EC** on the inland transport of dangerous goods (ITDGD) requires Member States to apply the provisions of ADR (road) and RID (rail), and if applicable, ADN (inland waterway) to domestic transport, subject to some national derogations and additional provisions.

Notes:

Transporting and Moving Lithium-ion Batteries (LIB)

- Individual portable LIBs must be spaced correctly in their packaging / suitable container.
- When moving / transporting an automotive battery it must be contained in a shipping case.

333Kg is the maximum amount of Lithium allowed to be carried by one HGV.

Notes:

High Voltage Battery – Effective Segregation

The removed HV battery needs to be secured from mechanical damage and should be stored out of the working area and regular commuting ways. If required a collision protection should be installed.

Notes:

High Voltage Battery – Effective Segregation cont.

Consideration needs to be given to:

- Correct lifting of the battery using the lifting eyes or mountings
- Placing the battery on a level ground
- Ensuring the working area is sufficiently ventilated
- Having a Class D L2 powder fire extinguisher in the work area
- Correctly marking out the work area

Notes:

HV Battery - Anchor Points

Manual Handling Operations Regulations (MHOR)

The main provisions of these Regulations require employers to:

- Avoid the need for employees to undertake any manual handling activities involving risk of injury.
- Assess risks of the task, load and individual to carry out a manual handling tasks to try to reduce the risk of injury.
- Provide employees with information on the weight of each load (object, person or animal).

Where an employee is required to carry out a manual handling task, appropriate training of how to lift, carry and replace the load should first be given.

Notes:

Lifting and Slinging

Steps for safe lifting and slinging:

- Pre-use checks (inspecting the equipment)
- Select the correct lifting equipment
- Make sure the load is secure
- Lifting and slinging angles
- Check the area (hazards / collision)
- Moving the load (pre-warnings / observations)
- Lowering loads
- Post operational checks.
- Storage of the lifting and slinging equipment

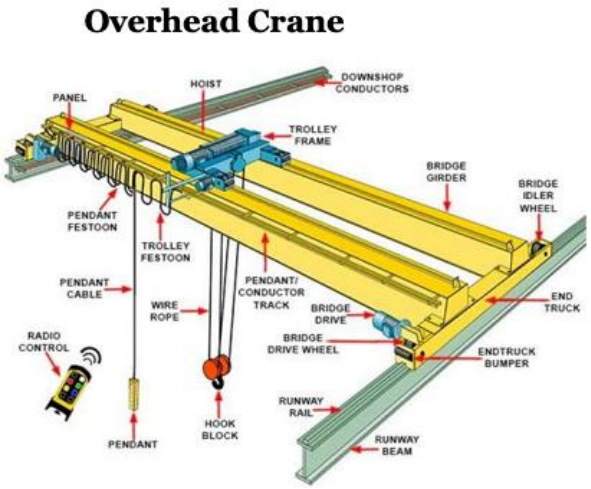
Notes:

Pre-use Checks

Before any **lifting** and **slinging** takes place a pre shift check must be carried out on the equipment used. This includes checking for, rips, tears, cracks, stitching coming loose, wear, clasps, discoloration, tags, to name just a few.

Report any faults immediately.

Notes:



Select the Correct Lifting Equipment

Before lifting a load make sure the weight, size, material, shape etc of the load is taken into account before selecting the correct lifting equipment.

Notes:

(Colour Coded / Weight Rated) Sling

Crane Hoist

Lifting Chains / Sling Hooks

Make Sure the Load is Secure

The correct method of securing the load when Lifting and Slinging is essential. ALWAYS double check the load is secure and will not come loose in transport. REMEMBER a choke hitch reduces what the sling can lift by 20%.

Notes:

Lifting and Slinging Angles

The best way to lift any load is vertical/straight up. Sometimes multi connection points are needed to secure the load, especially on long/wide loads.

REMEMBER that the lifting angle (including/working angle) will decrease what the sling can lift as the angle gets bigger. The recommended including angle between the two legs of a sling is 90 degrees. Always read the slings tag Lifting and slinging recommended angles.

Notes:

Check the Area

Before moving the load, check the route to make sure all precautions are taken to reduce the risk of an accident.

E.g. securing the area, doorways are blocked, making sure pedestrian are safe and clear etc.

Notes:

Moving the Load

The Make sure loads are carried at ground level. Under NO circumstances must loads be carried over people's heads. Hand signals can be used if necessary.

Notes:

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Lowering Loads

Always ensure the load has a destination location before moving. Lower loads carefully ensuring the load is stable once in place.

Never drag material slings or chains from underneath a load, place on runners/skids if necessary.

Notes:

Post Operational Check

A check should be completed once the Lifting and Slinging is done.

This is to so you are confident that everything is functioning as it should. Make sure no damage has occurred while using the equipment and report any faults immediately.

Notes:

Storage of the Lifting and Slinging Equipment

All of the equipment should be stored correctly when the job has been completed.

Firstly when the equipment is stored correctly it is easily found when you need it again.

Secondly, it ensures the equipment is not damaged. Store all equipment in the correct locations. Furthermore it also prevents slipping and tripping accidents in the workplace.

Notes:

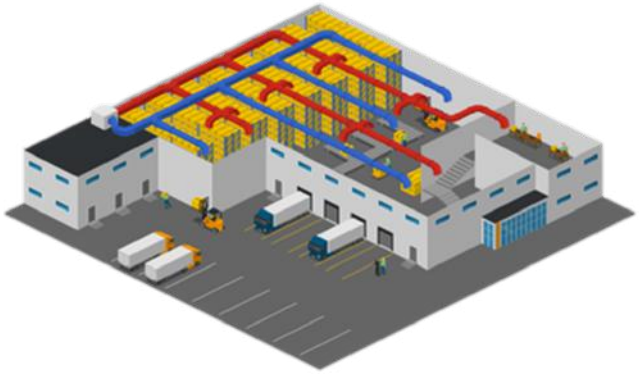
Premises Controls – Safety Signs/Signage

All '(ABTOs) Authorised Battery Treatment Operators' – Plant and Facilities are subject to the HASAWA 1974 regulations as well as those specific to battery accumulator treatment operations.

For e.g., Safety systems could include a sprinkler system in a common warehouse premises, why would / could this be a problem in a LV/HV Battery processing facility?

Notes:

BT6 Decommissioning and Sustainable Reutilisation of Batteries

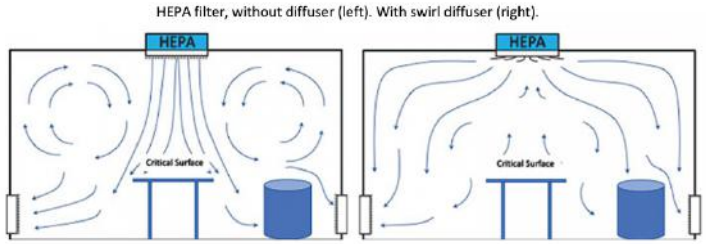


Premises Controls – Temperature Control/Ventilation

Heating, Ventilation, and Air Conditioning (HVAC) is the use of various technologies to control the temperature, humidity, and purity of the air in an enclosed space. Its goal is to provide thermal comfort and acceptable indoor air quality for the facilities operations. Simplified it is controlled by:

- Supply
- Extraction

Notes:



Premises Controls – Temperature Control/Ventilation cont.

When working with batteries, plants and facilities use a variety of 'clean rooms' and 'air movement' protocols.

For example:
Laminar Flow - The air travels smoothly for both supply and change.
Positive pressure environments - The air in the building has an increased pressure forcing e.g. dust and other contaminants to go to ground or an exit flow.

Notes:

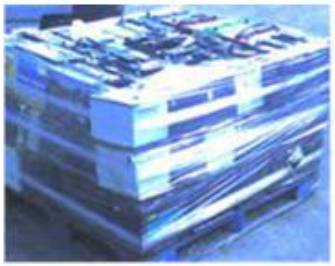
BT6 Decommissioning and Sustainable Reutilisation of Batteries

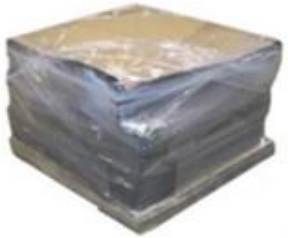
Arrival/Palletising – 12V Batteries from Waste Collectors

Forklifts are a common method of moving the received batteries around.

Safety 1st Approach:

- Safe Containment
- Safe Collection
- Secure when being moved





To improve safety ensure batteries are stacked correctly and are appropriately palletised.

Notes:

BT6 Decommissioning and Sustainable Reutilisation of Batteries

Realtime Logistics – Technology Improvements

Real-time tracking of forklifts or other vehicles, helps your logistics and production managers achieve greater:

- Efficiency
- Profitability
- Safety

This makes better use of your fleet by cutting down wasted man hours and more importantly preventing accidents.

Notes:

Heatmap

Spaghetti flow

Realtime Logistics – Technology Improvements cont.

As well as the routes of each forklift, advanced visualisation can bring an understanding of processes to streamline the traffic and remove bottlenecks. These include heatmaps showing how the density of the traffic is distributed within the facility.

These commonly understandable visualisation methods help to onboard and get the agreement of all stakeholders for increasing the ‘efficiency’ and cutting time wasted costs.

Notes:

Loading/Unloading

Specialist Vehicles are used with various end effectors / connective equipment.
For the movement of containers, a 'Container Loader' is used.

There are two types of container packing, Full Container Load (FCL) and Less-than-container Load (LCL) or break bulk shipments.

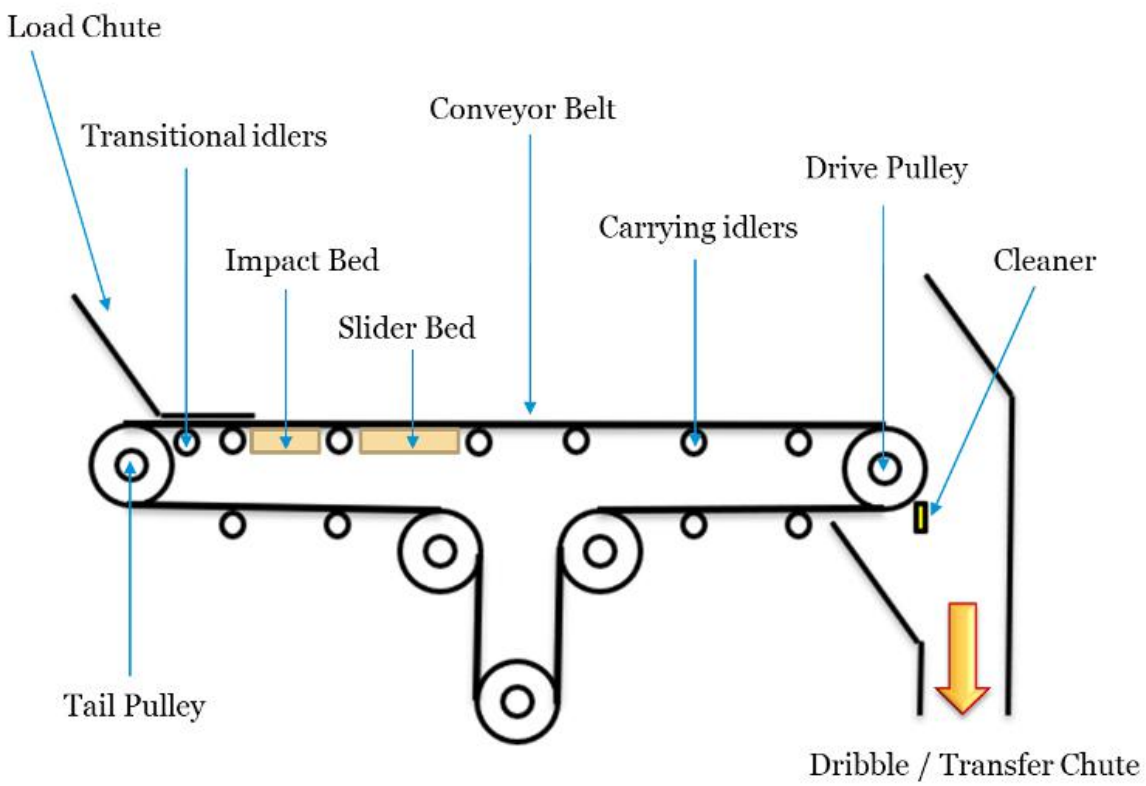
Notes:

Forklift Trucks

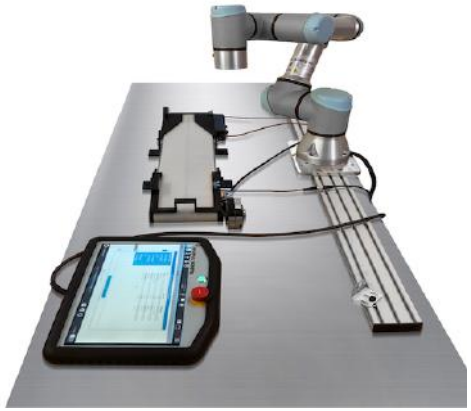
- **Class I:** Electric motor rider trucks.
- **Class II:** Electric motor narrow aisle trucks.
- **Class III:** Electric motor hand trucks or hand/rider trucks.
- **Class IV:** Internal combustion engine trucks (solid/cushion tires)
- **Class V:** Internal combustion engine trucks (pneumatic tires)

Notes:

Conveyor Belt System – Moving the Product/Material



Notes:



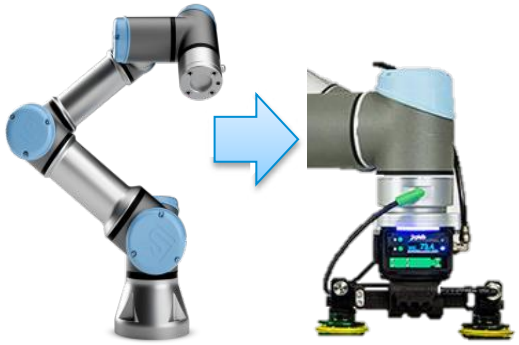
Cobots 'Robotics' - Automation

A Cobot is a Collaborative Robot. This means that the robot is able to work alongside people.

They differ from industrial robots, which tend to be large robots that work for example in the car manufacturing industry.

They require less safety protocols and are interactive / safe for people to touch, move or manipulate.

Notes:



Cobots 'Robotics' – Automation cont.

A Cobot comprises of the following components:

- Manipulator arm
- End effector
- Connecting cables
- Controller box/pendant

Notes:

Notes:

End Effector – Basic Hand Gripper

This is a simplistic design which makes it perfect for precision assembly tasks.

- Grip force 60 to 185 N
- Payload up to 5 kg

End Effector – Advanced 3 Finger Gripper

Notes:

This is ideal for advanced manufacturing and robotic research, the 3-Finger Gripper is the best option for maximum versatility and flexibility.

- Four grip types: Pinch, Wide, Scissor and Basic Mode
- Control each of the fingers separately, plus feedback from each
- End effector is compatible with all major industrial robots
- Payload up to 10kg

BT6 Decommissioning and Sustainable Reutilisation of Batteries

End Effector – Vacuum Picker

Vacuum Grippers are ideal for picking a wide range of different materials, those with either even or uneven surfaces such as cardboard, glass, metal sheet (dry) and plastic / polymer sheet.

- Energy source: Compressed air or electricity
- Picker mass: around 340g *(per suction cup)*
- Powerful vacuum flow
- Low Noise

Notes:

Robotics and Automation Advantages

There are several *(claimed)* advantages by automating processes:

- Reduced operation costs
- Improved product quality
- Improved quality of work for employees (high skills)
- Increased production output
- Increased manufacturing flexibility – ease of reuse
- Reduced waste
- Improved health and safety
- Reduced labour turnover
- Reduced capital costs
- Saving on space

Notes:

Robotics and Automation – Risks and Barriers

Some of the risks and barriers to automation include:

- Technical risk
- High variability
- Health and safety
- Payback period
- Skill levels
- Floor space
- Company culture
- Working environment

Notes:

Technical Risk

There needs to be a thorough analysis of the risks and is particularly important for complex technical tasks, this analysis will test the feasibility of adopting robotics to automate processes.

Notes:

High Variability

Usually, robotics and automation systems are deployed in industries with low variability and high volumes. Increasingly the advances in robotics are enabling organisations with product variability to consider automating processes.

Notes:

Health and Safety

Robotics and automation improve the levels of health safety than manual operations as they remove manual handling. Robots do have their own safety hazards but fatalities and injuries are low compared to those caused by manual handling.

Notes:

Payback Period

A longer-term view needs to be taken of this. Ordinarily payback might be calculated over two years but a well maintained robotic and automation system should provide a minimum payback of 5 years, with some system payback extending to 10 years.

Notes:

Skill Levels

The skill needs of personnel to operate robotic and automation systems could be a barrier. Investment in training and recruitment will be needed.

Notes:

BT6 Decommissioning and Sustainable Reutilisation of Batteries

Floor Space

Robotics and automation in some instances may require more floor space than manual operations though in many instances they save on space.

Company Culture

Resistance to change and a fear of robots taking jobs is often mentioned as reasons not to install automation**.** In the long term automation has created more jobs than have been lost and at a higher skill level.

Notes:

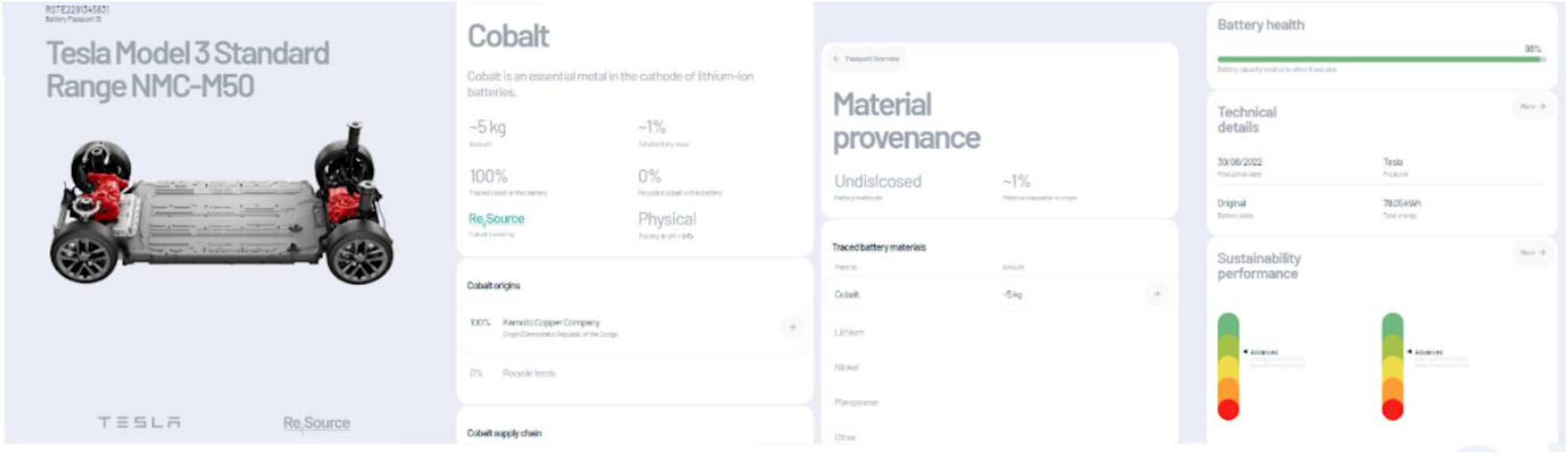
Working Environment

This needs to be carefully considered when thinking about automation. Automation systems are generally tolerant of working environments however there may be some extreme working environments that do not lend themselves to automation.

Notes:

BT6 Decommissioning and Sustainable Reutilisation of Batteries

Battery Passports

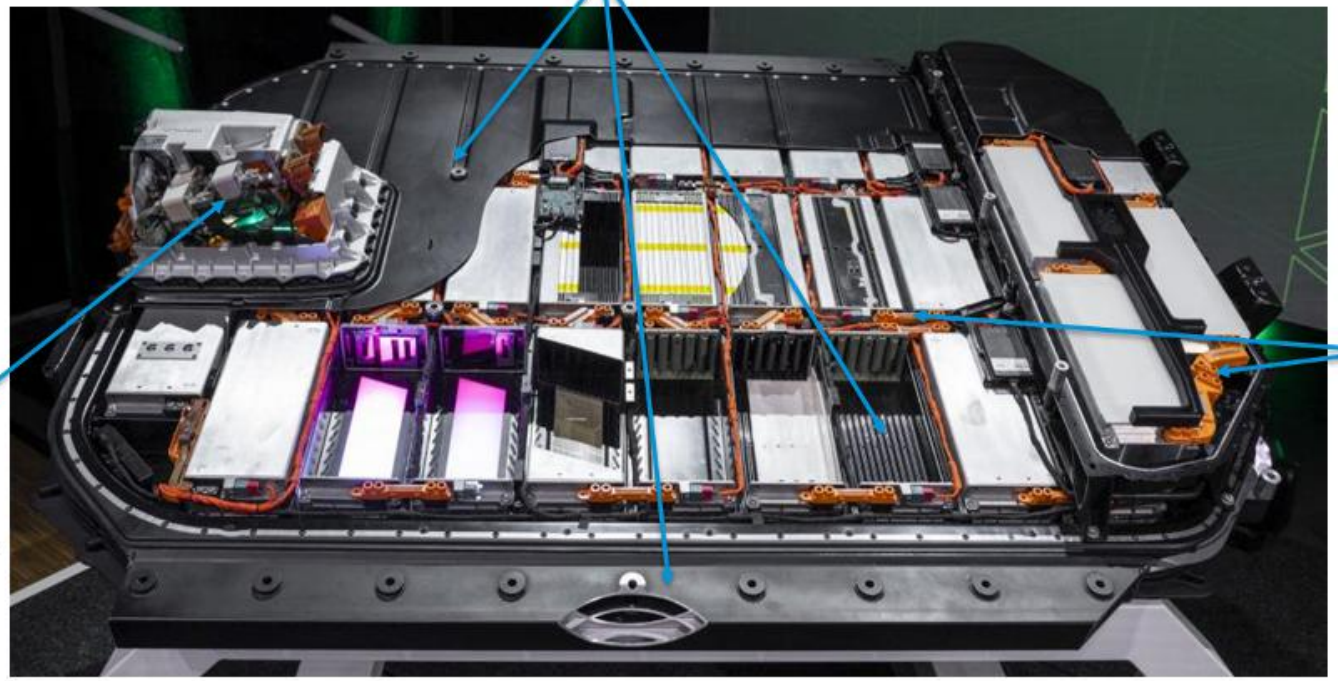


Notes:

High Voltage Battery Recycling

The Crash shell, Lid and Base – Steel Alloy, Aluminium = Widely recycled (Composite is harder to recycle).
(Recycled separately to the battery)

The BMS / BMU Is removed, this would come under regulation **(EU) 2012/19/EU** waste electrical and electronic equipment. *(Recycled separately to the battery)*



The HV Cabling, (PVC, Copper multi-core) and the Busbar links (PVC, Copper or Nickel) = Widely recycled. *(Recycled separately to the battery)*

Notes:

Inbound Logistics – Unpacking/Checking

When unpacking and checking high voltage batteries always ensure you:

- Wear the correct electrification PPE
- Check that the battery is 'locked out'
- Check and qualify the battery passport

Notes:

Inbound Logistics – Lifting and Handling

When using an overhead hoist or crane, always ensure the battery anchor points are securely connected to the hoist/crane prior to any lifting.

Please note: Specific qualifications are available for lifting and slinging, in addition to a range of training courses.

Notes:

BT6 Decommissioning and Sustainable Reutilisation of Batteries

Inbound Logistics – Weighing

The battery weight is a good indicator for its integrity / identity.

The listed weight can also indicate the batteries designation in kWh in packs that use similar housings etc.

Please note: Most high voltage automotive batteries can weigh in excess of 300kg.

Notes:

Inbound Logistics – Positioning the Battery

When positioning/lowering the high voltage battery always ensure it is level and central to the device it is being lowered onto.

Notes:

Inbound Logistics – Battery Management System Diagnosis and Discharge

The Battery Management System (BMS) diagnosis takes place on a diagnosis read machine with specific OEM software.

Note: Manual Service Disconnect (MSD)/Service Disconnect Switch (SDSW) to be replaced**.** Pack needs to be re-energised for the battery to be discharged.

Notes:

Inbound Logistics – Disconnect/Test for Dead (MSD/SDSW)

Follow the OEMs guidance on lockout (each vehicle is slightly different) in general the guidance is:

- Put on your PPE.
- Remove the MSD / SDSW / 12v HV lockout
- Wait the mandatory 10mins *(on 400v systems)* can be up to 15mins *(on 800v systems)* for de-energising.
- Test your meter (Proving unit, x2 times)
- Test for dead - COM to ground point, then positive lead to each side of the socket (done separately) to confirm 0v (Zero volt)
- Lockout the socket with the dummy plug.

Notes:

BT6 Decommissioning and Sustainable Reutilisation of Batteries

High Voltage Battery – State of Charge (SOC)

The SOC provides information about the current amount of energy stored in the battery. This is shown as a percentage from 0% (empty) to 100% (full).

An alternative form of measure is the Depth of Discharge (DoD), which is the reverse of SOC, 100% (empty) 0% (full). the DOD tells us how much percentage of charge is consumed in the battery.

Notes:

High Voltage Battery – State of Health (SOH)

As a battery ages and is used it will degrade. The State of Health is a measurement that shows the batteries current capacity measured against it's capacity when new. Often displayed as a percentage.

The State of Health will determine if the battery can have a second life utilisation or if it needs to be decommissioned.

Notes:

Pack/Module Repair or Replace

To determine if a pack/module should be repaired or replaced the condition of the batteries will need to be assessed thoroughly.

Any fire damaged or impacted batteries will need a comprehensive assessment before being re-used and if deemed dangerous they should be destroyed through incineration.

Notes:

Test Equipment – Current Clamp

A current clamp, also known as current probe, is an electrical device with jaws which open to allow clamping around an electrical conductor. This allows measurement of the current in a conductor without the need to make physical contact with it, or to disconnect it for insertion through the probe.

Notes:

Test Equipment – Digital Multi-Meter (DMM)

Digital multi-meters (DMM) are designed to measure current, voltage, and resistance, although some models have additional capabilities for testing other parameters such as temperature etc.

Notes:

Test Equipment – Voltage Testers

Voltage testers are devices for measuring both alternating and direct current voltages. Voltage testers continuously show the current voltage visually on the meter's indicator.

Notes:

Test Equipment – Proving Unit

A proving unit is a battery-powered portable device that serves as an electronic voltage source to safely verify the operation of an electrical test tools such as a digital multi-meter (DMM), clamp meters or other electrical testers.

Notes:

Inbound Logistics – Disconnect/Test for Dead (MSD/SDSW)

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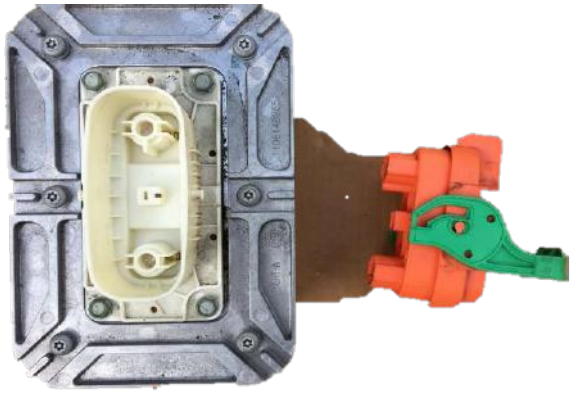
- Put on your PPE.
- Remove the MSD / SDSW / 12v HV lockout
- Wait the mandatory 10mins *(on 400v systems)* can be up to 15mins *(on 800v systems)* for de-energising.
- Test your meter (Proving unit, x2 times)
- Test for dead - COM to ground point, then positive lead to each side of the socket (done separately) to confirm 0v (Zero volt)
- Lockout the socket with the dummy plug

Notes:



Manual Service Disconnect (MSD)

A safety disconnect switch provides a means of quickly disconnecting mechanical or electronic systems from their primary power source safely.

These switches operate both automatically, to protect against circuit faults, as well as manually in case an emergency stop or planned maintenance is required.

Notes:

Pyrotechnic Disconnect Fuse

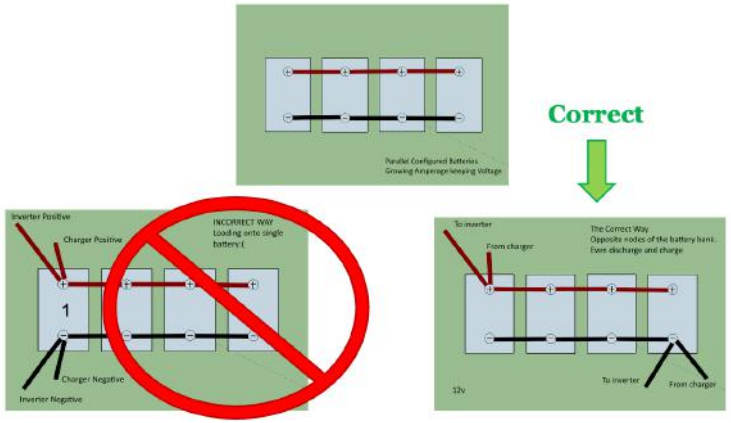
A pyrotechnic disconnect fuse is a high voltage positive battery terminal fuse which explodes and disconnects the electrical connection irreversibly to avoid short circuit or fire when a fire is detected or it is impacted. The positive terminal coming out of battery is disconnected the same second, disconnect fuse is activate.

Notes:

Battery Cover Removal

The removal of the high voltage battery cover is a mechanical process involving the removal of all of the cover bolts, in line with the OEMs dis-assembly instructions.

Notes:



Batteries Joined in Parallel

When batteries are joined in parallel the voltage stays the same but the Ah capacity is increased with every battery added.

In this design, the charger positive and negative terminals should be on different batteries to avoid too much draw (and heat) on one battery during charging and discharging.

Notes:

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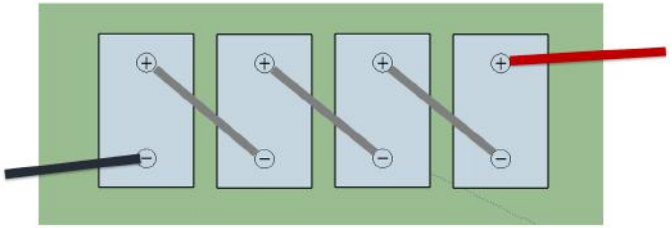
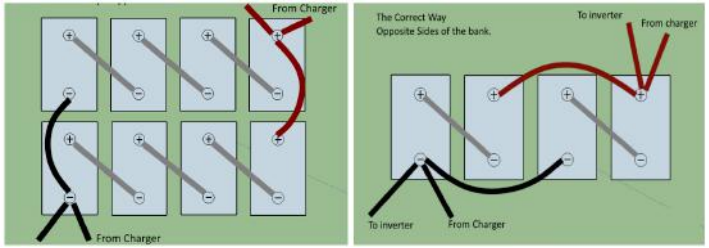


Batteries Joined in Series

When batteries are joined in series the voltage increases with every battery added and the Ah capacity remains the same.

Notes:

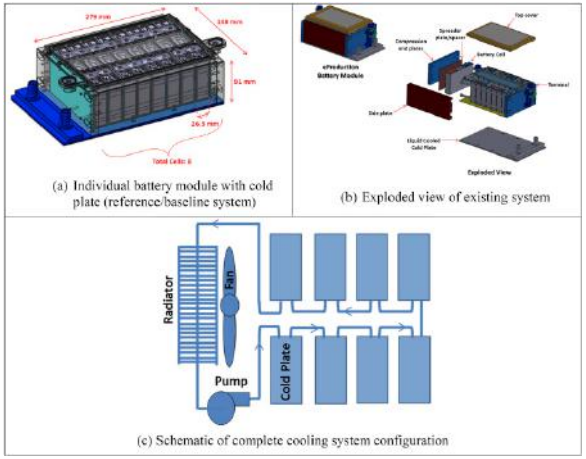


Batteries Joined in Series and Parallel

When batteries are joined in both series and parallel the voltage and the Ah capacity increases with every battery row added.

Notes:

BT6 Decommissioning and Sustainable Reutilisation of Batteries



Battery Management System (BMS) Removal

The Battery Management System (BMS) is the "brain" of the pack and ensures safe operation of the pack within pre-determined safe set parameters.

Disconnection and removal of the BMS must be completed following the OEM's disassembly procedures.

Notes:

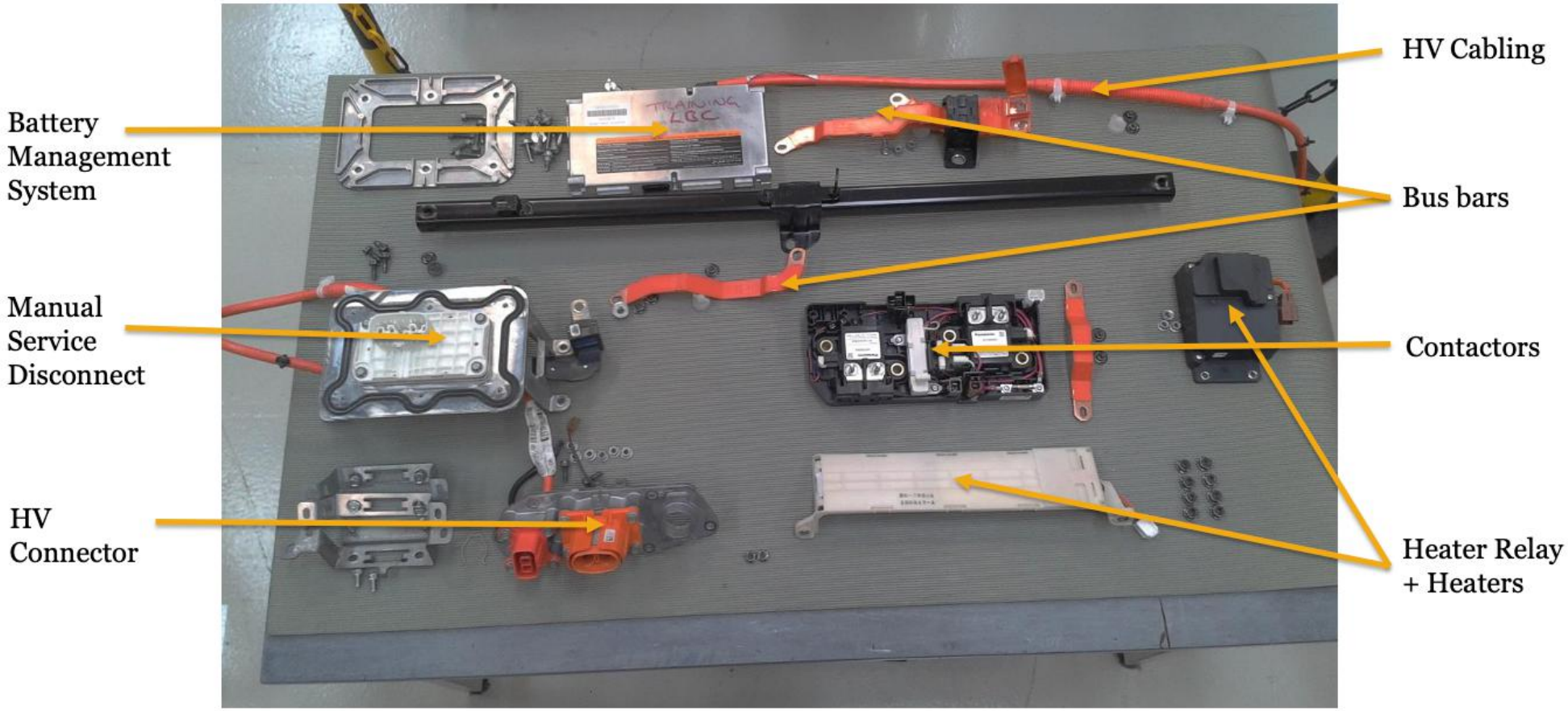
Series and Parallel Links Removal

This is the removal of the series or parallel high voltage links, to break the modules down.

E.g. if the battery is 300v and has 10 modules, removing the series links makes them 30v each to work with. This is further reducing risks.

Notes:

Control Parts – Removed



Notes:

Battery Module Removal – Assisted Lifting

A high voltage battery module can be removed and manoeuvred by one person when using assisted lifting and slinging equipment.

Please note: The use of this equipment will require specialist training.

Notes:

Battery Module Removal - Manual

A two-person lift is required by law under MHOR for an object in excess of 25kgs. Many battery modules will exceed 25kgs and therefore will require two people to lift and move them if lifting and slinging equipment is not available.

Notes:

Battery Module Replacement

It is important to replace modules with those in a similar condition. This is so once the battery is repaired the cells will balance.

Dead or depleted modules tend to parasitic draw from the others.

Putting in a brand-new module would overwork the existing ones, causing degradation to occur faster.

Notes:

Finalising the Pack Repair

At this stage the OEM contactors have been removed or replaced and the OEM BMS will have been replaced with connections for a 3rd party control unit.

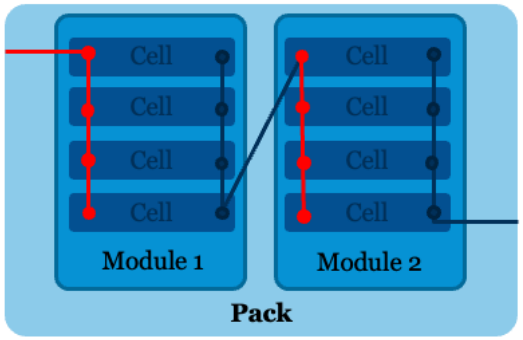
Notes:

3rd Party Battery Management Systems

Each battery cell has a wiring tap attached to measure cell voltage and temperature. This is relayed to the Cell Monitoring input which sends the information to the Battery Monitoring Unit (BMU)/Battery Management System (BMS).

The image on the left shows a single module in series (8s). In this configuration there is no parallel string.

Notes:



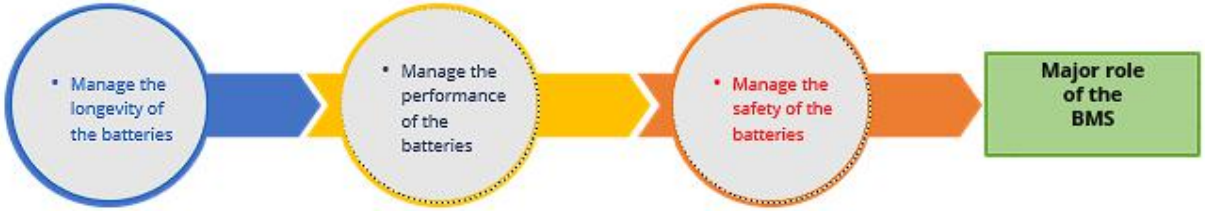
2s – 4p

3rd Party Battery Management Systems cont.

On the left is an example of a balanced layout. In this example four cells are in parallel in one module and then linked in series to a second module.

Notes:

The Role of the BMS



The BMS monitors necessary parameters such as voltage, current and temperature through the sensors in the battery system. Then, it predicts the state of charge (SoC) and the health (SoH) of the battery based on the data. It reduces the differences between the battery cells, a process called cell balancing. The system prevents over-charging, over-discharging or over-current.

Notes:

3rd Party Contactors

A contactor is an electrical device which is used for switching an electrical circuit on or off. It is considered to be a special type of relay. However, the basic difference between the relay and contactor is that the contactor is used in applications with higher current carrying capacity, whereas a relay is used for lower current applications. Contactors are compact in size. Generally, these electrical devices feature multiple contacts. These contacts are in most cases normally open and provide operating power to the load when the contactor coil is energised. Contactors are most commonly used for controlling electric motors.

Notes:

BT6 Decommissioning and Sustainable Reutilisation of Batteries

High Voltage Wiring

A high-voltage cable (HV cable) is a cable used for electric power transmission at high voltage. A cable includes a conductor and insulation. Cables are considered to be fully insulated. This means that they have a full rated insulation system which will consist of insulation, semi-conductor layers, and a metallic shield.

Notes:

Reutilisation – Energy Storage Systems (ESS)

Energy Storage Systems (ESS), also known as a Battery Energy Storage Systems (BESS) are highly adaptable and flexible devices which allow energy to be stored for use when needed later. They use the batteries to store electricity so it can be used when required.

Notes:

BT6 Decommissioning and Sustainable Reutilisation of Batteries

Battery Deployment (Transportation)

To commission a containerised ESS might require several trucks per container, depending on the size of deployment. This is due to a Heavy Goods Vehicle (HGV) only being able to carry a maximum of 333Kg of Lithium under DGSA regulations.

Notes:

Container Placement

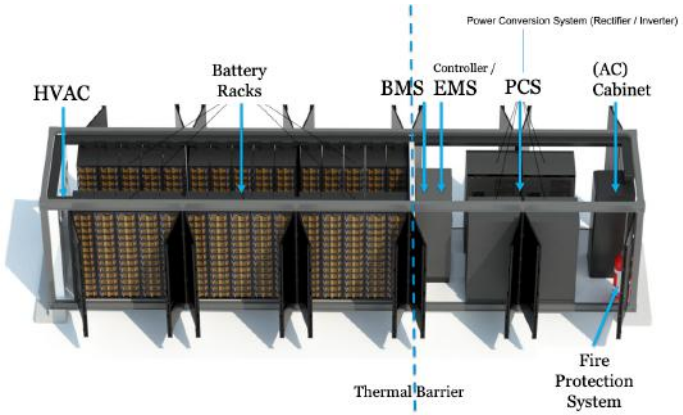
When placing a container you need to consider the type of surface it will be located on.

If placing it on soft ground it will require a stem wall construction to secure it correctly.

If the base is hardcore, it will require concrete piers.

Notes:

BT6 Decommissioning and Sustainable Reutilisation of Batteries



Container Layout

The image on the left shows the layout of a battery storage system container.

The thermal barrier is there to act as a firewall in the container to protect the control systems from the rack side.

Notes:

HVAC

HVAC is the Heating, Ventilation and Air-Conditioning system. The purpose of this is to keep the container at optimal temperature and humidity.

Notes:

BT6 Decommissioning and Sustainable Reutilisation of Batteries

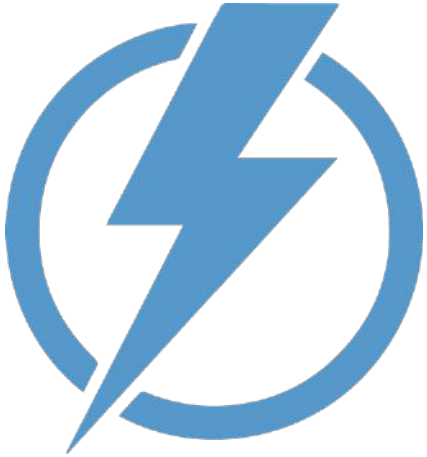
Battery Racks

This is the racking within the container which holds the battery modules or packs.

BMS

A battery management system is utilised within the container to monitor the voltage, current and temperature.

Notes:



Controller/EMS

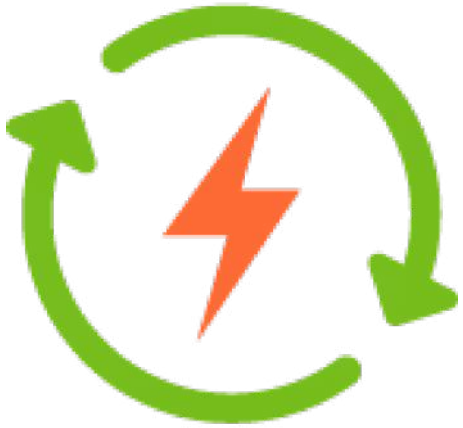
The Energy Management System (EMS) will include software and hardware to enable updates to the system remotely.

(AC) Cabinet

The AC cabinet allows for an AC (grid) connection at 415v Three Phase, or 230v Single Phase.

It also allows for the connection of solar/wind arrays.

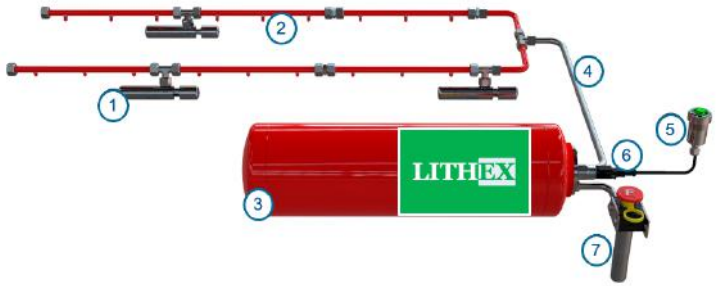
Notes:



PCS

PCS is the Power Conversion System. This has both an inverter and a rectifier to convert alternating current (AC) to direct current (DC) or DC to AC.

Notes:



Fire Protection

This is an automatic fire detection/protection system which will deploy HALON to supress an electrical fire.

1. Nozzle/Fire sprinkler head(s)
2. Rail pipe(s)
3. Lith-Ex/L2 powder supply bottle
4. Main system feed pipe
5. Over pressure/automatic drain valve
6. First stage/valve assembly
7. Heat detector (Pyrofuse)/manual actuator

Notes:

BT6 Decommissioning and Sustainable Reutilisation of Batteries

Fire Protection cont.

Methods of monitoring for fire include:

- Smoke detectors
- Panel programming
- Facilities management software

Notes:

Battery Placement (Alternative)

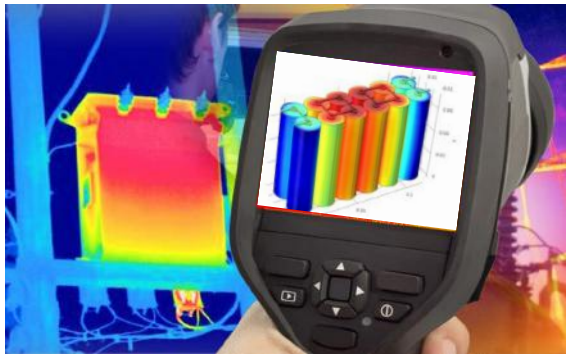
Racking systems can be customised to suit domestic building needs, as well as commercial needs. This may be a smaller system, made up of modules. The advantage of the modular system though is that it can be expanded upon.

Notes:

Energy Connection

A grid connected PV (photovoltaic) system is one where the photovoltaic panels or array are connected to the utility grid through a power inverter unit allowing them to operate in parallel with the electric utility grid.

Notes:



Visual Checks/Testing – Thermal Imaging

A common use for thermal imaging Camera is the regular thermal surveys as part of electrical equipment maintenance.

The prime advantage of thermal imaging camera is that it enables accurate inspection of electrical equipment without interrupting the machine operation. This allows a user carryout preventive maintenance without causing any downtime.

Notes:

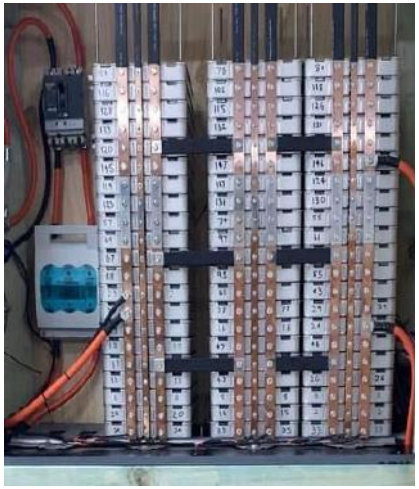
BT6 Decommissioning and Sustainable Reutilisation of Batteries

Installing Multiple Containers

When installing multiple containers on a site there are some considerations to be mindful of.

- Regulatory spacing between the containers (guidance is 1 to 4 metres)
- Emergency services need to be able to access the site
- The distance from any dwelling (guidance is 3m (min) to 7.5m)
- A disaster plan and impact assessment on the surrounding area

Notes:



Domestic Systems

Domestic systems use modules from EV battery packs in second life. Instead of using the whole battery the modules are removed and tested individually.

In a lot of cases, the domestic ‘power wall’ providers, use ‘new’ overstock from the automotive manufactures – repurposing an overprovision.

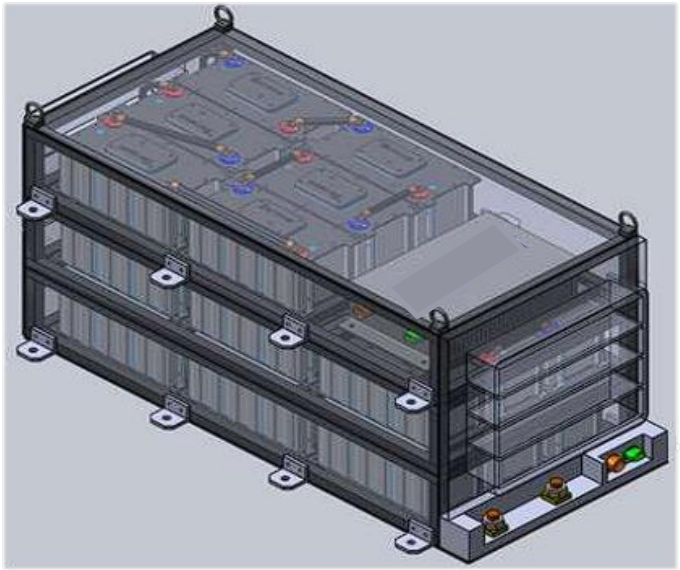
Notes:

Future Technologies – Supercapacitors

Key Characteristic	Units	Supercapacitor	Batteries
Voltage	V	2.5 – 5V	1.2 – 4.2
Cold Operating Temp	°C	**-40**	-20
Hot Temperature	°C	**+70 (85)**	+60
Cycle Life		**>500,000**	300 – 10,000
Calendar Life	Years	**5-20**	0.5 – 5
Energy Density	Wh/L	1 – 10	**100 – 350**
Power Density	W/L	**1000 – 10,000**	100 – 3,000
Efficiency	%	**>98**	70 - 95
Charge Rate	C/x	**>1,500**	<40
Discharge Time		Sec / Minutes	**Hours**

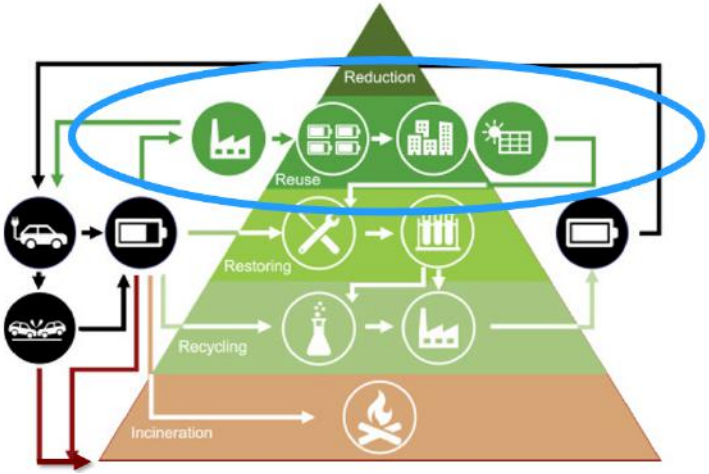
There are some key advantages of supercapacitors:

- Long calendar life (up to 20 years) and high charge / discharge cycles (millions)
- No replacement
- Maintenance free
- Predictable wear out / time to end of life
- Simple monitoring & voltage balancing
- High power, high efficiency, low resistance
- Wide temperature range: -40 to +85C
- Light weight
- Environmentally friendly
- No heavy metals
- No thermal runaway
- Scalable with modular configuration



Notes:

BT6 Decommissioning and Sustainable Reutilisation of Batteries



Pathways

The diagram to the left shows the different pathways of battery reclaiming, re-utilisation, recycling or incineration.

Notes:

Re-Utilisation – Energy Storage Systems (ESS) and Re-Life

High voltage battery packs that still have a residual capacity between approx. 70% and 80% are sorted, collected, tested and repaired to be used in Energy Storage Systems (ESS).

Depending on a customer's requirement, these companies can link together numerous HV battery packs to create DC power storage banks to meet a business's energy requirement needs. (Or domestic home systems).

Notes:

BT6 Decommissioning and Sustainable Reutilisation of Batteries

Conforming to Battery Regulations and Standards

WEEE Regulations
(EC) 2006/66/EC on batteries and accumulators and waste batteries and accumulators
(this regulation covers - battery packs, modules and cells only.)

Notes:

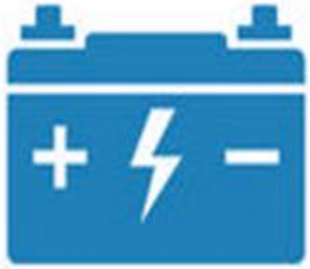
(EC) 2006/66/EC – Portable Batteries

Portable batteries are:

- Sealed
- Under 4Kg and carried by an average person without difficulty
- Not an automotive or industrial battery
- Not designed exclusively for industrial or professional use

Notes:

BT6 Decommissioning and Sustainable Reutilisation of Batteries



Notes:

(EC) 2006/66/EC – Industrial Batteries

Industrial batteries are:

- Designed only for industrial/professional use
- Used as a source of power for propulsion in an electric or hybrid vehicle
- Unsealed, but not an automotive battery
- Sealed and not a portable battery

Notes:

(EC) 2006/66/EC – Automotive Batteries

Automotive batteries are:

- Designed for vehicles, including those used off road, such as racing cars and tractors
- Any battery used in vehicles, such as in the key fob/remote

BT6 Decommissioning and Sustainable Reutilisation of Batteries

Waste Refuge Centres

All local authorities (waste refuse centres) in the UK will collect and process household and 'low voltage' automotive batteries.

Automotive 'waste collectors' (sometimes referred to as car scrapyards) will buy (plus test for safety), then either sell on or move to an 'ABTO' approved battery treatment operator a larger 'HV' battery pack from a vehicle.

Notes:

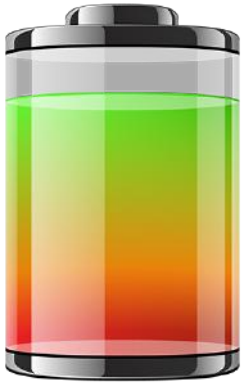
Image: Freepik.com

Waste Refuge Centres cont.

Manufactures also have a collection scheme and storage area for a return to base system for the 'HV' battery packs. (The manufacturer is still responsible for safe repair, recycling or disposal of its products.)

Notes:

BT6 Decommissioning and Sustainable Reutilisation of Batteries



Battery Waste which can be Processed at Refuge Centres

All household batteries including 'button' batteries from watches.

Battery packs from laptops, mobile phones, power tools and remote-control units.

Car batteries can also be recycled but only at designated collection points, not in your home recycling.

Notes:

Minimum Recycled Content

The EU have set targets on this as a 'minimum recycled quantity' % in legislation.

By 2035 EV battery recycling could provide at least 22% of the lithium and nickel and 65% of the cobalt necessary for European production.

Notes:

BT6 Decommissioning and Sustainable Reutilisation of Batteries

Form: Delegation of approved/appropriate person

This form is for packaging/battery companies to delegate their document signing function

January 2017

An approved/appropriate person must sign applications for approval and registration, data submissions (including data template submissions and changes to registration details and data) and statements of compliance/declaration of compliance. The approved/appropriate person is responsible for submitting data either to

- the Compliance Scheme acting on its behalf the appropriate authority*
- the Secretary of State (Regulatory Delivery)

The approved/appropriate person must be one of the following

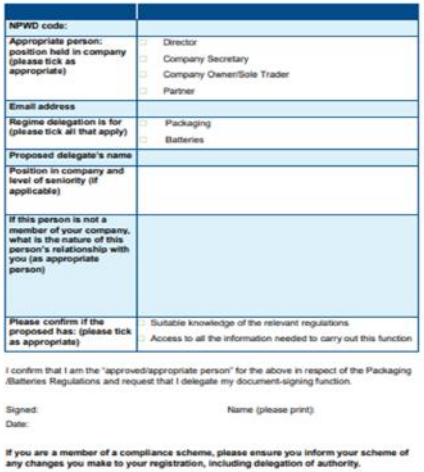
Legal entity	Approved/Appropriate person
Company registered in UK	A Director or the Company Secretary*
Partnership	A Partner
Sole Trader	Individual
Other	A person who has control or management of the business

*According to Companies House registration

If you are an approved/appropriate person of an operator and you want to delegate your function for signing documents or information to another person you must sign a statement confirming you wish to delegate your function and return it to the relevant environmental regulator or Secretary of State. If you are a member of a compliance scheme, you may choose to submit your request via them. We have 28 days to assess your application from when we receive it.

If you are not a member of a compliance scheme, you must ensure that the proposed delegate is given the appropriate access to NPWD by your SuperUser. If you do not know your NPWD number, you can find this on the public registers on NPWD at:
https://npwd.environment-agency.gov.uk/

* Environment Agency for England, National Resources Wales for Wales, SEPA for Scotland and Northern Ireland Environment Agency for Northern Ireland.



NPWD code:	
Appropriate person: position held in company (please tick as appropriate)	☐ Director ☐ Company Secretary ☐ Company Owner/Sole Trader ☐ Partner
Email address	
Regime delegation is for (please tick all that apply)	☐ Packaging ☐ Batteries
Proposed delegate's name	
Position in company and level of seniority (if applicable)	
If this person is not a member of your company, what is the nature of this person's relationship with you (as appropriate person)	
Please confirm if the proposed has: (please tick as appropriate)	☐ Suitable knowledge of the relevant regulations ☐ Access to all the information needed to carry out this function

I confirm that I am the "approved/appropriate person" for the above in respect of the Packaging /Batteries Regulations and request that I delegate my document-signing function.

Signed: Name (please print):

Date:

If you are a member of a compliance scheme, please ensure you inform your scheme of any changes you make to your registration, including delegation of authority.

Approved Battery Treatment Operator (ABTO) – Licence and Approval

To apply for approval you must have:

- At least one UK site for treating and recycling waste batteries
- An 'environmental permit'.

Notes:

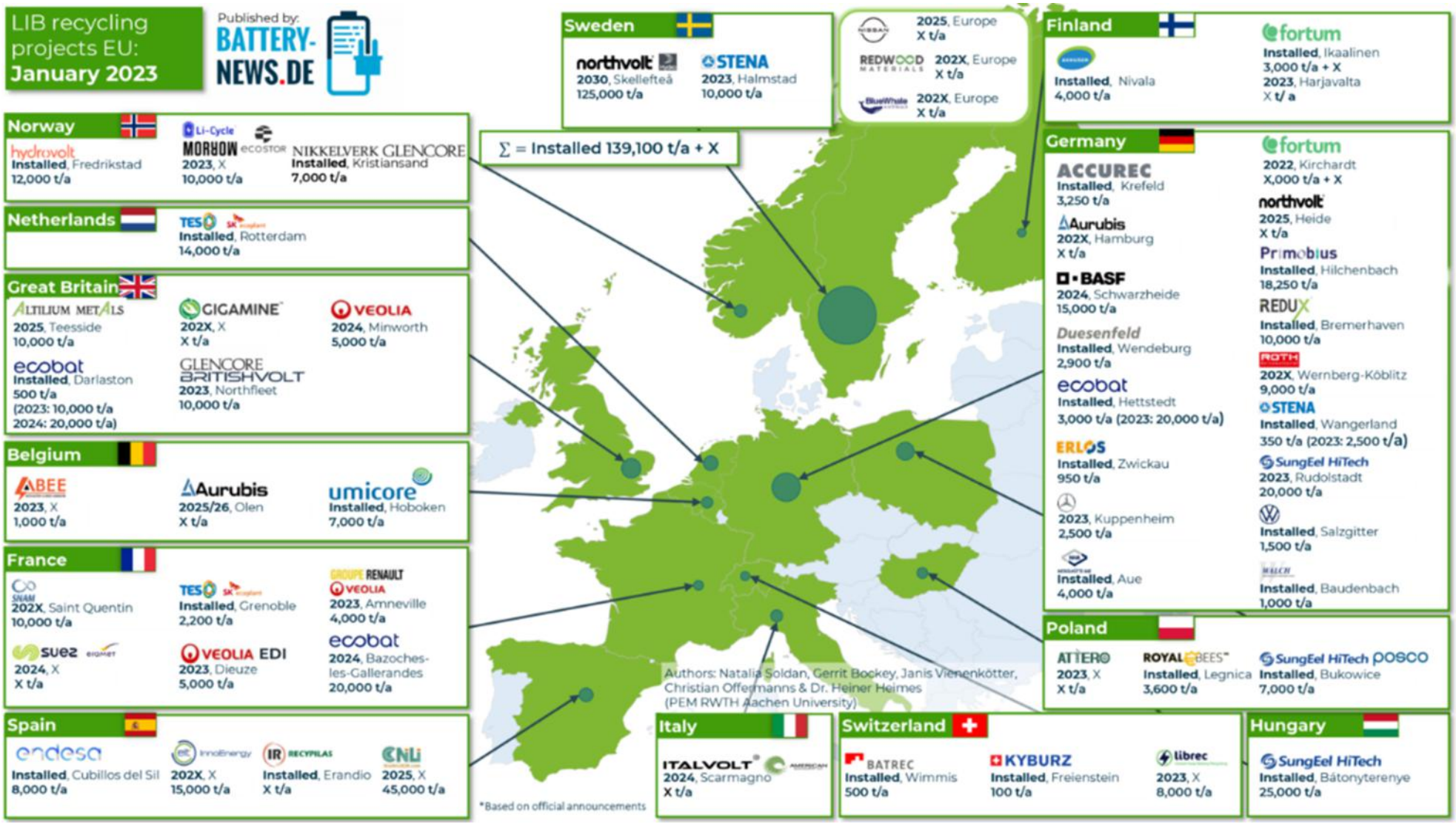
Approved Battery Treatment Operator (ABTO) – Licence and Approval cont.

An approved or appropriate person is:

- A director or company secretary of a registered company
- A partner or member of a partnership, including limited liability partnership
- The obligated person if providing information as an individual
- A person who has management of that body (the producer is a company not registered in the UK)

Notes:

Lithium-Ion Battery Recycling Projects



BT6 Decommissioning and Sustainable Reutilisation of Batteries

Battery packs,
Modules or cells.

WEEE

Compliance: Labelling

WEEE Labelling needs to be clear on products, and separated into:

- Waste Electrical and Electronic Devices (Right Symbol)
- Waste Batteries (Left Symbol)

Notes:

Control of Substances Hazardous to Health (COSHH)

Control of Substances Hazardous to Health Regulations (COSHH). This legislation covers substances that are hazardous to health.

Substances can take many forms which includes:

- Chemicals
- Products containing chemicals
- Fumes
- Dusts

Notes:

Control of Substances Hazardous to Health (COSHH) cont.

Every year, thousands of workers are made ill by hazardous substances, contracting lung disease such as asthma, cancer and skin disease such as dermatitis. These diseases cost many millions of pounds each year to:

- Industry, to replace the trained worker
- Society, in disability allowances and medicines
- Individuals, who may lose their jobs

Notes:

Control of Substances Hazardous to Health (COSHH) – Hazard Statements

A hazard statement is a phrase that describes the nature of the hazard in the substance or mixture. A hazard statement will be determined by the application of the classification criteria.

Examples of battery hazard statements include:

- Hazardous voltage inside
- Toxic if swallowed
- Corrosive, if the battery is leaking
- Explosive, risk of explosion if damaged, punctured or pierced

Notes:

Control of Substances Hazardous to Health (COSHH) cont.

The Control of Substances Hazardous to Health Regulations (COSHH) requires the employer to consider:

- Preventing exposure to hazardous substances
- Replacing with a safer alternative
- Changing the process to limit exposure

If this cannot be achieved then assess the risk from the substance.

Notes:

Control of Substances Hazardous to Health (COSHH) cont.

Identify the substances

- Their use
- Where used?

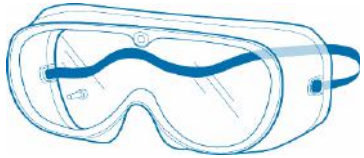
Identify who is at risk

- Who comes into contact?

Assess the risk

- What is the hazard?
- The likelihood of harm occurring
- The seriousness of injury that may occur

Notes:



Training Requirements for COSHH

The employer must provide information, instruction, training and supervision on:

- Risks from the hazardous substances
- Control measures used
- Spillage procedures
- How to report problems or faults
- Emergency procedures

Notes:

Control of Substances Hazardous to Health (COSHH) – Control Measures

As an employer, if control measures for the hazard are not possible then you should:

- Enclose the process
- Reduce the duration of exposure
- Provide ventilation
- Provide a safe system of work
- Ensure correct and appropriate PPE
- Provide training on all of the above

Notes:

Control of Substances Hazardous to Health (COSHH) – Control Measures cont.

Hazardous substances can enter the body via:

- Inhalation
- Ingestion
- Injection
- Absorption
- Instilled (eye)

Notes:

Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR)

The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations. Employers are required to report any work-related incidents, injuries and diseases to the Health and Safety Executive (HSE), or to the local authority environmental health department.

Notes:

Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR) cont.

The employer is required to record any work-related incidents, injuries and diseases in an accident book with:

- date and time of the incident
- details of the person affected
- the nature of their injury or condition
- their occupation
- the place where the event occurred
- a brief note on what happened

Notes:

Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR) cont.

An employee must report any of the following to the employer:

- Accidents
- Injuries
- Near misses

These events must be recorded in the accident book and the employer must investigate the incident.

Notes:

Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR) cont.

The following injuries or ill health must be reported:

- The death of any person;
- Specified injuries requiring immediate medical attention.
- 'Over-seven-day' injuries, relieving someone of their normal work
- For more than seven days as a result of injury caused by an accident at work.
- Reportable occupational diseases.
- Near misses, described as 'dangerous occurrences'.

Notes:

Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR) cont.

Timescales for notification of accidents to the Incident Contact Centre or enforcing authority:

- Immediately – deaths, major injuries and dangerous occurrences.
- Over 7 day absence – within 15 days.
- Over 3 day absence – record but do not report.

Notes:

Health & Safety Enforcement

Health and Safety Executives and Environmental Health Officers (working for the local authority) have the following enforcement powers and duties:

- Gain entry to premises at any reasonable time
- Give instructions
- Take samples, photographs and seize dangerous equipment
- Ask questions
- Advise employers and safety
- Be representatives

Notes:

Enforcement Actions

Enforcement actions can include:

- Give verbal or written advice
- Serve an improvement notice
- Serve a prohibition notice
- Commence a prosecution

Notes:

RIDDOR – Penalties for Breaking the Law

The penalties applicable to the Reporting of Injuries, Diseases and Dangerous Occurrences are as follows:

- Magistrates court:
  - Maximum fine £20,000
  - Maximum 6 months in prison
- Crown court:
  - Unlimited fine
  - Maximum 2 years in prison

Notes:

BT6 Decommissioning and Sustainable Reutilisation of Batteries

Glossary of Terms

Term/phrase/abbreviation	Explanation
BMS	Battery Management System
BPS / BPU	Battery Protection System / Battery Protection Unit
CAT ratings	Multi-meter category https://www.digikey.co.uk/en/blog/what-are-multimeter-cat-safety-ratings
Cell	An individual power source - cylindrical, pouch, prismatic or blade.
CMR	Convention on the Contract for the International Carriage of Goods by Road
DGSA	Dangerous Goods Safety Advisor
EDU	Electric Drive Unit
FA & T	Formation, Ageing & Testing
ICE	Internal combustion engine
KIB	Potassium Ion Battery
LAB	Lead Acid Battery
LBC	Lithium Battery Controller (same as BMS - different term)
LFP	Lithium, Iron Phosphate (Cells)
LIB	Lithium Ion Battery
MCU	Motor Control Unit

Glossary of Terms Cont.

Module	An arrangement of cells makes up a module
MRP - ERP	Manufacturing Requisition Planning / Enterprise Resource Planning
MVIB	Multi Valiant Ion Battery
NMC	Nickel, Manganese & Cobalt (Cells)
NMP	N-methyl-2-pyrrolidone (NMP) is the most common solvent for manufacturing cathode electrodes in the battery industry; however, it is becoming restricted in several countries due to its negative environmental impact.
Pack	An arrangement of stacked cells or modules joined in series and/or parallel, makes up a pack.
PVDF	Polyvinylidene fluoride more commonly known as (PVDF) polymers, are widely used as binders in lithium-ion batteries. It can be injected, moulded or welded and is commonly used in the chemical, semiconductor, medical and defence industries, as well as in lithium-ion batteries.
SAP	Systems Application and Products (Planning)
SEI	Solid Electrolyte Interphase
SIB	Sodium Ion Battery
TMS / TMU	Thermal Management System / Unit