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UNCONCIOUS INCOMPETENCE

NO RISK, IT HAS GOT WHEELS

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Unconscious Incompetence

Are we putting high-energy batteries where we sleep?

A Facebook post from Bedfordshire Fire and Rescue Service, together with two YouTube videos, set me thinking about what appears to be a growing gap between **battery technology, installation practice and the level of safety awareness surrounding it.**

The Bedfordshire post concerned a fire attended by the Service where a massage device had been left charging while the property was unoccupied. The battery subsequently went into **thermal runaway**.

The post quite rightly highlighted sensible precautions around charging lithium-ion battery-powered equipment.

But it left me asking a rather uncomfortable question:

Are we applying the same level of caution to much larger, higher-energy lithium battery systems that we are increasingly installing inside our homes, caravans, motorhomes and other occupied spaces?

The motorhome example

The first YouTube video showed an incident in the United States involving a recreational vehicle — what we would generally call a motorhome or campervan in Europe.

A small battery energy storage system experienced thermal runaway.

Fortunately, the battery was installed in a large externally accessed locker and the vehicle was fitted with detection. The incident also occurred during the day, when the occupants were outside the vehicle.

Even so, one of the occupants apparently inhaled some of the gases produced by the battery event.

That got me thinking.

Then came the second example

The second YouTube video involved a campervan owner who wanted a more substantial electrical system installed.

His requirements were relatively straightforward:

- Power for a coffee machine.
- Charging for laptops and other equipment.
- Power for his wife's hair straighteners.
- Greater electrical independence while travelling.
- Solar generation and battery storage.

He already carried a portable battery but was concerned that, in a collision, it could potentially become a projectile.

The resulting installation was impressive.

Solar panels, inverters and **two 144 Ah lithium-polymer batteries** were professionally installed underneath the bed.

Each battery was reportedly in excess of £500, so this was clearly a significant investment.

The owner was understandably delighted with the installation.

However, one comment particularly caught my attention.

He described driving somewhere and subsequently discovering that his refrigerator was operating from **230 V AC while the vehicle was being driven.**

That raises another question:

What happens when we combine a high-energy battery system, an inverter, 230 V AC, a moving vehicle, occupants sleeping above the batteries and the possibility of a collision?

So, are there standards?

There are standards and regulations covering various aspects of electrical installations, recreational vehicles, batteries and charging systems.

But the question I think we should be asking is whether the **existing framework adequately addresses the specific fire and life-safety consequences of installing high-energy lithium battery systems within occupied vehicles.**

This is not simply an electrical engineering issue.

It is also a:

**Fire safety issue. Hazardous materials issue. Occupant safety issue.
Emergency responder issue. Vehicle crash-safety issue.**

And perhaps we need to start looking at these systems in that much broader context.

What should a standard for high-energy batteries in occupied vehicles contain?

These are my thoughts — and I would genuinely welcome debate from vehicle manufacturers, battery manufacturers, installers, engineers, fire and rescue services and regulators.

1. Battery location

Where reasonably practicable, high-energy batteries should be located in a **dedicated enclosure or locker separated from the occupant compartment.**

Where batteries are installed internally, consideration should be given to providing appropriate fire-resisting construction between the battery compartment and the occupants.

A target of **30 minutes fire resistance** should be considered for the enclosure and separation, subject to the specific vehicle construction and battery system.

The objective should not simply be to contain a fire.

It should be to provide occupants with sufficient time to **detect the event, escape and raise the alarm.**

2. Ventilation and off-gas management

A thermal runaway event can produce significant quantities of gases and potentially ignitable, toxic and corrosive products.

Simply providing a small ventilation opening should not automatically be regarded as adequate.

The system should be designed to consider:

- The potential quantity and composition of off-gas.
- Pressure development.
- Direction of gas discharge.
- Prevention of gas entering the occupant compartment.
- The location of ventilation outlets.
- The possibility of gases entering through windows, doors or other openings.

Ventilation should discharge to a safe external location.

A vent should not simply terminate underneath or adjacent to an openable window.

There may therefore be a case for an interlock or other control system where ventilation arrangements could create a foreseeable pathway for hazardous gases to enter the vehicle.

3. Battery monitoring and early warning

The battery management system should be capable of identifying abnormal conditions, including:

- Abnormal temperature rise.
- Excessive temperature.
- Abnormal voltage.
- Abnormal current.
- Cell imbalance.
- Other parameters indicating potential battery failure.

Where technically possible, these warnings should be capable of being transmitted to the vehicle's fire detection and alarm system.

Early warning is critical.

Waiting until visible smoke or flame appears may mean that the battery is already well into the failure process.

4. Dedicated detection

A dedicated battery compartment should have appropriate detection.

Depending upon the battery technology and installation, this could include combinations of:

- Smoke detection.
- Heat detection.
- Rate-of-rise detection.
- Carbon monoxide detection.
- Gas detection.

The important point is that detection should be **appropriate to the failure mode of the battery**, rather than simply installing a generic domestic smoke alarm.

5. Separation of 230 V AC when driving

An appropriate electrical interlock should be considered so that, when the vehicle engine is started or the vehicle is placed into a driving condition, the system prevents inappropriate energisation of the vehicle's 230 V AC circuits.

This should be designed to eliminate the possibility of **unintended energisation** rather than relying upon the occupant to remember to operate a switch.

Where an installation permits 230 V AC operation while travelling, that arrangement should be clearly defined, engineered and protected.

6. External responder identification

The vehicle should have an **approved external identification marking** indicating that it contains a high-energy battery system.

The marking should be readily visible to emergency responders.

It should communicate, as a minimum:

HIGH-ENERGY BATTERY SYSTEM

with sufficient additional information to assist responders in identifying the battery location and isolation arrangements.

This is particularly important where the battery installation is concealed beneath beds, seating, floors or within storage compartments.

7. Emergency isolation

The principal isolation points for:

- Battery systems.
- Solar photovoltaic systems.
- Inverters.
- Other significant energy sources.

should be **clearly identified, readily accessible and appropriately marked for emergency responders.**

The location of the isolation points should also be included within emergency documentation.

And then there is the question of firefighting

This is perhaps the most important point.

A lithium battery undergoing thermal runaway is not simply a conventional fire.

It can involve:

- Rapid heat release.
- Flammable gases.
- Toxic and corrosive gases.
- Re-ignition.
- Propagation between cells.
- Stored electrical energy.
- Potentially dangerous electrical voltages.
- Difficult access to the battery itself.

Therefore, the advice given to occupants should be extremely clear.

Occupants should not attempt to physically intervene in a battery thermal-runaway event.

Their priorities should be:

Raise the alarm. Get out. Keep others away. Call the emergency services. Tell responders that a high-energy battery is involved.

The objective should be life safety first — not saving the battery, vehicle or property.

Perhaps the uncomfortable question is this...

We are becoming increasingly comfortable with installing batteries containing **many kilowatt-hours of stored energy** inside places where people sleep.

We quite rightly tell people not to leave small lithium-ion devices charging unattended.

Yet we are simultaneously installing much larger energy-storage systems into occupied vehicles and domestic premises.

That does not necessarily mean that these installations are unsafe.

It does mean that we need to ask whether **our safety philosophy, installation standards, detection systems, emergency procedures and responder information have developed at the same speed as the technology.**

The technology is moving quickly.

Have our standards moved quickly enough?

And perhaps, more importantly:

Do we fully understand the consequences of putting high-energy lithium batteries inside the spaces where people live, sleep and travel?

I don't pretend to have all the answers.

But I do think this is a conversation we need to have **before rather than after the next serious incident.**

What do you think should be mandatory for high-energy lithium battery installations in motorhomes, campervans and other occupied vehicles?

I'd particularly welcome views from **battery manufacturers, vehicle converters, electrical engineers, fire investigators, fire and rescue services, insurers and regulators.**

Just my thoughts

