# Risks associated with electric storage batteries

## What happened?

Recently, NOPSEMA was notified of a fire that occurred in the battery room on a production facility. This incident has highlighted the potential for thermal runaway events, specifically, when there is short circuit between two or more battery banks of uninterruptible power supply (UPS). This incident was likely caused by leaking electrolyte fluid contacting a conductive metal cabinet frame in the UPS battery room. There were no injuries caused as a result of this incident. However, containing the fire, albeit relatively small, presented challenges.

**Figure 1 – First entry into the battery room post incident.**

**Figure 2 – Battery cabinet with doors removed. Damage within left cabinet.**

## What could go wrong?

Lead acid batteries are capable of delivering an electric charge at a very high rate and, when charging, can release flammable hydrogen gases. As such, when these hydrogen gases are combined with oxygen, they have the potential to cause an explosion.

Valve regulated batteries described as ‘maintenance free’ are less likely to release hydrogen than conventional flooded electrolyte batteries in normal operational conditions. However, it is still important to take care when charging valve regulated batteries. Hydrogen can be released through the pressure relief valves if the battery charging current or voltage are exceeded, which can also lead to a potential explosion.

Batteries can contain significant stored energy. Under certain circumstances this energy may be released very rapidly. This can occur during short circuit faults, for example, when the terminals are short-circuited. In the event of a short circuit condition, very large fault currents can be generated, which can result in rapid heat rise. Explosions associated with the fault can result in a shower of molten metal, which can cause serious injuries and ignite explosive gases present around the battery.

Most battery cells produce low voltages and therefore there is limited risk of electric shock, however, some large battery banks produce more than 120 volts DC. Personnel should be protected from the dangers of electric shock by ensuring that:

- live conductors are effectively insulated or protected
- access to areas where there are dangerous voltages is controlled
- appropriate warning signage is displayed.

## Key lessons

Battery installations should be designed to eliminate or reduce the risk of fault currents associated with battery terminals or short circuits to the battery stands or trays. Battery stands or trays should be insulated and access to battery terminals, inspection caps, or charge indicators should be sufficient to allow effective maintenance to be conducted safely.

- Store batteries in a cool, well-ventilated area away from ignition sources. Where batteries are arranged in two or more tiers, adequate circulation of air should be provided.
- Large battery banks should be located in a dedicated battery room with minimal other equipment and services.
- Dedicated battery rooms should consider potential explosive gas (hydrogen) release under both normal charging and fault conditions and should consider utilising explosive protected electrical equipment within the space.
- Battery room ventilation systems and ducts should be separated from other ventilation systems and lead to safe open air locations.
- Battery rooms should be provided with smoke and/or heat detection. In addition, provision of gas detection should also be considered for battery rooms.
- Battery rooms not provided with fixed active fire protection systems such as carbon dioxide (CO2), Inergen or other inert gas should be provided with portable CO2 or dry powder fire extinguishers.
- Batteries should be fixed to prevent any movement arising from the motions of any floating facility.
- Battery storage design should consider containment of potential electrolyte leakage and should be spill proof.
- Lead acid and alkaline batteries should not be placed in the same space unless separated by suitable screens.
- Follow all instructions and manufacturers recommendations and check the manufacturer’s specifications on battery storage and battery charging thresholds. Record date of manufacture, installation, and the maximum end of life of batteries.

Ensure procedures are in place for undertaking regular visual inspections including checking for cleanliness, corrosion, electrolyte levels leaking electrolyte, charge indicators, charging current, system voltage, charger status and alarms, and earth fault indication.

Regular load testing of battery banks should be performed and the discharge duration and accepted voltage drop should be identified in the performance standards. Thermography testing while battery banks are subjected to load conditions should be considered to identify any loose connections that can lead to a supply loss or result in a potential fire.

Battery maintenance should consider the effects of battery sulfation, which can lead to a number of battery faults, for example, cell short circuit, excessive voltage drop or lead to casing damage and electrolyte loss.

Battery charger fault indication and alarms should be considered and appropriately monitored to ensure effective battery charging is maintained.

Battery earth fault detection systems should be provided for larger battery installations to provide warnings of low levels of insulation resistance.

The facility performance standards should clearly identify the operational performance required for the battery systems. Operational performance may include:

- the minimum operating duration required for the battery emergency loads
- the maximum accepted voltage drops for the battery system
- the key minimum testing and inspection periods that ensure an effective emergency supply is ready on demand.

Battery replacement by failure is generally not considered appropriate for batteries supplying safety critical or emergency loads that are required to function on demand. Batteries should be replaced before they reach their end of life condition.

Battery fire is a credible event; these hazards (fire hazard and stored energy) should be assessed as part of the safety case for the facility.

Operators should prepare a mitigating emergency response procedure for responding to a battery thermal runaway event or battery room fire. The emergency response procedure should cover containing the event, firefighting, training, and emergency preparedness drills.

## The legislation

Schedule 3 of the *Offshore Petroleum and Greenhouse Gas Storage Act 2006* places specific duties on the operator of a facility to take all reasonably practicable steps to ensure that:

- any plant, equipment, materials and substances at the facility are safe and without risk to health and
- to implement and maintain systems of work at the facility that are safe and without risk to health.

Facility operators, employers, and persons in charge of work activities should review their practices for the use of battery banks, particularly banks of batteries storing 120 volts DC and above, with regard to the above information.

## Contact

For further information email alerts@nopsema.gov.au and quote Alert 61. NOPSEMA safety alerts are published at nopsema.gov.au, on the ‘Safety Alerts’ page under the ‘Safety’ tab.