Innova Power Solutions

Primary Lithium Battery Pack Handling

1. Warning:

- The use of the product is limited to power down-hole specialized tools for the directional drilling market only.
- Hazard of fire, explosion and severe burn.
- Do not short circuit, Do not charge, Do not force over-discharge,
- Do not disassemble, Do not crush, penetrate or incinerate.
- A battery pack or cell may leak or explode if it is heated above the battery rating temperature printed on the battery pack.

2. Storage

- Store in original shipping boxes until ready to use.
- To maximize the shelf life of the batteries, store in a cool, dry, well-ventilated area. The ideal temperature for storage is at room temperature (23°C / 73°**F**) or below.
- Segregate new batteries from used or depleted ones. Do not keep an overabundance of depleted batteries.
- Storage areas should be equipped with Class D fire extinguishers.
- Carefully stack boxes to prevent the crushing of batteries in lower boxes.

3. Before Use and Reuse

- Know or establish safety procedures and a safety chain of command. Have an exit plan should there be an emergency. Know plans for warning others in the facility.
- Be aware of the safety data sheet (SDS) included with every shipment. This can be referenced in emergencies.
- It is not recommended to apply direct heat to the battery. If applying direct heat to the battery, it is necessary to follow your company's safety procedures.
- Be aware of the related hazard assessment to the task about to be performed.
- Know the expected temperature conditions, and maximum temperature rating of the battery before putting it in the tool. The maximum temperature rating is printed on the battery pack.
- Make sure the battery is not physically damaged:
    1. Make sure there are no cracks, dents, or damaged connectors.
    2. Check the wires and harnesses for any damage.
    3. Make sure there are no damages or swellings on the battery outer tube.
    4. Note any discoloration on the outer tube. This could be the beginning signs of a leaking battery.
    5. Note any strange odours, like rotten eggs.
    6. Be aware of any abnormal temperatures.
    7. Check the wiring of the battery for short circuits, low voltage, or any other schematic anomaly.

- Keep working areas free from anything that can electrically short a battery, such as metal tools, conductive materials, puddles, or containers of water.
- Only work on non-conductive surfaces

4. Emergency Events

Hot Cell or Battery Pack

When drawing current from a battery It is normal for the battery to have a small increase in temperature that will decrease when the flow of current stops. Other events, but not limited to, such as excessive shock and vibration, or an external short can cause the battery's temperature to rise as the event continues. This can lead to the cell reaching critical temperature. Because of this, the pack can potentially vent or explode. This can be an extremely dangerous situation and extreme caution needs to be taken.

- Evacuate the area if any abnormal temperature is detected on a battery pack.
- If the situation allows it, determine if an external short is present and remove it as quickly as possible.
- Monitor the temperature from a safe distance using a non-contact thermometer or thermal imager.
- Continue monitoring until one of the following situations occurs:
    1. The pack starts to cool
    2. The pack vents
    3. The pack explodes
- If the pack starts to cool, continue monitoring until it reaches room temperature.
- If temperature monitoring equipment is not available, do not approach it for at least 24-hours.
- Once it has cooled, remove the pack from the work area.
- Dispose of properly.

Vented Cells or Packs

The severity of a vent can range from a slight leak of electrolyte to an actual explosion. If a leak is detected, the following precautions should be taken:

- Let everyone know immediately what has happened, and isolate the pack at least 100 feet away from other people or other batteries, in a well-ventilated area. There are no preventative methods of containing a battery that is heating up or venting, except removing people from the area and relocating the battery to an area that will cause minimal damage.
- It could take anywhere from a few hours to many days for a battery to complete its event. Do not handle until it is completed, and has cooled down. When it is no longer hot, and the rotten egg smell has subsided, this will indicate the end of the event. Any liquid present will have turned into a gas, and corrosion may take place.
- When a damaged battery needs to be handled, do not breathe the electrolyte in or allow it to come in contact with bare skin. Put on appropriate protective gear: Acid proof apron or lab coat, goggles or face shield, acid-proof rubber gloves and acid gas respirator.
- Put the pack into a suitably sized bag, fill with a minimum of 1 lb. of baking soda (one small box), and remove excess air and seal closed.

- Place the first bag into the second bag and pour a minimum of 5 cups of vermiculite. Remove excess air and seal closed.
- Place everything in a third bag along with again, a minimum of 1 lb. of baking soda, remove excess air and seal closed.
- Segregate the pack in a safe area until it can be disposed of properly.
- Absorb any spilled electrolyte on work surfaces with baking soda or vermiculite. Sweep the contaminated absorbent material into a plastic bag and dispose of it properly.
- Ventilate the area until the odour is no longer apparent.

Exploded Cells or Battery Packs

Though it is unlikely that a lithium battery would explode, misuse and abusive conditions of the battery could lead to this rare event.

- Evacuate all personnel from the affected area.
- Ventilate the area until the smoke has cleared and the odour is gone.
- Do not handle an exploded pack until it has cooled, and follow the handling procedures of a vented pack.
- Sweep up any debris and/or contaminated absorbent material and contain it in a sealable plastic bag. Cover material with baking soda, Do not let the debris come in contact with any other cells/packs, as it could contain metallic fragments that could lead to a short circuit.
- Dispose of the bag of debris, following the proper hazardous waste disposal regulations.
- The affected area should be cleaned with a baking soda and water solution, or a commercially available liquid acid neutralizer. After the initial cleaning is complete, a second wipe down with soap and water may be necessary.
- If the event happened while the battery was assembled to the downhole tool, do not attempt to force the damaged battery from it. If the battery cannot be extracted from the carrier, it can all be disposed of together.

Fires Involving Lithium Batteries

Personal safety is the main concern should lithium batteries be involved in or near a fire.

- Immediately evacuate the area and all personnel should be accounted for.
- Notify emergency response immediately.
- Portable Class D fire extinguishers should be considered a last resort for fighting a lithium battery fire, as they require the emergency responder to be in very close proximity to the fire.
    - Class D extinguishers are only effective on a lithium metal fire as it smothers the lithium and prevents any oxygen from supporting the fire. Class D extinguishers are not useful unless there is active exposed lithium.
    - It is most likely that by the time people evacuate, make a plan, get the class D extinguisher and come back the actual lithium has burned itself out.
- We caution AGAINST using CO2 on lithium metal. It is Ineffective and the high-pressure CO2 will blow the lithium under the nearby paint locker or fuel storage tanks.
- Secondary fires are the most likely issue and copious amounts of water are the best way to prevent the fire from expanding. Flooding the area with water will cool surrounding batteries as well as reduce the possibility of more batteries venting.

5. Disposal

Discharged batteries will have a remaining amount of reactive chemicals within them with the potential to cause hazardous damages. Before disposal, keep these batteries in an appropriate area.

- Follow local, state and federal hazardous waste disposal regulations
- Lithium batteries, for disposal, may be transported to a permitted storage facility and/or disposal site according to local regulations.
- Use packaging material that complies with local regulations.
- Batteries to be disposed of must be packaged in a strong outer box and isolated with an effective means to prevent external short circuits.
- Discharged/used batteries must not be kept in the same area as new or unused batteries.
- Store any discharged battery away from any source of moisture
- Keep away from other reactive solvents, metal surfaces or containers.
- Do not handle any battery to be disposed of without the proper TDG training.
- Be aware of hot cells during disposal.
- Isolate battery terminals or exposed cell sections to prevent short-circuiting.
- Do not dispose of vented or exploded batteries until the corresponding hazards have been adequately mitigated.

6. First Aid

The internal contents of the cells are extremely hazardous. If any fluid leaks, it is corrosive and very dangerous if it is inhaled. The following measures should be followed should a person become exposed to leaked electrolyte:

- **Eye Contact:** Flush with cool running water for at least 15-minutes. Hold eyelids open and rinse thoroughly. Seek immediate medical attention.
- **Skin Contact:** Rinse with large amounts of cool running water. Remove contaminated clothing. Avoid hot water and rubbing the skin. Seek medical attention if a burn develops.
- **Inhalation:** Move to fresh air. If breathing is difficult, administer oxygen. If not breathing, give artificial respiration and seek immediate medical attention.
- **Ingestion:** Drink copious amounts of water. Do not induce vomiting. Seek immediate medical attention.

Disclaimer: The purpose of this material is to provide safety fundamentals on the use of lithium batteries. This guide should never replace the current health and safety norms, health and safety procedures, health and safety policies or work practices related to lithium batteries of your company or the Safety Data Sheet (SDS) provided with the batteries or cells. In no event shall our company be liable for any direct, indirect, punitive, incidental, special consequential damages, to property or life, whatsoever arising out of or connected with the use or misuse of our products.