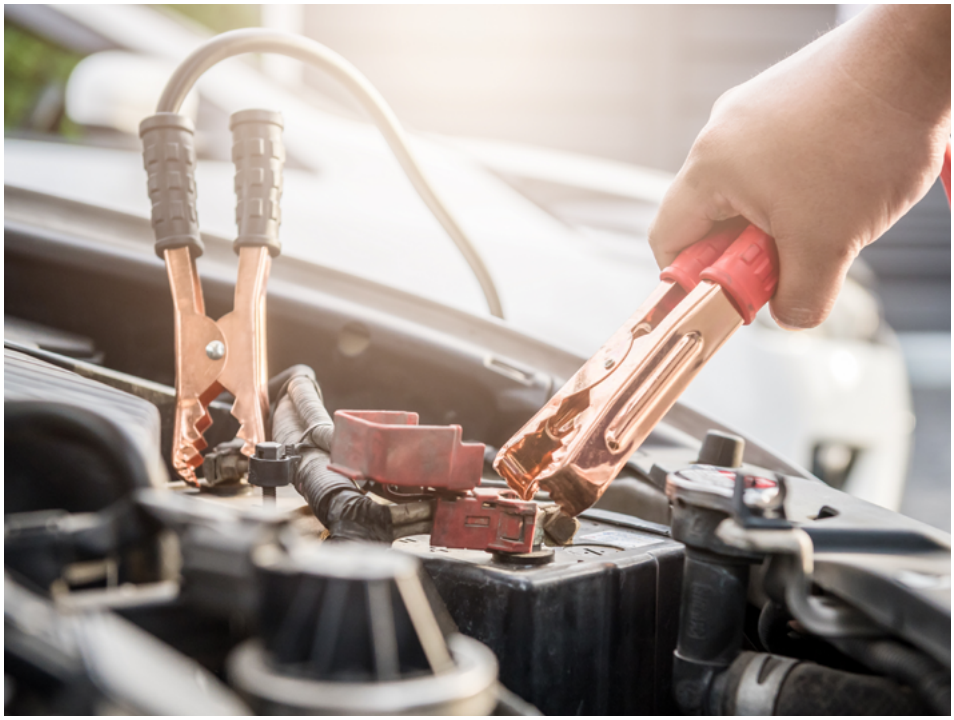
TDI Safety @ Work
Division of Workers' Compensation

Vehicle Battery Safety Fact Sheet

HS20-006A (7-20)

Industrial equipment and vehicles -- and the batteries that power them -- constantly evolve. Recent advances in battery technology and the increase in popularity of electric vehicles are changing the way people's lives and workplaces are powered. Newer, lighter, more energy-dense batteries are projected to revolutionize many industries within the next 10 years.[1] However, despite these advances, battery health and safety risks remain.



Vehicle Battery Categories

The types of vehicle batteries and technologies used are vast, but their purposes remain the same: to convert chemical energy into electrical energy. For the purpose of powering vehicles, batteries are lumped into three main categories: 1) wet-cell or flooded batteries; 2) valve-regulated lead-acid batteries; and 3) electric-vehicle or traction batteries.

Wet-Cell or Flooded Batteries

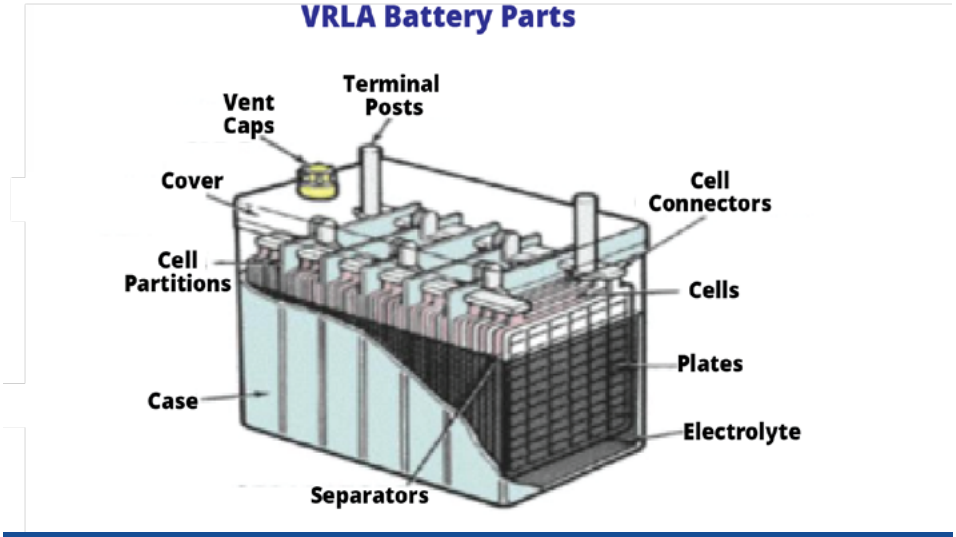
Wet-cell batteries, or flooded batteries, date back to 1836 and are one of the first present-day battery categories created. Types of wet-cell batteries include **starting, lighting, and ignition (SLI) batteries**, which deliver short, quick bursts of power, and **deep cycle batteries** for sustained power for long periods of time.[2] These batteries contain a liquid (an electrolyte) made of sulfuric acid and water. The combination of the electrolyte with the lead plates inside the battery can produce highly combustible gases that must be vented.

Valve-Regulated Lead-Acid (VRLA) Batteries

VRLA batteries -- often referred to as sealed lead-acid batteries -- are considered no-maintenance liquid batteries. Unlike wet-cell batteries, no water needs to be added to the VRLA cells. It also means these batteries do not need to remain upright, which reduces spillage and corrosion issues. Some types of VRLA batteries include **absorbed glass mat (AGM) batteries**, which hold the electrolyte on a glass mat separator, and **gel batteries**, which have a jellified electrolyte held in calcium plates.[3]

Electric-Vehicle (EV) or Traction Batteries

EV batteries, or traction batteries, are used to power electric and hybrid vehicles. These are usually rechargeable **lithium-ion (Li-ion) batteries**. EV batteries are designed to give high ampere-per-hour capacity for long periods of time. They have a low self-discharge rate, which means they can remain fully charged after many weeks of storage.[4]



Vehicle Battery Hazards

Batteries pose a variety of potential health and safety hazards. Among the most common are:

Battery Acid

Always handle lead-acid batteries with care. The sulfuric acid is corrosive to metal, damaging to tissue, and poisonous if swallowed. It can cause permanent harm in:

- **eyes**, potentially resulting in blindness;
- **skin**, causing painful burns, irritation, and scarring;
- **lungs**, damaging the mucous membranes when fumes are inhaled; and
- **internal organs**, likely resulting in death when ingested.

Lead

Lead is a toxic metal that can enter the body when inhaled as dust or ingested by lead-contaminated hands touching the mouth. In adults, lead can cause memory loss, lowered ability to concentrate, and damage to the reproductive system. It is also known to cause high blood pressure, nerve disorders, and muscle and joint pain.[5] In children and fetuses of pregnant women, high lead levels can affect a child's growth, cause brain damage, harm kidneys, impair hearing, and create behavioral problems.

Flammable Gases

Recharging, moving, or shaking a lead-acid battery can produce an explosive mixture of hydrogen and oxygen gases that escape through the battery's vents. These fumes, if allowed to accumulate in a small area, **ignite easily** and can cause a fire or explosion. An exploding battery can cause severe injury from flying container pieces and acid.

Most modern batteries include a flame arrestor – a porous filter on the battery's vents – designed to prevent flames from entering the battery. However, it is vital to keep any form of ignition -- such as smoking, open flames, or spark-producing items, such as grinders, welders, or other electrical equipment -- far away from batteries.

Electrical Shock and Burns

When lead-acid battery terminals are short-circuited by any conductive object, such as a metal tool or jewelry, sparks can generate enough heat to cause severe burns and melted metal. Accidentally placing a wrench between the positive and negative battery terminal posts can produce a current similar to a welding arc. It can damage the tool and the battery and may even cause the battery to explode.

In addition to accidental short circuits caused by conductive objects, dust mixed with battery acid can create a low resistance path that can short circuit the battery.

Keep batteries clean and free of excess dust to avoid conditions that may cause a fire or battery explosion.

EV batteries deal with different levels of high voltage, and if not properly handled during repair may cause electrocution. Always consult the vehicle manufacturer's instructions and use insulated tools and gloves when working with EV batteries.

Physical Injury from the Weight of the Battery

Lifting batteries incorrectly can cause sprains, strains, or injuries. Batteries, like those used in forklifts, are heavy and require proper material handling equipment to lift safely.

Environmental Hazard

Lead-acid and EV batteries pose a threat to the environment if not properly discarded. Acid spills not contained can contaminate the soil and ground water. It can also become airborne when it dries, causing potential tissue irritation and permanent damage.

Safe Vehicle Battery Handling

Safe Handling of EV Batteries

Risks for battery accidents in electric and hybrid vehicles are low. However the main potential hazard is electrocution if the vehicle accidentally turns on during repair. To address this concern, many auto manufacturers have installed a safety switch that disconnects the battery from the vehicle's electrical system. Another safety feature auto manufacturers have installed are color-coded high voltage cables to warn of potential electric shock. Most of the cables are orange, but in some electric and hybrid models, the cables are blue. Always check the manufacturer's manual to locate the safety switch and to identify the cable color coding.

Use these additional precautions when working with EV batteries:

- keep the remote key fob away from the vehicle to prevent any accidental operation of electrical systems or movement of the vehicle;
- check the vehicle for signs of damage to high voltage electrical components or cabling;
- avoid contact with high-voltage cables until the EV battery has been disconnected;

Disassembling the battery of an electric vehicle.

- isolate (disconnect and secure) the battery system so that it cannot be accidentally switched back on before work is complete;
- use insulated tools and test equipment (isolated vehicle batteries and components may continue to have large amounts of energy and high voltage even after disconnection);
- refer to manufacturer's data on how to discharge stored energy;
- use the manufacturer's control measures following a collision on an electric or hybrid vehicle (the damage may make it impossible to fully isolate the high voltage electrical system or discharge the stored energy);
- reduce risks by removing batteries or providing insulation during any high-temperature operations, such as painting, where booth temperatures may exceed battery temperature limits; and
- post warning signs in the work area to ensure people are aware of the dangers.

Safe Handling of Lead-Acid Batteries

The main safety concern with lead-acid batteries is the corrosive electrolyte and its ability to produce an electrical charge. Always use the following safety precautions when handling lead-acid batteries:

- store batteries upright;
- never overfill a battery;
- keep battery vent caps tight;
- ensure that the battery recharging location has proper ventilation, necessary fire protection, and emergency equipment;
- remove all metal jewelry from hands, wrists, neck, and body piercings before working on a battery;
- never place tools or metal objects near or on top of a battery;
- avoid leaning over the battery when charging, testing, jump-starting, connecting, or disconnecting the battery;
- keep flames or sparks – such as cigarettes or grinding equipment -- away from batteries;
- use insulated tools to avoid sparks;
- ensure that charger cables and clamps are in good connection to avoid an electrical arc;
- never jump start a frozen battery; and
- always consult the vehicle, battery, and charger's instruction manual.

Personal Protective Equipment (PPE)

When working with **lead-acid batteries**, PPE should include:

- chemical splash goggles or safety glasses with side shields worn under a full-face shield;
- acid-proof gloves made of rubber or neoprene;
- acid-resistant clothing or a rubber or neoprene apron; and
- acid-resistant safety shoes or boots.

Additionally, when working on a battery, ensure that clean water is nearby in the event of a chemical splash. When servicing a battery in the workplace, OSHA Standard 1910.151(c) requires that an eyewash station is located nearby.

When working on **hybrid or electric vehicles**, PPE should include heavy rubber Class 0-rated gloves. Always ensure there are no pin holes, cracks, tears, or splits in the gloves that would allow direct contact between skin and voltage.

Protect the Environment

Discarding or improperly disposing of vehicle batteries is illegal in Texas. The Texas Natural Resource Conservation Commission requires the delivery of used batteries to a battery retailer, battery wholesaler, secondary lead smelter, or a recycling facility authorized by the Environmental Protection Agency (EPA). To ensure battery acid spills do not contaminate the soil and ground water, neutralize electrolyte spillage using alkali-based chemicals and powders, such as soda ash or baking soda.

Treating Vehicle Battery Injuries

The National Highway Traffic Safety Administration reports that around 7,000 hospitalizations occur each year due to motor vehicle battery injuries. An estimated 32% of those injuries are a direct result of motor vehicle battery explosions. Additionally, the non-profit agency, Prevent Blindness America, reported in 2003 that nearly 6,000 individuals suffered serious battery-related eye injuries.[6]

Vehicle battery injuries are preventable. However, in the event of an accident, proper and quick treatment can make a difference. Follow these tips for treating battery-related injuries:

Battery Acid in Eyes

If the eyes are splashed with acid:

- hold the eyelid(s) open and flush the contaminated eye(s) with clean, flowing lukewarm water for 30 minutes while seeking medical attention;
- repeat flushing if irritation persists;
- do not interrupt flushing the eye even if it keeps the emergency vehicle waiting;
- take care not to rinse contaminated water into the unaffected eye or onto the face; and
- transport the victim to an emergency care facility.

Ensure that first aid providers avoid direct contact with the acid and wear chemical protective gloves.

Battery Acid on Skin or Clothes

If the skin or clothing is splashed with acid:

- neutralize the acid immediately with a solution of baking soda, soda ash, or household ammonia and water, then rinse using clean water;
- remove any contaminated clothing and flush the affected area with flowing lukewarm water for at least 30 minutes; and
- seek medical attention if irritation persists.

Battery Acid if Swallowed

If battery acid is ingested:

- drink large quantities of water or milk, followed by milk of magnesia;
- do not encourage vomiting; and
- seek medical attention as soon as possible.

Battery-Related Burns

In the event of burns, apply a dry sterile dressing and seek medical treatment.

Electric Shock

In the event of electric shock:

- approach the affected person with care;
- ensure the individual is clear of the conductor, then switch the equipment off or break the current;
- never touch a person attached to a conductor with bare hands (use an insulated material, such as wood, rubber, plastic, or rolled paper to detach the conductor from the victim); and
- contact emergency medical services and give artificial respiration, if advised, until help arrives.

Inhaled Gases

In the event of inhaled vehicle battery gases:

- remove the affected person to fresh air;
- give artificial respiration if the person is not breathing; and
- call emergency services immediately.

Spillage

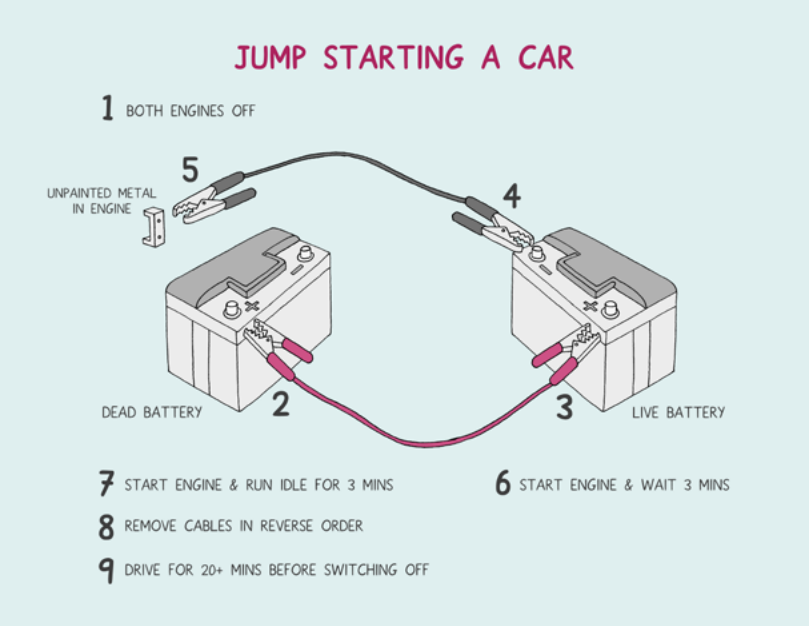
In the event of battery acid spills:

- stop the battery acid leak and treat the spill while wearing appropriate PPE;
- use a neutralizer to treat battery acid spills on a vehicle, then rinse with clean water;
- sift baking soda or another neutralizer on a puddle of electrolyte on the floor until the mixture stops fizzing, then remove with an absorbent material;
- wash away small spills with large quantities of water;
- keep an emergency kit with corrosion-resistant plastic tools and materials to use to absorb acid liquids;
- dam large acid spills to prevent entry into drains, waterways, and sewers;
- clean up large spills using an absorbent material and dispose of in a suitable acid-resistant container according to EPA universal waste regulations; and
- ensure that fire extinguishers are available and employees are trained in proper portable fire extinguisher use.

Safe Vehicle Battery Maintenance

Batteries are often neglected until a vehicle fails to start. Expensive service charges and the inconvenience of being stranded can be avoided by following proper battery maintenance:

- ventilate the battery compartment to release any build-up of gases before tightening loose terminals or performing any other maintenance or repair;
- extend the battery's lifespan by never overfilling or under-filling a wet-cell battery;
- drive a vehicle at least weekly to keep the battery charged;
- keep the battery free of dirt and grease;
- clean the battery's terminals and posts regularly;
- service the vehicle's engine regularly to prevent overloading the battery;
- check the charge rate of the vehicle's alternator at every service;
- check the battery for cracks, corrosive materials, and loose wires during each oil change;
- check the condition and make any corrections needed to the tension of the V-belt, which charges the alternator; and
- never repair or rebuild a damaged battery unless trained and authorized by the manufacturer.



Charging/Jump-Starting Vehicle Batteries

Most people assume they know how to charge or jump-start a vehicle battery, however, many do it wrong. Before charging or jump-starting a battery, follow these safety tips:

- wear splash-proof, polycarbonate goggles with the ANSI safety designation Z-87;
- never smoke or operate anything that may ignite the flammable and explosive gases a battery can give off when charged or jump-started;
- make sure jumper cables are free of rust and corrosion, and have no exposed wires;
- never use electrical tape to cover exposed wires on jumper cables; and
- never jump-start a battery if the vehicle's fluids are frozen.

Jump-Starting Lead-Acid Batteries

After taking appropriate safety precautions, use these steps to charge or jump-start the battery:

STEP 1: Park the vehicle that needs to be jump-started next to a vehicle with a good battery. Pull the vehicle close so the jumper

cables reach from the battery of one vehicle to the battery of the other. Shut off both engines and prop open the hoods or trunks, depending on where the batteries are located within the vehicles.

STEP 2: Find the red (positive) and black (negative) battery terminals. Each battery has two metal terminals. One is marked positive (+), the other negative (-). There are also red (positive) and black (negative) cables in the jumper cable set. Never connect the red cable to the negative battery terminal.

STEP 3: Connect the positive cables to the positive terminals starting with the dead battery. Do not let the positive cable touch anything metal other than the battery terminal. Then, connect the other end of the positive cable to the positive terminal of the good battery.

STEP 4: Connect the negative cable to the good battery, but not to the dead battery. On the vehicle that has the dead battery, connect the negative cable to metal on the engine block, not on the battery terminal, carburetor, fuel lines, or moving parts.

STEP 5: Start the vehicles beginning with the one with a good battery. To start charging the vehicle, start the vehicle with the good battery. Wait two or three minutes, then try to start the vehicle with the dead battery. If the vehicle does not start, wait a few more minutes, and repeat. If the car starts, continue with step 6.

STEP 6: Remove the cables in reverse order. Remove the black negative clamp from the ground of the assisting vehicle. Then, remove the black negative clamp from the assisting vehicle. Next, remove the red positive clamp from the assisting vehicle, followed by removing the red positive clamp from the vehicle that needed a jump.

STEP 7: Drive for 20-plus minutes before switching off. Fully charge the faulty battery at the first opportunity.

Charging an Electric Vehicle Battery

Many hybrid vehicles cannot be plugged in to charge the battery. Instead, its battery is charged when braking and by the internal combustion engine. However, in electric and plug-in hybrid vehicles, the driver recharges the battery in a similar way combustion engine vehicles get filled-up with gas.

The time it takes to charge an EV battery can be as little as 30 minutes, or more than 12 hours, depending on the size of the battery and the speed of the charging point. The Health and Safety Executive, a British government agency responsible for workplace health and safety, estimates the following times and practices for charging EV batteries:

- a typical electric vehicle (60kWh battery) takes just under 8 hours to charge from empty-to-full with a 7kW charging point;
- many electric vehicles can add up to 100 miles of range in 35 minutes with a 50kW rapid charger;
- the bigger the vehicle's battery and the slower the charging point, the longer it takes to charge from empty to full;
- most drivers charge an electric vehicle like charging a mobile

phone, topping it off during the day, if needed, and giving it a full charge overnight;

- rapid chargers are the fastest way to charge electric vehicles, providing between 60-200 miles of range in 20-30 minutes;
- work or home charging points typically have a power rating of 3.7kW or 7kW;
- all EV batteries can charge on compatible charge points with a higher maximum charge rate than they can handle (they charge at the maximum rate that they can accept); and
- almost all EV batteries can rapid-charge, however, most plug-in hybrid EV batteries cannot.

A growing number of options are available for charging electric and plug-in hybrid vehicles. However, the most common methods of charging these batteries are:

- **Charge at home.** Assuming someone has access to a garage with electrical service, the easiest way to keep an EV battery charged is for the owner to charge it at home. All electric vehicles come with basic charging units that plug into a standard 120-volt wall socket. This is called Level 1 charging, and usually takes eight or more hours for a full charge using a house current. By installing a dedicated 240-volt line in the garage, along with a specific Level 2 charger, charging time can be reduced to about four hours.

  According to the Environmental Protection Agency's fuel economy website, which uses the medium current price for electricity, driving an electric vehicle costs less than $0.04 per mile. Additional savings may be available by using smartphone apps that let owners know when to charge their vehicle based on local electric companies' discounted off-peak rates.

- **Public charging.** The number of public electric vehicle charging stations installed across the U.S. is expanding rapidly. As of March 2020, around 78,500 public charging outlets are located across the country. Texas, second only to California, is a leader in providing the most electric vehicle charging stations and charging outlets in the U.S. Most charging stations are in areas with a higher concentration of electric vehicle sales; and are typically installed in apartment buildings, public parking garages, retail parking lots, and new-car dealerships. A variety of websites and smartphone apps are available to direct drivers to the nearest charging location.

  Most public outlets provide Level 2 charging for topping off an electric vehicle's battery while shopping or dining. However, Level 3 charging, called DC fast charging, is also available at some locations. Level 3 charging can bring an electric vehicle's battery up to 80% of its capacity in 30 minutes. Be aware, though, that some Level 3 chargers use different connecting ports than others, so drivers may need to use an adaptor to tap into a given unit.

- **Workplace charging.** Companies using electric vehicles have chargers at their facilities, and many have electric vehicle chargers in their garages and parking lots for employee use. Typically, these are Level 2 chargers, which allow vehicle's to charge over an eight-hour workday. Workplace charging is still not common; however, Texas offers workplace electric vehicle supply equipment rebates for employers wishing to offer the service.

Removing and Installing Lead-Acid Batteries

Follow all safety precautions when removing or installing a battery:

1. **Shut off all lights and other electrical loads before removing or installing a battery.** Refer to the Safe Vehicle Battery Handling information presented earlier in this publication before beginning.

2. **Identify the positive and negative terminals.** Before removing the old battery, note the location of the positive battery terminal and mark its polarity on the cable. This will help prevent installing the new battery in the reverse position.

3. **Disconnect the battery terminal cables.** Loosen the screws on the cable clamps. Remove the negative cable first, then the positive cable.

4. **Unfasten and remove the battery hold-down strap.** This is the metal strap that keeps the battery secure. Also, remove the two long screws holding the strap to the battery.

5. **Pull up on the battery to remove it.** Keep the battery upright to ensure battery acid does not spill. Do not lift the battery by its terminals.

6. **Inspect the battery.** Look for possible damage or corrosion.

7. **Clean the tray where the battery rests.** Use steel wool or a wire brush to clean the metal clamps and remove any corrosion.

8. **Place the new, full-charged battery in the battery tray.** Ensure that the battery is placed so that the positive and negative terminals line up with the corresponding cables. Secure the hold-down strap over the new battery. To prevent damage to the plastic case and cover, do not over-tighten the hold-down strap.

9. **Attach the cables.** Attach the positive (red) cable first, followed by the negative (black) cable. Do not over-tighten the terminal bolts.

10. **Dispose of the old battery.** Bring the old battery to the store or workshop where the replacement battery was purchased, or to any other spent-battery drop-off location. Again, it is a violation of Texas law to discard or improperly dispose of vehicle batteries.

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