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Safe Handling of Hazardous Voltage Battery Storage Systems

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Contents

Foreword

NEMA's Energy Storage Council developed this document to identify safety issues such as arc flash when handling hazardous voltage battery packs. This document also identifies electrical safety categories that are important to understand before proceeding with energized electrical work associated with automotive batteries and other hazardous voltage systems. It covers direct and indirect hazards, shock and arc boundaries, hazard risk categories, and personal protective equipment (PPE); ensuring proper storage/isolation in battery packs; and checking the current status of the battery. It also covers best practices for testing the state of health of battery systems and procedures for obtaining a permit to work on high-voltage (HV) vehicles. This document is not intended to be a comprehensive step-by-step process to eliminate all risks from dismantling energy storage systems.

About the National Electrical Manufacturers Association (NEMA)

Founded in 1926 and headquartered near Washington, D.C., NEMA represents 325 member companies that manufacture products used in the generation, transmission and distribution, control, and end use of electricity. These products are used in utility, industrial, commercial, institutional, and residential applications. The association's Medical Imaging & Technology Alliance (MITA) division represents manufacturers of cutting-edge medical diagnostic imaging equipment, including MRI, CT, X-ray, and ultrasound products. Worldwide sales of NEMA-scope products exceed $140 billion.

About the NEMA Energy Storage Council

The NEMA Energy Storage Council is established to coordinate activity between NEMA members and non-members to:

– develop and promote standards, white papers, other technical documents, and educational materials to facilitate the production, integration, re-use, and recycling of energy storage devices;
– gather market data and perform other industry research related to energy storage;
– advocate for policies that benefit stakeholders across the energy storage value chain; and
– educate electrical distributors, installers, consumers, and authorities having jurisdiction on related code requirements and best practices.

At the time this document was approved, the Energy Storage Council was composed of the following members:

Argonne National Laboratory
Automotive Recyclers Association
Battery Resourcers
Kulr Technologies
UL Solutions
Call2Recycle
EPRI
Generac Power Systems, Inc.

Glossary

arc flash hazard	A source of possible injury or damage to health associated with the release of energy caused by an electric arc.
automotive dismantler/recycler	An entity that is lawfully authorized to engage in the acquisition and dismantling of motor vehicles for processing and selling recycled original equipment components, high-voltage batteries, cores, and recyclable materials.
automotive recycling	The safe and environmentally responsible processing of motor vehicles for the sale of ROE-Recycled Original Equipment® automotive parts and recyclable materials.
deenergized	Free from any electrical connection to a source of a potential difference and from electrical charge; not having a potential different from that of the earth.
depollution	The minimum technical requirements for the treatment of end-of-life vehicles, such as discharge of battery pack and removal of explosive devices such as air bags and seat belt tensioners.
electric vehicle (EV)	A vehicle propelled by an electrified system that is powered by high-voltage batteries and/or capacitors. The high-voltage batteries and/or capacitors are capable of being recharged by an external energy source.
hazardous voltage	OSHA considers all voltages of 50 volts or above to be hazardous.
high-voltage battery recycler	An entity that is engaged in the collection and recycling of high-voltage batteries for the purpose of reuse, repurposing, and recycling of recyclable materials.
internal combustion engine (ICE) vehicle	A motor vehicle exclusively powered by hydrocarbon-based fuel products.
scrap metal processor	One who, from a fixed location, utilizes machinery and equipment for processing and manufacturing iron, steel, or nonferrous metallic scrap into prepared grades and whose principal product is scrap iron, scrap steel, or nonferrous metallic scrap to sell for remelting purposes.
qualified person	One who has demonstrated skills and knowledge related to the construction and operation of electrical equipment and installations, and has received safety training to identify the hazards and reduce the associated risk.
shock hazard	A source of possible injury or damage to health associated with current through the body caused by contact or approach to exposed energized electrical conductors or circuit parts.
state of charge	The level of charge of an electric battery relative to its capacity. The units of SoC are percentage points (0% = empty; 100% = full).
high-voltage vehicle (HVV)	Any electric vehicle or hybrid electric vehicle that has an onboard high-voltage (DC voltage over 60 volts) battery power source.[1]
hybrid electric vehicle (HEV)	A motor vehicle powered by both an internal combustion engine and an electric motor powered by a high voltage battery.

[1] Federal Motor Carrier Safety Administration and Commercial Vehicle Safety Alliance, *Inspecting Electric Drive Commercial Vehicles*

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1 Background

Life-after-first-use industries such as automotive dismantlers/recyclers are realizing the need to process hazardous-voltage electric vehicle batteries as the mobility market electrifies and batteries become one of the largest end-of-life products. Batteries are used extensively in hybrid and all electric vehicles. These vehicles typically use a 12-V battery to operate airbags, windows, door locks, and interior and exterior lights. Modern electric vehicles can also contain battery systems in the 400-V to 800-V range. All hazardous-voltage batteries pose a risk if they are not properly prepared by trained personnel and using all necessary standard operating procedures. This danger can be higher if the battery systems in the vehicles have been compromised due to an accident. Lithium-ion batteries contain high energy and present electrical, chemical, and thermal hazards. It is imperative that these vehicles are only dismantled and processed at end-of-life by a certified facility. Improper handling of the vehicles can lead to serious injury or death from electric shock.

Hazardous-voltage battery systems can also be used in non-transportation applications, such as in residential, commercial, or industrial facilities.

1.1 Qualified/Unqualified Person

Those who work on or near electrical equipment must be qualified to do so, as authorized by the institution authority having jurisdiction. A qualified person is one who “has skills and knowledge related to the construction and operation of the electrical equipment and installations, and has received safety training to recognize and avoid the hazards involved”.[2] An additional precaution is needed for work on energized electrical systems. Live work (i.e., work on energized conductors) should be avoided whenever possible. However, automotive battery systems are always energized (unless they have been completely discharged) and do not provide any circuit protection or interruption such as circuit breakers in alternating current (AC) systems that stop the flow of electricity.

Whether someone is considered to be a "qualified person" will depend upon various circumstances in the workplace. For example, it is possible and, in fact, likely for an individual to be considered "qualified" with regard to certain equipment in the workplace but "unqualified" with regard to other equipment (see OSHA 29 CFR 1910.332(b)(3) for training requirements that specifically apply to qualified persons). An employee who is undergoing on-the-job training and who, in the course of such training, has demonstrated an ability to perform duties safely at his or her level of training, and who is under the direct supervision of a qualified person, is considered to be a qualified person for the performance of those duties. Note that this program does not meet the requirements for becoming a “qualified person.” [3] For more information, see NFPA 70E Article 110.6 and OSHA 29 CFR 1910.332 (Training).

Requirements of a qualified person:

– completion of required training on the hazards of electrical equipment and operations;
– training and experience in working with electricity;
– knowledge of electrical hazards (such as shock and flash) and how to avoid them;
– ability to distinguish exposed energized parts from other parts of electrical equipment;
– ability to read and interpret a facility’s electrical one-line diagram;
– ability to determine nominal voltage of exposed live parts;
– ability to determine approach distances when working on electricity;
– knowledge of proper personal protective equipment (PPE);
– knowledge of lockout/tagout procedures;

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[2] OSHA 29 CFR 1910.399

[3] Prevention Strategies for Electrical Currents, National Safety Council