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THOUGHT LEADERSHIP

PUBLISHED 2Q 2021

Is Your EV Safe Enough?

Strategies to meet new safety standards for electric vehicles in China

June 17, 2021

The global electric vehicle (EV) market is expected to reach $550.4 billion USD by 2024. China alone is expected to comprise approximately 60% of that market. While battery technology advancements in the EV industry have allowed for higher energy, faster charging, and longer cycle life, safety concerns over battery failure and thermal incidents persist. According to the Chinese State Administration of Market Regulation, approximately one EV-related fire occurs per week in China.

In response to this growing field, China has issued three new national safety standards effective January 1, 2021. The mandatory standards put forward safety requirements for the vehicle as a whole and the battery pack, including the required implementation of early battery failure detection mechanisms. It is important for EV manufacturers to assess their battery safety and reliability and make improvements where needed to comply with these new standards. Careful design review, thorough quality control processes, and close battery management system (BMS) monitoring can help manufacturers mitigate battery safety challenges and maintain compliance in the Chinese market.

The New Chinese Safety Standards

Electric Vehicle Safety Requirements (GB 18384-2020)– This standard stipulates electrical and functional safety requirements for EVs. It introduces new requirements for a battery system thermal event alarm signal and increases existing requirements for vehicle waterproofing, insulation resistance, and monitoring.

Electric Bus Safety Requirements (GB 38032-2020) – This standard specifies test conditions and requirements for battery compartment site collision, charging systems, and waterproofing of electric buses.

Electrical Vehicle Traction Battery Safety Requirements (GB 38031-2020) – This standard emphasizes battery cell and system-level safety and reliability under mechanical, electrical, and thermal abuse, as well as various environmental conditions. While many of the test items and requirements are similar to those found in existing international standards, a new addition is the thermal runaway propagation test. It requires that the EV provide an advance warning 5 minutes before a hazardous situation inside the passenger compartment that stems from thermal runaway and propagation from the vehicle battery.

Meeting New Battery Safety Requirements

Under the new Chinese standard, an EV should give vehicle occupants a 5-minute warning to help avoid a dangerous situation. Currently, most BMSs generate alerts based on abnormalities in key parameters, such as temperature, state-of-charge, pressure, or voltage at the pack level. However, a BMS alone may not be enough to achieve the required early alert. Gas, smoke, or temperature sensors at the system level may also be required for early hazard detection. Accurate modeling and monitoring of state-of-charge and state-of-health signals at both the battery pack and cell levels can help support real-time safety evaluation and possible failure prediction.

Is Your EV Safe Enough?

Our team at Exponent has abundant experience with abuse testing to force thermal runaway at cell and pack levels and thermal diffusion behavior simulation within a system. Our extensive failure analysis experience also allows us to establish a correlation between failure patterns and specific cell shortcomings. This can help us identify the critical risk processes required for early battery failure alerts and successful implementation of a 5-minute warning.

Mitigating Battery Safety Challenges

To achieve the 5-minute early-warning requirement, it is important not only for manufacturers to instrument the battery packs with appropriate sensors but also to limit thermal runaway and thermal propagation.

Many factors can cause an EV battery cell to experience thermal runaway. Examples include imperfections in cell material, contamination during the manufacturing process, an improperly designed BMS, and external damage. By monitoring electrochemistry, thermology, and mechanics at the material, cell, pack, and system levels throughout the battery life cycle, manufacturers can help reduce the risk of thermal runaway. In the event that thermal runaway does occur, manufacturers can incorporate functions into the system design that minimize the risk of thermal propagation. Examples include improving thermal electromechanical and control designs, optimizing cell sealing, decreasing the leakage of flammable ingredients, and adding insulation materials.

Exponent's teams frequently conduct design reviews to examine battery material selection and support the factory audit process. We can also perform accelerated-rate and long-term testing, estimate a cell's safety limits and usage life, and provide design-specific reviews and guidance for EV manufacturers seeking to operate in China.

How Exponent Can Help

Exponent's multi-disciplinary team of mechanical, electrical, electronic, chemical, and materials engineers and scientists has investigated failure modes, conducted design reviews, and performed reliability testing across battery cells, packs, and systems. We can help EV manufacturers mitigate battery safety challenges and maintain compliance for safe vehicle operation in China.

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