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ELECTRIC VEHICLE CHARGING INFRASTRUCTURE IN PARKING GARAGES: SAFETY CONCERNS AND WORST-CASE SCENARIOS

by Brett Bigger Founder of BatteryIQ, and Sr. Trainer, NOBLE

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Executive Summary

The rapid integration of electric vehicle (EV) charging infrastructure in parking garages—especially those beneath or attached to mixed-use developments—presents new safety, operational, and security risks. While advancing sustainability goals, the introduction of high-energy lithium-ion battery systems into densely populated, often enclosed spaces presents unique safety challenges. This paper examines the hazmat, safety, and security risks tied to EV-related incidents, including uncontained thermal runaway events, compromised emergency egress, and the exploitation of EV fires in terrorist attacks. The goal is to inform developers, emergency managers, security planners, and municipal decision-makers of the critical risks and mitigation strategies needed before construction or retrofitting.

1. Introduction: A Shift in Infrastructure, A Shift in Risk

The U.S. is experiencing an unprecedented expansion of electric vehicle (EV) ownership, which is expected to continue, and with it, the need for widespread charging infrastructure. Parking garages—particularly in urban, high-density, or mixed-use environments—are becoming key locations for EV charging nodes, regardless of whether they are optimal for this capability. These environments inherently pose significant challenges:

- 1. Confined spaces
- 2. Limited ventilation
- 3. Proximity to residential, commercial, and public areas
- 4. Complex evacuation pathways

When combined with the unique hazards of lithium-ion batteries—specifically the risk of thermal runaway and toxic gas emissions—the potentially devastating consequences of an EV fire escalate dramatically.

2. Beyond the EV Fire: Assessing the Complete Threat

2.1 EV Fire in a Basement Parking Garage of a Mixed-Use Building

Scenario: An EV initiates thermal runaway in the underground garage of a structure housing residential units above and retail businesses at ground level.

Significant Risks:

- 1. Release of toxic gases (HF, CO, VOCs) infiltrating HVAC systems
- 2. Fire suppression challenges due to vehicle accessibility and battery re-ignition
- 3. Total loss of egress routes for residents above
- 4. Smoke migration leading to upper-floor evacuations and casualties
- 5. Long-duration burn event resulting in structural degradation

2.2 Coordinated Terrorist Attack Leveraging EV Fire

Scenario: A terrorist strategically ignites an EV inside a parking structure as a distraction, redirecting first responder focus away from the actual target (e.g., a nearby public venue, transit hub, or government facility).

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Significant Risks:

- 1. First responders overwhelmed by a hard-to-extinguish, high-visibility incident
- 2. Secondary attacks occurring while response units are committed to the fire
- 3. Use of additional lithium-ion-powered devices (e-bikes, scooters) to amplify the event
- 4. Erosion of public trust in EV infrastructure safety

2.3 Cascading Failures in a Fully-Occupied Charging Zone

Scenario: One EV undergoes thermal runaway while charging; adjacent vehicles are parked in close proximity and also plugged into high-capacity chargers.

Significant Risks:

- 1. Fire spreads from vehicle to vehicle, each acting as a new ignition source
- 2. Charging stations contribute to arc flash or electrical panel compromise
- 3. Ventilation systems are overwhelmed, reducing air quality and visibility
- 4. Infrastructure damage requiring months of structural rehabilitation

3. Compounding Risk Factors

While the integration of electric vehicles into fleets is increasing, responding to EV fires presents distinct challenges due to several unique factors.

- 1. Lack of training for fire/rescue personnel on EV fire behavior in confined spaces
- 2. Delayed identification of EVs involved in a fire or crash
- 3. Failure to integrate passive and active ventilation systems tied to EV charging zones
- 4. Inadequate fire codes for multi-level or underground charging facilities

4. Recommendations & Mitigation Strategies

The key factors that must be considered to optimally mitigate the risks to safety and security posed by EVs include environmental design, operational preparedness, and security planning.

Environmental Design

- 1. Designated EV charging zones with reinforced fire barriers
- 2. Smart ventilation systems triggered by heat/gas sensors
- 3. EV-only sections located on open-air or above-ground levels
- 4. Fire-rated cable trays and isolated power shutoff systems

Operational Preparedness

- 1. Regular EV incident response training for fire/rescue and security teams
- 2. Unified signage and labeling for EV identification
- 3. Coordination with OEMs for vehicle-specific fire response protocols
- 4. Installation of fire suppression systems designed for lithium-ion events

Security Planning

- 1. Integrate EV fire scenarios into site-wide emergency response plans
- 2. Incorporate threat-based risk assessments into infrastructure development

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- 3. Surveillance and anomaly detection focused on charging infrastructure
- 4. Redundant communications systems for maintaining control during incidents

5. Conclusion

EV adoption will only accelerate, and with it, the proliferation of EV charging stations within public and private parking garages. While this transition supports clean energy goals, it must be balanced with a comprehensive understanding of the risks posed by lithium-ion batteries to the public, particularly in confined and populated environments. Mitigating significant risks—whether accidental or deliberate—requires a multi-disciplinary approach spanning fire safety, structural design, counterterrorism, and emergency management.

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For consultation, site assessments, or responder training related to EV safety and infrastructure hardening, please contact:

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