

Reassessing Transport Safety Regulations in the Era of Emerging Propulsion Technologies

For over six decades, the IAEA Transport Regulations (SSR-6) have provided the international framework for safe transport of radioactive materials, classified as Class 7 Dangerous Goods under the UN Orange Book. These regulations establish tiered safety requirements for different package types based on historical accident data and conventional transport conditions. The thermal testing protocols for Type B packages designed to withstand severe accidents were developed specifically to simulate hydrocarbon fuel fires, reflecting the dominant vehicle propulsion technology of the 20th century.

Type B package testing involves subjecting pre-damaged specimens to extreme thermal conditions. The current standards require specimens to first reach thermal equilibrium at 38°C to account for solar heating and internal heat generation, followed by exposure to a fully engulfing hydrocarbon fire for 30 minutes. This test fire must maintain an average temperature of 800°C with specific emissivity and absorptivity coefficients. These parameters were carefully established to represent worst-case scenarios involving traditional fuel-powered vehicles.

However, the rapid global adoption of electric vehicles (EVs) powered by lithium-ion batteries has introduced fundamentally different fire hazards that challenge these long-standing safety benchmarks. Battery fires exhibit several unique and concerning characteristics compared to conventional fuel fires. They can reach significantly higher peak temperatures, often exceeding 1,000°C, and are prone to thermal runaway - a self-sustaining exothermic reaction that can cause reignition even after initial suppression. Additionally, these fires release toxic gases like hydrogen fluoride and require substantially more time and resources to extinguish, sometimes burning for hours rather than minutes.

The growing prevalence of EVs on roadways creates two distinct safety challenges for radioactive material transport. First, as logistics operators pursue decarbonization, EVs may increasingly be used to transport radioactive materials directly, particularly for medical isotopes and industrial sources. Second, and perhaps more immediately concerning, is the risk posed by mixed traffic scenarios where conventional radioactive material transport vehicles share roads with numerous EVs. In such cases, an EV fire adjacent to a radioactive materials shipment could subject the containment system to more extreme conditions than those tested under current standards.

These emerging risks highlight several potential gaps in the existing regulatory framework. The 30-minute fire duration requirement may be insufficient given the prolonged burn times characteristic of battery fires. The temperature profiles and heat transfer mechanisms differ significantly between hydrocarbon and battery fires, potentially affecting material performance.

Addressing these challenges will require a comprehensive reassessment of transport safety regulations. Potential updates could include extending fire duration requirements, incorporating battery-specific thermal parameters, and adding criteria for resistance to toxic gas exposure. Container designs may need to evolve as well, potentially incorporating advanced insulation materials or active cooling systems. Operational measures such as establishing EV-exclusion zones for high-activity shipments or implementing real-time thermal monitoring could provide additional layers of protection.

The transition to alternative propulsion technologies represents a significant evolution in transport safety considerations. As battery-powered vehicles become increasingly prevalent, international regulatory bodies must proactively adapt safety standards to ensure continued robust protection against emerging hazards. This will require close collaboration between regulators, battery manufacturers, fire safety experts, and transport engineers to develop science-based updates to the SSR-6 regulations that reflect 21st century transportation realities.

Country or International Organization

Instructions

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