

Mega-Trends in Mobility, 5G & IoT

Impact on Materials Use and Fire Safety

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Introduction

The **mega-trends in mobility** address "things" within the network of physical objects, the **Internet of Things (IoT)**

Specific **examples** are the new technology **network 5G** able to connect a huge number of IoT devices, **and e-mobility** in transportation



Sources: Ribera Solutions and EMFexplained



New Technologies and Fire safety

In these new, future-oriented technologies, it is essential to **consider** the impact of combustible materials and components on **fire safety**

The **quickly growing number of physical objects** used in IoT, 5G and e-mobility **requires high fire safety standards** to protect life and property.





What is the Internet of Things IoT?

The Internet of Things (IoT) describes the network of physical objects "things" that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet



Source: nexgen.ch



Embedded IoT Devices and Appliances

- These embedded things are products pertaining to the concept of the "smart home", include devices and appliances (lighting fixtures, thermostats, home security systems and cameras, and other home appliances) and devices controlling these systems (smartphones and smart speakers)
- These new technologies lead to the exponential proliferation of smart devices in the built environment and transportation



Source. PC-welt



Flammability of IoT Products

- These "things" increasingly consume energy and are potential ignition sources
- Appliances and control devices recalls show that fire safety requirements are often not met
- One of the main causes for fires resulting from malfunction (overheating, electrical components failure, etc.) was the use of non-flame-retarded plastics



Sources: imartcity.com

onehourairftworth.com



Recalls of Products Used in IoT

The main **international recall** websites **portals OECD**¹ **and RAPEX**² report that the **main E&E products recalls due to fire hazard** are in order of importance:

- Mains and cord **extensions**
- **Power banks** and power supply
- Plug adapters, USB chargers
- Batteries and **battery** packs
- Heating/cooling devices (heaters, dehumidifiers, air conditioning, thermostats)
- Smaller kitchen **appliances** (toasters, mixers, water heaters, coffee makers)
- Whitegoods (dishwashers, refrigerators, washing machines)
- **Computers**, notebooks, laptops, tablets, speakers

¹ https://globalrecalls.oecd.org/#/

² https://ec.europa.eu/consumers/consumers/safety_products/rapex/alerts/?event=main.immediatlyPublishedNotifications&Ing=en



Flammability of Materials Used in IoT Products

In many cases, recall reasons given were:

- Material used easily catches fire
- Material has no flammability performance
- Material is **not fire-resistant**
- Plastic is **flammable**
- Plastic is not heat resistant
- Plastic is not self-extinguishing



Source: abcnews4.com

As IoT and related products will exponentially grow in the future, there is a **strong need to use flame retarded materials** complying with basic fire safety requirements **in these new technologies**



Fire safety Requirements and Tests used for E&E Equipment

Fire safety requirements aim at reducing the fire hazard of electrical devices and appliances. **Overheating, glowing parts, short circuits, small open flames** are the **main ignition sources.**



They are simulated by glow wire, small and large flame tests



Glow Wire Tests

The most important **flammability and ignitability tests for appliances** are the glow wire tests

Main use: household and kitchen appliances, whitegoods

- IEC 60695-2-10 Apparatus and common test procedure
- IEC 60695-2-11 Flammability test for end products (GWEPT)
- IEC 60695-2-12 Flammability test for materials (GWFI)
- IEC 60695-2-13 Ignitability test for materials (GWIT)



Materials test setup



End products test setup



Small Flame Tests

The most important **open flame tests** for electrical equipment and electronics (E&E) are the small flame tests (needle flame, horizontal/vertical 50 W tests, UL 94 HB, V2, V1, V0) **Main use**: housings, parts in appliances, IT, computing (PWB, connectors, switches)

Needle flame test IEC 60695-11-5 flammability tests (UL 94) 50 W vertical flame test method, IEC 60695-11-10









Larger Flame Tests

The most important larger flame tests for E&E equipment are the 500 W and UL 94 5VA and 5VB tests

Main use: electrical equipment with stringent fire safety requirements

500 W vertical flame test method IEC 60695-11-20

UL 94 5VA or 5VB



Source: KA Testing





Source: Korea.UL.com



Fire safety of E&E Equipment in IoT, 5G and e-mobility

Products meeting these tests have **higher fire safety levels** and **contribute to protect lives and property**

It is essential to use **flame retardant products** in the new exponentially growing IoT, 5G and e-mobility technologies



Source: Keysite



5G Technology Network

- The 5G wireless technology network will connect IoT devices in the future
- 5G is expected to accelerate the adoption of IoT. The number of such linked devices worldwide is likely to soar to 125 billion by 2030, up from about 11 billion in 2018 (Source DBS Group Research)
- Global mobile data traffic is expected to grow 4 times from 38 (2019) to 160 exabites¹ per month (2025)
- This massive data growth will be fueled by the mobile data consumed by over 6 billion people using smartphones, laptops and a huge number of devices in the years to come



Source: linkedin Telcosales

¹ exabyte = 1 billion billion bytes



5G Small Cells

- 5G Small Cells are low power mini base stations allowing uninterrupted coverage for connecting devices with miniature cell towers placed 250 meters apart throughout cities and other areas
- 5G uses frequencies such as millimeter waves which get blocked by obstacles.
 5G Small Cells address this blocking problem
- 5G Small Cells receive the 5G signal from main NarrowBand NB station and relay the same to users. When the user moves behind an obstacle, the cell phone automatically switches to the small cell mini base station to keep the connection intact





5G Small Cells Use

5G small cells can be used to provide **outdoor and in-building** wireless service

Outdoor uses

Cactus design for desert states

However, this **pole design** is **more common**



Source: aldensys.com



Source: Claude Boullevraye de Passillé

Source: telecominfrastructure.com



5G Small Cells Use Indoors

Due to their small sizes, **5G small cells can be installed easily in indoor places** such as enterprises, manufacturing or distribution facilities, corporate offices, and entertainment or public venues (shopping centers, stadiums or hotels)



Source: Ericsson



Source: Ericsson



Source. NCTA technical papers



Source: Samsung



5G Flame Retardancy

- **5G needs a multitude of small cells** in the home, the office, and commercial, retail or outdoor public space
- 5G also leads to a **large increase in energy** usage among consumers
- This **creates new fire hazards**, which can be **addressed by using flame retardant plastics** in 5G-related products



Source: Ericsson



E-Mobility

 E-mobility is another megatrend. Zero-emission, battery-powered vehicles and interconnected, autonomous mobility will revolutionize transportation



Source: Roland Berger



E-Vehicles

- Electric vehicles (EVs), use one or more electric motors or traction motors for propulsion
- Commonly, the term **EV** refers to an **electric car**
- E-mobility uses for EVs are electric powertrain, information, communication technologies and connected infrastructures for the electric vehicles propulsion



Source: Pixabey/cco



E-Mobility Technologies and Systems

- Powertrain Technologies include full electric vehicles, plug-in hybrids, and hydrogen fuel cell vehicles that convert hydrogen into electricity
- E-mobility Systems require lightweight, space-saving, and multi-electrical (conductivity, insulation) powertrains
- EVs typically charge from conventional power outlets or dedicated charging stations





E-Vehicles Fire Safety Requirements: Interiors

As for other road vehicles, e-vehicles must meet fire safety requirements requirements for **car interiors** to **U.S. FMVSS 302 or ISO 3795**



These **requirements are old (1972) and rather low** and do not consider the fire safety needs of modern road vehicles



E-Vehicles and The Need for More Fire Safety

Modern cars and EVs in particular require higher fire safety, because the fire hazard increases

- For components such as the electric motor which can reach voltages of 400 to 600 V, versus 12 or 48 V for vehicles today
- Due to the multitude of electrical motors as potential ignition sources



Source: e2e.ti.com



Flame Retarded Plastics in EVs

- Plastics used in EVs help to reduce the weight of these vehicles
- Plastics parts in e-mobility applications have to meet fire safety requirements, mostly UL 94 V0, down to 0.4 mm thickness
- This is mainly achieved at reasonable cost by using flame retardants
- Examples are flame retarded engineering plastics such as polyamides and PBT



Source: Domo

Polyamide



Source: BASF



Flame Retarded Plastics in EVs

 For loading stations, flame retarded plastics components such as plugs, socket outlets and cables are used to provide adequate fire safety



Source: Distrelec



Source: New York Times



Source: epfl



Specific Fire Safety Requirements for The Electric Powertrain

- UNECE: In the United Nations Economic Commission for Europe, WP 29 is responsible for the harmonization of vehicle regulations
- WP 29 develops regulations with technical requirements for the assessment of safety and environmental performance of Electric Vehicles (EV), Hybrid Electric Vehicles (HEV) and Fuel Cells Vehicles (FCV) laid down in the UNECE Regulation 100 and 132 (epowertrain, electric shock)
- In July 2013, an addendum to Regulation 100 concerning the approval of vehicles regarding specific requirements for the electric power train was introduced. In Annex 8E a fire resistance test is mandatory



Electric power train: Li-ion battery



Test rig for electric power train



UNECE Regulation No. 100 Annex 8E Fire Resistance

The purpose of this test is to verify the **resistance of the Rechargeable Energy Storage System** (REESS) **against** exposure to **fire** from outside of the vehicle. If this requirement is met, this will allow the driver and passengers enough time to leave the vehicle





Conclusions

- The mega-trends IoT, 5G networks and e-mobility currently transform our world
- The exponential growth of appliances and control devices in IoT and 5G networks, as well as in e-mobility requires products with improved fire safety
- Electrical products recalls have shown that non-flame-retarded plastics are a major cause of fires
- Flame retarded plastics used in IoT things, 5G technology networks and emobility will help to meet fire safety requirements and contribute to reduce the fire hazard of these products
- Flame retardants contribute to pass demanding flammability and real-scale tests, and thus improve the fire safety of combustible materials at reasonable cost

More on fire safety and flame retardants can be found in the 4th edition of the **Plastics Flammability Handbook** Available from Hanser in February 2021

https://www.hanserfachbuch.de/buch/Plastics+Flammability+Handbook/9781569907627





Thank you for your attention