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ASSESSMENT OF RISK AND DANGER IN THE OPERATION OF ELECTRIC BUSES AND CARS IN URBAN ENVIRONMENTS

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Abstract: *There are many expert analyzes on the use of electric vehicles and the potential danger of fire and explosions that they represent. Sales of electric vehicles at the global level have exceeded ten million, and the trend is a significant increase in sales. Electric cars and buses have advanced battery management systems. When lithium-ion batteries used to power electric vehicles ignite, they burn much differently than the gasoline used to power vehicles with an internal combustion engine. Although these batteries provide an efficient and effective power source, the likelihood of them overheating, catching fire, and even exploding increases when they are damaged or improperly used, charged, or stored.*

All this imposes the need to increase the fire protection measures during the operation of such vehicles in public transport to the highest level of safety, all in order to protect users and the environment, as well as the readiness to manage emergency situations. The aim of the work is to draw the attention of both the scientific and professional public to the seriousness and responsibility of using new technologies in transportation.

Key words: *Electric vehicles, Batteries, Emergency situations, Explosion, Risk*

1. INTRODUCTION

The international electric vehicle market has experienced great growth over the past decade. The fact is that more and more users decide to have this type of car, and this dictates the imperative to take care of the safety of the vehicle, i.e. the flammability of the battery. Governments around the world are stimulating sales of electric cars to help protect against climate change. The development of such electromobility sectors and the construction of new

places and charging stations require a solution that would guarantee the safe use and exploitation of electric vehicles, especially in terms of fire protection.

The advent of electric cars has also led to the need for larger charging areas. Bearing in mind that every electric charger creates a risk of short circuit and fire, a new type of protection is necessary to protect the building and its inhabitants, but also to help the firefighters in extinguishing fires in such underground spaces. It is very important to pay attention to raising awareness about the proper use and use of such vehicles of the future.

2. SAFETY WHEN OPERATING ELECTRIC VEHICLES IN URBAN ENVIRONMENTS

Electric vehicles were first introduced to the public back in the 1800s, but they didn't see mass production until 1996, with their popularity increasing over the past decade thanks to companies that make this type of vehicle. There are three types of electric vehicles: hybrid (HEV), plug-in hybrid (PHEV) and fully electric vehicles (EV or AEV).

Among the numerous advantages of electric vehicles, the following stand out: lower current costs, environmental acceptability, absence of congestion charges in ultra-low emission zones (ULEZ) in many cities, state financing for vehicles with low emission of harmful gases free parking in some areas, reduced noise pollution, and renewable electricity tariffs for those who charge their cars at home. Electric vehicle manufacturers have previously claimed that they are very safe from fire, and evidence suggests that the lithium-ion batteries used in electric vehicles are in fact just as safe or even more reliable than conventional fuel vehicles.

Reports from a number of companies dealing in this field state that numerous studies show that fires in electric vehicles are no more certain than those in traditional cars with an internal combustion engine. Electric vehicles don't use fuel, don't need a catalytic converter, and their electric motors don't overheat, which are the main causes of car fires. Of course, in the event of a traffic accident or electrical system failure, e-vehicles could catch fire (P. Sun, et al. 2020) In some cases, if a fire does occur in the vehicle, there is an option to use a special cover. Namely, according to the Fire isolator site, this cover has passed numerous live tests. It is a fire protection cover that prevents the spread of fire from the battery, i.e. enables control of the situation. Such fire blankets are resistant to high temperatures of up to 1,600 degrees Celsius, which are tested according to ISO EN 13501-1, AND they work by taking away oxygen that slowly extinguishes the fire - in fact, they have a suffocating effect. However, it should be remembered that the cover will not completely extinguish the fire in the battery, but will only allow the situation to be controlled.

The main danger in electric vehicles is when the battery they use is damaged. The use of lithium-ion batteries is still relatively recent compared to the beginnings of the use of fuel, so the frequency of fires in classic cars can be predicted more easily, and for valid data on electric cars, some time must pass. In principle, electric vehicles are extremely safe, but the main danger arises when the lithium-ion battery is damaged, which can happen if it is exposed to extreme heat or if the battery cell wall breaks due to some pressure on it.

Lithium-ion batteries can store a huge amount of energy in a very small space. If the battery is exposed to excessive heat or there is penetration into its case, then you get an internal short circuit, which causes what is called joule heating, the current creates a lot of heat and a chemical reaction occurs that creates even more heat. This process can cause 'battery ignition' and even explosion, making these batteries dangerous (P. Sun, et al. 2020).

Considering what we know, the frequency of fires in electric vehicles is not high, and the safety and security of batteries should be the first concern of manufacturers, if they want this market

to gain complete primacy from 2035. Namely, this year is taken as a turning point in the use of electric vehicles in Europe, because it will be prohibited to drive diesel and gasoline vehicles. Managing emergency situations that may arise when using such vehicles is crucial, and one of the most likely situations to occur is a fire. Extinguishing fires on standard vehicles that use fuel takes about an hour, with the involvement of only a few firefighters. Electric vehicles need to be extinguished in an average of 5 to 6 hours, with the participation of 30 to 40 firefighters and about 80,000 liters of water.

Electric cars really seem like a simple solution to promote even more environmental awareness in today's world. During 2023, more than 452,000 electric cars will be registered, which represents an increase of 41% compared to the previous year. However, despite their "green" trend, electric vehicles carry numerous risks like any other vehicle on the road, and in some cases even a little more (Cabrera Castillo E. 2015).

3. DANGERS WHEN OPERATING ELECTRIC VEHICLES

Although there is no solid evidence that electric vehicles cause more accidents, some characteristics of these vehicles may increase the likelihood. For example, lithium batteries can cause fires, and pedestrians may not hear an EV approaching due to the lack of engine noise.

Electric vehicles, although they represent a big step towards more sustainable transport, bring with them certain risks that cannot be ignored. Understanding these risks is crucial in order to keep users and the environment protected.

Explosions as a consequence of thermal instability

In addition to fires, electric cars can be susceptible to explosions due to thermal instability of batteries. Thermal instability can occur due to intense overheating of batteries, which causes a chain reaction within the battery cells, leading to an explosion. These explosions not only endanger the lives of drivers and passengers, but can also cause significant damage to surrounding property and infrastructure.

Fires caused by lithium-ion batteries

One of the main risks associated with electric cars is fires caused by defects in lithium-ion batteries. These batteries, which are the heart of any electric vehicle, can cause a fire if they become damaged, overheated or short-circuited. Lithium-ion battery fires are extremely dangerous because they spread quickly and are difficult to put out with standard fire extinguishers.

Risks associated with electric cars in crashes

Although EVs offer many benefits, they also carry significant risks. For example, the vast majority of EVs use lithium-ion batteries. They are similar to the batteries found in cell phones and laptop computers.

The problem with lithium-ion batteries is that they store a lot of energy in a small space. When ignited, they explode. The more batteries an electric vehicle has, the bigger the explosion. For example, Tesla EVs have around 7,000 batteries.

The explosive nature of lithium-ion batteries can pose a significant problem for first responders. An even bigger problem is that these batteries don't need oxygen to burn. Traditional firefighting methods, such as extinguishers, fire blankets and foam, extinguish flames by depriving them of oxygen, meaning these methods will not work when electric vehicle batteries catch fire.

Another security issue is power. Many EV models accelerate much faster than regular vehicles. This can surprise drivers who were not expecting it. According to one study, EVs crash 50% more often than traditional vehicles because of this.

Risk of electric shock

Another significant hazard with electric cars is the risk of electric shock. High-voltage systems that power electric motors and batteries pose a serious risk, especially in the event of a traffic accident or when the vehicle requires repair. Inadequate training or carelessness when handling these systems can lead to fatal consequences.

Environmental hazards due to fire

In the event of a fire, in addition to the direct danger to human life, there is also a serious environmental threat. Toxic gases released during the burning of lithium-ion batteries can contaminate the air and soil, posing an additional challenge for rescue teams and for environmental protection.

4. FIRE PROTECTION

Extinguishing electric car fires is a particular challenge for firefighters as they can last for hours. Standard extinguishing methods, such as the use of water or foam, are often not sufficient to extinguish a lithium-ion battery fire. Specialized techniques and means, such as the use of dry chemicals or specialized apparatus, are needed to effectively extinguish a fire.

Fires caused by burning lithium-ion batteries require large amounts of water and personnel to extinguish them. For these batteries to catch fire, they burn at very high temperatures. The problem is that even after a vehicle fire is extinguished, there is a risk that the battery will catch fire again. This can happen if the energy from the battery is transferred to another metal object, such as a chain, that touches the vehicle. For example, if the vehicle is moved or if a chain is passed over it, this can create new electrical connections that could reignite the fire, causing the fire to spread out of control.

Because of these dangers, many companies avoid towing electric vehicles after an accident because of the risk of the vehicle catching fire again. Instead, they are often stored in large open fields, leaving enough space between vehicles (about 15 meters), to reduce the possibility of fire spreading to other vehicles. Statistics show that, on average, putting out a fire on a standard vehicle that uses fuel takes about an hour and can be extinguished with a few firefighters and about 4,000 liters of water. In contrast, electric vehicles require an average of 5 to 6 hours to put out, with the participation of 30 to 40 firefighters and about 80,000 liters of water (Spinner et al. 2015).

The structure of lithium-ion batteries is such that their negative and positive electrodes are separated by a thin, sensitive layer, called a separator. It prevents the electrodes from touching and causing a short circuit.

Electric bikes and scooters have similar problems. They are powered by lithium-ion batteries which, if cheaply made, can explode if left on charge for too long. The electrolytes that make up the thin and vulnerable membrane that separates the anode and cathode are sensitive to even minimal amounts of dust or damage, which can lead to battery corrosion and the possibility of ignition. When one cell in a battery catches fire, it causes a chain reaction that causes all the surrounding cells to catch fire, quickly going from a small spark to a large fire (Wang Zet al.2019).

The production of electric vehicles has grown exponentially in the last decade and will only continue to grow. With climate change becoming more pronounced and the number of electric vehicles increasing, combustion fires may become more common.

5. MANAGEMENT OF EMERGENCY SITUATIONS IN CASE OF ACCIDENTS WHEN USING ELECTRIC VEHICLES

The preparation of the Disaster Risk Assessment (mandated by our legislative framework) represents a unique measure for increasing the quality and comparability of data as well as improving databases on the risks of natural disasters and other accidents in a certain area. Risk assessment identifies the sources of possible endangerment, looks at the possible consequences, needs and possibilities of implementing measures and tasks of protection and rescue from disasters (natural disasters and technical-technological accidents). From the aspect of determining the sources of possible endangerment, it is necessary to give importance to future new potential dangers (which is also the goal of this paper) and to the introduction of new technological achievements in the use of means of transport in urban areas and their safe exploitation. The fact is that electric vehicles are increasingly used in urban areas for the transportation of the population, from the perspective of profitability and sustainable development. We can talk about risk when there is a possibility of loss, but also a possibility of gain (eg an employer invests in production in order to make a profit). As this research is related to security, we look at risk from that aspect, that is, from the aspect of loss. Loss (damage) is the violation of the physical and/or psychological and/or moral integrity of people and/or endangerment of material and natural assets and/or systems and/or the environment. these types of vehicles. The fact is that we still lack measurable data for an adequate analysis, and this paper cannot refer to that either, but it aims to point out the potential dangers for users, as well as for the environment and the routes on which electric vehicles travel.

If you were to analyze the potential risk of using electric vehicles in urban areas, it should be emphasized that the probability of a fire or explosion is very small, but the fact is that in the event of such an event, the consequences would be catastrophic (Justen R, et al..2011). The consequences of such events would not only be for the users of electric vehicles, whether it is an individual or a public sector vehicle, but also for the environment that could be affected by this accident. was maximally safe for users and the environment. It must be emphasized here that with organized and planned action, we can reduce the negative outcome of such events, because even though the maximum protection measures have been applied, there is always a probability that an unmarried event will occur. Viewed in isolation without any contexts, connotations and comparisons, in and of themselves Electric vehicles are indeed better for the environment than their gasoline alternatives, but their new technology has created problems that need to be solved. Poor manufacturing and extreme weather can cause electric cars and electric bikes to catch fire. These flaws can have disastrous consequences if not managed properly.

However, it should be noted that the coverage of electric vehicle fires is disproportionate to the number of fires that occur. There are 25 fires for every 100,000 electric vehicles sold, compared to 1,530 fires for every 100,000 gas vehicles. However, electric vehicle fires are frequent news because they are newer, less frequent and more interesting to the public. This is misleading because it appears that these fires and their dangers are more common and more likely than they actually are. While this coverage is disproportionate, it highlights important issues that need to be addressed as sales of these vehicles increase. Finally, the problem of recycling and disposal of old batteries from electric cars carries its own risks. Improper storage or handling of these batteries can lead to leakage of dangerous chemicals, fires or explosions, which pose a significant risk to workers at recycling facilities, as well as to the environment.

6. CONCLUSION

Electric cars are certainly the technology of the future, but it is necessary to be aware of the risks they carry and take all the necessary precautions. The industry must continuously work to improve safety standards, educate users and rescue teams, and advance technologies to reduce the risks associated with these vehicles. With new technology inevitably comes new risks - risks for the environment and for the consumers who use it. Through the dangerous, unsustainable use of cobalt and nickel, which seriously damage the environment, and the risk of vehicle spontaneous combustion, appropriate measures must be taken to reduce the risk to both the planet and users. There are always solutions, but there should be interest in passing legislation to regulate the procurement, safety testing, and quantity of imports of such vehicles, as well as clauses that will motivate electric vehicle manufacturers to act more sustainably, discouraging the use of poor and often harmful production processes, solving problems associated with this new technology. The readiness to react in emergency situations is crucial both for preserving the lives of users and for the normal functioning of life and work in urban areas.

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