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**A COMPARATIVE ANALYSIS OF THE PRINCIPLES OF
CONDUCT OF FIRE BRIGADES DURING INCIDENTS WITH
ELECTRIC AND HYBRID VEHICLES, DEVELOPED
IN 2020 AND 2023**

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Electric vehicles are definitely the future of transport, as they mainly create electromobility and are to change the image of Poland in the coming years. They contribute to the improvement of air quality and the country's energy security. The development of electromobility in the field of transport has presented emergency services with another challenge.

In connection with the introduction of electric cars to the automotive industry, the National Headquarters of the State Fire Service of Poland have become well aware of the threat posed by the increase in the number of vehicles on Polish roads and the need to standardize the rules for extinguishing fires in these types of cars. Therefore, in June 2020, a document entitled *"Standard rules of conduct during incidents with passenger cars with electric drive"* was issued. This document was in force in all units subordinate to the State Fire Service. During the creation of the above-mentioned document, consultations were held with manufacturers of electric vehicles, research institutions and fire protection units[1].

Bearing in mind the dynamic development of transport, a task force was established to develop the *"Standard rules of conduct during incidents with electric and hybrid cars"*. This document was approved on 25 May 2023 and replaced the existing regulations from June 2020.

The research team's priority was to improve the safety of firefighters during their operations and increase their knowledge in this field. During the development of the new regulations, the team members analyzed not only the solutions used in other European countries, but also the available results of research and experiments. What is more, they participated in lectures given by modern vehicle manufacturers [2].

Analyzing the changes that have been introduced over the last 3 years, these are:

1. Extending the rules to include hybrid vehicles, i.e. a

combination of electric and combustion engines. The previous regulations did not include a classification of such vehicles. It has now been developed and described in detail.

2. Extension of the rules to include non-passenger vehicles. The number of electric vehicles is growing at a rapid pace. Currently, the number of electric delivery vehicles, trucks and buses is increasing. The previous document described only passenger vehicles, as they were the most popular in the automotive market.

3. Emphasize the importance of proper hazard recognition and the use of vehicle rescue cards. Firefighters can find rescue cards directly in the vehicle or in mobile apps. These cards show a diagram of the vehicle with the most important elements for emergency services: the location of body reinforcements, the location of airbags, gas belt tensioners and batteries and accumulators.

4. Presentation of the most modern solutions used by manufacturers to facilitate the operation and recognition of the car.

5. Determination of the situation and temperatures that qualify for the decision to cool the battery, including cooling times and intervals. The basic task for those extinguishing such a fire is to extinguish the visible flames and then lower the temperature of the traction battery. Thanks to this, we can stop the uncontrollable further increase in the temperature of the battery and reduce the violence of the chemical reaction.

6. Presentation of the risk associated with the release of flammable and toxic gases during thermal decomposition of the battery, and thus the need for personal protective equipment, multi-gas sensors and the need to approach operations "with the wind at your back" or with the generated air stream from the smoke exhaust fan.

7. Drawing attention to the appropriate extinguishing agents and the method of their administration. The following extinguishing agents can be used to extinguish the fire: water and ABC or AB fire extinguishers.

8. Presentation of ways to use a fire extinguishing container to sink an electric car. Nowadays, special containers are becoming more and more common, which, after pulling in a pre-extinguished vehicle, are poured with water and left for several hours. In this safe and water-saving way, the firefighting operation is completed. On the one hand, this allows for virtually complete control over the fire, and on the other hand, it significantly reduces the need for water during the entire firefighting operation.

9. Prohibition of interference (cutting, crushing, opening) with batteries, cables, and other high-voltage equipment.

As a result of these changes, firefighters must constantly improve their professional skills, as they will contribute to improving safety in transport [3]. As a matter of fact, the development of electromobility in the country is quite dynamic, but the number of electric vehicles on Polish streets is still hardly impressive compared to other European countries.



Fig. 1. Container for extinguishing electric vehicles [1]

References

1. URL: <https://www.gov.pl/web/kmpsp-krakow/dwa-nowe-kontenery-ratownicze-na-wyposazeniu-km-ppsp-w-krakowie>
2. «Standardowe zasady postępowania podczas zdarzeń z samochodami osobowymi z napędem elektrycznym», National Headquarters of the State Fire Service of Poland, 2020.
3. «Standardowe zasady postępowania podczas zdarzeń z samochodami z napędem elektrycznym i hybrydowym», National Headquarters of the State Fire Service of Poland, 2023.