

MODERN METHODS OF FIRE SUPPRESSION: THE USE OF UNMANNED SYSTEMS IN FIRE SUPPRESSION AT DRAVA INTERNATIONAL

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ABSTRACT

The aim of this paper is to present the capabilities and advantages of using unmanned systems in operational activities conducted by components of the civil protection system, with a particular focus on a real-life example of extinguishing a large industrial fire at the Drava International facility in 2023. The paper focuses on two advanced systems: the DOK-ING MVFD-5 unmanned multifunctional firefighting and decontamination vehicle, and the DJI Matrice 30T unmanned aerial vehicle, which together contributed to more efficient intervention management and the protection of human lives.

Methodologically, the application of these two systems in the field was analysed by reviewing their technical specifications, roles in the actual incident and mutual interaction. Special attention is given to the use of the DOK-ING MVFD-5 in high-risk zones, where it reduced the need for firefighter entry and prevented the fire from spreading to the production hall, as well as to the DJI Matrice 30T's capability to transmit real-time video to the command and communication container, which enabled accurate allocation of vehicles and firefighting personnel on the ground.

The results showed a significant increase in the safety of civil protection personnel, improved situational awareness, faster and more precise deployment of resources, and greater overall intervention effectiveness. The tactical deployment of both the DOK-ING MVFD-5 and the DJI Matrice 30T enabled rapid, safe and effective containment of the fire, while also assisting incident commanders in making data-driven decisions based on real-time information. In conclusion, the use of unmanned systems in firefighting represents a significant step forward in the modernisation of firefighting tactics. The Drava International incident confirms their functionality, efficiency and value in demanding operational conditions, paving the way for broader integration of such technologies into the civil protection system.

Keywords: unmanned systems, DOK-ING MVFD-5, DJI Matrice 30T, firefighting, civil protection

INTRODUCTION

Unmanned systems have become a key tool in protection and rescue operations, both globally and in the Republic of Croatia. Their use in hazardous environments, without direct exposure of rescuers, significantly increases the safety and efficiency of all

participants involved in emergency interventions. They are increasingly employed for reconnaissance, hazardous material detection, firefighting, hazardous material removal, and search and rescue operations - particularly in locations that pose a danger to human responders.

Legal framework for the use of unmanned systems in the civil protection system of the Republic of Croatia

The use of unmanned aerial vehicles (UAVs) within the civil protection system is regulated by both European and national legislation. The key EU regulations are Implementing Regulation 2019/947 and Delegated Regulation 2019/945, which govern operational rules, technical requirements and safety standards. UAV operations are categorised according to risk (open, specific and certified categories), and obligations are prescribed for pilots and operators, including flight limitations and privacy protection in line with the General Data Protection Regulation (GDPR).

In the Republic of Croatia, the implementation of EU regulations is supported by the Air Traffic Act and the Ordinance on Airspace Management. UAV geographical zones have been introduced to ensure the safe conduct of drone operations, including emergency interventions coordinated with Croatia Control Ltd. (Croatian Air Navigation Services).

The Croatian Civil Aviation Agency (CCAA) is responsible for authorising and supervising specific operations, while the Regulation on Aerial Imaging defines the conditions and limitations for aerial photography, with a particular focus on data protection and pre-publication material oversight.

DOK-ING MVFD-5: technical and operational capabilities

The DOK-ING MVFD-5 is a multifunctional, unmanned, tracked vehicle designed for operation in extremely hazardous environments. It enables remote firefighting, hazardous material detection, decontamination, transportation of dangerous substances, and obstacle removal, significantly reducing the risk to operational personnel.

The vehicle weighs approximately 11.5 tons when empty, and up to 14 tons when fully equipped. It is powered by a robust 6-cylinder diesel engine delivering 186 kW of power. The MVFD-5 is equipped with a hydraulic arm that reaches up to 6.6 metres, an integrated pump with a capacity of 2000 litres per minute, and tanks for 2000 litres of water, 300 litres of foam, and 200 litres of decontaminant. Its armoured chassis, featuring thermal protection and a sprinkler system, allows operation in temperatures up to +80 °C.

The DOK-ING MVFD-5 is remotely operated from distances of up to 1500 metres via a control unit. Terrain monitoring is supported by a total of nine cameras operating in both visible and thermal spectra.

During the Drava International fire in 2023, the vehicle proved crucial in preventing the spread of fire to the production hall and in protecting firefighters from exposure to life-threatening situations.

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DJI Matrice 30T and Matrice 300 RTK: specifications and applications

The DJI Matrice 30T and DJI Matrice 300 RTK are advanced unmanned aerial vehicles (UAVs) designed for reconnaissance, search and rescue, surveillance, and inspection operations, with strong resistance to adverse weather conditions. Both models offer encrypted image transmission up to a range of 15 km.

DJI Matrice 30T

A compact and easily portable drone equipped with integrated optical, thermal and laser sensors. It has a flight time of up to 41 minutes and an IP55 protection rating. The zoom camera (48 MP), wide-angle camera (12 MP), thermal camera with an accuracy of ± 2 °C, and laser rangefinder enable precise reconnaissance and monitoring. The RTK module provides centimetre-level positioning accuracy. Operationally, it is used for tactical reconnaissance, search and rescue, surveillance, infrastructure inspection, and orthophoto map creation.

DJI Matrice 300 RTK

A more robust platform with higher payload capacity (up to 2.7 kg), flight time of up to 55 minutes and IP45 protection. Its RTK system ensures centimetre-level accuracy, while multiple onboard sensors enable 360° obstacle avoidance. It supports multiple gimbal payloads, including:

- H20T (optical + thermal + rangefinder),
- L1 (LiDAR + RGB),
- P1 (45 MP for photogrammetry),
- third-party sensors.

It is intended for long-duration surveillance, search and rescue missions, infrastructure inspections, and operations in CBRN (chemical, biological, radiological, and nuclear) environments.

Case study: fire at Drava International d.o.o. (Osijek, October 2023)

1. Introduction

Fires at industrial facilities present a complex challenge for all emergency response services, especially when involving large quantities of flammable materials and hazardous substances. On 4 October 2023, one of the largest fires in the

past decade in Eastern Croatia broke out within the premises of Drava International d.o.o. in Osijek. The combustion of baled PET packaging triggered a prolonged incident, posing significant health and environmental risks. During this intervention, for the first time, a combination of the DOK-ING MVFD-5 unmanned firefighting vehicle and unmanned aerial vehicles (UAVs) operated by the Civil Protection Directorate was deployed at full operational capacity, making this event particularly important for analysis.

2. Onset of the incident and fire scope

The fire was reported at 00:40 hours, and upon the arrival of the first firefighting units, an open storage area containing burning baled PET packaging was found. The fire quickly spread to a large quantity of baled PET packaging and soon reached the production hall, with thick black smoke visible from several kilometres away. Due to the potential toxicity of the smoke, the Civil Protection Headquarters issued a public warning through the SRUUK system of the Civil Protection Directorate, advising residents to close their windows and remain indoors. During the intervention, three firefighters were injured – one seriously and two with minor injuries.

More than 100 firefighters from professional and volunteer fire brigades participated in the operation. The intensity, complexity and duration of the intervention make this case a benchmark for future operations involving advanced technologies and emergency management.

3. Activation of unmanned systems

In the early morning hours of the same day, teams from the Civil Protection Directorate were deployed to the fire site with a multifunctional unmanned ground vehicle (DOK-ING MVFD-5) and two unmanned aerial vehicles: the DJI Matrice 30T and DJI Matrice 300 RTK.

The first phase of the operation involved firefighting using the DOK-ING MVFD-5 and preventing the fire from spreading to the production halls.

The DOK-ING MVFD-5 was used for frontal firefighting, directing the water jet towards deep-seated hotspots, and cutting off the fire's progression towards the production facility. Its resistance to high temperatures and ability to operate from a safe distance enabled effective firefighting without exposing firefighters to additional risk.

In total, more than 100 firefighters from professional and volunteer fire departments participated in the intervention. The intensity, complexity and duration of the operation make this case a benchmark for future emergency responses involving advanced technologies and crisis management.

4. Aerial support and reconnaissance

Unmanned aerial vehicles (UAVs) were used continuously throughout the entire intervention, both

day and night. Their thermal and optical cameras enabled:

- detection of active and underground hotspots,
- identifying the fire progression direction,
- monitoring the deployment of firefighting personnel and equipment,
- creation of orthophoto maps and 3D models.

Live video was transmitted in real time to the mobile command and communication vehicle, allowing commanders to make informed decisions based on aerial data. This significantly improved coordination among units and optimised the distribution of resources

5. Combined effect of UGV and UAV systems

The combination of the DOK-ING MVFD-5 and UAV systems proved crucial in controlling the fire. Drones monitored the development of the situation, while the DOK-ING MVFD-5 was deployed tactically exactly where it was most needed. This coordination enabled the creation of a so-called "buffer zone" and a barrier between the burning baled PET packaging and the production halls.

One of the key moments was preventing the fire from spreading towards the nearby woodland and the remaining storage area of baled plastic. Based on aerial footage, a decision was made to remove combustible material and create a 10-metre-wide protective corridor.

6. Intervention in the grove: underground hotspot

Several days after the fire began, a thermal imaging camera detected elevated ground temperatures in a grove along the southern edge of the factory. It was identified as smouldering organic material beneath the soil surface – a so-called underground fire. In such situations, the surface may appear stable, while roots or humus continue to burn underneath.

The DOK-ING MVFD-5 was deployed to the location, where a partial collapse of the ground occurred, causing flames to break out. Since the vehicle was unmanned, potential injury to firefighters was avoided. The vehicle then directed its nozzle towards the hotspot and began several hours of firefighting operations. Thermal imaging monitoring confirmed that the heat source was completely extinguished, thereby eliminating the risk of reignition.

7. Final phase and conclusion

The fire was officially extinguished on 13 October 2023. In the final phase, excavators were used to cover the smouldering plastic, while drones conducted daily overflights of the site, capturing thermal images to detect any remaining hotspots. The last traces of thermal anomalies were eliminated through coordinated efforts between the firefighters and the DOK-ING MVFD-5 vehicle.

8. Final recommendations

The use of unmanned systems in this intervention demonstrated their operational value:

- The DOK-ING MVFD-5 enabled operations in extreme

conditions without endangering personnel,

- UAV platforms provided the command with a comprehensive situational overview,
- The combined use of systems resulted in a more effective and safer firefighting strategy.

It is recommended to:

- Systematically integrate UGV and UAV systems into all

firefighting protocols,

- Train teams for joint operations involving multiple unmanned systems,
- Define operational procedures for the coordinated use of technology in large-scale interventions.

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SAVREMENE METODE GAŠENJA POŽARA: PRIMJENA BESPOSADNIH SISTEMA U GAŠENJU POŽARA U DRAVA INTERNATIONAL

SAŽETAK

Cilj ovog rada je prikazati mogućnosti i prednosti primjene besposadnih sistema u operativnim aktivnostima sastavnica sistema civilne zaštite s naglaskom na konkretan primjer gašenja velikog industrijskog požara u pogonu Drava International koji se dogodio 2023. godine. U fokusu rada su dva napredna sistema: višenamjensko besposadno vozilo za gašenje požara i dekontaminaciju DOK-ING MVFD-5 i bespilotna letjelica DJI Matrice 30T, koji su zajednički doprinijeli učinkovitijem upravljanju intervencijom i zaštiti ljudskih života. Metodološki, provedena je analiza primjene ova dva sistema na terenu kroz pregled tehničkih specifikacija, uloga u stvarnoj situaciji i njihove međusobne interakcije. Posebno je analizirana upotreba DOK-ING MVFD-5 u zonama visokog rizika gdje se smanjila potreba za ulaskom vatrogasaca i spriječilo širenje požara na proizvodnu halu te sposobnost DJI Matrice 30T da u stvarnom vremenu prenosi video signal u zapovjedno-komunikacijski kontejner na osnovu čega se vršio raspored vozila i vatrogasaca na terenu. Rezultati primjene pokazali su znatno povećanje sigurnosti pripadnika službi sistema civilne zaštite, bolji pregled situacije na terenu, bržu i precizniju raspodjelu snaga te veću ukupnu učinkovitost intervencije. Kombinacija taktičke primjene DOK-ING MVFD-5 i Matrice 30T je omogućila brzo, sigurno i efikasno sprječavanje širenja požara na objekte te je zapovjednicima olakšala donošenje odluka zasnovanih na podacima dobivenim u realnom vremenu. Zaključno, upotreba besposadnih sistema u gašenju požara predstavlja značajan korak u modernizaciji vatrogasne taktike. Incident u Drava Internationalu potvrđuje njihovu funkcionalnost, učinkovitost i vrijednost u zahtjevnim operativnim uslovima, otvarajući prostor za širu integraciju ovakvih tehnologija u sistem civilne zaštite.

Ključne riječi: besposadni sistemi, DOK-ING MVFD-5, DJI Matrice 30T, gašenje požara, civilna zaštita

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