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Use of TEN-T for the movement of Search & Rescue teams within the framework of CBRN-E response

David Rehak[a*], Heidi Janeckova[a], Martin Hromada[b], Vit Stritecky[c], Eliska Speldova[d], Panagiota Benekou[e]

[a]*VSB – Technical University of Ostrava, Faculty of Safety Engineering, Lumirova 13, 700 30 Ostrava, Czech Republic*
[b]*Tomas Bata University in Zlín, Faculty of Applied Informatics, Nad Stranemi 4511, 760 05 Zlín, Czech Republic*
[c]*Technological Platform Energy Security Czech Republic, V Holesovickach 1443/4, 180 00 Praha, Czech Republic*
[d]*Czech Standardization Agency, Biskupsky dvur 1148/5, 110 00 Praha, Czech Republic*
[e]*Center for Security Studies, P. Kanellopoulou 4, 101 77 Athens, Greece*

Abstract

Current threats, such as natural disasters, technological accidents or targeted attacks involving CBRN-E aspects, are becoming increasingly frequent and complex. For this reason, there are constantly increasing demands not only on the population protection, but also on the Search and Rescue Teams allocated to manage these large-scale disasters. In the context of responding to possible incidents, the rapid and safe transport of these teams represents a significant logistical challenge. Specifically, this concerns the transport of specialized equipment, which, due to its size or weight, can be difficult to transport within the Trans-European Transport Network.

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1. Introduction

The human population is permanently threatened by various types of threats of anthropogenic or natural nature, such as earthquakes, tsunamis, fires or industrial accidents. These threats can lead to the emergence of large-scale disasters (UNDRR, 2015), which can have fatal impacts not only on the population, but also on the infrastructure or the environment.

* Corresponding author. Tel.: +420 596 992 816
E-mail address: david.rehak@vsb.cz

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Due to the extensive impacts, these disasters require the immediate deployment of the necessary teams with specialized equipment (so-called Search and Rescue teams – S&R teams) for the purpose of mitigating measures, repairs, response and recovery (Bogue, 2019). S&R teams are therefore mainly deployed in rescue operations, including, for example, work in water, forests, collapsed buildings or landslides (Zawawi, 2023).

However, in the context of gradual modernization and growing demands on the functioning of society, these threats are also escalating, especially the threat of terrorist attacks carried out using chemical, biological, radiological, nuclear and explosive agents, or CBRN-E (Benolli et al., 2021). For this reason, individual states have focused primarily on training their special forces in the event of an incident involving CBRN-E (Ellis, 2013). This fact has given rise to many professional literatures, which are mainly devoted to the training possibilities of S&R teams (Björn et al., 2014; Murtinger et al., 2021; Zawawi, 2023).

Although the professional literature mainly addresses the response of S&R teams using virtual scenarios (Zechner et al., 2023), none of them focuses on the issue of transporting these teams to a given incident. The transportation of S&R teams and their equipment thus becomes a significant logistical challenge, in which it is necessary to consider possible complications. Based on these facts, the aim of the article is to draw attention to the issue of transporting forces and resources of S&R teams using the Trans-European Transport Network.

2. CBRN-E Response Specifications

In general, the abbreviation CBRN-E refers to accidental or intentional incidents involving chemical, biological, radiological, nuclear or explosive aspects. An intentional incident can be considered, for example, terrorist attacks in the environment of critical infrastructure, which aim not only to damage or destroy the given infrastructure (Lovecek et al., 2021; Hromada and Lukas, 2011), but also to affect the largest possible number of people. An example is the London transport bombing (2005), which resulted in 52 deaths and more than 700 injuries (Strom and Eyerman, 2008). Due to the major impact on the population, infrastructure or environment (i.e. interests protected by the state), CBRN-E threats represent a complex risk that requires a dynamic, multidisciplinary and coordinated approach from emergency services and other agencies (JESIP, 2016).

Currently, in order to reduce the impact, in addition to the Geneva Conventions, specific conventions are also ratified, such as the Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction (OPCW, 1993). Furthermore, specific principles are defined, e.g. Responding to a CBRN(E) Event: Joint Operating Principles for the Emergency Services (JESIP, 2016), or professional exercises implemented (Deya, 2020). These exercises primarily use simulation technologies, such as virtual and mixed reality (Altan et al., 2022), which were created to strengthen the resilience of first responders or specialized S&R teams.

3. Search and Rescue Team Specifications

Populations around the world are increasingly exposed to disasters, such as earthquakes, tornadoes, industrial accidents, traffic accidents with the release of hazardous substances, and terrorist attacks (Markova et al., 2023). Due to their nature, these events often require the deployment of specialized teams consisting not only of members of the fire, rescue or police forces (Petinaux et al., 2014), but also healthcare professionals (Ferguson et al., 2023) or engineers (McGuigan, 2002). The essence of these forces is not only to protect human lives, but also to support stability and reconstruction in affected areas. In order to ensure an immediate coordinated response, the EU civil protection mechanism was created (Council of the European Union, 2024), which introduced a system of "modules", i.e. Search and Rescue Teams specialized in certain types of interventions depending on the nature of the incident.

Thanks to their multidisciplinary composition and self-sufficiency in search and rescue, these teams play a key role in responding to emergencies around the world, e.g. Indonesia 2018, Japan 2011, Haiti 2010 (Zawawi, 2023). An example is the Czech USAR Team (2024), which is capable of searching in urban environments not only with the help of dogs and electronic search equipment, but also for lifting heavy loads, penetrating steel or reinforced concrete structures, rescuing using rope techniques, building struts or detecting hazardous substances.

Although many S&R teams are equipped with means for detecting hazardous substances or managing interventions with the occurrence of CBRN-E, these interventions represent one of the most demanding types of operations, due to the need for not only a high level of expertise, advanced technology, but also the coordination and transport of

specialized equipment such as personal protective equipment or decontamination equipment (Fitch et al., 2003; Luther et al., 2006; Coleman et al., 2019). For this reason, countries around the world are calling for training of S&R teams with CBRN-E presence. One example is the Civil Support Training Activity (CSTA), which helps to provide specialized training for national military forces to detect chemical agents, perform decontamination procedures, and provide first aid to exposed individuals (Deya, 2020).

The training of S&R teams in the context of CBRN-E incidents is currently receiving increasing attention. This fact is evidenced not only by the activities and publications presented above, but also by grant support from the European Union. An example is the project "TeamUP: Holistic capability and technology evaluation and co-creation framework for upskilled first responders and enhanced CBRN-E response". This project also focuses on the rapid and safe transport of S&R teams, specifically specialized equipment, which is difficult to transport due to its excessive size and dimensions (Council Directive, 1996). It is appropriate to plan the use of the Trans-European Transport Network.

4. Trans-European Transport Network Specifications

In the area of Trans-European Networks, the main objective of EU policy is the interoperability of regional and national infrastructures in the transport sector (Leitner et al., 2018) and energy sector (Hromada et al., 2021), which play a key role in the development of the European market and global competitiveness (European Investment Bank, 2024). In this context, the Trans-European Transport Network (TEN-T) is a strategic network. This transport network consists of a total of four types of transport infrastructure structured into two basic layers, i.e. the comprehensive network and the core network. The comprehensive network is defined as the multimodal connection of all European regions at NUTS 2 level and the core network as a subset of the comprehensive network containing the most important trans-European routes (European Parliament and Council, 2024).

The first type of TEN-T is railway transport infrastructure. This infrastructure consists of a number of area, line or point elements (Rehak et al., 2019; Fekete, 2011). Examples include railway lines including switches and tunnels, stations or trackside control and security. The second type is road transport infrastructure. Road infrastructure mainly includes roadways (e.g. bridges, tunnels, junctions), digital infrastructure and ICT systems for transport or the connection of freight terminals and logistics centres with other modes of transport within the trans-European transport network (European Parliament and Council, 2024). The third type is maritime transport infrastructure, which connects and integrates infrastructures such as landing approaches, sea channels or infrastructures indispensable for transport in the port area (European Parliament and Council, 2024). The last type is air transport infrastructure. In general, this infrastructure includes in particular airspace, airports, spaceports or the connection of airports with other modes of transport within the trans-European transport network (European Parliament and Council, 2024).

5. Usability of road and air TEN-T for S&R teams

Based on the above facts, it can be stated that the transportation of S&R teams is one of the key issues in the response to possible CBRN-E incidents. Although TEN-T has a total of four types of transport infrastructure, road and air transport infrastructure in particular have long been among the most used methods of transporting S&R teams in the European Union (Brejzova, 2014). The main advantage of transportation via these infrastructures is speed and flexibility. However, the full use of road and air infrastructure for the transportation of S&R teams presents a number of logistical challenges which can be identified with the help of the illustrated diagram (see Figure 1).

When using road transport infrastructure, S&R teams may face problems, especially when transporting oversized or oversized equipment with the necessary equipment, such as mobile laboratories, decontamination equipment or heavy equipment for rescue work. Possible complications can be expected with several elements of the road infrastructure (Directive, 2019). Especially when there is a need for transport through tunnels, the safety of which is mainly affected by their maintenance, which in the case of roadways is the responsibility of road administrators (Ministry of Transport, 2009). In addition to the technical condition, when planning a transport route, it is also necessary to take into account the inadequate transport dimensions and requirements, regarding the number and width of lanes, the clear (passage) height or the width of the portal. Some tunnels within Europe were constructed under

technical possibilities and transport conditions that no longer meet today's standards, i.e. they were put into operation a long time ago, and therefore there are different levels of their safety (Directive, 2004).

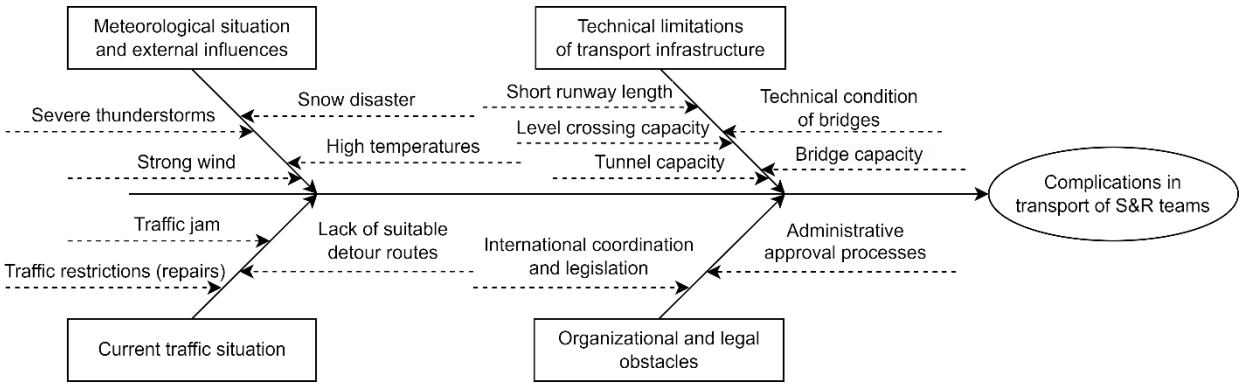

Fig. 1. Causes of S&R team transport complications.

Further complications may arise in the case of bridges, where it is necessary to consider not only the technical condition of the bridge, but also its load-bearing capacity, number and width of lanes, and the height of the bridge, primarily with regard to the location of the bridge (on the route or above the route). The condition of bridges in the Czech Republic is generally according to the Ministry of Transport (2016) is considered very bad. Many of them have a reduced weight limit, which does not allow the transport of heavy equipment. It is also necessary to take into account interchanges during transport (Directive, 2019), where limiting factors may include not only the number and width of lanes or the height and load capacity of bridges over land roads, but also possible bend slopes. Other factors that may affect the transport of S&R teams and their equipment are the current traffic situation (traffic jams) or the distance from the deployment site. Both of these factors can significantly affect the response time needed to resolve a given incident.

Air transport infrastructure is also important for the transport of S&R teams. This infrastructure allows for a significant reduction in the transport time of S&R teams and their equipment, but this type of transport also faces a number of logistical challenges. The first limiting factor is the length of individual runways, since sufficient runway length plays a significant role in the safe take-off and landing of flights with heavy equipment. The minimum length of landing and take-off runways is generally given by Commission Regulation (2014). However, this regulation does not set specific technical specifications, but only states that the usable landing length is understood as the length of the take-off and landing runway.

Other limiting factors are not only the taxiways used to ensure the safe and smooth taxiing of aircraft, but also the load-bearing capacity of the runway, which must be suitable for the operation of the aircraft for which it will serve (Ashford et al., 2012). In addition to the above factors, the current meteorological situation also plays a key role (Jeddi, 2012), such as strong winds, storms, dense fog or high temperatures. An example is the situation where approximately 50 flights were delayed due to extreme temperatures in the Arizona city of Phoenix (Hawkins, 2017). In addition to the above-mentioned limiting factors, it is necessary to take into account the possible limits of road transport within air transport, which plays a key role in connecting with the destination of a possible incident.

In the context of the factors identified above that may hinder or disrupt the transport of S&R teams, it is also necessary to take into account possible organizational and legal obstacles. In particular, those related to administrative approval processes, such as permits for the transport of excessive cargo or international coordination and legislation.

6. Conclusion

The response to incidents that have a large-scale impact on the population, infrastructure or environment is handled in the European Union not only by emergency services and other agencies, but also by specialized teams known as

Search and Rescue Teams. Based on the nature of the incident (e.g. earthquake or terrorist attack using CBRN-E), these specialized teams are sent to various international rescue operations. Although the resolution of each incident represents a considerable logistical challenge, insufficient attention is paid to the transportation of S&R teams and their equipment.

In the context of the transport of S&R teams, air and road transport can be considered the most important within the Trans-European Transport Network (TEN-T). Since it is necessary to transport a significant amount of equipment in a short time for incident resolution, possible elements of the given infrastructures and their limiting factors were identified in this regard, which are mainly the meteorological situation, technical limitations of transport infrastructures, current traffic situations and organizational and legal obstacles.

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