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THE ROLE AND THE RISKS OF EXPLOSIVE ORDNANCE DECONTAMINATION IN HUNGARY

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Abstract: The work of the experts of explosive ordnance disposal is very demanding in Hungary. Thousands of explosive remnants of war are still waiting for disarming in the soil. This public duty demands highly trained professionals who are able to meet the requirements of this lethal profession. The statistics are important to receive a complete picture about the background of projectiles and bombs. These military ordnances endanger everybody's live in their close distance. To understand the features of these dangerous devices, first the threats hidden inside their main parts must be identified. This may help us to make the explosive ordnance disposal tasks safer and to understand the possibilities during render safe procedures.

Keywords: Disarming; Decontamination; Explosive ordnance disposal; EOD; Explosives; Threat.

1 INTRODUCTION

The World War II was an enormous concussion for the whole planet. Its effect could also be felt in those countries where there was no factual military action. Our country was not in a good position, because in Europe it was the operational area of the opponent parties for 6 months. Those nations who did not reach Hungary in land warfare, they spread death and devastation in the courses of aerial operations.

These war facts are very determinative, as they have influence on the life of the population after decades. On a daily basis, they have to deal with handling and defusing of explosive ordnances (hereinafter: EO). It is rather impossible to find a construction site in the capital where a sort of grenade or bomb is not to be found. Unfortunately, not just the capital, but also the whole country is implicated. The lethal mechanism present in the entire region is common knowledge, at least for those facing the inconveniences of their handling.

Over the decades, after the end of the World War II hundreds of bomb disposals technicians and explosive ordnance disposals operators (hereinafter: EOD) died a heroic death. This fact confirmed that the threat we face is real, but according to my assumptions, there is a continuously deteriorating presence in the background. Therefore, these explosive devices could be more and more sensitive.

Another important aspect could be analysed by the data related to the alerts. With the analysis of the statistics, we can gain beneficial information, which can help to plan and organise the neutralisation tasks. According to my assumptions, those periods could be identified when the expected number of alerts are rising or decreasing. This could be a good forecast for the bomb disposal tasks.

2 HISTORICAL FACTS

The battles in our country had a great importance. Those military troops, whose main goal was to slow down or stop the Russian frontline, were building barriers, laying minefields on each crossroads, tracks and outskirts of high priority objects. The opponents used the entire spectrum of the military ordnance to reach their operational and strategic goals. [1; 5]

On the former operational areas, millions of artillery projectiles, mortar shells, aerial bombs, hand and rifle grenades, rockets, anti-tank devices, small arms ammunition and landmines were left behind. [2; 19] During the war, the presence of these devices was a serious problem, they could obstruct the different manoeuvres, took lives, but in the period of peace their importance increased. A post-war death is given much more attention since the period of fear is over and people try to step forward. In such a situation it is hard to acknowledge that death is still present and reaps most unexpectedly.

During the Hungarian battles, an amazing number of explosive devices were used, the significant part of which did not explode, the task of their management remaining to posterity. This is a work of professionals, who often give their lives neutralising the explosives. This is not a negligible number: more than 300 professionals died, performing a heroic duty from the end of the World War II until the present day. [2; 155-161] Unfortunately, the number of civilian casualties was significant, and many people lost their limbs or got wounds from shrapnel in the rebuilding period of the country.

3 WHO ARE THE EOD OPERATORS?

We hear many times the term of EOD experts or bomb squad in some news in television or while browsing on the internet. In such a case, we place the associated meaning after the word immediately: Those disarming the bombs. The original meaning of the word was different from the recent one, it formed for decades continuously, until it reached its today content.

The term of EOD operator can be originated from the German "Feuerwerkmesiter". In the beginning, these professionals dealt with the combination and optimisation of the artillery ammunition that remained unexploded as EO. Before World War I,

their main tasks were to take over these projectiles – which are able to explode – from the manufacturers, testing and monitoring them, and destroy those grenades that were not usable. The first cataclysm of the World brought a significant change. The bomb squad also tackled with combat tasks, because grenades and bombs left behind caused a lot of damage to the soldiers; the trained and established bomb patrols' mission was to neutralise the EO that was found. After the war ended, the former system was returned. As the former operational areas fell apart in detached regions of the country, not too many EO have been found; therefore, the expansion of capabilities was not necessary. [2; 13-14]

Later, the increasing number of standardised EO made it necessary that the specialists get serious training. The truly significant development of skill came true in 1939. At that time, neutralising the unexploded aerial bombs was one of the main partial tasks of the air raid precautions; therefore, it was essential to train EOD operators in a rather big number. Until the end of the World War II, hundreds of firemen and civilians got "air raid precaution" EOD training. In 1943, a few trained EOD patrols under the command of the Ministry of Defence were available, who were trained and equipped with modern tools. Their task was the destruction of bombs that were left behind after air strikes. [2; 14-15]

In 1944, an essential thing changed. The fighting arrived in our homeland; thus, the necessity arose for what became an EOD service. The dangerous military ordnance that was left behind and the elimination of the minefields needed much more comprehensive knowledge compared to earlier periods. By this time, not only a few dozen devices had to be prepared for neutralising, but hundreds of different types of explosives.

After World War II, the decontamination of the EO polluted areas had to start. The soviet military engineering units also took their part in these missions, but the millions of ordnance items could be neutralised and overridden only with mobilising huge resources. In Somogy County, the Engineer battalion, which was based there, also took its part in eliminating the minefields. The unit was led by the Bulgarian Major Dimov and Lieutenant Colonel Alajos Fodor. Solving the increased number of neutralisations, they started to use volunteers from the prisoners of war, of course after a quick preparation. These hundreds of volunteers performed a huge task, but they had to pay a dear price for this duty. There was a 10-person demining team, which finished its task with an 80 % human loss. [3; 34-39]

After this period, the engineer units and subunits were continuously reorganised [4], but this did not affect the EOD tasks. The public service mission at this time became crystal clear. The decontamination of the country from the explosive remnants of war seemed to take a long time. In the beginning, the minefields were the main problem; therefore, significant forces were deployed. The minefields were in a continuous area, so this task was not difficult to perform. In such a case, the area to be discharged, sooner or later would be restricted. The case of fired, dropped, or thrown remnants of war is entirely different. It was not possible to localise these types of EO, they could pop up everywhere, as the battle reached the entire part of the country.

As time went by, the specialists also had to face the danger of terrorism. This was separated from the tasks of the Hungarian Defence Forces decades ago, and the EOD unit of the Ministry of the Interior was established. Nowadays, the police department bomb squad is responsible for neutralising the improvised explosive devices. This does not mean that for military experts it is an unknown region, because they have to neutralise the weapons of terrorism across borders, during missions many times, not just in the past but also in the future.

That is the path, which led to the present EOD tasks. It changed a lot since the beginning, but all the time it formed in close relation with the grenades and bombs. The changes always followed the current requirements, and tens of millions of different dangerous materials were neutralised during the past decades. In our days, the amount of newly discovered EO is just a fraction of how many was found during the years after World War II, but it still not negligible. The professionals have thousands of tasks each year, they defuse thousands of remnants of war all over the country. This data itself is extraordinary and predestine the necessity of their public services for many decades to come.

4 STATISTICS REFERRING TO THE EOD TASKS

In the present days, it is no longer necessary to disarm millions of different explosive shells. This is the result of the hard work of the professionals, who risked their lives to clear the minefields and other explosive materials.

However, nowadays it is a significant engagement to deal with deadly assets. Via public service, the soldiers of the Hungarian Defence Forces 1st EOD and Warship Regiment (henceforth: 1st EOD REG) handle thousands of alerts. In order to do this, the 1st EOD REG operates a country wide on-call duty service, where the alerts of suspected explosive devices regularly arrive. This duty works constantly day and night, and it is able to record the received alerts.

Fig. 1 shows alerts for the past 30 years. The variance is very large. The difference between the highest and lowest reporting number is 979, which is a significant difference and shows a 33 % percent decline. Over time, that is an actual declining trend. Compared to an average of 2,379 annual alert number, the number of reported sites has decreased

to around 2,000 in the last four years. This could easily demonstrate a decreasing trend that could be expected. However, this requires further analysis as there have been similar temporary periods in the past.

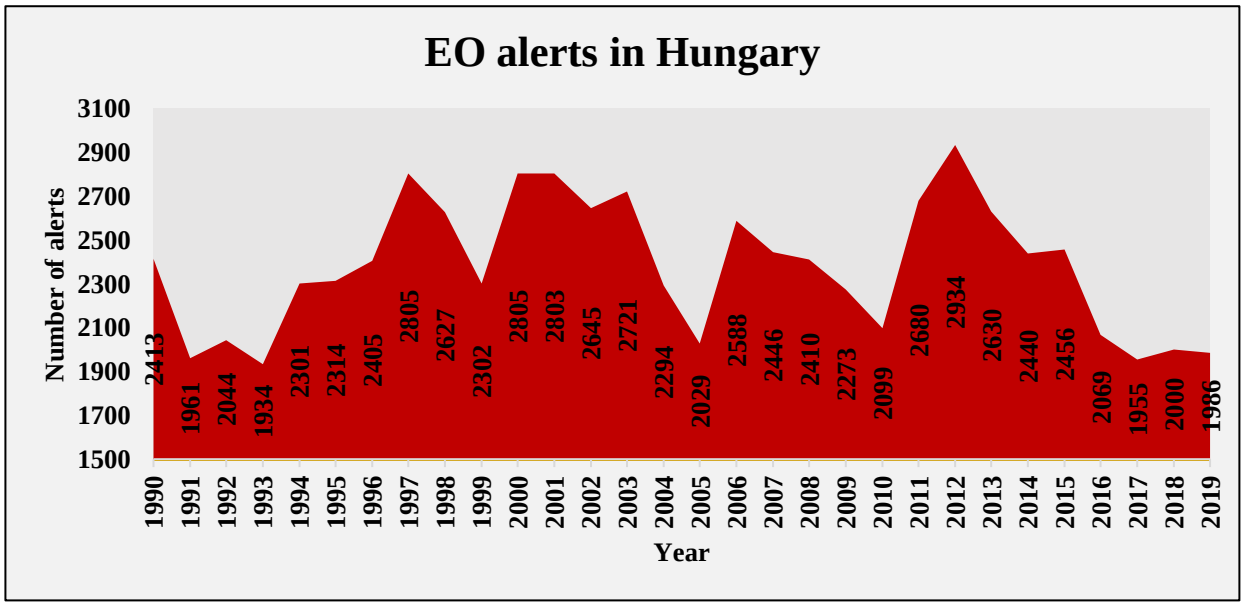

Fig. 1 EO alerts in Hungary
Source: [5].

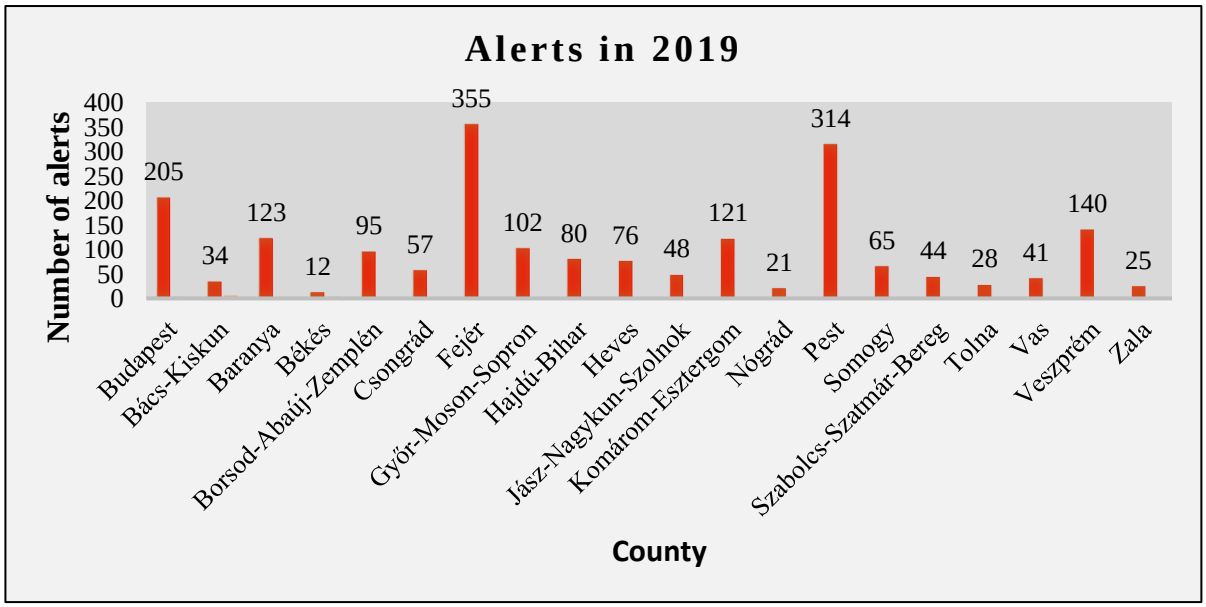

Fig. 2 Alerts in 2019
Source: [5].

In my opinion, several factors affect the annual number of alarms. The trivial aspect is the current state of the construction industry since investments have started with earthworks. Explosive devices may emerge from different depths in the soil, which may be influenced by their mass, material, shape and method of application. In Budapest, it is nearly impossible to build underground parking houses on frequented sites without first disarming air bombs. My personal experience is related to the construction of a garage next to the Parliament, where I had to disarm a Russian FAB-50 demolition bomb (with an AV–1 fuse: all-ways acting, impact detonating type) on 12 January 2014. Similar events happened in 2016 in the 11th district, next to the Rákóczi Bridge. Four air bombs in several meters' depth were found at a relatively small construction area. There were three American GP–1000s among them, and a single German SC–250, but not only these four items were handled by demolition experts on the site. [5]

Examples show that the surrounding areas of World War II priority target buildings and structures can still be contaminated with explosive objects.

Another factor stems from agriculture and forestry. In both areas, there are tasks where tillage is carried out. This work carries the risk of EO being uncovered, especially in areas of major battles. Such areas are along the line of the Danube, Budapest and its surroundings, Győr and its surroundings, Székesfehérvár and its surroundings, and certain parts of the shores of Lake Balaton. [6; 23] A higher number of reports were received from these parts of the country than from the rest. This is well proved by the fact that in 2019, the followings were the most frequented areas in terms of discovered explosive bodies: Fejér County, Veszprém County and Budapest. The dispersion is shown in Fig.2, which also shows that all parts of the country are affected at some level.

The weather should also be taken into account. This may affect several components. In snowy and prolonged winters, relatively less alarms are expected since no explosive objects can be discovered under the snow cover. In this case, hikers do not find suspected explosive bodies and less people spend time outdoors. Rainy, inland water periods and flooding periods also have an impact on the number of reports, as agriculture is pushed into the background. However, extreme drought can significantly increase the number of devices found on the waterfront. In 2018, the Danube River had a very low water level during an extended period. As a result, the number of reports was nineteen times higher for the Danube compared to the number in 2017. In 2018, these reports gave 5 % of the full year reports. [7; 69] It can be seen that extreme weather can also significantly influence the development of statistics.

5 GRENADES AND BOMBS IN HUNGARY

What is the necessary knowledge in the field of EO? Professionals have an enormous knowledge about the hundreds of types of dangerous military ordnance. This huge knowledge is not necessarily enough, and the usage of some databases is a requirement for experts. These sources of information help EOD operators during render safe procedures. The practical classification of EO is the following in Hungary:

- small arms ammunition,
- hand grenades (Fig. 4.),
- rifle grenades (Fig. 5.),
- mortar shells (Fig. 6.),
- anti-tank devices (Fig. 7.),
- artillery projectiles and ammunition (Fig. 8.),
- rockets (Fig. 9.),
- aerial bombs (Fig. 10.),
- landmines (Fig. 11.).

Every type has a different attribute that is well known by the EOD operators. In case of small-arms ammunition, the great majority of non-professionals cannot understand the possible danger in connection with this EO type. Everybody knows these ammunition items, but this familiarity is cursory. They can easily cause lethal wounds. The ammunition on Fig.3 is a 13 millimetres German EO that is quite similar to a 12.7 millimetres machinegun cartridge. Nevertheless, the German one has a fuse and it is filled with explosives, which means it is much more dangerous. It is very important to note that the moving and handling of every ammunition is the job of the highly trained experts.

Fig. 3 13 mm German ammunition
Source: author.

In the class of hand grenades, we can find some subclasses. In general, it can be categorised as an offensive or a defensive type. The defensive type is used thrown from fortified positions because of its high fragmentation effect. The offensive type is used during assault because it has a blast effect with no or minimal fragmentation. There are several other types, too. For example, one of them is used against armoured vehicles. They work with shaped charge by using Munroe effect. According to Gersbeck, the subcategories are the following: fragmentation, blast, heat, bursting smoke, burning smoke, illumination, incendiary, riot control and practice. [8; 116]

Fig.4 Hand grenades (from left to right): Soviet F-1M, German EiHgr–39n. A., Hungarian 42M
Source: author.

"Rifle grenades were devised to cover the tactical range beyond hand grenades. Designs vary from a hand grenade fixed to a simple stabilizer tube assembly to complex designs." [8; 133] The obsolete types were projected with blank ammunition with an additional equipment that was mounted on the rifle. Nowadays, under-barrel grenade launchers are the widespread solutions.

Fig. 5 Rifle grenades (from the top): Soviet VOG–17, German SS G. Pz.gr.–46
Source: author.

Mortars have a large range from 45 millimetres to 280 millimetres. These are filled with explosives or smoke mixture or illuminating mixture or chemicals etc. Mortar shells have a fin that can stabilise their flight but there are some spin stabilised types (these are rare). [9; 2-20] The bigger the diameter is, the bigger the possible destroying effect. The size is not enough because the fuse is important. It has to have a delay function to reach the expected action. These mortar shells are able to annihilate fortified positions. The smaller ones have a fragmentation effect, i.e. they have a point-initiated impact fuse. Between these categories, we can find those mortar shells that are able to operate with both effects. They have a fuse that is point initiated with an adjustable impact action and delay function. It is a rarity, but we can find anti-tank types in the field of mortar shells.

Fig. 6 Mortar shells (from the top): Soviet 82 mm O–832D and O–832
Source: author.

The EO is man-portable in the anti-tank devices category. These devices are developed to destroy armoured vehicles and they are used by the infantry. They have five main parts: warhead, fuse, rocket motor (optional), fin and launcher. For better effects on armoured vehicles, the warheads are designed with shaped charge. They have a rocket motor that is able to improve its effective range. The earlier types were made without a rocket motor; they projected the grenades with gunpowder cartridges or with mechanical solutions. For example, the British Projector Infantry Anti-Tank (PIAT) weapon was made with a powerful spring mechanism. Launcher systems or parts have two variations. The first type is multiple time reloadable; the other type is a single use.

Fig. 7 Anti-tank devices (from the top): German rockets of "Panzerschreck" and "Püppchen"
Source: author.

The projectiles and ammunition used by the artillery is the biggest EO category. This is my opinion based on my experience. We can see the huge variety of calibres, the dozens of subcategories and the thousands of types in this category.

They can be filled with explosives (basic types), chemical agents, riot control chemicals, illuminating mixtures, smoke mixtures, submunitions or propaganda sheets. The basic types have fragmentation, demolition, or combined effect. Projectiles can be stabilised by a spin or fin. Anti-tank projectiles with shaped charge are the most effective when they are fin stabilised. On the other hand, spin stabilised ordnances are more accurate. The fusing can be of impact, time delay or proximity type. Fuses can be in the nose or in the base. [9; 2-17] Sometimes it can be inside-body fuse, like the Hungarian 33M base-placed fuse of a 15 centimetres demolition projectile.

The render safe procedure of artillery projectiles and ammunitions is probably the biggest challenge in Hungary. Maybe this is my personal opinion, but it is based on my executing this demanding task for over 15 years.

Fig. 8 Artillery projectiles and ammunition: Soviet 203 mm projectile G–620, disarmed by the author in 2013, at Székesfehérvár
Source: author.

The rockets category has two main subcategories in the Hungarian practice, these are the unguided rockets and the guided missiles. The unguided rockets are obsolete. They are not so accurate, precise, or high-tech, but these surface-to-surface or air-to-surface devices have a great power that comes from the number of used ordnances at the same time. These rockets are used from multiple rocket launcher systems (e.g. American T–34 Calliope) and rocket pods (e.g. Russian UB–32). "The defining factors that categorize a munition as a "Guided Missile" are that the body being projected:

1. Is propelled by a missile motor or motors. This definition is easier to apply if the motor remains attached to the warhead during flight, but this is not always true.
2. The munition is internally or externally guided and capable of altering its trajectory while in flight." [8; 195]

Fig. 9 Rockets: Soviet M–8 unguided rocket
Source: author.

Types of guided missiles: surface-to-surface, surface-to-air, air-to-surface and air-to-air. Missile sections are the following: guidance section, control section, fin assemblies, motor section, warhead section, fuse section. It can contain some very dangerous parts like high-pressure gas bottles, high-voltage thermal batteries, generators and toxic compounds (e. g. helium bottle in the TOW missile).

The aerial bombs, i.e. the EO that is used by dropping from an aircraft do not meet the definition of rockets (or guided missile). They are attached to an aircraft with one or more lugs, with a few exceptions. For example, the bombs used during World War I were dropped from an open cockpit and they do not have any cleats. [8; 155-167]

1. "High Explosive:
   a) Fragmentation.
   b) General Purpose (GP) old style.
   c) GP new style.
   d) GP demolition bomb.
   e) Penetration.
   f) Guided.
   g) Fuel Air Explosive (FAE).
2. Fire:
   a) Photoflash.
   b) White Phosphorus (WP).
   c) Napalm.
3. Practice:
   a) With explosives or spotting charges.
   b) Inert." [8; 160-161].

Fig. 10 Aerial bombs: U.S. GP-2000, disarmed by the author in 2016 at Budapest
Source: author.

The predecessor of landmines is the so-called "land torpedo". Fedor Zubovics was the person who developed the high-level usage of it. [10; 21] Landmines cause huge problems all over the world. Minefields are armed after a war and the former warring parties have to face the challenge and the cost of demining. It is very important to remove those landmines because they can block the agricultural work, the restart process of the economy and endanger civilians' life. They can be hand or mechanically laid. The laying may occur by vehicles or with a dispenser unit like a submunition.

According to Gersbeck, this is the classification of landmines:

1. "Anti-personnel (APERS or AP).
   a) Blast.
   b) Fragmentation (frag).
   c) Bounding fragmentation.
   d) Directional fragmentation.
2. Anti-tank (AT).
   a) Blast.
   b) Armor-penetrating with shaped-charge or Explosively Formed Projectile (EFP).
3. Practice." [8; 232]

Fig. 11 Landmines: German Tellermine 43 anti-tank mine
Source: author.

The render safe procedures of these military ordnances can cause significant challenges to

professionals. They find obsolete devices on a daily basis, but because of the circumstances, sometimes this is much more problematic, than the disarming of modern ordnances. Every type of EO present in Hungary is shown here in my article. We can see on Tab. 1 the number of devices that are identified all over Hungary. It is easy to see that the number of small arms ammunition is the biggest, but the categories of artillery projectiles, ammunition and mortar shells are the most relevant. The numbers are not so important in these last two categories due to the size of the EO. For example, 1 piece of Russian 203 mm artillery projectile (Fig. 8) which has a demolition effect (type code: G–620, also called concrete-buster projectile) weights more than 100 kilograms. The most common disarmed EO in Hungary (based on my experience) is the Russian 82 millimetres mortar shell (Fig. 6) which has a fragmentation effect (type code: O–832 or O–832D). There is a contracted category in the table below for the other military devices like rifle grenades, rockets, fuses, parts of ordnances etc. I would like to underline the status of landmines in Hungary. The experts do not have to disarm a lot of them, because of the demining operations after the World War II.

The current status shows us that the EO clearance process is far from being finished in Hungary. The number of disarmed dangerous military devices verifies the importance of the public duty of EO experts. The outstanding numbers and the state of unarmed devices show the real volume of this task.

Now we can see the extreme danger behind this job, and we can understand the deep vocation necessary to pursue this profession.

Tab. 1 Number of identified EO from 2015 to 2019

No.	Name	2015	2016	2017	2018	2019
1.	Number of alerts	2,456	2,069	1,955	2,000	1,986
2.	High priority alerts	638	525	526	526	444
3.	Small arms ammunition	8,974	5,965	34,333	28,526	27,931
4.	Hand grenades	369	294	423	470	364
5.	Mortar shells	692	863	869	893	747
6.	Artillery projectiles and ammunition	4,585	3,708	1,221	3,575	2,486
7.	Aerial bombs	1,060	361	361	158	386
8.	Landmines	14	18	16	7	16
9.	Other unexploded ordnances	4,454	1,432	4,270	2,437	2,838
10.	Other safe objects (Did not contain any explosive or pyrotechnical parts).	801	742	552	2,506	3,476
11.	**Total**	**20,148**	**12,641**	**41,493**	**36,066**	**34,768**

Source: [5].

6 EO DANGEROUS FEATURES

Now we can see the enormous number of the possible EO alerts. EOD operators have to handle every alert as quickly as possible, but it is very demanding because of the number and type of grenades, bombs, landmines and projectiles. It is also hard to disarm the ordnances because of their large number: a few ten thousand pieces on a yearly basis in Hungary. After this, the sources of danger coming from the EO have to be examined. A non-professional may think that time works against these dangerous devices. They think that the aerial bombs, projectiles, and landmines become unarmed because of the natural degradation of explosives. Sometimes it happens, but there is the possibility of the worsening safety condition of explosives. Thus, it is very important to define those factors that have any influence on the render safe procedures.

6.1 The Explosive Charge

The process inside an EO is identical to explosive trains working. “In other words, the initiator, containing mainly primary explosive, is initiated by a small energy input and its explosive output initiates

the booster, which in turn, initiates the main charge that is, HE filling. The booster is sufficiently insensitive yet capable of initiation by the initiator. Booster explosives are limited in number (Tetryl and PETN) and their explosive properties are in between initiators and main charges." [11; 39]

The great majority of EO items are made and designed to annihilate troops, technical equipment, vehicles and buildings. Generally, this destroying power is coming from the main charge that is inside its body. Naturally, there are some exceptions. These ordnances do not contain explosive or main charge. Without any explosive materials, these projectiles are not authoritative, and I will not analyse them.

Almost every time, the blast of EO is a condensed-phase explosion. We can find a few exceptions. Some aerial bombs use liquid fuel. This type of bomb can create a fuel cloud in the air that is able to explode. These bombs are also called thermobaric bombs, vacuum bombs, or aerosol bombs.

Generally, the explosion is a very quick chemical transformation and this process generates a lot of energy. This energy or demolition power comes from the gases of chemical transformation. The gases rise and spread in the air and they have a high pressure, high velocity and high temperature. [10; 20]

The military EO are filled with military explosives. This is a very important point, because these explosives are much more reliable and stable than their industrial versions. Sometimes it is problematic to reach higher quality in a factory in wartime. In such a case, the production quantity is maximised, and the explosives can have an inferior quality. This is not an enormous problem, when there is a short time between production and usage. The usage is rather quick in wartime. On the other hand, the unexploded ordnances under the ground and the stockpiled ammunition can be problematic due to impure explosives. These polluted materials can be the fertile ground of a chemical transformation or recrystallisation.

"TNT, RDX and HMX are typical crystalline material used for explosive." [12; 77] These materials are not just explosives, these are military grade explosives. I will therefore analyse TNT (trinitrotoluene or trinitrotoluol or trotyl) to illustrate this problem. It is a widespread military use, secondary explosive. "TNT is still the most important explosive for blasting charges of all weapons. It is very stable, neutral, and does not attack metals; it can be charged by casting as well by pressing; it is insensitive and needs no phlegmatizers. It can be applied pure and mixed with ammonium nitrate (Amatols), aluminium powder (Tritonal), with RDX (Composition B), and combinations (Torpex, HBX, Trialenes)". [13; 338]

This perfect material is able to produce some awkward chemical processes. According to Meyer, Köhler and Homburg, TNT does not attack metals, but Orlova's book shows us another viewpoint. A Meisenheimer complex can arise from TNT in the presence of an alkaline solution and the metal salts of toluene can reach the sensitivity of primary explosives. [14; 89]

What does it mean in practice? The EOD operators have to handle those military ordnances that were fired or dropped. These grenades and bombs were exposed to extreme energy during their launch and when they hit their targets. This is not enough. Sometimes these military ordnances were also exposed to bad weather conditions for seven decades. The extreme energy could cause damage to the main charge, which means that the main charge could crack or/and compact. The cracks provide the chance for the effects of weather to reach the explosive charge. A damage inside the main charge can result in the appearance of air gaps that are necessary for the crystallisation process.

In the case of TNT, there is also a possible problem during the storage time. If the explosive has a bad quality (it is polluted with bad isomers), the so-called "toluene oil" separates from it. [14; 93] This separation can cause volume reduction and the explosive diverges from the wall of the charge cavity, the varnish layer can exfoliate and air gaps arise. The space inside the explosive charge is conducive to the crystallisation process and bigger crystals may grow, which is a very dangerous condition. It is prohibited to use an EO like this because of accidental explosion. These military ordnances will not be able to handle the force effect of launch or fire and only EO operators are eligible to move or disarm them. In this situation, the EO operator has to choose a nearby blasting area that is proper to annihilate them.

Concerning the danger of explosives, there is also another viewpoint. For example, TNT is toxic, and it is able to poison the human body through skin. It can attack the hematopoietic system and the digestive system. [14; 92] It can also destroy nature through its toxicity. Because of these toxic explosives, the wildlife is in real danger, but not every race is equally vulnerable. [15; 171] The explosives start to degrade in nature. The photochemical degradation changes its colour from yellow to brown. Bacteria of soil are able to degrade TNT and other dangerous materials. [16] Fungal degradation is also possible. [17] It does not mean that bacteria and fungi can disarm unexploded ordnances under the ground, because they cannot get into the ordnances.

6.2 Fuses

The fuses of the EO provide for the explosion to happen at the right time and in the right place. These devices can be simple and expressly complex. The simplest type works like a cartridge cap without any mechanical parts. There are several types, which use the blending of chemical components or a chemical method is used during the arming process. A cutting-edge equipment is built up with electronic parts like

Global Position System, Infrared System, and Proximity Sensor System etc. I will not analyse these modern devices, because EO troops never disarm fuses like these during public duty in Hungary. [18; 208-210]

In order to demonstrate the risks caused by an EO fuse, I show a British one. The No. 17 Mk I, II, III bomb fuse (Fig.12) is one of the most dangerous devices. This is a tail fuse or pistol with a chemical delay of half an hour to 36 hours. The basic principles of operation are impact (mechanical) action, chemical action and anti-withdrawal action. The arming mechanism works through the vane. The arming time lasts until the vane finishes eight spins. It is used in several types of aerial bombs (GP 250 Mk I, II, III and GP 500 Mk I, II, III, V). [18; 208-210]

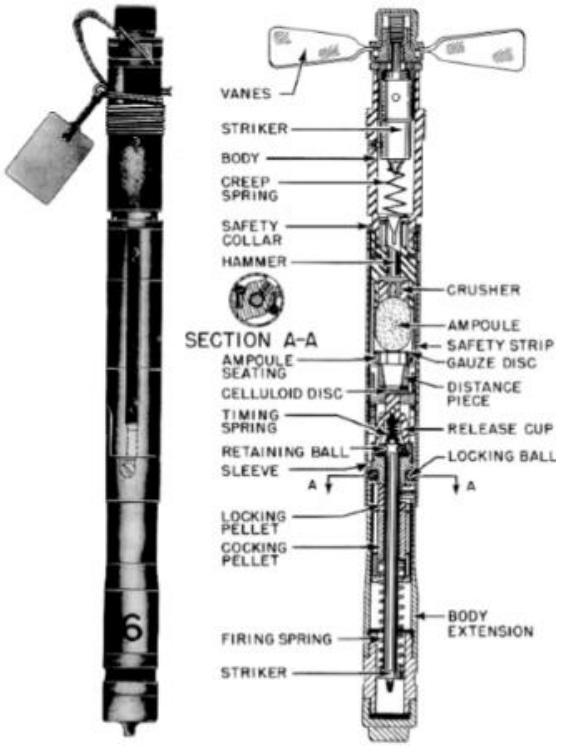

Fig. 12 British aerial bomb fuse No. 17
Source: [18].

The most important parts of the operation of the fuse are the followings: after the arming process, when the bomb hits its target and the striker weight (through the hammer and the crusher) smashes the ampoule which is filled with acetone, after a few other processes the acetone corrodes the delay celluloid disc, when the celluloid disc is softened or dissolved the timing spring lifts up the release cap and the cocked firing spring can force (retaining balls are also forced to move out of the way) the striker to hit the detonator's cap.

We can find some very important information in the last example. The explosion of the bomb depends on a small celluloid disc inside the fuse. This celluloid part is durable, but we cannot know the extent of the action of the acetone. It might happen that the disc is only partly dissolved during the arming process. Later, the bacteria and the bad effects of weather could worsen this condition due to damaged parts. This is a very hard situation for an EOD team, because they do not know the actual state or stability of the fuse. Furthermore, it is impossible to unscrew the fuse, because it has an anti-withdrawal action.

The render safe procedure of these devices is one of the greatest challenges. It can show us clearly that the fuses are very dangerous parts of an EO despite the fact that they spent 70 years in the soil. Not every ordnance is so problematic like this, but one type is enough to set up a new rule or a new disarming process in this profession.

6.3 Other sources of danger

Nowadays, the number of terrorist attacks committed with explosions is increasing, and it is widespread all over the world. [19; 258-259] I will not analyse the risks of the improvised explosive devices (Victim Operated, Time Delay, Suicide Born, Radio Controlled etc. [20]) and the homemade explosives, because this is the duty of the Hungarian Police.

I would also like to avoid the Chemical, Biological Radiological and Nuclear EOD tasks in this article, because this field of disarming is very complex. This task demands specially and highly trained troops. [21; 25] Thus, I accept the fact that these ordnances are very hazardous.

7 CONCLUSION

Now we can see a general idea about the quantity of the tasks of EOD teams in Hungary. The number of alerts and the statistics of the last few years forecast a very long term when the professionals will have to handle dangerous remnants of war on a daily basis. The number of identified EO is high, and the organising of the render safe procedures demands high prudence.

I identified a few sources of danger during the review of EO. These devices may cause lethal danger after more than 70 years. Besides, they are able to cause more highly dangerous conditions than ever before. The possible chemical transformation of explosives and the corrosion or deformation of the inner parts of fuses makes the unarming process much riskier. The handling of a CBRN EO is an extremely challenging task and the worsening processes make it more and more dangerous.

Data and processes show us the world of EOD operators. This world is full of challenges and danger and only the most dedicated troops have the right to pursue this profession.

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References

[1] GELLÉRT, T. *Tűz és víz katonái. MH 1. Honvéd Tűzszerész és Hadihajós Zászlóalj*. Budapest: Zrínyi Katonai Kiadó, 1981.

[2] BUCSÁK, M., A. CSURGÓ, T. HORVÁTH, L. LÁNG, S. MOLNÁR, L. POSTA, ZS. SZATAI and VÖRÖS, M. *70 év az életveszély árnyékában. A magyar tűzszerész- és aknakutató alakulatok története 1945–2015*. Budapest: Zrínyi Kiadó, 2015. ISBN 9789633276532.

[3] FEHÉR, J. Akna és lőszermentesítés Somogyban. In: HAJDU, R. J., PAP, J. (eds.) *Aknászok, tűzszerészek. Hős magyar honvédek a II. világháborúban és a következő években.* Mezőkövesd: Legatum, 2006. ISBN 9638722606.

[4] KOVÁCS, T., J. NYERS and J. PADÁNYI. *Építünk, védünk, alkotunk. A műszaki csapatok története 1945-től napjainkig.* Budapest: Zrínyi Kiadó, 2012. ISBN 9789633275412.

[5] Compiled by the author based on the HDF 1st EOD REG's archive.

[6] VÖRÖS, M. and DARUKA, N. Tűzszerészek a közszolgálati feladatok ellátásában. In: *Seregszemle*. Székesfehérvár: *MH ÖHP* [online]. 2012. **10**(2), pp. 22–33. [cit. 2020-03-05]. Available at: https://honvedelem.hu/files/files/33676/seregszemle_2012_2.pdf

[7] EMBER, I. A dunai alacsony vízállások tűzszerész tapasztalatai 2018-ban. In: *Műszaki Katonai Közlöny* [online]. Budapest: Ludovika Egyetemi Kiadó, 2019. **29**(3), pp. 65–78. ISSN 2063-4986. [cit. 2021-02-25]. Available at: https://doi.org/10.32562/mkk.2019.3.5

[8] GERSBECK, T. *Practical Military Ordnance Identification*. Boca Raton: CRC Press, 2014. ISBN 9781439850596. Available at: https://doi.org/10.1201/b16615

[9] DEPARTMENT OF THE ARMY – U.S. MARINE CORPS: *Unexploded Ordnance (UXO) Procedures (FM 21-16).* [online] Washington, D.C.: Department of the Army, 1994. [cit. 2021-02-25]. Available at: www.globalsecurity.org/military/library/policy/army/fm/21-16/index.html

[10] LUKÁCS, L. *Szemelvények a magyar robbantástechnika fejlődéstörténetéből.Különös tekintettel a továbbfejlesztés várható irányaira és a kor új kihívásaira*. Budapest: Dialóg Campus Kiadó, 2017. ISBN 9786155680359.

[11] AGRAWAL, J. P. *High Energy Materials*. Weinheim: Wiley-VCH, 2010. ISBN 9783527326105. Available at: https://doi.org/10.1002/9783527628803

[12] KUBOTA, N. *Propellants and Explosives – Thermochemical Aspects of Combustion*. Weinheim: Wiley-VCH, 2002. ISBN 3527600507. Available at: https://doi.org/10.1002/3527600507

[13] MEYER, R., J. KÖHLER and A. HOMBURG. *Explosives*. Weinheim: Wiley-VCH, 2007. ISBN 978-80-527-31656-4.

[14] ORLOVA, J. J. *Brizáns robbanóanyagok kémiája és technológiája*. Budapest: Műszaki Könyvkiadó, 1986. ISBN 9631064662.

[15] JOHNSON, M. S. and C. J. SALICE. Toxicity of Energetic Compounds to Wildlife Species. In: SUNAHARA, G. I., G. LOTUFO, R. G. KUPERMAN and J. HAWARI. (eds.) *Ecotoxicology of Explosives*. Boca Raton: CRC Press, 2009. ISBN 9780849328398.

[16] AHMAD, F. and J. B. HUGHES, J. B. Anaerobic Transformation of TNT by Clostridium. In: SPAIN, J. C., J. B. HUGHES and H. KNACKMUSS. (eds.) *Biodegradation of Nitroaromatic Compounds and Explosives*. Boca Raton: CRC Press, 2000. ISBN 1566705223.

[17] FRITSCHE, W., K. SCHEIBNER, A. HERRE and M. HOFRICHTER. Fungal Degradation of Explosives: TNT and Related Nitroaromatic Compounds. In: SPAIN, J. C., J. B. HUGHES, and H. KNACKMUSS. (eds.) *Biodegradation of Nitroaromatic Compounds and Explosives*. Boca Raton: CRC Press, 2000. ISBN 1566705223. Available at: https://doi.org/10.1201/9781420032673

[18] DEPARTMENT OF THE NAVY, ORDNANCE SYSTEMS COMMAND: *British EO*. s. l. Naval Ordnance System Command, 1946.

[19] HORVÁTH, T. A műveleti környezet műszaki támogatásának kihívásai. In: KRAJNC, Z. and J. CSENGERI. (eds.) *Humánvédelem – békeműveleti és veszélyhelyzet-kezelési eljárások fejlesztése* [online]. Budapest: Nemzeti Közszolgálati Egyetem, 2016. [cit. 2020-03-29]. Available at: http://real.mtak.hu/33554/1/tanulmanygyujtemeny%20_ujratervezes_CsJ_KZ_1.5.pdf

[20] KOVÁCS, Z. Az improvizált robbanóeszközök főbb típusai. In: *Műszaki Katonai Közlöny* [online]. Budapest: NKE HHK és MHTT Műszaki Szakosztály, 2012. **22**(2), pp 37–52. ISSN 2063-4986 [cit. 2020-03-29]. Available at: https://mkk.uni-nke.hu/document/mkk-uni-nke-hu/2012_2_03_IED-k_főbb_típusai_-_Kovács_Z.pdf

[21] BEREK, T. ABV (CBRN) tűzszerészcsoport, mint a biztonsági kihívásokra adott válaszlépés. In: *Bolyai Szemle* [online]. Budapest: Dialóg Campus Kiadó, 2016. **25**(4), pp. 22–34. [cit. 2021-02-25]. ISSN 14161443. Available at: https://nkerepo.uni-nke.hu/xmlui/bitstream/handle/123456789/14564/ABV%20(CBRN)_%20t%20zszer%C3%A9szcsoport,%20mint%20a%20biztons%C3%A1gi%20kih%C3%ADv%C3%A1sokra%20adott%20v%C3%A1laszl%C3%A9p%C3%A9s.pdf?sequence=1

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