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CASES OF USING IMPROVISED EXPLOSIVE DEVICES

Abstract. The paper presents an analysis of the cases of the use of improvised explosive devices (IED) in 2011 where vehicles of the Polish Military Contingent in Afghanistan were involved. Methods of IED use and methods of their detonation are described. Conclusions refer to the implemented preventive measures, recommended modifications in the design of military vehicles and guidelines for their use.

Keywords: explosive, improvised explosive device, armoured personnel carrier.

1. INTRODUCTION

The subject matter that is dealt with in this paper has been the topic of several dozen publications in the recent two decades. Publications and dissertations in this area included the identification of risks, countermeasures, assessment of the impact on the safety of the crews or changes in the design of new versions of vehicles.

Armed conflicts that were taking place at the turn of the 1990s and which still continue today bring about both military and non-military threats. The North Atlantic Alliance identified threats as "resulting from the lowering of the strength of the opponent by exploiting its weaknesses using methods that differ significantly from standard operating procedures and measures" [19]. Such a scenario has indeed unfolded in Afghanistan. The Taliban, being the weaker side of the conflict and possessing disproportionate armaments as compared to the ISAF forces, began to use non-standard means and technology to inflict losses. After the Soviet-Afghan conflict (1979-1989) Afghanistan was left with plenty of explosives in the form of mines, bombs, artillery shells and diverse ammunition [28]. Easy access to post-war leftovers created the possibility of using them in the form of improvised explosive devices (IEDs), which were fabricated or installed in a non-standard manner and contained destructive, dangerous, harmful, pyrotechnic or incendiary chemicals designed to destroy, neutralise, harass or distract [1] in quantities corresponding to high TNT equivalents. An estimate made in 2002 numbered the mines remaining in Afghanistan on 17 million out of total 30 million that were used during the Soviet-Afghan conflict [26].

Information on IEDs gained in Iraq was discussed, for instance, in [30], where the authors analysed the actions and warfare with the use of IEDs during Operation Desert Storm. The article [31] characterised and described the explosive devices used, their design and principle of operation. Based on the design and methods of detonation and activation phases of the explosive charge, a list showing the number of attacks was presented.

Experiences from operations in Afghanistan were presented in literature ([33], [38], [41]) where the characteristics of trap mines, their design, principle of operation and deployment were discussed. As regards the manner in which the attacks were carried out, the
author of article [34] analysed the characteristics of the attack attempts in Iraq and Afghanistan, referring to the methods and means of attack. Methods in which attackers acted to stop an army column in the IED blast zone and the rules of moving coalition forces to minimise or eliminate the risk of IED attack were presented. With regard to countermeasures and tactics of combating threats ([26], [35], [37], [39], [40]), an assessment of the risks by improvised explosive devices and the strategy of counteracting improvised explosive devices were presented. With regard to terminology, an attempt was made ([25], [36]) to sort out the terminological and typological issues regarding the definitions of IEDs.

A team of scientists, professors Kaczmerek, Kubiński and Kawka of the National Defence Academy, now the War Studies University in Warsaw, presented in their research papers selected examples of incidents broken down by individual turns in the Polish Military Contingent. The analyses presented in the paper supplement the contents of the cited publications.

2. STATISTICS OF THE HAZARDS OF IMPROVISED EXPLOSIVE DEVICES IN THE THEATRE OF OPERATIONS IN AFGHANISTAN

About 40% of all fatalities in Afghanistan were caused by injuries suffered from IEDs, as illustrated in Figure 1.

![Fig. 1. Causes of deaths of soldiers in Afghanistan in the years 2001-2015](image)

Data presented in the Operation Enduring Freedom website (www.icasualties.org) [1] show that the highest losses caused by IEDs were recorded in the years 2009 - 2011.

In 2010 the coalition's losses due to this cause amounted to 368 persons, as presented in Figure 2.
Cases of using improvised explosive devices

According to data from the theatre of operations in Afghanistan in the years 2010 - 2014 included in the reports on the state of security in Poland ([11 - 15]), the Military Gendarmerie initiated procedures in cases of 19 murders and 77 attempts to kill (Article 148.2.4 of the Penal Code - use of firearms or explosives), as shown in Figure 3.

This article presents a retrospective analysis of the incidents during the period of Taliban’s greatest activity in relation to the armed forces of the Polish military contingent (convoys) in 2011, as shown in Figure 3. Table 1 and Figure 4 list cases of IED attacks on vehicles of the Polish ISAF military contingent in relation to the total number of incidents on a monthly basis, as reported during the VIII, IX, X turns of ISAF.
Table 1. A quantitative summary of IEDs used during turns VIII – X of the ISAF Polish Military Contingent in 2011 (source: data from the Operations Support Unit/Armed Forces Operational Command, Military Gendarmerie Headquarters, District Prosecutor's Office)

<table>
<thead>
<tr>
<th>Item</th>
<th>Calendar month</th>
<th>IED - attack</th>
<th>IED - attack on vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>II</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>III</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>IV</td>
<td>13</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>V</td>
<td>25</td>
<td>6</td>
</tr>
<tr>
<td>6</td>
<td>VI</td>
<td>44</td>
<td>5</td>
</tr>
<tr>
<td>7</td>
<td>VII</td>
<td>48</td>
<td>6</td>
</tr>
<tr>
<td>8</td>
<td>VIII</td>
<td>16</td>
<td>0</td>
</tr>
<tr>
<td>9</td>
<td>IX</td>
<td>20</td>
<td>3</td>
</tr>
<tr>
<td>10</td>
<td>X</td>
<td>15</td>
<td>2</td>
</tr>
<tr>
<td>11</td>
<td>XI</td>
<td>21</td>
<td>0</td>
</tr>
<tr>
<td>12</td>
<td>XII</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Total in 2011</td>
<td></td>
<td>226</td>
<td>25</td>
</tr>
</tbody>
</table>

Fig. 4. Number of IED attacks on vehicles of the ISAF Polish Military Contingent (author's study)

3. ANALYSIS OF IEDs

Unlike conventional minefields and mines, Improvised Explosive Devices are more difficult to detect and identify, and therefore more dangerous. Their design is based on simple, readily available and cheap materials, and it does not pose particular technological or logistic difficulties. The exterior appearance of IEDs, due to the use in their fabrication of objects that
Cases of using improvised explosive devices

are not usually associated with explosive charges, often precludes their proper identification, and facilitates their transport and deployment.

**3.1. IED design**

The main structural components used in the construction of improvised explosive devices in the cases analysed here included:

− explosive material;
− body (container);
− initiator;
− power source (optional);
− activating device.

**3.2. Explosive material**

The destructive properties of any IED are determined by the type of explosive charge placed therein, which may be modified by including elements that enhance the effectiveness of the device. Analysis of incidents of 2011 shows that the basic explosive material used in IEDs in Afghanistan was homemade explosive (HME). The group of chemicals used as HMEs is presented in Table 2.

**Table 2. Chemicals classified as HMEs**

<table>
<thead>
<tr>
<th>Item</th>
<th>Designation</th>
<th>Substance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ANAL</td>
<td>ammonium nitrate and aluminium</td>
</tr>
<tr>
<td>2</td>
<td>ANFO</td>
<td>ammonium nitrate and fuel oil, petrol</td>
</tr>
<tr>
<td>3</td>
<td>ANS</td>
<td>ammonium nitrate and sugar</td>
</tr>
<tr>
<td>4</td>
<td>UN</td>
<td>urea nitrate</td>
</tr>
<tr>
<td>5</td>
<td>PS</td>
<td>potassium chlorate</td>
</tr>
<tr>
<td>6</td>
<td>BC</td>
<td>barium chlorate</td>
</tr>
<tr>
<td>7</td>
<td>TATP</td>
<td>acetone peroxide</td>
</tr>
<tr>
<td>8</td>
<td>HMTD</td>
<td>hexamethylene triperoxide diamine</td>
</tr>
</tbody>
</table>

These substances differ in physicochemical properties which determine their use. Due to their physicochemical properties (sensitivity), peroxides were used as detonators: acetone peroxide (TATP), hexamethylene triperoxide diamine (HMTD) and Armstrong's mixture. Chlorate-based mixtures were used as booster explosives or as the main explosive charge. Nitrates were used as the main explosive charge playing the role of a blasting material.

The record of incidents and information given in [22] show that among substances of the HME group the ones used most often in 2011 included mixtures of ammonium nitrate with aluminium (ANAL) and potassium chlorate mixed with oil or with powdered sugar.

There are several grades of ammonium nitrate available on the free market: porous prilled, non-porous prilled, and powdered. These grades differ in fineness, crystal size and are of similar purity. Detonating properties of a mixture of ammonium nitrate and aluminium
powder depend on the type, content, particle size of the ingredients and on how intimately these ingredients are mixed.

3.3. Container

During the period discussed, the containers used for holding explosive materials in IEDs were in the form of items that are commonly found in car repair shops or farms. These included plastic boxes, barrels, canisters with a capacity of 20 to 40 dm$^3$.

![Fig. 5. Examples of containers with HME found in Afghanistan in the years 2010-2012](image)

Fig. 5. Examples of containers with HME found in Afghanistan in the years 2010-2012

a) photo from [21]. b) photo by Grzegorz Motrycz

Containers with the explosive were covered with plastic film for protection. The reason for this was that ammonium nitrate based explosives were highly sensitive to moisture content variations. They are highly hygroscopic and absorb ambient moisture or even bind water. Figure 6 shows an example of how such charges were protected.

![Fig. 6. Examples of protection for containers with HME found in Afghanistan in the years 2010-2012](image)

Fig. 6. Examples of protection for containers with HME found in Afghanistan in the years 2010-2012 [23]

The quantity of explosive material was estimated from the residue after detonation and the geometric parameters of the explosion site. In the case of the incidents studied, the quantity of HME used in the attacks was within the range of 30 to 45 kg. The information provided here is derived from reports and descriptions of incidents. One should bear in mind that theses are estimates based on information processed by members of the Weapon Intelligence Team (WIT).
Cases of using improvised explosive devices

These, however, do not disagree with statistical data processed by a team [22] which concluded that an average weight of an IED charge in 2010/2011 was 30 kg, which is equivalent to, for instance, four TM 62M antitank mines.

3.4. Method of initiating an explosion

Means for initiating an explosion are materials and/or devices that initiate the explosion phase. Explosive charges weighing 30 to 45 kg required the use of explosion boosters (intermediate detonators) for detonating all of the explosive charge. Detonating cord, TNT, etc. were used for this purpose. Initiating may be effected by electrical or mechanical detonating means.

Table 3 lists the initiators used in improvised explosive devices in attacks against the vehicles of the Polish Military Contingent in the period studied (2011).

Table 3. Initiators in IEDs used in attacks against vehicles of the Polish Military Contingent in 2011

<table>
<thead>
<tr>
<th>Item</th>
<th>IED types</th>
<th>English</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>CWI E D</td>
<td>Command Wire Improvised Explosive Devices</td>
</tr>
<tr>
<td>2.</td>
<td>PPI E D</td>
<td>Pressure-Plate Improvised Explosive Devices</td>
</tr>
</tbody>
</table>

Explosion initiation in a PPIED (Pressure-Plate Improvised Explosive Devices) is effected by closing an electric circuit. The fuse usually consisted of two planks with two metal parts in between connected by cables. The metal parts were separated from each other by means of two springs. When a wheel of a vehicle run over the contraption the resistance of the springs was overcome, the metal parts were brought into contact with each other and the electric circuit was closed. At that moment the IED exploded. There were also cases of using antipersonnel mines as detonators.

A diagram of a PPIED is shown in Figure 7.

Fig. 7. Diagram of a PPIED
Another example of explosive charges in the period studied was the CWIED type, schematically illustrated in Figure 8. This type of IED was detonated by electrical means. This type of IEDs was planted in areas where vehicles had to slow down (e.g. road bends, road constrictions, culverts, hills, loose ground surface, river and stream beds). The charge was triggered when the vehicles passed by a distinct reference point.

![Diagram of a CWIED](image)

**Fig. 8. Diagram of a CWIED**

### 3.5. Power source

In the case of PPIED (Fig. 7), packeted C-type batteries (output voltage 1.5 V) were typically used as the power source, connected by a two-wire cable with a pressure element. Such press activated devices found in the theatre of operations by the US forces are shown in Figures 9a and 9b. The design of such devices evolved with time. Initially this was a simple wooden structure with metal parts, e.g. saw blades, parts of a metal saw, metal cans. Later, around 2010, a new type of structure, the so-called "Afghan plank", made of mineral wool and aluminium foil began to appear. Such structure was harder to detect when the vehicle route was inspected.

![An 'Afghan plank'](image)

**Fig 9. An 'Afghan plank'

a) photo Justin Sullivan/Getty Images [16], b) pressure plate - photo [17]
Cases of using improvised explosive devices

Alternating current sources used by Talibans in CWIEDs (Command Wire Improvised Explosive Devices), shown in Figure 8, included various type of chargers and generators providing voltages of 110V, 220V. These devices were connected to the power source by means of a cable line, 100-250 m long, locally concealed. Cables used included two-wire cables, copper wires, antenna wires. Such materials were used in repair shops and households.

This method of detonating improvised explosive devices posed a hazard for the terrorists themselves, due to the length of the cables used and the need to conceal the cables after planting the IED. The terrorist could be revealed while preparing the charge. The terrain and type of soil in Afghanistan often caused bad masking to contribute to thwart the attack.

The cable was usually concealed at a depth of ca. 20 cm. A novelty in the masking tactics used by terrorists was to hide the cables in underground irrigation tunnels.

3.6. Terrain – method of placement

The sites selected by attackers provided:
– proximity of stores of improvised explosive devices;
– ease of delivery;
– ease of observation;
– predictability of the emergence of ISAF forces.

Analysis of the sites of terrorist attacks shows that such attacks were in most cases carried out on dirt or gravel roads with nearby walls encircling numerous gardens and crop fields. Such terrain was the most favourable in terms of preparing an IED attack. Proximity of bushes and trees provided excellent conditions for conducting observations and for retreating after carrying out a CWIED attack.
Other sites of planting IEDs/mines were crossings of major dirt roads with cycle roads, e.g. between neighbouring villages. In those areas the moving column of vehicles raised clouds of dust which limited visibility. The effectiveness of attack always depended on the limited visibility caused by dust raised by the preceding vehicle. A vehicle that deviated from the track of the preceding vehicle became a potential target of an attack.

3.7. Manner of attack on a column of vehicles

The Talibans improved their tactics and modified it as the ISAF forces changed their operational tactics. In general, the forces (vehicles) were lured into the area where the explosive charge was planted, and an additional charge was prepared to be exploded after arrival of rapid reaction forces.

The vehicles of the ISAF Polish Military Contingent moved on roads in convoys. The number of vehicles in a patrol varied depending on the tasks to be carried out. Usually, however, there were 5 to 12 vehicles in a patrol.

The moment of attack on a vehicle in a column was random, but statistically most of the attacks were on the 2nd, 3rd or 4th vehicle in a column. Detonation, in the case of KTO Rosomak vehicles, took place between the 2nd and 3rd axle of the vehicle, which means front or middle part of the vehicle.

In most cases IED attacks on vehicles were not accompanied by enemy firearm attacks. The reason was the allied forces' superiority in armament. There were only few cases of attacks combined with fire exchange.

3.8. Damages inflicted on vehicles by IEDs

An IED explosion along the course of the vehicle wheel, regardless of the location of the charge, does not cause major damage. It may destroy the wheel, elements of the suspension or of the hydraulic struts. This has no major impact on the vehicle crew, and in fact the crew may even be unaware of the explosion. The reason for this is that most of the energy of the detonation wave is dissipated in open space and has little impact on the vehicle - see Figure 12.
An IED explosion under the middle of a vehicle, in cases where there is space for the detonation wave to disperse, does not pose a hazard for the crew, and its impact on the vehicle is limited.

The worst case is that of an IED explosion under the middle part of the crew compartment. The bottom surface of the vehicle in that area is relatively close to the ground, the burst wave has little space to disperse and in consequence it makes a strong impact on the ground and on the bottom of the vehicle. This often leads to the penetration of the crew compartment (interior of the vehicle).

The pressure inside the crew compartment may increase (positive pressure) or decrease (negative pressure). This variability is caused by the entry of the pressure wave into the vehicle interior through existing points lacking tightness and by the bottom panel of the vehicle behaving like a membrane deformed by a short pulse. Rapid pressure change (within ten or more milliseconds), even a limited one, may be a significant factor disabling the crew and eliminating them from further combat.

4. CONCLUSIONS

The subject of IED attacks is still a current one, despite mission of the Polish Military Contingent being history now. Improvised Explosive Devices were not prepared and deployed by random. Their fabrication was carried out in a planned manner, and their design was thought out and aimed at maximising losses among the ISAF forces.
Experience gained during the missions of the Military Contingent has not been wasted. Most of the cases of IED attacks have been described in detail and recommendations were formulated in existing vehicle instructions and traffic regulations (convoy, single vehicle) or necessary changes were made in the design of military vehicles.

5. REFERENCES

[17] Motrycz G.: Materiały niepublikowane, WIHiE.


