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## PILOTLESS VEHICLE APPLICATION POSSIBILITY IN TERRORIST AIMS ON SEVESO TYPE OBJECTS ESTIMATION

The application and protecting from quadcopters in terrorist aims on industrial objects question analysis is conducted. It is shown that characteristics of modern quadcopters suffice for their possible use in terrorist aims on industrial objects is sufficiently. It is determined, that a loss from one UAV can in 500000 times and more to exceed the cost of quadcopters and explosives.

**Keywords:** pilotless vehicle, terrorist act, explosive, damage.

**Problem statement.** Modern development of technique attained a moment, when application of pilotless vehicle (UAV) finds a place in:

- fires determination in woodlands;
- monitoring and data transmission on the area and air space chemical impurity;
- exploring of underflooding districts, earthquakes and other emergency situations;
- monitoring of the transport highways, oil- and gas pipelines, high-voltage lines and other objects state;
- photo and video surveillance ground area, nature, leisure.

In it's turn at emergency UAV can be used in such situations:

- emergency detection;
- emergency liquidation participation;
- victims search and rescue;
- emergency damage estimation.

In spite of obvious pluses from these devices appearance and their use, there is a array of spheres, where they can bring negative results. One of such directions is UAV application as an ignition source or constructions destruction [1-4].

Taking into account the uncontrolled UAV use, their possible application in terrorist aims, is appear a problem.

### ***Analysis of recent researches and publications.***

The literature analysis shows that a row of works is sanctified to the UAV use in military aspects and terrorist aims.

In [1] it is noted that the modern vector of defensive offers the most perspective possibilities for development of NT, including for UAV. It is shown that is exist the tested systems, that providing successful UAV full-size platforms deployment in different conflicts of the whole world, especially in Iraq

and Afghanistan wars. Thus, terrorism threat and regional instability provide demand on asymmetric war prosecution technologies [1].

In [2-4] it is noted, that the remotely pilot-controlled pilotless vehicles can be used by terrorists for attacking shopping centers, sport events and public meeting. Researches suppose that "Crowds on sport events or mass meeting can be vulnerable, if a future terrorist group wants to search means for dispersion of chemical or biological substances.

For solving this problem it is offered:

- limit the accessible on sale UAV carrying capacity;
- create the system of preventive measures for UAV, that crossing restricted flight area;
- work out the anti-aircraft defense systems, effective against UAV;
- limit by program code the flights zones of UAV.

It should be noted that in most cases UAV regard as a primary danger and don't examine possibility of initiating by UAV large explosions, fires on objects with combustible gases and liquids, that can be classified as SEVESO objects.

**Statement of the problem and its solution.** The main goal of the work is an estimation of UAV application possibility in terrorist aims on the SEVESO type objects.

To the objects of such class, that have in technological process combustible gases and liquids in great numbers it is possible to take oil bases, oil- and gas-transferring plants, condensated hydrocarbon gases reception and storage terminals etc. The geometrical sizes of these objects can change from a few hundred meters to a few kilometers (fig. 1.).



Fig. 1. Oil refinery photo

At the risks estimation on these objects, development of emergency situations localization and liquidation plans, in overwhelming majority, it is consider the reasons of emergency situations origin, that is appear effect of technological equipment elements refuses, errors checking and management systems or object personnel, are.

However UAV application in terrorist aims, in particular – quadcopters, can bring to the unpredictable emergency situation development scenarios. In this case an emergency situation can develop more dynamically, can have a few points of initiation etc.

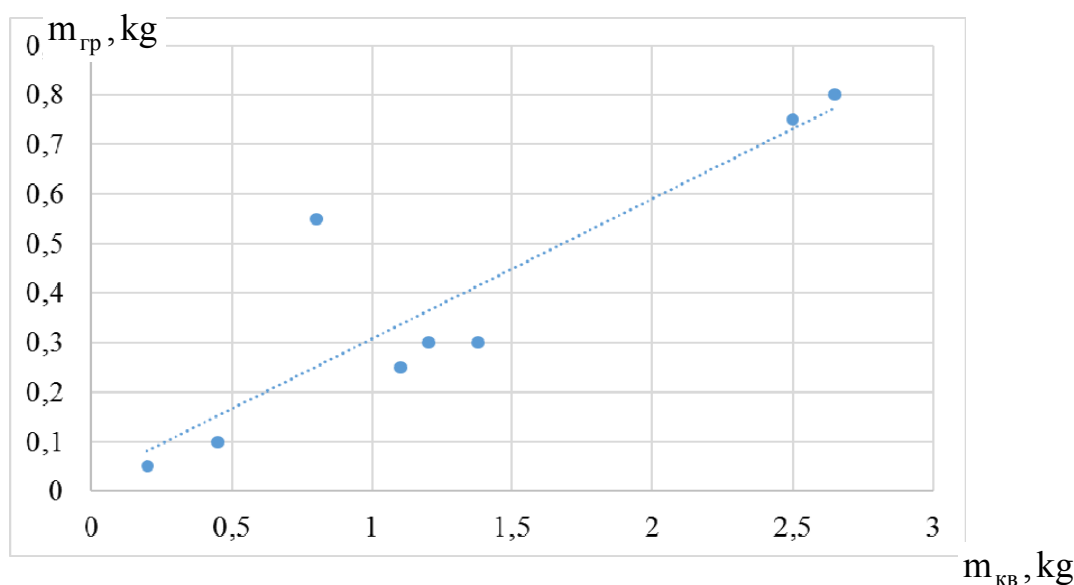
One of characteristic, that should be noted in this case is appliance weight, load-carrying ability, flight range. Descriptions of some quadcopters are demonstrated in the table 1.

**Tab. 1. Characteristic of UAV (quadcopters)**

	Name	Appliance weight, kg	Load-carrying ability, kg	Flight range, km	Cost, euro
1.	Zala421-21	1,2	0,3	2	1200
2.	Геоскан 401	2,5	0,75	24	30000
3.	Microdrones MD4-1000	2,65	0,8	20	40000
4.	SQ-4 Recon	0,2	0,05	1,5	32000
5.	SQ-4	0,8-1,1	0,55-0,25	3	1800
6.	DJI Phantom 4 Pro	1,38	0,3*	7	2000
7.	HUBSAN X4	0,45	0,1	1	200

An analysis shows that cost of vehicles that have flight range more than 1 kilometer is amount more than 200 euro, that is affordable sum. At flight time 3-5 minutes, for practically any quadcopter enough time for achieving modern industrial facility territory.

On a fig. 2 dependences of vehicles load-carrying ability from their mass is shown.



**Fig. 2. Dependences of quadcopters load-carrying ability from their mass**

Figure analysis shows that the vehicles load-carrying ability is average 20-30% from their mass. Thus, quadcopters characteristic allow them be the fires and explosions initiators.

Shock wave is the main explosives damaging action. Therefore for determination of explosives damaging action it is necessary to calculate explosion excess pressure [5]. The calculation of excess pressure size  $\Delta P$  (fig. 3) is conducted on the basis of the reduced radius over explosion zone

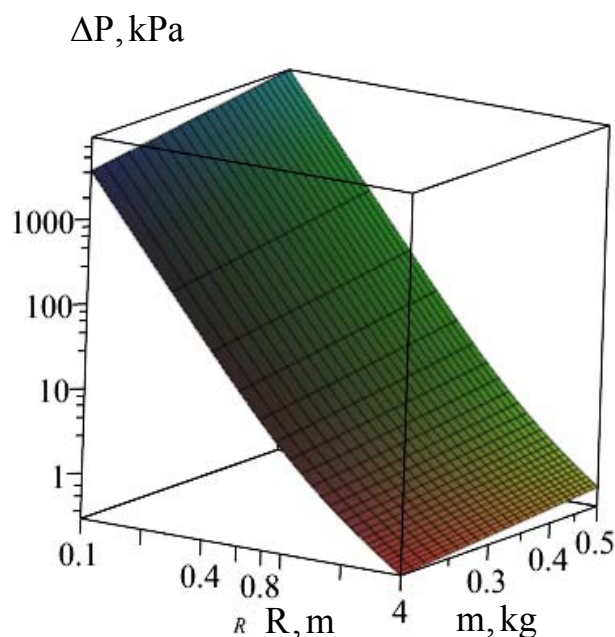
$$\bar{R} = \frac{R}{\sqrt[3]{2KMT_{\text{D}}}}, \quad (1)$$

where  $R$  – distance from the explosion center, m;  $M$  – mass of charge, kg;  $K$  – coefficient, taking into account laying surface character;  $T_{\text{D}}$  – trotyl equivalent of explosive, on a formula

$$\Delta P = \frac{7}{3} \left( \sqrt{1 + \bar{R}^3} - 1 \right)^{-1}. \quad (2)$$

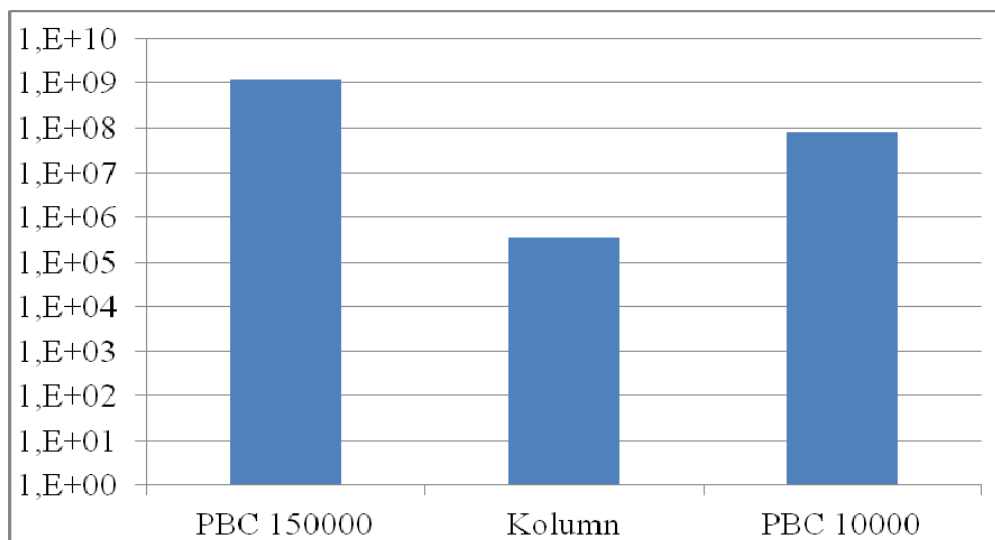
Figure analysis shows that even in the distance 0,5 meters are possible forming of excess pressure more than 100 kPa, that can damage a process equipment and be the ignition or explosion source of the formed combustible mixture.

So, for example, at the cost of trinitrotoluene 1000 \$/kg caused damage from one UAV can in 500000 and more than times exceed the quadcopter and explosives cost (on the example of one tank with petrol, taking into account the cost of tank and fuel only).



**Fig. 3. Dependence of explosion excess pressure from substance mass and distance from an epicenter**

On a fig. 4 shown a highly inflammable liquids combustion energy at an emergency to the expended energy at the terrorism act (1 kg of TNT) ratio.



**Fig. 4. Highly inflammable liquids combustion energy at an emergency to the expended energy at the terrorism act ratio**

Obviously, that application 4-5 UAV can fully paralyze facility work, stop a technological process and do impossible promptly emergency liquidation because of the forces shortage.

**Conclusions.** As a result of the conducted work:

- the analysis of application and protecting from quadcopters in terrorist aims on industrial objects question research conducted;
- it is shown that modern quadcopters characteristic is suffice for their possible use in terrorist aims on industrial objects;
- it is determined that damage from one UAV can in 500000 and more than times exceed the quadcopter and explosives cost;
- it is shown that explosive mass, that able to carry quadcopter is suffices for process equipment damage and can be the ignition or explosion source of the formed combustible mixture.

## REFERENCES

1. Micro UAVs [Electronic resource] // Access mode: <http://pickar.caltech.edu/e103/papers/Micro%20UAVs.pdf>.
2. Terrorist 'could use drones for chemical and biological attacks' [Electronic resource] // Access mode: <http://www.telegraph.co.uk/news/uknews/terrorism-in-the-uk/11177388/Terrorist-could-use-drones-for-chemical-and-biological-attacks.html>.
3. Analysis: Model planes as weapons of terror [Electronic resource] // Access mode: <http://edition.cnn.com/2011/09/29/opinion/model-plane-attack/index.html>.

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4. Terror and toy planes - not so remote [Electronic resource] // Access mode: <http://security.blogs.cnn.com/2012/08/07/terror-and-toy-planes-not-so-remote>.

5. Guidelines for the analysis of the risk of accidental explosions and the determination of the parameters of their mechanical action РБ Г-05-039-96.

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**Оценка возможности применения беспилотных летательных аппаратов в террористических целях на объектах типа СЕВЕЗО**

Проведен анализ изученности вопроса применения и защиты от квадрокоптеров в террористических целях на промышленных объектах. Показано, что характеристики современных квадрокоптеров достаточны для их возможного использования в террористических целях на промышленных объектах. Определено, что ущерб от одного БПЛА может в 500000 и более раз превышать стоимость квадрокоптера и взрывчатки.

**Ключевые слова:** Беспилотный летательный аппарат, теракт, взрывчатка, ущерб.

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**Оцінка можливості застосування безпілотних літальних апаратів в терористичних цілях на об'єктах типу Севезо**

Проведено аналіз вивченості питання застосування і захисту від квадрокоптера в терористичних цілях на промислових об'єктах. Показано, що характеристики сучасних квадрокоптерів достатні для їх можливого використання в терористичних цілях на промислових об'єктах. Визначено, що збиток від одного БПЛА може в 500000 і більше разів перевищувати вартість квадрокоптера і вибухівки.

**Ключові слова:** Безпілотний літальний апарат, теракт, вибухівка, збиток.