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COMPUTERIZED ASSESSMENT OF INTEGRATED SITE RISK SPECIFIC TO INDUSTRIAL INFRASTRUCTURES OF EXPLOSIVES, TAKING ACTS OF MALICIOUSNESS INTO CONSIDERATION

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Abstract: *The general safety rules applicable to high-risk industrial sites are based on both the 4 principles of working safely with explosive substances (knowing the risks, separating the risks, limiting the risks and overlapping safety devices), as well as the specific characteristics of the general and particular reports of explosion safety, together with the technical aspects related to the possible causes of explosion, the effects of explosion and safety distances, the protection against accidental triggering of the explosion, as well as the security in the field of explosive powders and pyrotechnic systems highlighting the limits related to the principle of pyrotechnic safety (knowledge, prevention and limitation of pyrotechnic risk).*
The scientific article offers an original perspective of solving the problem in the field of explosion risk generated when explosive materials are involved, taking into account acts of ill-will, using the working facilities of some dedicated software for its analysis and evaluation, and the results obtained are expressed in a technical manner integrated within the specialized IT application TERRORISK.EXE 01.
Keywords: *safety, industrial infrastructure, risks, explosion, explosive materials.*

1. Generalities regarding the technology of rapid detection the explosive materials

For the annihilation the acts of maliciousness (including those of smuggling prohibited and/or dangerous substances) the applications of modern physics are practical technical solutions not only necessary, but in the context of the current political and social development even mandatory tools. This difficult situation becomes even more complex when the question arises of studying the samples taken from the production area of the event resulting in the explosion [1], [2], [3].

The investigation of evidence for the purpose of detecting traces of threat in residues and the identification of explosive material, namely for the forensic investigations undertaken to find out the perpetrators are complex, laborious and difficult activities. It therefore follows that the success of such an investigation is interdependent with the accuracy of the revealed evidence, with the acquisition of forensic practices and procedural actions, but also with the equipment of the latest generation analysis systems. Considering that, in such situations, the performance of the operative assurance of results for the proper conduct of the investigation requires reducing the time horizon for the analysis.

A new challenge from the technical-scientific point of view is represented by the expansion of the innovative solutions of the range of explosives, both in terms of standardized explosives and those

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manufactured by artisans, their recipes being particularly complicated, and their concealment tactics increasingly ingenious, harmonizing with the requirements of the current level of progress [4].

If the analysis procedures in the laboratory are based on methodologies that assume the use of static investigation equipment, which is reflected in the accuracy of the result indicators, those that are used in situ for the rapid identification of the presence of explosive substances, must ensure the obtaining of values with thresholds acceptable and predictable sensitivity and selectivity under conditions given by already existing mass and gauge configurations. These systems must allow the detection and identification, as the case may be, of different types of explosive substances, starting from the ultra-trace level, nano and reaching up to picograms, thus determining the sensitivity characteristic, in relation to the widest possible range of explosive materials, ensuring increased selectivity.

Explosive materials, solid ones, and especially liquid ones, generate vapors (a process intensified with increasing temperature), forming a gaseous phase on their surface characterized by a parameter called vapor pressure.

This vapor pressure is usually expressed as a relative concentration in the air and only exceptionally as a pressure. Thus, there are the following expressions, according to (1):

$$\begin{gathered}\frac{part}{milion}\,(ppm)=\frac{1}{10^6}=\frac{1\,molecule}{1\,million\ air\ molecules}\\ \frac{part}{billion}\,(ppb)=\frac{1}{10^9}=\frac{1\,molecule}{1\,billion\ air\ molecules}\\ \frac{part}{trillions}\,(ppt)=\frac{1}{10^{12}}=\frac{1\,molecule}{1\,trillion\ air\ molecules}\end{gathered}\tag{1}$$

The specific characteristic (1) facilitates their detection, having a smaller contribution to the detection of explosive mixtures, in which case the vapor pressures are significantly lower in relation to those of each individual component element (even when they are found in the same quantity), because they are embedded in matrices such as: polymers, oils, resins or fats, as well as their "chaining" in various ways of packaging with different materials, the detection can also be influenced by weather conditions or regional environmental factors, depending on the technique used [5], [6], [7].

The acts of terrorism committed all over the world, many with extremely severe consequences, have brought into question the obligation to combat operations undertaken with ill will, in order to detonate artisanal devices made of explosive substances. From this perspective, the detection of explosive substances, with a high degree of accuracy, constitutes an extremely current technical-scientific challenge, including for the situation when they are ″closed″ inside an improvised explosive device, or when they are not commercialized, being handmade.

The situation of improvised explosive materials is more complicated and can be solved, both on the basis of increasing the selectivity and sensitivity of detection/identification practices/procedures, as well as by upgrading methodologies to the "tendencies" of terrorist threats (new materials used, production techniques / concealment / placement of an improvised explosive device). ″The marking″ of explosive materials was carried out based on a framework regulated by an international convention dated as early as 1998, and there are also numerous scientific forums for the purpose of dissemination, knowledge and diversification of the adopted solutions.

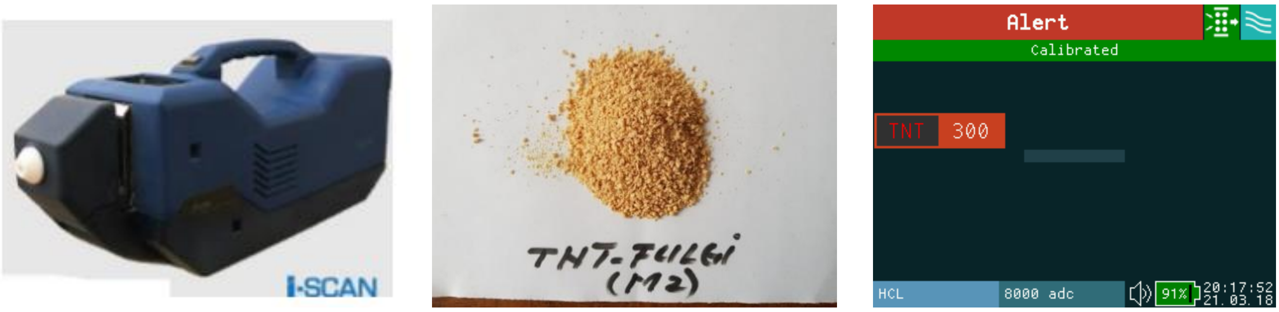

Figure 1. I-SCAN LSD for threat trace determination (TNT sample)

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Markers intended for detection or identification in post-accident investigations are substances introduced in small percentages in the composition of the explosive material. At the current level, chemical substances (eg.ortho and para mononitrotoluene), radiofrequency microchips (used to mark pharmaceutical and cosmetic products) and microparticles are used as markers in the used procedural methodologies [8], [9], [10], [11].

The I-SCAN LSD The I-SCAN LSD can be used for the examination of territories, spaces, mobile objects and goods, respectively for detection of the explosive materials.

2. Computerized assessment of global risk (explosion /occupational/ terrorist attack risk) specific to industrial sites in the field of explosives [12], [13], [14], [15], [16]

IMESAFR v2 Bundle - Specialized probabilistic risk assessment software for personnel of explosives storage units that calculates QD (Quantity Distances) - safe distances from explosives stores (fig.2).

DIRE Version 1.0 - Specialized automatic analysis software for assessing risks and susceptible vulnerabilities, as a result of potential terrorist actions or other incidents with explosions (fig.3).

EXPLO5 - The specialized computer application intended for estimating, based on the elements of chemical composition of explosive substances, the parameters that define these types of substances (detonation speed, detonation energy, detonation pressure, etc.), as well as determining the probability of explosion of them (fig. 4).

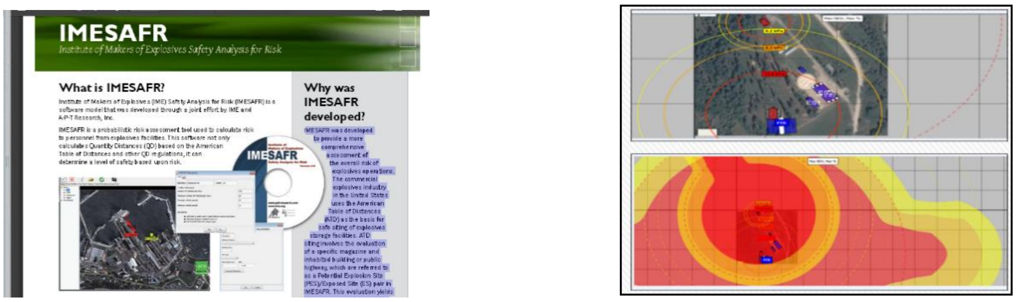

Figure 2. The specialized IT application IMESAFR V 2.0

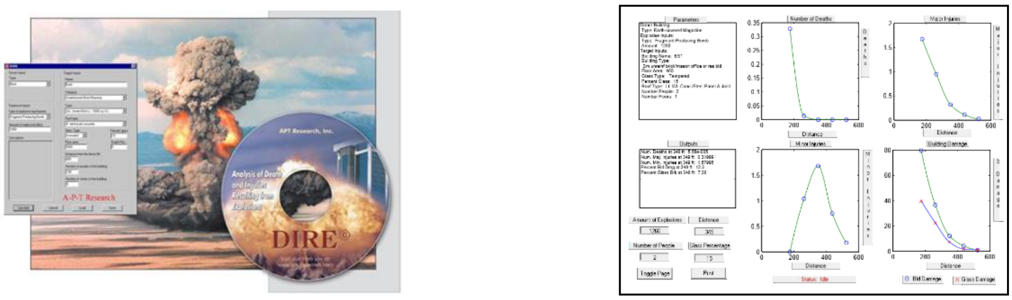

Figure 3. The specialized IT application DIRE Version 1.0

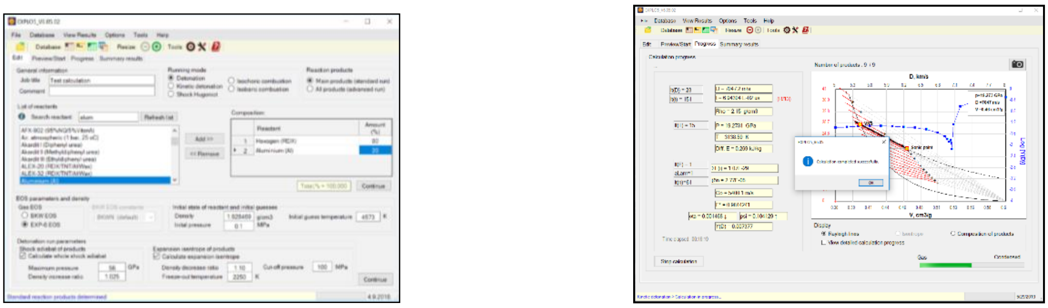

Figure 4. The specialized IT application EXPLO5

3. Presentation of the specialized IT application TERRORISK.EXE 01 specific to the evaluation of the explosion risk generated by explosive materials

The TERRORISK.EXE 01 program is a work tool used for the operative and procedural management of risk management documents produced on industrial sites in the field of civil explosives when dangerous substances of an explosive nature are involved, using the work facilities of dedicated software in this field (IMESAFR, DIRE, EXPLO5), as well as the results of threat trace determinations using the specialized I-SCAN equipment [17], [18], [19], [20], [21].

The launch of the TERRORISK.EXE 01 program is shown in the screen in figure 5.

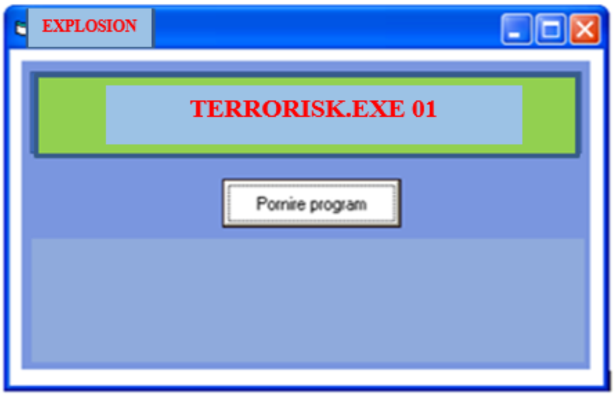

Figure 5. TERRORISK.EXE 01 - Launching the program

Figure 6 shows the work window in which the user is to opt for one of the 7 zones, named: **Zone 1-**DIRE, **Zone 2-**IMESAFR, **Zone 3-**EXPLO5, **Zone 4-**I-SCAN, **Zone 5-**Procedure of work DIRE, **Zone 6-**Work Procedure EXPLO5 and **Area Work Procedure I-SCAN**.

Figure 6. TERRORISK.EXE 01 program working window

These areas offer the following facilities:

- Zone 1-DIRE, from where the results obtained with the DIRE utility can be used regarding the assessment of risks and susceptible vulnerabilities, as a result of potential terrorist actions or other incidents with explosions (fig.7). In this work area, accident scenarios can be configured taking into account acts of bad will, and the results obtained from the evaluation are imported into the reporting document and will be viewable by pressing the button on the right.

Figure 7. Working window with Zone 1-DIRE

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- **Zone 2-IMESAFR**, where the results obtained with the IMESAFR utility can be used regarding the probabilistic risk assessment for the personnel of explosives storage units that calculate QD (Quantity Distances) – safety distances from explosives stores, determining the level of safety based on the estimated and appreciated risk. In this work area, accident scenarios can be configured taking into account the activity carried out on the site, the nature and the amount of explosive substance in TNT equivalent, and the results obtained from the evaluation are imported into the reporting document and will be viewable by pressing the button in right (fig. 8).

Figure 8. Working window with Zone 2-IMESAFR

- **Zone 3-EXPLO5**, where the results obtained with the EXPLO5 utility can be used regarding the thermochemical prediction of the detonating behaviour of explosive substances;
- **Zone 4-I-SCAN**, where the results obtained with the I-SCAN equipment can be used for the detection of trace amounts of organic substances with low volatility;
- **Zone 5-DIRE** work procedure, where the PL_DIRE work procedure can be consulted in detail, regarding the correct use of the specialized DIRE software;
- **Zone 6-EXPLO5** work procedure, where the PL_EXPLO5 work procedure can be consulted in detail, regarding the correct use of the specialized EXPLO5 software;
- **Zone 7-I-SCAN** work procedure, where the PL_I-SCAN work procedure can be consulted in detail, regarding the correct and safe use of the specialized I-SCAN equipment.

For ensure the security of the information and data the access to the application and to the system documents is achieved by authentication with a uniquely identified password (fig.9):

Figure 9. TERRORISK.EXE 01 - authentication with a uniquely identified password

4. Conclusions

- The TERRORISK.EXE 01 program is a work tool used for the operative and procedural management of explosion risk assessment documents produced on industrial sites in the field of civil explosives when dangerous substances of an explosive nature are involved, using the work facilities of dedicated software in this field (IMESAFR, DIRE, EXPLO5), as well as the results of threat trace determinations using the specialized I-SCAN equipment;

- The specialized IT application TERRORISK.EXE 01 ensures the operative and procedural management of the explosion risk evaluation documents generated on industrial sites following the detonation of explosive materials, taking into account malicious acts, in order to maintain the technical and organizational capacity according to the applicable requirements in the field, in predictable conditions of technological and occupational security;

-TERRORISK.EXE 01 can be a viable solution to the operative and procedural solution to the problem in the field of civil explosives, offering the following advantages: the planned and documented approach to occupational health and safety issues specific to the activities carried out in the presence of site-specific explosion risk industrial where operations are carried out specifically with explosive materials; knowledge and awareness of issues in the field of security/safety of operations specifically with explosive materials; ensuring a favourable and efficient socio-professional climate in the field of human resources allocated to activities in the field of civil explosives; measurable results.

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