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# TECHNICAL EXPERTISE OF INCIDENTS CAUSED BY THE NONCOMPLIANT USE OF PYROTECHNIC ARTICLES FOR ENTERTAINMENT

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***Abstract:*** *This paper highlights the results of research on the technical expertise of incidents caused by the improper use of explosive materials, specifically pyrotechnic articles for entertainment, emphasizing the necessity of a multidisciplinary and systematic approach to conduct thorough and objective analyses. The case study presented in this paper illustrates adaptability and innovation in expertise techniques, essential elements for addressing the unique challenges posed by each incident. This adaptability is crucial for the continuous improvement of safety practices to prevent unwanted events. By analyzing a real case, a replicable model is provided for the management and technical expertise of similar incidents. Thus, the vital role of technical competence in the field of safety and explosion protection is underscored.*
***Keywords:*** *Technical expertise, Pyrotechnic articles for entertainment, Hazardous incident, Working hypotheses, Specialized tests, Event occurrence mechanism*

## 1. INTRODUCTION

Directive 2013/29/EU, issued by the European Parliament and the Council on June 12, 2013, aims to harmonize the legislation of European Union member states concerning the placing on the market of pyrotechnic articles. It seeks to ensure a high level of health and safety protection for consumers and professionals, as well as environmental protection. The directive includes definitions, scope, exceptions for pyrotechnic articles, requirements for market placement, classification of pyrotechnics based on use, purpose, and risk level, including noise levels and specific parameters of constructive types. It establishes essential safety requirements for pyrotechnic articles marketed in the EU, emphasizing the need for conformity procedures, conformity assessment, marking, and supervision to ensure that products meet the established standards [1].

Government Decision No. 1102 of 2014 serves as a fundamental legislative framework for regulating pyrotechnic articles in Romania, aligning with the standards and requirements of the European Union. It ensures not only the free movement and responsible marketing of pyrotechnic products on the domestic market but also the protection of consumers and the general public by setting strict safety and compliance requirements. By detailing the obligations of economic operators and implementing clear conformity assessment procedures, HG 1102/2014 contributes to risk prevention and increases awareness and responsibility in the use of pyrotechnic articles [2].

## 2. MATERIALS AND METHODS

The technical expertise procedure for explosive materials in the context of incidents arising from their use involves the following steps:
Request for technical expertise, the official documentation from the requesting authority is received and recorded, defining the purpose and objectives of the technical expertise. This includes ordinances, preliminary reports, and a list of available evidence. A preliminary review of the documentation and evidence is conducted

to ensure their completeness and relevance to the expertise's objective.

Formation of the expertise team, a multidisciplinary team of experts is assembled, including engineers, researchers, and technicians specialized in explosive materials, mining safety, and explosion protection. A briefing session is organized to ensure all team members understand the expertise objectives and the specific working methodology.

Preliminary Analysis, the available documentation and material evidence are thoroughly analyzed to identify key information and establish an investigation strategy. A detailed expertise plan is developed, including testing and analysis phases, necessary instruments and equipment, and an activity schedule.

Conducting the technical expertise, testing procedures (experiments are conducted under controlled conditions in a designated testing range, using specialized techniques and equipment to measure the physical and chemical characteristics of the explosive materials); Data Analysis (the collected data is processed and analyzed using specialized software to interpret the experimental results and determine the characteristics of the pyrotechnic articles).

Expertise report preparation, data structuring (the collected information is organized into a logical structure, including the applied methodology, obtained results, and their analysis); Conclusion drafting (conclusions are formulated based on data analysis, highlighting relevant aspects of the expertise and classifying the pyrotechnic articles into the appropriate risk categories).

Proposals and recommendations, based on the expertise conclusions, concrete proposals are developed for the safe use of pyrotechnic articles and for preventing unwanted incidents. Recommendations are provided for improving safety and explosion protection regulations, based on the latest research and industry best practices.

Finalization and submission of the report, the expertise report undergoes a final review to ensure the accuracy and consistency of the presented information. Submission and Archiving (The finalized document is submitted to the requesting authority, and a copy is archived within the institution, ensuring the confidentiality and security of the information).

This procedure ensures a systematic and comprehensive approach to the technical expertise of pyrotechnic articles, contributing to the identification and minimization of risks associated with the use of these explosive materials.

## 3. OBJECTIVES

The case study regarding the technical expertise of incidents caused by the noncompliant use of pyrotechnic articles for entertainment is briefly presented below.

From the analysis of the materials and documents provided, the following observations were made:

In the courtyard of a guesthouse, approximately 20 meters away, there was a rectangular-shaped pool running from north to south. At the southern end of the pool, there was a terrace where private events were organized.

Description of the incident location**,** the incident took place within the courtyard of the guesthouse, as shown in Photo 1:

**Fig. 1.** The Terrace with the Pool Where the Incident Occurred

Consequences of the incident, the undesirable event that occurred at the guesthouse had the following consequences: The bodily integrity of several individuals present at the private event organized at the guesthouse was affected by the explosion of the improvised pyrotechnic assembly; Material damage caused by metal fragments from the improvised pyrotechnic assembly, resulting from its explosion.

Description of the Pyrotechnic Articles involved in the incident, according to the documents and material evidence provided for the expertise, it results that for the fireworks display organized during the private event held in the guesthouse's courtyard, outdoor stage pyrotechnic articles of the *jerbă* type (aerial fountains) were used.

***Hypotheses analyzed for the occurrence of the incident***

Hypotheses regarding the occurrence of the incident in correlation with the provided information and data, specialized literature, and the professional expertise of INCD INSEMEX Petroșani specialists, are as follows:

***The method of using the Pyrotechnic Article***

Improper use of the pyrotechnic article by creating an improvised, inadequate, and dangerous assembly, which consisted of fully inserting the pyrotechnic article into a steel tube, placed on a steel plate, and which could have led to the occurrence of the incident [3].

This hypothesis *is supported* based on the arguments presented above and considering the duration, method, and conditions of storage, as well as the possibility that some pyrotechnic items could be subject to climatic-induced heating phenomena or self-heating due to slow decomposition processes after the expiration date, generating vapors and combustible/explosive gases produced and/or accumulated during their operation, within the interstitial space defined by the gap between the steel casing dimensions and those of the pyrotechnic item, with the casing fully covering the item, limiting their release to the exterior due to the welded cap on the upper part of the casing, allowing the pyrotechnic item to function only by directing the spark jet through the central hole made in the casing, thereby ensuring the formation of a potentially explosive dangerous mixture at the base of the casing.

***The effects of exothermic reactions over time on pyrotechnic loads***

Maximizing the reaction rate for a pyrotechnic or explosive composition can be explained in one word: homogeneity. Any means that increases the intimate contact between the compounds of a mixture will lead to an increase in reactivity, which expresses the rate at which the matter in the mixture transforms into the compounds resulting from the reaction, expressed in grams or moles per second. Increasing reactivity beyond a certain threshold can lead to a decrease in the safety of the mixture, making it highly sensitive to external stimuli or even the presence of atmospheric oxygen. Initiation energy can be developed mechanically through friction, impact, thermally from an open flame or electric spark, or pyrotechnically, from incandescent bodies/electrical filaments, chemically through the initiation of a chemical reaction between two or more compounds by coming into contact.

This hypothesis *cannot be fully supported* because no evidence was found regarding the manifestation of this phenomenon in terms of decomposition and the triggering of unpredictable reactions.

This hypothesis *can be established*, based on the arguments presented above, in the triggering of the phenomenon that generated the undesired event described in the first hypothesis, considering the origin, method, and conditions of storage, as well as the expiration date, which could have led to the modification of the physico-chemical and functional characteristics of the product.

***Electric short circuit with the ignition of insulation and surrounding property***

Unanticipated initiation of pyrotechnic articles could be due to an electrical short circuit, which may generate a spark, flame, or overheating of electrical lines and switching equipment, with incendiary effects on nearby materials. Based on the analysis of the documents and video evidence provided, no indications were found that would lead to the hypothesis of an electrical defect as the source of the initiation of the event.

This hypothesis regarding the initiation of the pyrotechnic articles is excluded, as no indications were reported that would lead to the occurrence of an electrical defect as the source of the initiation of the event.

***Atmospheric electrical discharges***

In the case of weather phenomena that induce lightning strikes, the ignition or damage of objectives or trees/vegetation can be considered if they are not protected by lightning rods with an appropriate coverage area. According to the video recordings and the weather report from the analyzed period, it is evident that no phenomena were recorded that could have caused atmospheric electrical discharges capable of generating dangerous energies [4], [5].

This hypothesis is excluded, as no weather conditions were recorded at the time of the event that could lead to fire-generating phenomena.

***Electrostatic discharges***

Electrostatic discharges can initiate pyrotechnic compositions stored freely or loaded into pyrotechnic articles if the energy level/sensitivity is exceeded. These dangerous electrostatic charges can accumulate on the surfaces of insulating materials, and if they are in proximity to the pyrotechnic charge, they can trigger its initiation.

The accumulation of electrostatic charges is a phenomenon related to the movement of objects (pyrotechnic articles, packaging, equipment used by workers, air currents, etc.)

The active energy level of electrostatic charges specific to pyrotechnic articles without electrical means is very high and is unlikely to be considered as a plausible effective source.

According to the literature and industry practice, for pyrotechnic articles with an electric initiation system (such as stage articles: categories T1 and T2), this risk can be considered if there are surfaces for the accumulation of electrostatic energy due to activities such as assembly, handling, transport, etc. However, this was not the case, considering the situation observed at the location of the undesired event [6].

This hypothesis regarding the initiation of pyrotechnic articles due to electrostatic discharge is excluded, as at the time of the event, no assembly, handling, or transport operations were being carried out that could generate dangerous electrostatic energies, and no person was present in proximity or acting on the product that caused the undesired event.

***The Arson effect (intentional ignition as an act of malicious intent)***

According to the literature, it has been revealed that a series of material damages caused by fires were not accidental but were generated by acts of malicious intent (Arson effect), based on competitive and/or interpersonal considerations. Such means of intentional ignition can be considered, including incendiary bottles with gasoline or diesel, known as 'Molotov cocktail', torches, or rags soaked in liquid fuels or similar items, which could have been activated to cause a fire.

Based on the analysis of the documents and video recordings provided, which highlight the activities carried out during the private event, no actions by individuals with malicious intent were identified or observed that could have triggered the products used in organizing the fireworks display and generated the undesired event.

This hypothesis is unlikely, given the documented information provided, and therefore <u>it is excluded</u>.

## 4. RESULTS

Next, a series of experimental tests conducted at the INSEMEX range with pyrotechnic articles similar to those used during the organization of the fireworks display that caused the undesired event, resulting in the injury of several individuals and material damages, are highlighted, in order to reproduce the phenomenon of initiation/accidental explosion triggering.

<u>*A. Experimental test conducted on a similar assembly, with the pyrotechnic article, which was mounted in the normal operating position*</u>

For the experimental test, a similar pyrotechnic article was used to reproduce the phenomenon of ignition/initiating and accidental explosion, using an assembly consisting of (Photo 2):

- a steel cylindrical casing with a welded cap at the top, featuring a central hole;
- a pyrotechnic article (category T2) with an electric ignition system mounted in the metal casing, in the correct position with the spark jet release nozzle at the top, positioned in line with the hole in the casing's cap;
- a base plate made of steel sheet, square-shaped, with a welded pipe in the center;
- ignition system with a black plastic casing, powered by a 9V battery, equipped with an on/off switch, test-trigger switch, control LEDs, radio antenna, and two pairs of terminals for connecting two pyrotechnic articles with an electric ignition system);
- a remote control with a brown plastic casing, powered by a 12V battery, used for remote activation of the ignition system via radio waves.

**Fig. 2.** General view of the assembly used in the experimental test "A"

As a result of the experimental test, it was found that after initiating the electric igniter using the remote control initiation system, the pyrotechnic article was triggered by the emission of a jet of sparks until the complete consumption of the pyrotechnic composition, generating thermal, luminous, and sound effects, as well as smoke, without destroying the integrity of the steel casing (Fig. 3).

**Fig. 3.** Triggering / Ceasing the operation of the pyrotechnic article correctly inserted into the metal casing

*B. Experimental test conducted on a similar assembly, with the pyrotechnic article mounted in an incorrect position*

For the experimental test, a pyrotechnic assembly similar to the one in point A was used, with the difference that the pyrotechnic article (category T2) with an electric initiation system was mounted in the metal casing in an incorrect position, with the nozzle for the release of the spark jet positioned at the lower part, not aligned with the hole in the casing's lid (Fig. 4).

**Fig. 4.** General view of the assembly used in experimental test "B"

Following the experimental test, it was found that after the electric igniter was activated using the remote initiation system, the pyrotechnic article was triggered, releasing a jet of sparks until the complete consumption of the pyrotechnic composition, generating thermal, luminous, and sound effects, as well as smoke, without compromising the integrity of the steel casing, especially at the lower part of the casing [7].

*C. Experimental test conducted on a similar assembly, with the addition of an extra quantity of pyrotechnic composition at the bottom*

For the experimental test, a similar pyrotechnic article was used to reproduce the phenomenon of ignition/initiation and accidental explosion, utilizing an assembly consisting of:

- A cylindrical steel casing, fitted at the top with a welded lid, featuring an opening in the central area;
- A pyrotechnic article handmade from a pyrotechnic composition similar to those in the T2 category, equipped with an electric ignition system consisting of an igniter introduced at the upper part through the nozzle hole intended for directing the spark jet (pyrotechnic effect). The pyrotechnic article has the following dimensions: H = 160 mm, outer diameter 62 mm, inner diameter 50 mm, with a cylindrical cardboard body, loaded with nitrocellulose and metallic powder (170 g), completely sealed at the lower end with a 20 mm thick pressed clay ballast, and at the upper part with a 20 mm thick ring-shaped pressed clay collar, featuring a 14 mm hole, sealed with aluminum foil. The article is equipped with two copper and PVC insulated leads (0.9 m in length) intended to supply power for the ignition of the electric igniter. As additional pyrotechnic composition, approximately 10 g of "flashpowder" (a mixture of potassium perchlorate and metallic powder) was added to the lower part. This improvised pyrotechnic article was mounted in the metal casing in the correct position with the spark jet nozzle at the lower part. The article was also equipped with a second electric ignition system at the lower part to trigger the initiation of the additional "flashpowder" charge, aiming to correlate the timing of the normal operation until the pyrotechnic article exploded, leading to the unwanted event. To maintain the protection of the additional charge for its initiation with the second ignition system, a steel metal cap with a

bolt-tightening system was used, fixed at the lower part of the metal casing (Fig. 5) [8].

- A square steel plate, with a welded pipe in the central area;
- initiation system with a black plastic casing, powered by a 9 V battery, (equipped with an on/off switch, test-trigger switch, control LEDs, radio antenna, and two pairs of terminals for connecting two pyrotechnic devices with an electric initiation system);
- A remote control with a brown plastic casing, powered by a 12 V battery, used for remotely triggering the initiation system via radio waves.

**Fig. 5.** General view of the assembly used in the experimental test "C"

Following the experimental test, it was found that after the initiation of the electric igniter located at the top, which is intended to initiate the pyrotechnic composition using the remote initiation system, the functioning of the pyrotechnic device was triggered by the release of a spark jet for approximately 5-8 seconds. Afterward, the second initiation system for the additional pyrotechnic charge, located at the bottom, was activated. The phenomenon of explosion was observed, generating thermal, luminous, sound, and smoke effects, as well as dynamic effects due to the ejection of fragments resulting from the disintegration of the assembly and the destruction of the steel casing (Fig. 6).

**Fig. 6.** Fragment of the casing resulting from its destruction

*D. Experimental test conducted on a similar assembly, using the empty casing of a pyrotechnic article involved in the event and two initiation systems, namely one with electrical initiation and the other with a fast-burning fuse.*

An experimental test was conducted at the INSEMEX testing range using a handmade construction similar to the pyrotechnic article that generated the event, repurposing an empty cardboard casing of a pyrotechnic article involved in the event, provided by the criminal investigation authorities, for the purpose of reproducing the ignition/activation and accidental explosion phenomenon, using an assembly consisting of:

- a metal casing made of steel in a cylindrical shape, equipped at the top with a welded cap having a central hole;
- a pyrotechnic article crafted manually from a pyrotechnic composition similar to those found in T2 category pyrotechnic articles, equipped with an electric ignition system consisting of an electric igniter inserted at the top through the nozzle hole intended for directing the spark jet (pyrotechnic effect). The pyrotechnic article has dimensions of H=200 mm, an outer diameter of 60 mm, an inner diameter of 50.5 mm, and a cylindrical cardboard body with a composition of nitrocellulose and metallic powder weighing 210 g (20 g of pyrotechnic powder at the top initiated by the first electric ignition system, followed by a separating ballast layer that allows contact between the 20 g of pyrotechnic powder at the top and the remaining 190 g of pyrotechnic powder at the bottom through a rapid burning fuse, for sequential operation: normal operation with the emission of a spark jet followed by an explosive phenomenon generated by the ignition of the rapid-burning fuse located in the 190 g mass of pyrotechnic composition). It is completely sealed at the lower end with a 20 mm thick pressed clay ballast and at the top with a pressed clay collar with a 14 mm hole, 20 mm thick, and sealed with an aluminium foil. It is also equipped with two copper electrodes, each 0.9 meters long, with PVC insulation, intended for power supply to trigger the electric igniter. This improvised pyrotechnic article was installed inside the metal casing, positioned correctly with the spark jet nozzle at the top, and fitted with a second ignition system through the rapid-burning fuse, aimed at synchronizing the timing of the normal operation until the explosive phenomenon occurred, leading to the unwanted event. (Fig. 9).
- - a base plate made of steel sheet, square-shaped with a side length of 150 mm and a

thickness of 4 mm, featuring a welded pipe at the center with the following dimensions: an outer diameter of 50.92 mm, an inner diameter of 44.70 mm, and a length of 80.70 mm; (Fig. 7).

- initiation system with a black plastic casing, powered by a 9 V battery, featuring a power switch, a test-fire switch, control LEDs, a radio antenna, and two pairs of terminals for connecting two pyrotechnic articles with an electric initiation system); (Fig. 8).
- a remote control with a brown plastic casing, powered by a 12 V battery, used for remote activation of the initiation system via radio waves.

**Fig. 7.** General view of the assembly used in experimental test "D"

**Fig. 8.** Handcrafted pyrotechnic article used in experimental test "D"

As a result of the experimental test, it was found that after the initiation of the electric igniter located at the upper part, which is intended to initiate the 20 g of pyrotechnic composition, the pyrotechnic composition was activated for 2-3 seconds using the remote initiation system, after which an explosion-type phenomenon occurred due to the untimely initiation of the quick-burning fuse located in the 190 g pyrotechnic composition mass. This led to thermal, luminous, and sound effects, as well as dynamic effects such as the projection of fragments resulting from the disintegration of the assembled unit and the destruction of the steel casing (Fig. 10) [9].

**Fig. 9.** The explosion resulting from the initiation of the quick-burning fuse, which activated the 190 g of pyrotechnic composition located at the lower part

**Fig. 10.** Highlighting the dynamic effects manifested on the components of the assembled unit, namely: deformation of the pipe section, rupture of the weld seam, detachment of the protective cap of the power supply batteries for the initiation device, and a metal casing fragment resulting from the explosion

*E. Experimental test conducted on a similar assembly, using the empty casing of a pyrotechnic article involved in the event and two initiation systems, one with electric initiation and the other with a slow-burning fuse.*

An experimental test was conducted at the INSEMEX testing range using a handmade construction similar to the pyrotechnic article that caused the event, repurposing an empty cardboard casing of a pyrotechnic article involved in the incident, provided by the criminal investigation authorities, in order to reproduce the ignition/initiation and accidental explosion phenomenon using an assembly (Photo 14) consisting of:

- a cylindrical steel casing with a welded cap at the upper part, featuring a central hole;
- a hand-crafted pyrotechnic article made of a composition similar to those in the T2 category, equipped with an electric ignition system consisting of an electric igniter introduced at the upper part through the nozzle hole, aimed at directing the spark jet (Photo 12). The pyrotechnic article has dimensions of H=200 mm, an outer diameter of 60 mm, an inner diameter of 50.5 mm, and a cylindrical body made of cardboard, filled with nitrocellulose and metallic powder of 210 g (30 g of pyrotechnic powder at the upper part, initiated using the first electric ignition system, followed by a separating ballast layer that enables contact between the 30 g of pyrotechnic powder at the upper part and the remaining 180 g of pyrotechnic powder at the lower part through the use of a slow-burning fuse, in order to sequentially

operate the device. This results in the normal operation, emitting a spark jet (pyrotechnic effect) followed by an explosion caused by the initiation of the slow-burning fuse, which activates the entire 180 g of pyrotechnic composition). The device is fully closed at the lower end with a 20 mm thick pressed clay ballast, and at the upper part with a pressed clay annular collar with a 14 mm hole, 20 mm thick, sealed with aluminium foil. It is equipped with two copper conductors with PVC insulation, 0.9 m long, intended for powering the electric igniter. This improvised pyrotechnic article was installed in the metal casing, positioned correctly with the spark jet nozzle at the upper part, and equipped with a second ignition system via the slow-burning fuse, in order to correlate the functioning times until the occurrence of the explosion that led to the undesired event. (Fig. 11) [10].

- a base plate made of steel sheet, square-shaped;
- ignition system with a black plastic casing, powered by a 9 V battery, (equipped with an on/off switch, a test-release switch, control LEDs, a radio antenna, and two pairs of terminals for connecting two pyrotechnic articles with an electric ignition system);
- a remote control with a brown plastic casing, powered by a 12 V battery, used for remotely triggering the ignition.

**Fig. 11.** General view of the assembly used in experimental test "E"

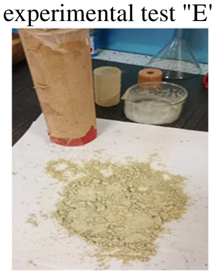

**Fig 12.** The handmade pyrotechnic device used in experimental test "E"

As a result of the experimental test, it was found that after the initiation of the electric igniter located at the upper part, designed to initiate the 30 g of pyrotechnic composition, using the remote initiation system, the pyrotechnic composition was activated for 5-8 seconds, after which an explosion-like phenomenon occurred due to the unexpected ignition of the slow-burning fuse, which activated the entire 180 g pyrotechnic composition, producing thermal, luminous, sound, and smoke effects, as well as dynamic effects from the ejection of the steel metal casing, while maintaining its integrity.

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## 5. DISCUSSION

The results obtained from the five experimental tests provide relevant insights into the failure modes and risk factors associated with noncompliant use of pyrotechnic articles. Test A and B, which simulated standard and incorrect mounting without additional compositions, showed safe operation with no casing damage, reinforcing the importance of correct orientation and adherence to technical specifications.

In contrast, tests C, D, and E demonstrated how minimal modifications—such as adding flash powder or combining electric initiation with fuse-based ignition—significantly increase the risk of explosion and casing destruction. These results align with findings from prior studies [5], [6], [9], which emphasize that ignition timing, composition homogeneity, and confinement within rigid structures are critical variables influencing pyrotechnic behaviour.

From a forensic perspective, the capacity to replicate the explosion under controlled conditions using similar materials supports the first hypothesis—improper assembly combined with aging or degraded pyrotechnic products. The dynamic effects observed (fragmentation, deformation, and projection) offer valuable reference data for post-incident analysis and training of safety inspectors.

The interdisciplinary expertise involved—engineering, chemistry, and safety regulation—enabled a holistic reconstruction of the event. Furthermore, the results underscore the need to update safety protocols and testing practices, especially for improvised assemblies and expired products. The comparative outcomes of the five experiments are summarized in Table 1.

*Table 1*

**Comparative Summary of Experimental Test Outcomes**

| Test | Assembly Type | Extra Ignition | Observed Effects | Casing Integrity |
|---|---|---|---|---|
| A | Correct orientation | No | Normal operation: spark jet, no explosion | Preserved |
| B | Incorrect orientation (nozzle down) | No | Normal operation: spark jet, no explosion | Preserved |
| C | Correct + added flashpowder | Yes (2 electric igniters) | Explosion, strong dynamic effects, fragmentation | Destroyed |
| D | Correct + 190g pyrotechnic + fast fuse | Yes (electric + fast fuse) | Delayed explosion, dynamic effects, fragmentation | Destroyed |
| E | Correct + 180g pyrotechnic + slow fuse | Yes (electric + slow fuse) | Delayed explosion, dynamic effects, partial | Partially affected |

## 6. CONCLUSIONS

From the hypotheses analysed and evaluated, two are retained with high probability, namely:

-*Malfunction (explosion) of the pyrotechnic article that generated the event due to possible non-conformities related to:* the age and unfavourable storage conditions of the pyrotechnic article, manufacturing defects of the pyrotechnic article, and improper use of the pyrotechnic article through an inadequate and dangerous assembly consisting of fully inserting the pyrotechnic article into a metal support made of a cylindrical steel casing, with possible structural manufacturing defects or wear caused by repeated use, disposed on a metal base plate made of steel;

- *The effects of exothermic reactions over time on pyrotechnic charges*.

For both hypotheses considered plausible, it is believed that the undesirable event occurred as a result of the malfunctioning (explosion) of a non-compliant pyrotechnic article of unknown origin, equipped with an electric initiation system, using an inadequate and hazardous setup consisting of the complete insertion of the pyrotechnic article into a metal support made of a cylindrical steel casing, which could generate shrapnel with a particularly high danger level. This casing may have possible structural defects either due to manufacturing issues or wear caused by repeated use, and it was placed on a steel base plate that served as a support for another pyrotechnic article.

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**Expertiză tehnică a incidentelor cauzate de utilizarea necorespunzătoare a articolelor pirotecnice pentru divertisment**

Lucrarea evidențiază rezultatele cercetării privind expertiza tehnică a incidentelor cauzate de utilizarea necorespunzătoare a materialelor explozive, în special a articolelor pirotehnice de divertisment, subliniind necesitatea unei abordări multidisciplinare și sistematice pentru a efectua analize aprofundate și obiective. Studiul de caz prezentat în această lucrare ilustrează adaptabilitatea și inovarea în tehnicile de expertiză, care sunt esențiale pentru a face față provocărilor unice pe care le prezintă fiecare incident. Această capacitate de adaptare este crucială pentru îmbunătățirea continuă a practicilor de siguranță în vederea prevenirii evenimentelor nedorite. Prin analiza unui caz real, se propune un model replicabil pentru gestionarea și efectuarea expertizei tehnice în cazul incidentelor similare. Se subliniază astfel rolul vital al competenței tehnice în domeniul securității și protecției împotriva explozivilor.

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