

# Practical skills and safety requirements in the profession of pyrotechnician

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**Abstract.** National legislation states that a pyrotechnician is a person who has specialist knowledge and is authorized to handle and use pyrotechnic entertainment items. It is necessary to acquire technical and practical knowledge, but above all the training of skills in the proper use of pyrotechnic articles, taking into account the specific risk and the complexity of the execution of the operations. At INCD INSEMEX Petroșani, the technical and practical facilities for the organization of qualification courses in the profession of pyrotechnician have been developed, leading to an increase in the level of knowledge and the acquisition of practical skills. In this sense, the infrastructure for teaching and verifying the appropriate acquisition of the disseminated information was developed based on the application of modern pedagogical and psychopedagogical concepts to facilitate the learning process for people who come from a heterogeneous environment from the perspective of age differences and level of studies/accumulated experience held. The paper highlights the results of the modernization of the methodological and practical infrastructure as well as the technical facilities in terms of optimizing and increasing the quality of the training process for the pyrotechnician qualification.

## 1 Introduction

Pyrotechnic articles present a high level of risk, even if the pre-market assessment has confirmed that the safety requirements for the product and category have been met.

The preparatory operations to be undertaken by the pyrotechnics team require the organization of the activity to anticipate and eliminate the risks to which the workers from the pyrotechnics team, the public or the objectives in the adjacent area may be subjected. During use, there are a number of objective and subjective factors that can lead to dangerous situations and unwanted events, [1].

The use of pyrotechnic entertainment articles of category F2 (pyrotechnic articles of entertainment that present a low risk and a low noise level and are intended for outdoor use in confined spaces), category F3 (pyrotechnic articles of entertainment that present a medium risk, which are intended for outdoor use in large open spaces and whose noise level is not harmful to human health) and category F4 (high-risk entertainment pyrotechnic articles, known as "professional entertainment pyrotechnic articles", which are intended for use

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exclusively by pyrotechnicians and whose noise level is not harmful to human health), pyrotechnic articles of category P2 (pyrotechnic articles, other than entertainment pyrotechnic articles and stage pyrotechnic articles, which are intended to be handled or used exclusively by pyrotechnicians.) and theatrical pyrotechnic articles is entrusted only to persons authorized as pyrotechnicians. [7,8] (Fig. 1)

Romanian citizens and citizens of a member state of the European Union or the European Economic Area can work as a pyrotechnician on the territory of Romania.

As a result of the increase in the requirements regarding the improvement of the methodological, theoretical and practical infrastructure in the field of pyrotechnic articles, the technical and IT infrastructure was developed at INSEMEX for the organization of training courses in the profession of pyrotechnician to lead to an increase in awareness and understanding of the updated information contained in the harmonized educational programs, [3].



**Fig. 1.** Pyrotechnic articles.

Romanian citizens can work as pyrotechnicians only after obtaining the appropriate professional qualification and authorization. The authorization is proven by the pyrotechnician's card.

## **2 Technical, organizational and security skills in the pyrotechnician job**

The execution of fireworks requires the establishment of precise organizational and security measures to eliminate the risks of injury or damage to the security of buildings, infrastructure or the environment. Coordination of the fireworks works are performed by an authorized pyrotechnician.

### **2.1 Technical and organizational skills in the pyrotechnician job**

The pyrotechnician coordinates the activities for the execution of the fireworks, obtains all the necessary approvals from the institutions authorized to organize the fireworks. It also checks the firing site and delimits the safe zone of the firing site, [4].

When choosing the place to set off the fireworks, it will be taken into account that it is not near: buildings or installations with a fire risk; hospitals, nursing homes, schools or

kindergartens; less than 50 m from residential buildings with up to 4 levels and less than 100 m from those with more than 4 levels; on public roads open to road traffic, on pedestrian alleys and in open spaces with agglomerations of people; at a distance of less than 500 m from the forests, [5-8].

The shooting place will be located depending on the type and calibre of the pyrotechnic products used, at a safe distance from spectators and buildings, and in the case of using electric filament lighters, it must be located from high voltage power lines at safe distances appropriate according to the regulations in force.

After determining the firing location, the unloading of the means of transport and the preparation of pyrotechnic articles and firing devices (mortars, supports, cables, desks) are carried out, [3].

The preparatory operations begin with the installation of the supports and the vertical and inclined launch pipes, after which they are loaded with the specific pyrotechnic articles to which the electric igniters are mounted and the installation of the other pyrotechnic articles that are not loaded into the pipes. (Fig. 2)



**Fig. 2.** Firework preparation operations.

The electric igniter is mounted on each bomb before it is loaded into the launch tube. Do not prepare several shells at once.

After loading and installing the pyrotechnic articles, proceed to the realization of the connection circuits between the lighters and the control panel by means of connecting cables (conductors).

After finishing the fire connection circuits, their continuity is checked using a measuring device intended and approved for this purpose, where the checking current is less than 25 mA.

Until the initiation of pyrotechnic articles installed for fireworks, they will be supervised by the pyrotechnician or another authorized person.

The lighting is done at the command of the firework organizer. Before starting the pyrotechnic articles, the pyrotechnician will check once again that no spectators have entered the safety zone.

After performing the zone control, connect the control panel to the power source. The minus (-) pole connects to the switch control wire.

After the end of the fireworks, wait 20 minutes and, after that, the pyrotechnician is obliged to control the place of ignition. It will be checked whether there are any remains of products that could start a fire and whether there are any misses and any unlit material is carefully collected, after which you can move on to disassembling the devices and tightening the cables.

At the shooting site there will be 2 fire extinguishers to intervene in case of necessity. Fireworks are not carried out during storms and atmospheric electrical discharges.

## 2.2 Safety measures for the preparation and installation of mortar tubes

Mortar tubes are cylindrical tubes closed at one end. Mortar tubes have taken the name of military equipment products that are used to fire at targets located at relatively small distances.

Mortar tubes can be made of steel, plastic material, fiberglass reinforced resin, multi-layered cardboard, etc. (Fig. 3)



**Fig. 3.** Mortar tubes of different calibres.

Regarding their dimensions, the calibre of the mortar tubes is several mm larger than that of the shell, thus allowing the free movement of the bomb during throwing. A clearance of approximately 5 mm between the bomb and the mortar tubes is recommended. The length of the mortar tubes positively influences the initial speed of its launch and implicitly the altitude at which the aerial bomb operates. It is recommended that the length of the mortar be  $6 \div 7$  times its calibre.

Mortar tubes with metal pipes for firing saluting bombs are prohibited. This is because in the event of an accidental initiation of the mortar tube bomb, cutting shrapnel with high kinetic energy may occur, causing loss of life.

Before placing and mounting the mortar tubes on the field, it is necessary for the pyrotechnicians to know the layout of the viewing public and the directions from which the

wind is blowing. This information will facilitate his mission of placing the mortar tubes because he must ensure a slight inclination of  $5 \div 10^\circ$  of the pipes in relation to the vertical and in the direction opposite to the public.

If the wind speed can be higher than 6 m/s, then this angle of inclination must be higher and even reach  $20^\circ$ .

The location of the mortar tubes or mortar batteries must be open, without the presence of trees, electrical networks or any other obstacle that could interfere with the trajectory of the bombs.

No mortar tube must be placed near high-risk targets: petrol stations, warehouses of flammable materials, vehicles, etc.

After mounting the mortars, it is mandatory to mark the dangerous area, in which the access of people except for pyrotechnicians is prohibited. Marking is done with red tape or similar. It is recommended to mount some indicator strips on the mouth of the mortars when the bomb leaves the mortar. This facilitates remote indication of bomb operation.

It should also be noted that all mortar tubes (individual mortar tubes or linked in batteries) must be permanently protected against rain and atmospheric moisture, usually by covering. It is recommended to use thin polyethylene films.

In order to also ensure protection against incandescent debris that falls to the ground after the operation of the other mortar tubes, it is advisable to protect the mouth of the mortars by additionally covering them with an aluminum foil.

The installation of bomb mortar tubes must comply with the following requirements:

- a. Mortar tubes must be installed firmly and stably with an adequate degree of fixation (stiffening) so as to avoid overturning or falling to the side (angular movement) during the execution of fireworks;
- b. Mortar tubes of size 7" and size 8" are fixed separately, depending on the internal distance;
- c. Mortar tubes of size 10" and larger are fixed separately;
- d. The number of mortar tubes fixed on each independent grid must comply with the requirements in table no. 1.

**Table 1.** The number of mortars fixed on each rack (crate/box) independently.

Specification	The number of mortars fixed in each rastel
Mortar for size bombs 3"	100
Mortar for size bombs 4"	80
Mortar for size bombs 5"	40
Mortar for size bombs 6"	30
Mortar for size bombs 7"	20
Mortar for size bombs 8"	12
Mortar for size bombs 10" and bigger	4 (if it is a single shot)

After the mortar tubes are installed, but before the shells are loaded, inspection is done by checking the stability of the bomb mortars, angles and distance between mortar tubes, etc.

## 2.3 Safety precautions when loading, connecting and initiating shells

The loading of the shells (fig. 4) must be in accordance with the following requirements:

- a. electric igniters must not be fitted before charging (except for shells with shorting measures and connector - supplied as such);
- b. mortar tubes must be dry and clean, without water or other residues, and a mortar must be loaded with a bomb and successive loadings are not allowed during firing;
- c. shells must be correctly loaded (throwing charge down, effect charge up) carefully, inserted into the bottom of the correct sized mortar tube, and must not be loaded with the effect down;
- d. wet shells or defective shells with leakage of composition or shells with bursts during handling must not be loaded;
- e. waterproofing and fire resistance measures must be taken, they are carried out immediately after loading.

The wicks must be properly and firmly connected, with waterproofing and fireproof measures, a sharp blade must be used to cut the wick when necessary (on a wooden surface). Ignition of the initiation system is carried out after the wiring is arranged and the connection is completed; when testing is done, uninvolved persons must move to safe areas.



**Fig. 4.** Loading shells into mortar tubes.

## 3 Conclusions

From the research carried out, the following conclusions can be highlighted:

- in the safe organization and production of fireworks, it is necessary to comply with the security requirement regarding compliance with the safety distances listed in the instructions for use or on the product packaging;
- proposals regarding the establishment and correct application of organizational and security measures both for the staff of the pyrotechnics team and for the viewing public, when performing fireworks;

- raising awareness and making pyrotechnicians responsible for ensuring a maximum level of safety and health when carrying out activities with pyrotechnic articles to achieve the proposed goal;
- the correct performance of preparatory operations for loading, connecting and initiating pyrotechnic articles that must be undertaken by pyrotechnicians to anticipate and eliminate the risks to which workers, the public or the objectives in the adjacent area may be subjected.
- depending on the weather conditions, the place of firing and the pyrotechnic articles used, the pyrotechnician must establish precise organizational and security measures to eliminate the risks of injury or damage to the security of buildings, infrastructure or the surrounding environment.

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