Explosion during the destruction of munitions

May 21, 1996

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France

Explosives / ammunition
Risk analysis / Safety study
Organisation / Procedures

THE FACILITIES INVOLVED

The site:

The accident site was being operated by a private firm on a parcel of land sandwiched on a military base that had been leased by France's Ministry of Defence. The installation had been subject to the set of regulations governing classified facilities for the destruction of munitions and the operations of an explosives depot; official authorisation was granted by Prefectural order issued on November 26, 1956 (and then modified in 1959).

The facility underwent a pyrotechnic safety inspection on February 21, 1990 by the Armament Division Inspectorate for powders and explosives. The key comments stemming from this inspection focused on:

- the considerable delay experienced compared with regulatory prescriptions on occupational safety and protection inside pyrotechnic installations;
- the need for regularisation on behalf of classified installation legislation for certain categories of activities;
- improvements to be introduced in procedures to ensure technician safety.

A legislative updating procedure was proposed in 1991; the public hearing was held towards the end of 1991. During deliberations, it appeared that the facility was actually located on a parcel that according to the land use plan prohibited classified facilities not directly related to agricultural activities.

In September 1995, the zone's *Mont de Berru* land use plan revision process was initiated, with a public hearing held from January 8 to February 8, 1996.

On September 4, 1995, the classified facilities inspection authorities requested a re-examination of both the safety report and impact assessment study regarding "waste" considerations.

The unit involved:

The rather rudimentary munitions destruction zone contained a series of holes or "furnaces", dug using a power shovel and surrounded on two sides by a barricade (see diagram below).

In order to destroy the ammunition by “setting off”, the company used dynamite. Since such an approach could not ensure the total destruction of munitions packaged in crates, onsite personnel were required to empty the contents into the furnaces and then remove the crates.

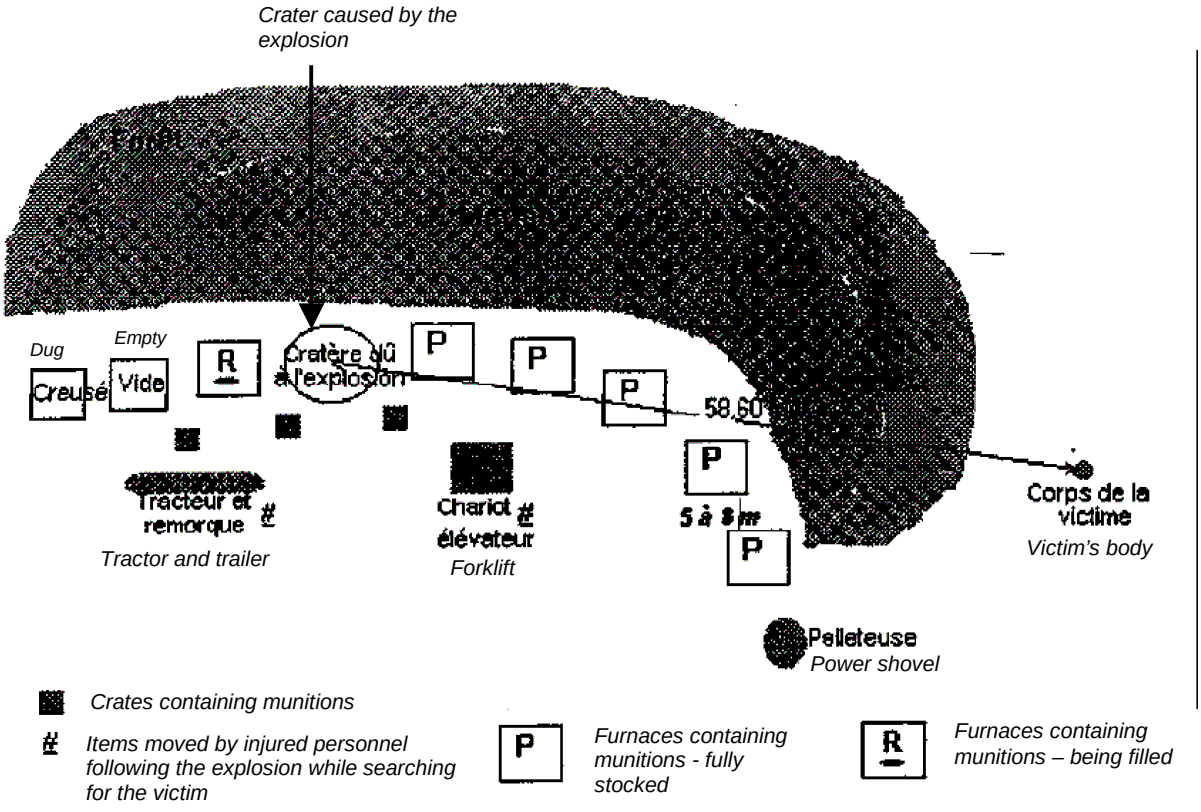


Diagram of the installation
(Source: DRIRE - Regional Directorate for Industry, Research and the Environment - Champagne-Ardenne Region)

These operations, performed by 5 staff members, consisted of preparing the holes and then filling them with the ammunition intended to be destroyed. A technician at the bottom of the hole was responsible for unloading the ordnance (i.e. opening crates, removing contents). Two other technicians would hand to the first one the full crates and then recover the empty packaging at the rim of the hole. The last two employees outside the hole were responsible for stacking the empty crates onto a trailer.

These handling operations increased the risks during preparation of the holes :

- the technician, working at the bottom of the hole, was in direct contact with the munitions and ran the risk of accidentally stepping on live ammunition, to an even greater extent when filling the furnace opening;
- all crates had to be opened and emptied, thus generating a significant shock risk.

Judging from the storage of crates in the vicinity of the furnace being filled, three types of munitions planned for destruction were present on the day of the accident:

1/ Shaped charges packaged in "tall" crates; 24 crates of this type were used in the furnace;

2/ "Boosters" with detonators placed in "flat" crates;

3/ Ignition boosters with detonators also placed in "flat" crates; a total of 13 flat crates were assigned per furnace.

THE ACCIDENT, ITS CHRONOLOGY, EFFECTS AND CONSEQUENCES

The accident:

At the time of the accident, around 3:00 pm, several other munitions destruction furnaces had been prepared. It would seem that the planned quantities for these various furnaces had been exceeded.

A technician was working in the bottom of a furnace that had already been filled with the contents of several tall and flat crates. He lifted the cover of one of the crates with shaped charges when the explosion occurred. All shaped charges contained in the box reacted simultaneously, which in turn caused the munitions already placed in the furnace to explode as well.

The cell phone brought by the team to the handling site was destroyed in the explosion. One of the least seriously injured employees called the rescue services from an adjacent business. The French military police ("*gendarmerie*") arrived on the scene, followed by fire-fighters at 3:45 pm.

Consequences of the accident:

The 46 year-old technician working at the bottom of the hole was killed instantly. His badly mutilated body was ejected a distance of 58 m behind the barricade and over a grove of trees standing 3 m high.

The four other technicians all sustained injuries; two of them were in serious condition. A crater was formed. The bursts struck the ground; the tractor and its accompanying trailer were damaged and the door of a passenger car blown off.

The European scale of industrial accidents:

By applying the rating rules applicable to the 18 parameters of the scale officially adopted in February 1994 by the Member States' Competent Authority Committee for implementing the '*SEVESO*' directive on handling hazardous substances, and in light of information available, this accident can be characterised by the four following indices:

The parameters composing these indices and their corresponding rating protocol are available from the following Website: http://www.aria.developpement-durable.gouv.fr

About one hundred kilograms of explosives would have simultaneously reacted. This quantity represents less than 0.1% of the corresponding Seveso tier (50 tonnes - unclassified explosive substances within Division 1.4 as per the U.N.'s ADR convention), which is equivalent to Level 1 of the "quantities of hazardous materials" index according to parameter Q1; as a result, the overall level of the "hazardous materials released" index reached 1.

Since the explosion led to a death and four injuries, 2 of which were serious, the "human and social consequences" index was evaluated at a level of 2.

Given the lack of information available on environmental consequences, the corresponding parameter was not rated, as was the case for the "economic consequences" index.

THE ORIGIN, CAUSES AND CIRCUMSTANCES SURROUNDING THE ACCIDENT

The shaped charges, stacked on rollers, displayed on one side of the crate fabric braids, which were held in place by a clip that served to "pull the pin" on the charge, thus triggering the charge.

The inside of the crates was padded along the edges by expanded polystyrene. The mine removal unit provided a detailed examination of the contents of one of the crates: the majority of charges whose "heads" were placed against the polystyrene wall padding had lost their safety clip, which when in its proper position holds a "drawer" containing a fuse.

In the safe position, the fuse is offset with respect to the striker. Once the clip has been removed, the drawer spring is actuated and the fuse assumes a position next to the striker. If a half-turn is carried out on the ballasted nylon braid, the striker moves onto the fuse: a shock on the fuse head then triggers the explosion (see diagram opposite, provided by the mine removal unit).

Given the quantities of active materials contained in the shaped charges, boosters and ignition devices as well as the number of crates found near the furnaces during loading, the mine removal unit estimated the loading of each furnace to lie between 60 kg and 80 kg.

SHAPED CHARGE: 155 m/m
CARGO BOMBLET SHELL

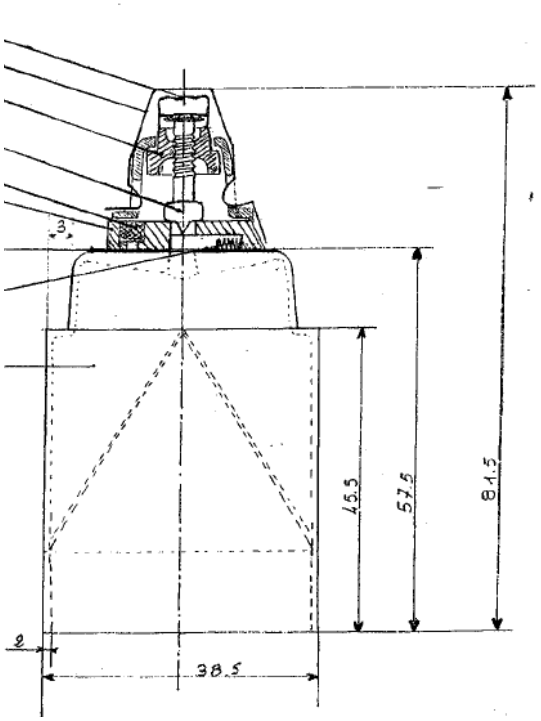
BALLASTED BRAID
SAFETY CLIP

STRIKER HOLDER
MASS
STRIKER

DETONATOR FUSE
FUSE HOLDER
DRAWER

SPRING
FASTENING PLATE
DRAWER RETURN SPRING

EXPLOSIVE



ACTIONS TAKEN

Within the scope of emergency measures adopted to ensure site safety, the mine removal unit detonated the furnaces loaded with munitions that had remained inactive and moved the crates of munitions stored adjacent to the furnaces for destruction on another site.

The hearing found considerable neglect of regulations relative to pyrotechnic safety, especially the absence of any analysis of risks specific to the operations performed, along with the absence of an updated safety study and operating protocol, plus a lack of technician training. The general set of safety guidelines had been placed in a folder located in a room at the site's entrance area.

Both the safety report and pyrotechnic hazard study included as an Appendix to the project conducted in 1991 pointed out that the "unit charges exploded were lighter than 50 kg and buried" (in the furnace). The mine removal team concluded that after site clean-up the remaining charge amounted to roughly 150 kg. The Prefectural order regulating site operations set a total gross weight for munitions destroyed by detonation at 200 kg: this prescription was most probably not respected.

Site activity was suspended by Prefectural order on June 10, 1996 and extended until obtaining a new classified facilities authorisation, in conjunction with an updated safety study and a safety inspection by the Armament Division Inspectorate for powders and explosives. The site was ultimately liquidated as part of a bankruptcy proceeding, with a court order to complete a diagnostic evaluation and pollution clean-up.

LESSONS LEARNT

This tragic accident demonstrates the importance of risk analyses and safety studies for all pyrotechnic activities. These steps prove essential in order to identify risks and implement the appropriate prevention and protection measures (operating procedures, guidelines, individual protections, etc.). A solid organisation is necessary to ensure strict control over use of these types of products.

While progress has been achieved since the 1990's on destruction processes[1], the choice of process remains critical for destruction operations carried out at an "industrial scale"; the application of state-of-the-art rules in this field has served to mitigate the consequences, if not the risks.

Special precautions need to be taken for older munitions, or in more general terms for any "aging" product or object whose characteristics (e.g. stability, sensitivity) might no longer be nominal.

[1] For munitions in particular, industrial "dismantling" is now being promoted; highly hazardous objects are directly destroyed on a case-by-case basis.