Explosion of a shell within a scrap metal recovery company

May 14, 2008

Vierzon [Cher]

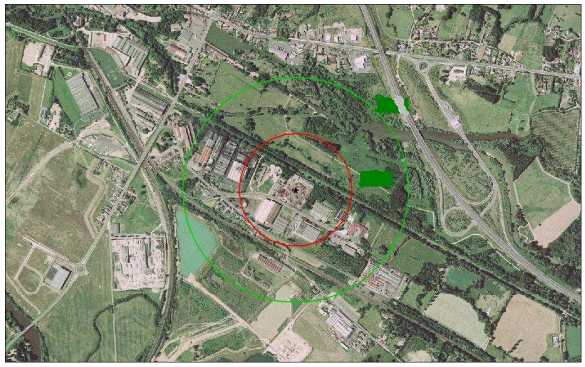
France

Scrap metal storage
Munitions (shells)
Picric acid
Explosion
Organisation / procedural aspects

THE FACILITIES INVOLVED

Accident site:

The site of this accident was a transit facility for ordinary industrial and assimilated waste as well as metal waste, whose transit and treatment requires an authorisation within the scope of the hazardous facility legislation. This facility lies in a relatively low-density industrial zone. The treated waste originated from sources as diverse as industries, commercial activities, local government, public-sector agencies and even individuals; the material is sorted and combined before being recycled or disposed.



The list of products acceptable for onsite processing had been established by prefectural decree. Special instructions were given to prohibit any explosives or munitions to enter the facility; only inert devices and equipment were acceptable.

A sizeable stockpile containing 100 to 200 tonnes of blank shells, discarded shell casings, inert training shells and other non-explosive shells stemming from an array of companies specialised in armament was present on the site, in addition to other products, including shells of unknown origin. Some of these very dated products had been stored at the facility for many years.

Onsite processing consisted of perforating the shell casing with a blowtorch before recycling the metal at a steel mill. The perforation of hollow casings is a necessary step prior to any kind of furnace-based recycling. Non-punctured hollow casings are actually capable of exploding in steel mills through dilatation of the air they hold.

The involved unit:

Two blowtorch cutting stations, separated by roughly ten metres, were set up outdoors amidst four large heaps of shell casings. The accident occurred at the south-western part of the facility, just opposite the compartment where these items had been stored.

For the most part, projectiles are produced by the armament industry (prototypes, manufacturing waste, munitions loaded with inert ballast) and for army firing ranges (training munitions, etc.). Others seem to originate from excavation work (past munitions stockpiles), and a final source could be traced to deliveries performed by other metal processing companies or by individuals engaged in collecting shells of unknown origin. The shell involved in this accident most likely fell into this last category.

THE ACCIDENT, ITS CHRONOLOGY, EFFECTS AND CONSEQUENCES

The accident:

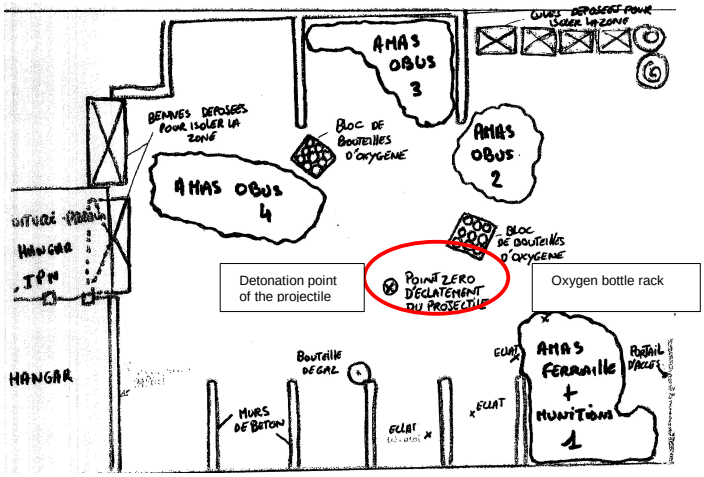
This accident took place on May 14, 2008 around 3:30 pm during perforation at one of the blowtorch stations on a shell separated from its warhead firing device, yet still containing a portion of its explosive charge. According to the Versailles Interdepartmental mine clearance centre, this shell would have been of French manufacture, 145 mm in size (for navy use) and made of steel, year 1916, weighing 27.2 kg with a 6-kg charge of melinite (i.e. picric acid or 2,4,6-trinitrophenol). As for the damage recorded, the mine clearance operators estimated that the shell must have contained between 1/3 and 2/3 of its explosive charge, i.e. between 2 and 4 kg.

It should be pointed out that an explosion had previously occurred at the site on the very same morning around 11 am, with a small calibre shell that caused slight injuries to one worker.

The blowtorch flame with a temperature of about 1,800°C induced a thermal shock in the shell casing. T he detonation point of the melinite was reached at around 320°C: the explosive inside the shell reacted by a partial deflagration, causing the shell casing to burst and projecting picric acid powder onto the victims and surrounding ground (yellowish traces of product could be found practically throughout the entire site). Approximately 20 grams of product would have actually exploded.

Rescue teams were called to the site; the accident scene was secured (removal of propane and oxygen cylinders) and a safety perimeter established. The site access road was closed for a few hours and personnel from the adjacent company had to be evacuated. The shells at the site were all sprayed with water. Since the drainage shutoff system had been activated prior to spraying, no impact was observed in the river running parallel to the site. A psychological counselling unit was set up to provide support for those suffering from shock.

The civil security mine clearance unit arrived on the site during the evening and proceeded with the installation of containers for demarcating a security boundary around the stockpiles and prohibiting access to company equipment and staff (see diagram below). This unit determined that the picric acid traces no longer presented any risk since the acid had been wetted by water poured onto the storage area by both fire-fighters and the subsequent rains.



(Source: Mine Clearance Unit)

(Source: DRIRE Agency)

The safety perimeter was kept in place: personnel access, in compliance with strict security requirements, was tightly controlled and gave rise to a procedural notice distributed to all staff and posted on the premises. It also included the physical extent of storage areas devoted to blank shells, discarded shell casings, inert training shells and other non-explosive shells originating from a variety of local companies specialised in armament.

Consequences of the accident:

One death and two injuries were reported. Two other employees working nearby suffered from shock.

The deceased worker was, at the time of the accident, sitting and relaxing in one of the cubicle areas formed by concrete walls opposite the deflagration point; he succumbed from the blast due to the reverberation of the shock wave on the walls.

The worker who was perforating the shell that caused the explosion was ejected some thirty metres away by the blast. He sustained multiple injuries on his right side as a result of the discharge of debris, in addition to an injury to his right eye. Hospitalised for 9 days, he was issued a two-month leave from work.

A third employee happened to be about ten metres from the scene of the accident, outside the concrete cubicles. He was only slightly hurt by the discharge, without being exposed to a direct hit by any of the shattered shell.

A dozen of shell fragments were found on the site as well as on the city street that borders the facility and on the roof and surroundings of a neighbouring firm. A nearby resident also found one shattered debris on his property, located 300 m from the explosion.

The European scale of industrial accidents

By using 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 the 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

The 3 kg of picric acid released the day of the accident represent less than 0.1% of the *SEVESO* threshold (50 tonnes - hazardous explosive substances in a division other than 1.4 according to the ADR agreement (United Nations)), which is equivalent to level 1 of the "Hazardous materials released" index according to parameter Q1.

It was estimated that a 20-gram load of picric acid exploded, which amounts to level 1 of the index labelled "quantity of material contributing to the explosion", according to parameter Q2.

As a result, the overall level of the "Hazardous materials released" index reaches a value of 1.

Three parameters are applicable in determining the rating level for the index of human consequences: H3, H4 and H5.

Parameter H3 reaches a level of 2, due to an employee death subsequent to the explosion.

Each of parameters H4 and H5 are categorised at level 1, due respectively to a nine-day hospitalisation of one employee (H4), and onsite care having to be administered to another injured employee (H5).

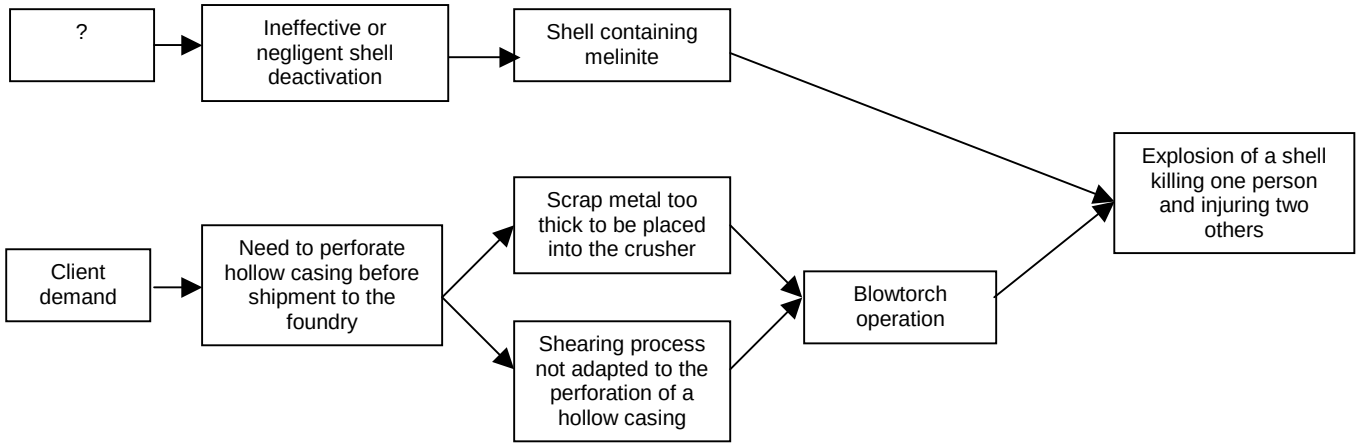
The overall level of the "human and social consequences" index is thus equal to 2.

THE ORIGIN, CAUSES AND CIRCUMSTANCES SURROUNDING THE ACCIDENT

The perforation operation was being conducted by a subcontractor comprising three Turkish workers. The fatal victim had been hired by this firm just a few days prior to the accident, yet did have previous work experience with this same employer under a different identity at the Vierzon facility.

Within the scope of work performed at this site, the operator did not verify the skill level possessed by the subcontracted personnel; moreover, the object cutting procedure was not communicated to any of the assigned individuals and no hot work permit or emergency response plan had been produced. The operator therefore had not correctly assessed the risks relative to these operations.

The company had circulated an internal instruction for cases of shells found in batches that had not been produced by the armament industry. This instruction included guidelines on how to secure the perimeter and notify the hierarchy, who in turn would call in the mine clearance unit. In all likelihood, the subcontracting firm had not been informed of this instruction. Even if the subcontractor knew the procedure, it is not certain that the blowtorch operator would have been able to recognise a non-inert shell. It should be noted that this instruction had not been applied during the morning accident.



Tree diagram of causes proposed by the facility operator, who did not list establishing the fire authorisation or verification of personnel skills or credentials, since the operator felt that neither the hot work permit nor the blowtorch specialist's credentials could have allowed anticipating the presence of a pyrotechnic product in a stockpiled shell.

The exact origin of the fatal shell remains unknown. It could not, however, have been produced by regional armament plants, which always deliver inerting certificates with objects to be recycled by this scrap-metal recycling company.

FOLLOW-UP STEPS

A prefectural decree imposed several emergency measures: definition and layout of a safety perimeter around the shell stockpile; implementation of access restrictions inside this perimeter; quality control and discharge of confined water subsequent to the intervention of emergency services; submission of an accident report specifically indicating the accident circumstances and causes as well as personal and environmental effects; measures adopted or anticipated in order to limit the potential of another similar accident; and the set of actions implemented for site cleanup.

The hazardous installations inspectorate noted the facts and highlighted the lack of compliance with a number of orders contained in the prefectural decree certifying facility authorisation, including:

- the onsite presence of at least one explosive waste item,
- no granting of a fire permit for operations involving the use of a blowtorch,
- absence of controls on both the training and qualifications of personnel called to work onsite,
- failure to pursue an independent company certification procedure,
- continuation of company activities following the explosion occurring the very same morning, neglecting to notify the appropriate public agencies (mine clearance unit or local gendarmerie -French military police-) even though an explosive device had been discovered on the site.

An external company was called to the site on the morning of Friday, May 16 to clean with water jets all picric acid traces on both the ground and the shell heaps. The water sprayed was recovered in containers and transported onto a transit site for subsequent treatment.

An exceptional meeting of the company's occupational safety, health and working conditions committee was convened on May 22 at 4:30 pm, during which the incident the same morning was confirmed.

The observations recorded by the mine clearance unit do not allow rejecting the onsite presence of other non-inert shells. A systematic inspection of the entire stockpile had to be carried out prior to any resumption of activities at the part of the facility inside the safety perimeter. A verification action programme covering all shells was submitted to the appropriate authorities in October 2008. Such a procedure, which requires securing the site during verification activities (with evacuation of personal during sorting operations), is to last several months.

An additional prefectural decree mandated:

- conditions relative to the verification and sorting of stockpiles contained inside the safety perimeter,
- if applicable, a sampling campaign of onsite soils in order to verify the absence of residual pollution,
- limitation of the maximum authorised duration of waste and scrap metal storage to avoid accumulating several years of stockpile at the site,
- improved traceability of objects with, at the very least, a separation of military and munitions type products.

On 18/04/2012, both the company and its sub-contractor were fined respectively 100,000 and 10,000 euros. The site director and manager were sentenced to 6 and 18 months suspended sentence and 80,000 euros in damages are to be paid to the victim's parents, as well as 3,000 euros for trade unions that associated the court action.

THE LESSONS LEARNED

One of the key points that had not been resolved at the time of this accident concerns the source of the exploded shell. Given the age of the site and the multiple sources of scrap metal supplied, shell origin could not be determined. The particular object might have been lying in a batch of metal from various and inadequately-referenced sources. These facts underscore the poor management practices in place regarding waste flows within the company; this lack of adequate documentation on the traceability of objects arriving at the Vierzon site, particularly their origin, would need to be revised.

This accident exposes a number of organisational deficiencies in the company and moreover in its relations with subcontractors, namely:

- poor delegation of individual responsibilities with regards to accident prevention, especially concerning subcontractors,
- lack of information or training for subcontracting personnel,
- absence of risk analysis targeting the type of works performed,
- failure to implement any procedures, instructions or operating protocols specific to subcontractors,
- no process for incorporating or utilizing feedback (the morning accident, which was rather similar, had been ignored).

In conclusion, this accident highlights the need for a distinct industrial sector devoted to the recycling or destruction of munitions in order to avoid mixing "scrap metal" of diverse origin, which may be quite hazardous and for which risks must be studied and sources thoroughly investigated.