Explosion in a cartridges-filling workshop

July, the 30th, 2002

Burbach-Wurgendorf

Germany

- Pyrotechnics
- Dynamite
- Cleaning
- Raw material quality
- Victims
- Property damage
- Process
- Organisation / inspection
- Expert evaluation

THE INSTALLATIONS IN QUESTION

The accident took place in a plant where cartridges were filled with gelatinous explosives. The plant was subject to license according to the German Federal Immission Control Act and part of an upper tier Seveso II-establishment. The operator had to fulfil the extended obligations of the German Regulation on Major Accidents (Störfall-Verordnung, the German implementation of the Seveso-II-Directive). A safety report had to be drawn up.

Due to the German Explosive Law which does not allow any endangered objects in the neighbourhood of such plants the establishment is located in a woody country far away from any residential districts.

The cartridges are produced by using a “Rollex-Machine”. The explosive (25 – 30 % ethylene glycol dinitrate, 60 – 70 % ammonium nitrate and < 2 % collodion wool) for a batch reaches the feeding hopper of the Rollex-Machine. Several explosion interruption devices are installed to prevent any propagation of explosions. From the hopper the explosive is metered to a conveying belt where it is distributed and drawn-out to a fleece. A portion of about 0,4 kg is pressed into a cell of the Rollex-Machine and rolled up with paraffined wrapping paper. After closing at both front sides the cartridge is thrown to a conveying belt. Rolling up and closing of the cartridges take place in the turrets of the Rollex-Machine.

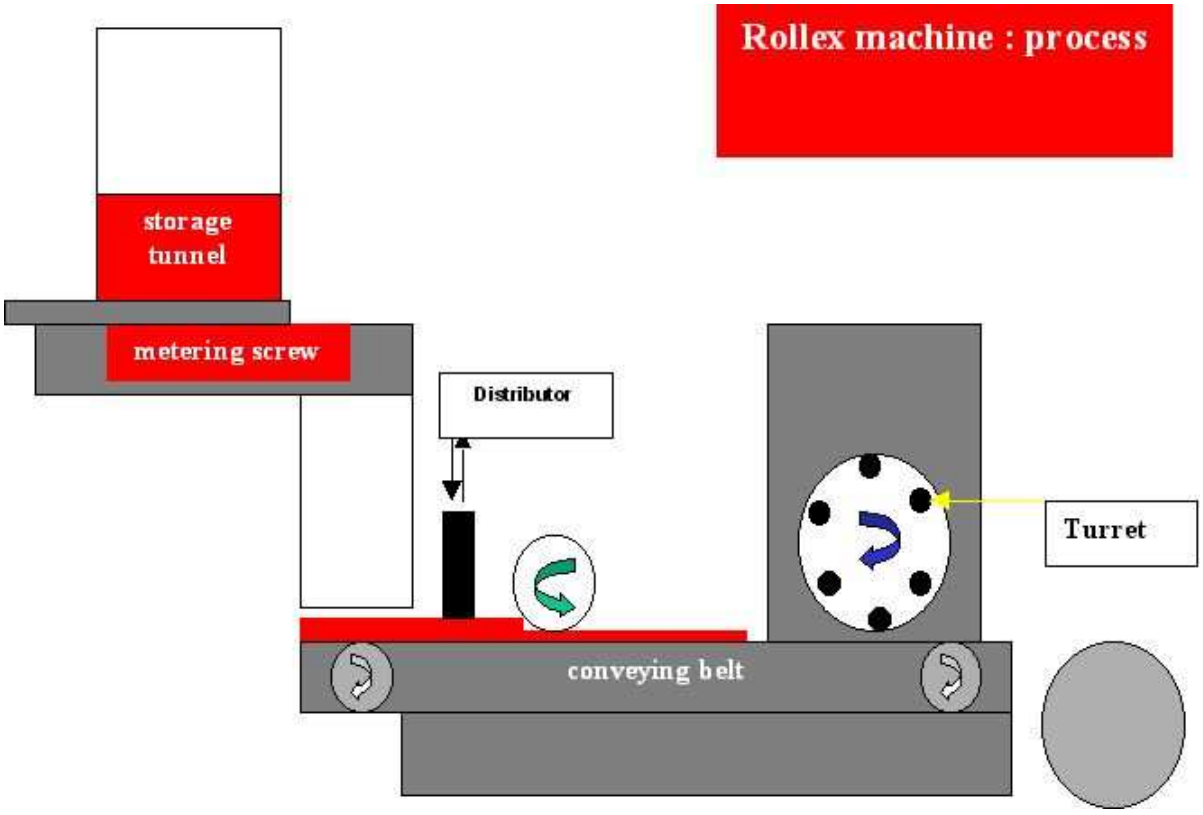

Schéma : R. D.

Till the day the accident happened several process steps especially during starting procedure had been executed in a manual mode. The employee had to stay at the machine for doing necessary adjustments till it was working in a sufficient manner.

THE ACCIDENT, ITS BEHAVIOUR, ITS EFFECTS AND CONSEQUENCES

The accident

On July, the 30th, 2002, at 12:35 h, the accident took place in the building where the Rollex-Machine was placed. About 90 kg explosives were involved. In the moment of explosion only one employee was working at the machine.

Photo : R. D.

The consequences

One employee surveying the process was killed: The body was found in a distance of 20 m from the place of explosion, his arms were ripped of and the body showed heavy injuries at his back as well as various fractures.

Additionally, the accident led to heavy damages by blasting debris and overpressure up to a distance of 120 m from the place of explosion.

Photo : R. D.

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The accident led to the following consequences :

- ✓ The ceiling of the building was completely demolished
- ✓ The Rollex-Machine was encumbered by earth
- ✓ Building fragments were being distributed within a radius of about 20 to 30 m.
- ✓ Some fragments were thrown to a distance of 150 m.
- ✓ Other fragments of the Rollex-Machine were found inside the destroyed building and in a distance of about 15 m from the place of explosion.
- ✓ The estimated cost of damages is about 0,5 Millions of euros.

European scale of industrial accidents

By applying the rating rules of the 18 parameters of the scale made official in February 1994 by the Committee of Competent Authorities of the Member States which oversees the application of the 'SEVESO' directive, the accident can be characterised by the following 4 indices.

The parameters that comprise these indices and the corresponding rating method are available at the following address: http://www.aria.ecologie.gouv.fr.

The 90 kg of dynamite represent 0.18% of the corresponding Seveso threshold (50 t – explosive substances classified in a division other than 1.4 as per the European Agreement Concerning the International Carriage of Dangerous Goods (ADR) (United Nations)), which equals level 2 of the "quantities of dangerous substances" rating per parameter Q1 (Q1 between 1 and 10 times the threshold).

Parameter H3 of the "Human and social consequences" index is rated as level 2: 1 employee was killed (H3 = 1 death).

The €15 parameters of the "economic consequences" index is rated as level 2: the amount of property damage (€15 between 0.5 M€ and 2 M€).

ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

To find out the causes leading to the accident an international commission of experts and also the German Federal Institute for Material Research and Testing (BAM) carried out detailed investigations. Unfortunately the reason for the accident could not be identified free from doubt. Nevertheless a lot of circumstances and observations led to the identification of some possible reasons

The circumstances

Most likely immediately before the explosion took place the employee was carrying out the following actions:

- ✓ Putting explosives on the conveying belt.
- ✓ Cleaning of components with a wire brush
- ✓ Cleaning of the Rollex-Machine with compressed air
- ✓ Pulling out three "waste trays" that were placed under the "Rollex-Machine" and giving the explosives caught with a plastic shovel into a waste container or back to the conveying belt.

The injuries of the employee led to the conclusion that he had died immediately due to the shock wave. They also show that in the moment of the explosion there was no direct contact between employee and explosives. The distance between the source of the shock wave and the victim was most likely more than 1 m. The investigators gave their opinion that the explosion event did not result from negligent actions of the employee.

The hypotheses

Finally the investigations led to two possible causes of the accident which were taken into account:

✓ Faulty explosive:

Special tests carried out with a sample of the explosive didn't lead to any indications concerning the cause of the accident. There were no deviations found from the values fixed for the composition of the explosive by the explosives permission. So a faulty explosive as accident cause came out of the question.

✓ Dangerous stressing

The explosive involved in the accident is very sensible to any mechanical stressing especially by impacts. Such stressing may occur due to :

- Impurities like slack parts of the machine, tools, etc,
- Parts of the machine failed due to fatigue or ageing processes
- Particles of ceiling dress or from the suction,

which could be able to ignite the explosive in the Rollex-Machine.

It was decided that more detailed investigations concerning the cause of the accident were speculative. So the whole production process had been evaluated by a fault analysis and appropriate measures had been taken.

ACTIONS TAKEN

Though it was impossible to find out the exact cause of the accident various measures were suggested by the expert group and implemented by the operator before restarting the production. These measures firstly have got the aim to prevent the input of impurities or foreign substances into explosives and raw material and secondly to guarantee the absence of any persons during the process of producing cartridges. In detail the following measures were taken into consideration :

✓ Preparing the raw material:

- -Now ammonium nitrate will be discharged from wagon or big bag to a closed pneumatic conveying system.
- There will be weekly inspections of screens for wood dust and wheat grit bran with regard to foreign substances.
- The conveying trays are covered with tightly closing tarpaulins.

✓ Mixing process:

- The ceiling construction in the belt tunnel has been cleaned and repaired. The free belt region was covered with domes and network. Additionally metal sensors have been installed at the end of the conveying belt before the raw material passes the closed vibration channel. Now there will be weekly inspections of ceilings, domes and networks.
- Tunnels and feeder regions are lined by fine-meshed network because in this region carriages are without covering.

✓ Explosive feeding to the building where the cartridges are produced:

The number of persons with permission of admittance is reduced.

✓ Producing cartridges in separate buildings:

- There is no more presence of any persons if the machine producing cartridges works also during starting and stopping. The entrance of persons is only for cleaning and repairing in the case the plant is out of action. This is guaranteed by key-operated switch and locked entrance regions.
- Critical combinations of materials like metal on metal will be prevented in the future to avoid ignition sparks.

✓ General measures for all process steps

All fixing elements in the installations which are able to contaminate the raw material or explosives in the case of detaching or falling down are secured.

There are safety rules created for employees concerning body decorative. Especially only clothing without pockets is allowed.

In the future an inventory of all tools and devices will be drawn up. All tools and objects which are brought into the buildings by craftsmen are registered. After finishing of an operation there will be a check whether all tools and objects have been taken from the plant or are installed (principle of surgeon).

LESSONS LEARNED

As a conclusion, the main principles resulting from the lessons learnt could be the following ones:

✓ Whatever the level involved, avoid the occurrence of creating a contamination of raw materials and explosive substance : use of covering devices (closed conveying systems, tarpaulins, fine-meshed network,…)

✓ Implementation of checking systems concerning polluting materials : regular and frequent inspections on installations and above all of fixing elements in sensitive areas, rules for employees,… For instance, the safety rules concerning the entrance of various materials in sensitive areas are very strict and harshly checked.

✓ If possible, use of materials involving no risk of critical contact such as metal / metal one.

✓ Implement devices on the machine able to avoid any human presence, even for adjustments, stopping or restarting steps.

✓ Reduce or even forbid the entrance to sensitive areas (even workshops in connection to the producing building or feeding tunnels)

✓ For this purpose, use locking devices (key-operated switch and locked entrance) in order to call the attention of surveying agents.