Risks in detonator loading operations (manual and automatic). Most relevant safety aspects.

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Introduction

Loading detonators involves handling of primary explosives and, therefore, poses a substantial risk of explosion. Manual loading implies relying on the operator and requires a great amount of continuous training, whilst automatic loading demands the existence of a qualified maintenance service, not to mention the adequate design of the machine.

In both cases, the isolation of the operator from the hazardous area is of paramount importance, pressing operations being the most likely to engender an explosion, triggered by any malfunction of moving parts of the machinery.

For that reason, any operation involving repairing or cleaning inside the machine has the characteristic of exposing the operator to an accidental explosion. Although being unlikely, the occurrence of such an event would have very severe consequences upon the affected operator, due to the combined effects of both the confined blast and the projections from a short range.

Years of detonator manufacturing have led to achieve a considerable experience in this field and gather useful information to prevent accidents. This presentation contains hints to help improve safety and develop work procedures.

GENERAL REVIEW OF THE SCHEME OF LOADING

The BASIC POINTS to define the process regarding safety are:

- Safety parameters (sensitivity to: friction, impact, static charges)
- Maximum quantities allowed on each step of the process
- Acceptable exposure (likelihood and severity) remote operations… when?
- Foreseeable operations (included in standard procedure)
- Unforeseeable operations due to incidences (management of the new hazards

And the main chapters in which a loading process can be divided are:

- TRANSPORT OF DRY BULK EXPLOSIVE
- DOSIFICATION INTO THE SHELLS
- PRESSING OF THE EXPLOSIVE INSIDE THE SHELLS
- TRANSPORT OF LOADED SHELLS

In our estimation, the previously mentioned points are sufficiently covered in publications such as the REFERENCES OF CODE OF GOOD PRACTICE IN FEEM p19. However, for this presentation we would like to focus on some very practical aspects of the loading practice that, in our experience, gather most of the existing hazards.

- Cleaning.
- Incident solving.
- And the importance of some details when designing those installations.

Cleaning methods

In the following lines, we will develop the application of the codes of good practice in three real cases of the facility of loading of detonators

- Ordinary cleaning of the facility
- Cleanings requiring dissembling of tools
- Cleanings requiring dismounting of structures

Ordinary cleaning of the facility

When devising the cleaning procedures it is important to point out that solvents must not be applied by means of compressed-air gun. This would have two undesirable effects: the buildup of static electricity and the dispersion of dust.

It must be very clearly stated that cleaning is not to change the location of the dust but to dispose of it. Some cleaning methods can apparently solve the problem by making the dust disappear from the desired surfaces but the fact is that we change one known location of dust by an unknown one. With regard to this it is worth bearing in mind that some surfaces such as concrete can conceal innumerable microscopic hollows where the dust can remain undetected for a long time, increasing its amount with successive cleaning shifts.

The cleaning liquids must be applied gently and to make sure they don`t spill. Once the dust is desensitized by the application of the liquids it can be picked up in rags.

The typical hazards are:

- The rags get dry before they have been safely disposed of. When the liquid vaporizes, the explosive now present in the rag recovers its initial sensitivity.
- Dust particles are dragged by the liquid itself and can be concealed between surfaces, remaining inaccessible and getting dry after a while. Any subsequent attempt to repair, remove, unscrew, etc. will pose a risk of initiation.

When cleaning with volatile products, breathing protection is strongly recommended. It must be regarded that the application of chemical products to reduce the likelihood of initiation increases other hazards such as hygienic exposure. Sometimes, the places where the products are applied make it difficult the use of localized extraction. The use of personal protection equipment is mandatory.

The removal of traces of explosive dust by means of vacuum can be an advantage and also pose a risk of explosion. If correctly designed, vacuum cleaning systems can assure an in depth cleaning but it must be regarded that the particles of primary explosive must be treated gently so as to avoid initiation. Some parameters such as particle speed inside the aspiration pipes and geometry of the pipes themselves must be taken into account. Water injection can be advisable and, of course, keep the recovered explosive in a vessel with water. Aspects as disposal are also affected by this design.

Cleaning requiring dissembling of tools (Lead Azide Hoppers and dosing plates with primary explosive)

Dosing plates in which explosive is present. The extraction must never be performed by hand. The likelihood of initiation in case of excessive friction is not acceptable. Remote extraction devices must be implemented (for instance, by a pneumatic cylinder).

When the extraction of the hopper itself can be considered a risk operation (closed space, size and weight) a guided system can be developed, offering the following advantages:

- No need to hold the weight and, consequently, easier performance of the task. This allows focusing on other aspects of the operation and being more accurate.
- The risk of accidentally dropping the hopper disappears.
- Reduces the likelihood of hitting the inner walls of the machine with the edges of the hopper and the consequent friction.
- Finally, if an ignition took place after all, the shield would protect the operator both from overpressure and shrapnel.

Cleanings requiring dismounting of structures

Frequency of cleaning accessible surfaces must be complemented with the cleaning of those that need previous removal of attached parts. It must be understood that this second cleaning engenders a hazard by itself.

Hence, the need to establish a rational balance in the frequency of cleaning: a trade-off between the expected quantity of concealed product and the cost and risk taken during the operation.

It is vital to identify beforehand those tasks that will pose a higher risk, in order to issue a procedure regarding the safest way to carry them out.

Examples of these measures include remote devices to cut or unwind nuts or jacks placed between surfaces to be removed.

Sometimes, when designing a cleaning-dismantling operation, it is necessary to determine beforehand which parts of the structure will be cut remotely and which ones will be removed and unscrewed in presence of the operator.

In these cases it is vital to regard aspects such us the degree of the personnel protective equipment (related to the expected severity in case of initiation) and the use of products to reduce sensitivity or destroy chemically the present traces of explosive (related to the likelihood of the initiation)

Incident solving

- Extraction of blocked punch out of the matrix

A good example of incident solving that poses a hazard of initiation is the case in which a punch gets stuck inside the shell during the pressing process.

The range of variability of the possible situations makes it really difficult to foresee an accurate procedure. Therefore, only general recommendations can be given and the adaptation to the specific requirements of each case rests on the experience of the supervisor. Sometimes, before attempting to solve the incident, word is sent to the OH&S department and a written procedure is issued for that specific case.

- Foreign bodies

An important source of danger of explosion is present when, accidentally, small undetected objects go inside the shells which are subsequently loaded with explosive and pressed by a punch. Depending on the nature of the foreign body the blast will take place or not. What can be taken for granted is that some kind of problem will arise from such a situation.

Several methods (optical or mechanical) can be implemented to avoid this situation. In automatic loading, the same system can be used to assure several necessary conditions, such as:

- Presence of shell
- Correct position (not upside down)
- Absence of foreign body

Some design tips

The stage of workstation design is the first step to a high safety standard in detonator loading. Some tips to be considered, prior to the construction of the machine or equipment, are:

- Avoid sharp surfaces against which friction can take place when removing parts of the equipments such as loaded hoppers. Dissembling procedures (for cleaning at the end of the shift, for instance) must be conceived to minimise handling of vessels containing primary explosives.

- Avoid places where dust can get inaccessible. The process of hopper loading and shell pressing will inherently engender the presence of explosive dust. The design must be thought to allow this dust to be landed on clean, obstacle-free surfaces, in order to help its consequent cleaning afterwards. Air pipes, pneumatic pistons, screws and nuts of any kind must be as far from the dust-generation places as possible.

- Blast endurance. One vital aspect when designing a workstation is to make sure that an accidental explosion will not extend its effects beyond the perimeter of the machine. Physical barriers, even those supplied by the manufacturer, may not have the required endurance. In some cases, real tests may be required.