Lesson Learned from Black Powder Accident

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Abstract:

MAXAM suffered an accident in the Black Powder Manufacturing site located in Kunigunde (Germany) in October 2018.

Several Lessons Learned came out of the incident, but the one we would like to share with the rest of SAFEX Members is the management of "human" safeguards.

The paper discusses what is considered a "human" safeguard and the methodology applied in MAXAM to value the protection offered by those safeguards and to measure it effectiveness.

Introduction:

MAXAM have a production plant for Black Powder located at Kunigunde (Germany). This facility has been operated by WANO Schwarzpulver GmbH since 2007, but has been producing black powder since 1682.

The main production of black powder is for blasting, fireworks, sporting and military.

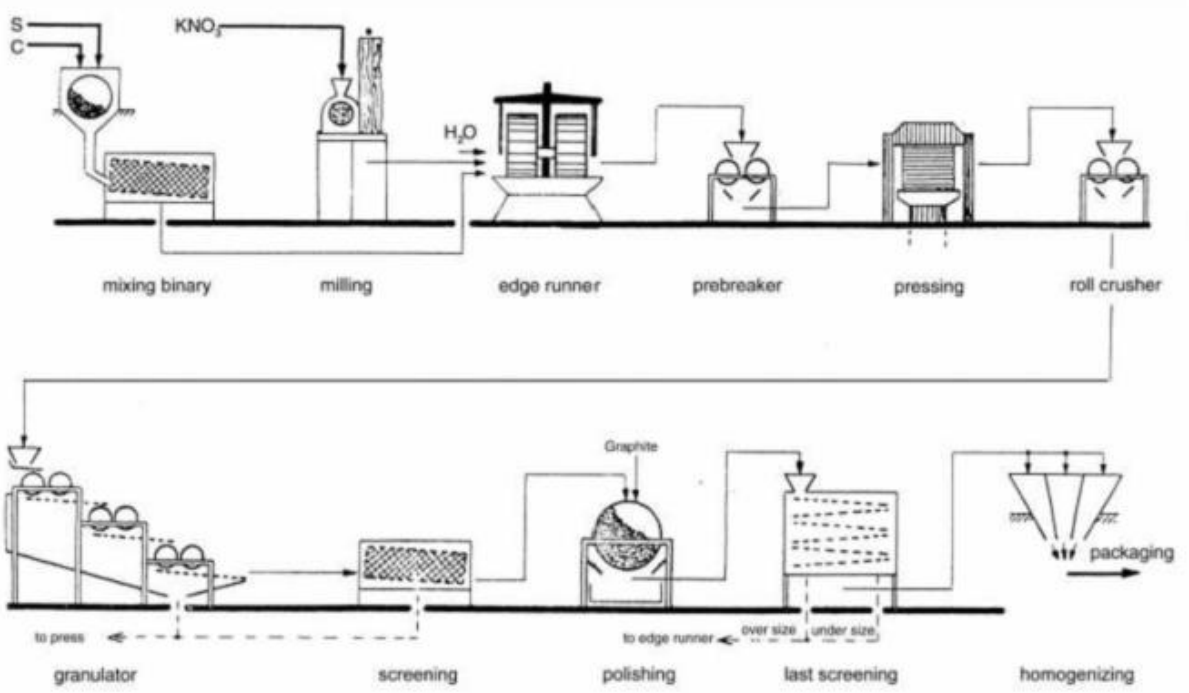
There are around 60 buildings in the facility that contain equipment for the black powder production. This equipment includes granulators, roll crushers, edge runners, ball mills, polishing drums, extruders, etc.

In October 2018, a fatal accident happened in Wano facilities, 6 months after the last revision of the process hazard analysis of this production. One of the actions established after the accident triggered a new revision for the PHA methodology and the consideration of the administrative safeguards in this process.

Main Body:

A. Accident Description

The production process for black powder is resume in the following scheme:



At 8:45AM (local time) on October 26th, 2018, an initiation took place in the building 55/2 where the roll crushing of pressed black powder is done before the granulation.

At that time of the initiation 200kg of black powder were inside the building that deflagrated.

A worker was caught by the deflagration suffering severe burns. It was not possible to be sure if the roll crusher was running or not in the moment of the initiation.

The injured person was found inside the building, near the entrance door.

Because of the deflagration, the weak wall completely burst and the equipment in the room was severely damaged.

Building 55/2 after the accident

B. Operating practice in roll crusher

The process in the roll crushing includes the following steps:

1. The compressed dry blocks of black powder coming from the press are transported to the roll crushing area in plastic (HDPE) boxes in a wooden trolley pulled by the worker; the trolley has a total of 200kg of black powder in 8 boxes.
2. Then once the trolley is parked inside the building, the worker picks up a box with around 25kg of black powder, climbs the stairs and places the box in the table of the machine.
3. Two or three blocks (estimated 15-20 Kg; not possible to put more) are then placed in the wooden feeder of the roll crusher manually, to be crushed into pieces of 30 mm.
4. The crushing process is then done in safe conditions as it starts when there is nobody inside the building (the worker presses a "dead man's button" from outside of the building: the machine start-up when the operator presses the button and stops when the button is released).
5. The small grains flow into another plastic box; when the first box is empty, the box in the floor with the crushed black powder is then put in the trolley.
6. The process is repeated until the 200kg are crushed; it is then transported to the next phase of the process.

The change is done by pressing two buttons in a near room; no access control to these buttons was in place. Interviews with the personnel indicates that all operators of the area know how to change the operating mode.

The Work Instruction only contained the risks and preventive measures that need to be addressed, not all the details in the working steps.

There is a PHA analysis done in March 2018 applying What If methodology.

- For the roll crushing area, the hazards considered included the initiation of the black powder due to the presence of foreign bodies, dust deposit on hot surfaces, faults in the electrical installation, electrostatic discharge by operators, tools or equipment and black powder in contact with overheated motors / bearings / rotating parts.
- As safeguards / mitigation factors / barriers the following was considered: the fact that the crushing operation is to be done without human presence, the regular cleaning following work instructions, electrical installations IP5x, mandatory anti-static and thermal protecting working clothes, electrostatic conductive safety shoes including monthly test of safety shoes, earthing regular lubrication.
- All risks were evaluated as trivial or acceptable. No corrective actions were identified as needed.

After the accident, an internal analysis and investigation process was initiated: 8 MAXAM experts were involved in the accident investigation, safety assessments and developing the internal action plan.

The internal action plan includes **43 safety measures** (immediate, medium- and long-term actions) and was put in place the week after the accident.

One of these measures was related with a deep review of the PHA methodology and the fact that many of the safety measures proposed during the analysis as risk reduction factors didn't work during the chain of events that resulted in the accident.

C. PHA Methodology Review

The MAXAM guide for PHA apply a simple formula for calculation of risk level of certain event / scenario. This formula considers four parameters to calculate final risk magnitude of the event:

- Severity (S)
- Probability of the cause (P)
- Safety Protection Level (SPL)
- Mitigation Capability (M)

RISK MAGNITUDE = (S x P x SPL) / M

S and P are parameters selected based in description of event / potential consequences.

SPL / M are parameters directly linked with safeguards selected as protection against the scenario.

MAXAM PHA guide establish different levels for these parameters that shall be selected during session for each scenario analysed.

After the incident and the review of the PHA was done, it was concluded that all the safeguards selected in the scenarios for the roll crushers (and many other manual operations) were of human nature, related always with the final action of a person instead of any physical device that could be activated automatically which implicate constant presence of the operator.

SPL / M parameters didn't discriminate between Physical safeguards and Administrative safeguards (procedures, PPE's, etc) and give same credit for both. Also, description of different levels only applies to physical devices, especially in the case of M.

The changes proposed in the methodology result in a better understanding of the real risk reduction that administrative safeguards can offer and reflect a discrimination of these against physical safeguards.

After the review, following changes were implemented in the guide:

- In scenarios where SEVERITY level selected is equal or higher than 40, that's considering more than 1 death, administrative safeguards will not be allowed for selection. This modification tries to prioritize better and intrinsic safer designs.

- In scenarios where SEVERITY level selected is 15 or below, that's considering maximum 1 death due to the scenario, administrative safeguards are allowed but with a several minimum requirements to achieve certain levels of SPL / M. In any case, one administrative safeguard never can reach the same level of protection that a physical level. These requirements and maximum levels allowed are describe in following table:

PARAMETER	TYPE OF SF	Min. Req. to select this level:		
		PARTIAL	NON-ADEQUATE	NON-EXISTENT
SPL	SOP / PPE	SOP that cover: - Specific hazards - Indicates preventive mesures - Include detailed description of different phases / steps and defined PPE's - Last revision was less than 3 years (or after an incident)	N/A	If don't comply with the previous one
M	SOP / PPE	a) Competences; assigned personnel to the position shall receive Refreshment training in the SOP every 3 years (or when SOP update / changes) **&** b) Task Observations (TO): yearly plan of the workplace – minimum 2 TO/year for this SOP or 1 TO of the SOP by operator / year if several operators cover the process under analysis.	**<u>If only complies with:</u>** a) Competences; assigned personnel to the position shall receive Refreshment training in the SOP every 3 years (or when SOP update / changes)	If don't comply with the previous one
M	PPE (additional)	a) Clear PPE category / rules of use / conservation / maintenance protocols (& calibration when applicable) described / available **&** b) Personnel shall be re-trained in those protocols every 3 years (only when applicable).	**<u>If only complies with:</u>** a) Clear PPE category / rules of use / conservation / maintenance protocols (& calibration when applicable) described / available	If don't comply with the previous one