Contractor management and employee awareness in transportation of explosives and hazardous raw materials demonstrated on two incidents (booster, MMA (monomethylamine))

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INTRODUCTION

By means of two incidents the importance of contractor management and employee awareness in transportation and related material handling and the challenges with contractor management will be demonstrated.

Incident 1 describes a leak of MMA while unloading a trailer tank. The (long term) contractor that uses these tanks solely for transportation of MMA conducted a repair on the tank inside (that included welding) without following the cleaning procedure. Welding cinder contaminated a gasket that contributed to the leakage. Auditing and improved contractor control (independent inspections after repairs) could prevent such incidents and hazardous situations.[2]

In the second incident, a cardboard box containing boosters was punctured during road transportation due protruding bolts on the trailer tailboard and inappropriate load securing. The protruding bolts were the result of a repair done by the contractor not following the required standards for carrying of hazardous material. A sloppy checklist control of the trailer and poor load securing contributed to this incident. The incident occurred in a lowly regulated country regarding transportation of dangerous goods and almost no road traffic control. As a common practice, cardboard boxes or bags are directly loaded and stacked into the trailer without the use of wrapped pallets and direct contact the inner walls of the trailer.

One of the learning points is to go beyond the boundaries where own high (safety) standards are applied and not only to agree on terms and conditions of a contract, but also to support and guide contractors that do not have expertise in the particular field of the hazards of explosives and its precursors (e.g. the contractor carrying boosters was aware that the trailer has to be closed all around and did the repair to his best knowledge, but has no perception about the potential consequences of a friction/impact event).

INCIDENT 1

This incident had been reported to SAFEX and a full investigation report is available under IR 874 AUSTIN.

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[2] A similar incident occurred when a contractor was using incompatible material for a gasket on a safety relief valve of an MMA tank that was replaced as part of regular maintenance. After 18 months of operation, an MMA leak through the safety relief valve occurred due to reaction with MMA and decomposition of the gasket material. This incident has also been reported to SAFEX (IN32-13).

MMA (monomethylamine) is the raw material used for the manufacture of MMAN (monomethylamine nitrate). MMAN is manufactured by nitration of MMA and is the main ingredient in the manufacture of watergel type explosives. Liquid MMA is unloaded from tank trailers at the site and transferred into storage tanks. MMA is highly flammable and toxic.

The hose and valve arrangement for unloading the MMA is illustrated in the following photographs.

***Picture 1**: MMA unloading area with tanks and unconnected discharge hoses*

***Picture 2**: Tank trailer discharge valves (one for each chamber)*

Incident Description

The unloading process of MMA had been interrupted. On recommencing the operation, the operator in charge checked the couplings of the discharge hose between the tank trailer and the MMA storage tank. He detected a MMA leak at the tank trailer's discharge valve hose coupling. On adjusting the connection manually, the leak worsened. The operator alerted the supervisor of the watergel plant that a MMA leak had occurred at the bottom of the MMA tank trailer. The supervisor ordered all MMA shut-off valves to be closed and to switch off power to the equipment in that area. At the same time he activated the site evacuation plan and all personnel were evacuated.

Incident Causes

A couple of days before the incident, the unloading process from the tank trailer into the storage tank had been interrupted as the maximum filling level of the storage tanks had been reached. Contrary to the operating instructions, the discharge hose remained connected between the tanks with all valves closed. The operating procedure requires the hose to be disconnected and a male plug to be inserted on the tank discharge valve until such time as the hose needs to be reconnected.

The tank trailer (owned by the forwarding agency and used for transport of MMA only) had been on repair prior to be refilled with MMA for delivery. Due to ageing of the welding joint between an internal stabilizer bar and the inner wall of the tank, the joint had to be re-welded. This was done by the tank owner. Even though the tank had been prepared and cleaned properly prior to welding, it appears that cleaning of the welding area had not been done properly after completion of the job. Small particles of slag remained inside the tank

close to the discharge valve outlet. These particles entered the Teflon gasket of the valve where they accumulated (Picture 4). As a consequence the gasket sprung a leak.

Furthermore, the operator in charge of the initial unloading failed to tighten the connection from the discharge hose to the tank trailer valve correctly. There was a quarter turn missing for complete closing which caused the MMA inside the discharge hose to leak slowly to the atmosphere. On detecting the leaking MMA prior to restarting the unloading, the operator loosened the connection even more as he manually checked the connection.

The coupling arrangement is illustrated in the following photographs:

***Picture 3**: Hose coupling*

***Picture 4**: Dismantled gasket showing slag particles that contaminated the Teflon sealing*

In summary, the incident can be described as a three stage event:

- The repair of the weld on the tank trailer was not completed properly. Slag particles entered the gasket of the discharge valve and compromised its sealing function.
- The operating instruction to disconnect the discharge hose when unloading is interrupted was not followed. This was made worse by the coupling not being tightened properly.
- MMA leaked passed a gasket which did not seal properly and collected in the discharge hose from where it was released into the atmosphere through the loose coupling.

INCIDENT 2

During the transfer of Explosives from Costa Rica to Panama, a box with 1 lb Boosters was punctured by 4 screws which were exposed on the back door of the transportation truck. Truck and trailer are owned and operated by a long term contractor authorized to haul explosives.

While loading the trailer with explosives, the boxes of 1 lb Boosters were placed in the last row behind pallets with 1.5 D product (packaged emulsion explosives) with no additional load securing for the stacked boxes with boosters. During road transportation, the upper rows of boxes started to shift and boxes slid towards the back door of the truck during transportation. There was enough space between the secured pallets and the back door for boxes to fall to the trailer bottom and become jammed between the full load and the back doors (Pictures 5 and 6).

One wing of the trailer back doors had been previously repaired by the forwarding company and a steel plate at the bottom of the door wing had been fixed with four screws/bolts that protruded to the inside of the trailer (Picture 7). The protruding screws punctured one of the boxes and also damaged the booster shells (Picture 8). Ongoing friction could have caused an ignition of the then open pentolite mass.

The truck carried 1.5 D Explosives on pallets and 2,000 units (40 boxes) of 1 lb Boosters.

Additional facts:

- Personnel in charge of arranging the loads with more than 10 years of experience.
- Driver of the Transportation Company with over 15 years on service and up-to-date certificates and training record.
- Loading Procedures for trucks are in place, but do not include specific instructions for securing.
- There is a form for truck inspection report.
- There were no comments on the inspection report (check list) regarding or mentioning the 4 screws exposed and the metal plate on the truck door.
- There is no maintenance report from FASOL (transport company) on the change made to the door.

Picture 5: Boxes fallen off from stack

Picture 6: Punctured box (center)

Picture 7: Repaired door and protruding screws

Picture 8: Detail of punctured box

DISCUSSION

As a general rule, the containment and control of chemical and explosives hazards is preventing from loss events and with this incidents and consequences/impacts.

There are also safeguards in place that bring deviations back under control or mitigate the consequences of an event.

Manufacturing and storage facilities are designed and operated in a way to ensure this and equipment and employees are under control of the legal entity.

The situation changes when hazardous or explosives materials are transported from A to B and third party contractors are entering the scene and materials are exposed to an environment that is influenced by other parties such as on public traffic roads.

Also the interfaces, where third party equipment for loading and unloading is brought in, and handover of material where employees from different parties are involved need to be carefully looked at.

The incident investigation from both incidents described reveals maintenance and repair procedures not being adjusted and taking care of the specific hazards of the materials involved.

This is partially due to third party contractors in the average not applying the same high level to maintenance and repair as the chemical process and the explosives industry, but also to a lack of knowledge when it comes to explosives Basis of Safety (BOS) rules (in the second case, where an explosion hazard from a potential friction or impact event has not been considered).

The above mentioned also applies to truck and trailer chassis and parts exposed to high wear and tear such as tires, particularly in lowly regulated countries regarding transport regulations for hazardous goods and/or – where such regulations are in place – lack of road traffic control and surveillance.

Both incidents also reveal that – looking at the interfaces loading/ unloading and use of checklists – handovers between different parties and their employees can only be as good as they are supervised, inspected and audited.

In the first case, checks required by the operating instruction were not verified or properly conducted, whereas in the second case, the protruding bolts where either overlooked or not identified as a hazard (as long as the body is closed and the material is contained, but that would mean that the own employee would lack BOS skills) or ignored for convenience/complacency.

The transport company hauling MMA is experienced in handling and transportation of dangerous goods such as natural gas, propane and ammonia. The trailer tanks used here are exclusively for the transport of MMA. It was agreed – as an amendment to the contract - that future repairs on tank trailers will be announced and an independent inspection of the repair will be conducted prior to customer’s authorization for re-use.

The Costa Rican entity agreed with the forwarding agency to review maintenance procedures and report forms and conducted training in explosive BOS principles for transportation. Trailers used in transportation of explosives were inspected at the site of all contractors and audits were conducted. In cooperation with the transportation companies an agreed internal norm on trucks and trailers for transportation of explosives material was developed that refers to legal requirements but also goes beyond those. This norm can be used as a practical guidance in giving examples of good and poor practices.

CONCLUSION

The transport of hazardous and explosive material is a field with multiple facets where hazards (fire, explosion, release) are brought in by parties directly and indirectly involved in the transportation process.

Third party contractors can introduce hazards and those risks need to be identified, assessed and mitigated. Control measures for third party equipment in hazardous areas must be part of the company's inspection plan.

Audits on forwarding agencies should include maintenance and inspections procedures and documentation should be reviewed. Internal lack of experience and controls – likely to become worse if repairs are subcontracted – can introduce concealed hazards.

At the interface loading/unloading, poor practices can gradually sneak in over time if the importance of required measures is not reinforced and regularly controlled.

Responsibilities and consequences in cases of third party non-conform transportation equipment need to be clearly defined and personnel need to be encouraged to stop loading or unloading if such defective or otherwise non-conform equipment is identified. The same principles as in explosives manufacturing and on site storage need to be applied.

Line management and supervisors should be critical in inspection of third party equipment and checklists applied need to be appropriate and loading/ unloading operations should be audited regularly.

TAKE HOME MESSAGES

Transportation of explosive material and its precursors has a wide spectrum of hazards that reach from on the road issues (e.g. public traffic, accidents, emergency response) to loading and unloading processes at the interfaces from site (stationary) to moving equipment (mobile).

All hazards need to be understood, assessed and controlled. Some of the hazards may be concealed.

Do not expect forwarding agencies to be aware of explosive BOS principles, though licenses for transportation of explosives or precursors are valid and drivers trained in transportation of hazardous material.

Contractor audits and its outcomes should be constructive with an open discussion on issues identified. Offering of client support for improvement and guidance is mostly appreciated with the benefit of better control on third party equipment.