Incident

Major accidents involving contractors

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Summary

Outsourcing is a general practice in many chemical process industries. Examples of common outsourced activities involving contractors are usually maintenance and installation tasks, such as assembling pipelines, hot work (welding storage tanks or pipe parts that are connected to equipment containing dangerous substances), cleaning and painting. Contract workers are generally not familiar with the site or installation and cannot be assumed to have much knowledge about the risks associated with the dangerous substances on the site. Risks that are obvious to employees may not be at all obvious to contract workers. Hence, to a large extent, the individual risk to contractors at a hazard installation is potentially higher than to employees of the site.

Keywords: Contractors

Selection of the case studies

This paper presents the results of the analysis of 47 major accident reports within the European Commission's major accidents reporting system, the so-called eMARS, involving contractors occurring over the last 20 years. Over 800 major accidents reported in eMARS were studied. Events were identified as an accident involving contractors on the basis of one or more of the following criteria – a contract worker was killed; a contractor worker was injured or a contract worker was involved in the sequence of events leading up to the accident. Five case studies from eMARS are analysed in detail below, and the main lessons learned from each are outlined.

Case1: Explosion of tank containing crude oil

The accident occurred when contract workers were installing a new pipe connection from two storage tanks (tanks 3 and 4) to a third one (see figure 1). To prepare for the welding operation, they removed the hatch at the base of tank 4 and entered the tank to remove the crude oil residue. Then they flushed the tank with fresh water and allowed hydrocarbon vapour to evaporate for several days. They did not clean out or purge tanks 2 or 3. On the day of the accident, one worker inserted a lit oxy-acetylene welding torch into the hatch and then into the open nozzle on the opposite side of the tank to verify that all flammable vapour had been removed before welding, which is clearly an unsafe practice. The workers laid a ladder on the tank roof, extending it across the 1.2 m space between the two tanks (tanks 3 and 4). Almost immediately after the welding operation began, sparks ignited the flammable vapour escaping from

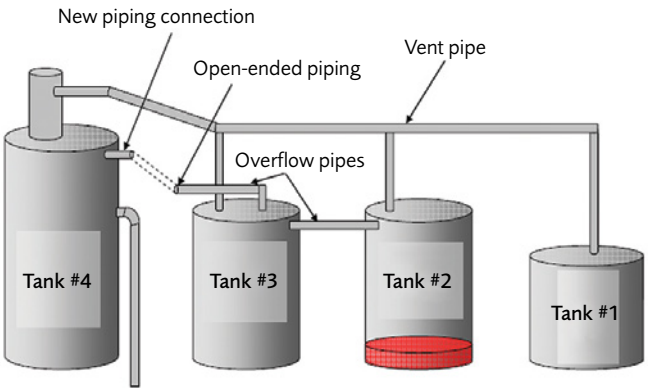

Figure 1 – Tanks involved in the incident (CSB)

an open-ended pipe about 1.2 m away from the contractors' welding activity on a fourth storage tank nearby. The explosion killed three of the contract workers and seriously injured a fourth one.

The accident occurred because neither company (i.e. the client oil company and the contractor company) used available guidelines for hot work safety or had a permit to work system. The client oil company did not require this latter one. In addition, the contractor company had no hot work procedure for welding activities at the worksite. Moreover, it was revealed that most welders hired by the contractor company were expected to have knowledge or experience of how to weld, and given this assumption, the contractor did not provide hot work safety training to its employees.

Lessons learned

The client company should develop and implement written procedures and provide contractor training to ensure safe work practices during hot work, tank cleaning and work at elevated locations. These measures would have assisted contract workers in identifying and eliminating hazards prior to beginning the welding operation. Finally, when two or more oil tanks are linked to each other, the connection pipes should be equipped with isolation valves to prevent the escape of flammable vapour.

Case 2: Explosion of tank containing potassium carbonate solution saturated with hydrogen sulphide

An explosion occurred during the welding of a pipeline of a tank containing potassium carbonate solution saturated with hydrogen sulphide. The explosion broke off the tank's lid, which subsequently leaned over to the side. One worker was

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thrown by the force of the explosion out of the tank's tray, fell to the ground and died. The second worker was also thrown off the tray but onto technical pipelines. He survived but was seriously injured. The accident occurred in the coal derivatives unit in the area of the potassium carbonate recovery installation and in the vicinity of coke gas condenser room. The workers involved in the accident were employed by a company that performed contract renovation works. The major cause of the accident was an explosion inside the tank, which occurred when flammable gas (hydrogen sulphide) inside the tank was ignited by sparks (that entered the tank through the open probe). The sparking occurred as a result of welding activities above the tank. Neither the operator nor contractors appeared to have taken appropriate safety precautions. Contractors undertook welding activities without formal written permission for works with the use of open fire on the operating facility. Furthermore, the tank contents were not sufficiently isolated from the pipeline before the work began.

Lessons learned

Access to the work area should not be permitted until hazards in the work area have been identified and controlled. Documentation of building and construction works should be reviewed periodically for this purpose. Instructions for renovation works should inform contractors of what potential hazards could exist and the procedures in place to minimise them. Moreover, the operator should make sure that contractors comply with the safety regulations and renovation procedures.

Case 3: Explosion of gas cylinder containing toluene diisocyanate

A fire occurred in and around the area of a factory that manufactured polyurethane resins and moulded them into car seat cushions. Contractors were using an oxy-acetylene torch during a shutdown to remove redundant pipework from the factory area. Sparks from hot work ignited combustible material in the area. At approximately 09.15 am, the contractors noticed flames, and employees in the area sounded the fire alarm at 09.17 am. At approximately 09.20 am a gas cylinder exploded and flames shot through the roof of the building. All personnel were evacuated to an area some 100 metres from the factory perimeter. No sprinkler system was installed in the establishment although combustible materials were present, including a wooden roof. Fire spread to the process and manufacturing area resulting in the subsequent destruction of the entire factory. There were no on-site casualties or off-site effects reported. The investigation revealed that the accident was caused when sparks from the cutting operation ignited combustible material. Hot work was performed in an area from which combustible materials had not been excluded. It is unlikely that a thorough hazard analysis was conducted prior to the hot work taking place. The fire protection measures applied by the facility were not adequate for the production and handling of polyurethane foams.

Lessons learned

Authorities should use all means to enforce relevant fire protection norms in commercial establishments, and specific

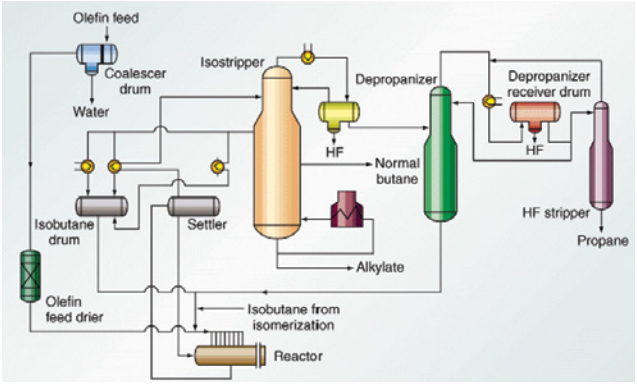

Figure 2 –Illustration of the HF Alkylation Unit (OGJ)

fire protection standards should be applied to activities where dangerous substances are involved. Hot work requires implementation of a robust, fully audited permit to work system.

Case 4: Pipeline release of hydrogen fluoride

In preparation for an alkylation unit shutdown, the major equipment had been emptied and the installation cleaned with nitrogen (see figure 2). It was then decided to drain the unit to remove all remaining fluids. The drain consisted of two valves and a blind flange. The blind flange was removed and replaced by a T-piece consisting of a manometer and a small valve. The T-piece was mounted in a horizontal way. A permit was written for two contractors to add a copper tube to the small valve on the T-piece. Because it was not easy to work with the T-piece mounted horizontally, they without notice decided to rotate it. While rotating the piece, the handle of the small valve touched a pipeline and the valve opened, releasing hydrofluoric acid. Both contractors were injured, one of them seriously. The T-piece on the drain was a temporary piece only installed for the shutdown. There was no standard in the company to which temporary pieces had to comply. The T-piece used screw thread, which made it possible to turn the T-piece.

Lessons learned

The accident highlighted the need for a standard for temporary pieces. The operator should ensure that all contractors understand the hazards associated with a temporary workplace and the process in case of emergency, by requiring them to receive training prior to their work. In the company, it was seen as normal that the manual valves in the line on which the T-piece was fitted had a small internal leak. Therefore, the work permit should have specified protective clothing for working on this line, as they would have anticipated that hydrofluoric acid would build up between the fixed (leaking) valves and the quarter turn valve on the temporary T-piece. A quarter turn valve is easily manipulated accidently, certainly while doing mechanical work in the immediate vicinity.

Case 5: Vapour cloud explosion due of a waste treatment tank

A vapour cloud explosion occurred in a fixed-roof cylindrical atmospheric tank (TKX) containing BES (bottom aqueous layer from stripping in waste water treatment) during hot works on the tank feed line (see figure 3). The existing feed line had been

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(source: ARPA Puglia)

Figure 3 – Pulled-off sparger line on the TKX viewed from the walkway and the projected roof at the foot of the TKX

cleared up and disconnected from the tank, without closing (blind flange) the tank or the line. The tank was half filled with BES. The aim of the maintenance operation, which had been contracted out to an external company, was to add a second feed line to the TKX tank. There were four contractors and one employee of the establishment involved in the hot work. One of the contractors started to cut the line with an electric disk cutter, generating sparks. These sparks ignited the explosive atmosphere present inside the tank causing an explosion, which resulted in the roof of the tank being thrown 20 metres. The contractor who was standing on the top of the roof, holding the line to be cut, was thrown with the roof and died in the accident. The other four workers, who were on the walkway leading to the tank, were injured by the debris of the tank. It was discovered that the operator had not considered the explosive characteristics of the BES and therefore this scenario was not included in the hazard identification studies or the risk assessment process. Consequently, the unit that involved the TKX tank was not classified as an ATEX area that would have excluded the use of electrical equipment such as electric disk cutter.

Lessons learned

The investigation revealed that the work permit procedure was not adequately applied during the maintenance operation and work permits forms were incorrectly filled by both contractor and operator. In particular, the safety measures required for 'hot' maintenance operations were not adopted. Further to these, written safety procedures were not clear and therefore caused confusion regarding the delivery of authorisation to the contractor. These aspects should be avoided by having an adequate permit to work system, with roles indicated and clear written safety procedures in place. Also, the operator should be knowledgeable about the characteristics of the substances appearing in the process, even if they are by-products of fermentation in the waste treatment unit – such a scenario should be included in the hazard identification studies and the risk assessment. These findings also question the efficiency of the plant safety requirements, specifically because internal oxygenation of the tank in order to avoid undesired fermentation must have been conducted regularly.

Conclusions

In a world where contracting out and sub-contracting has become quite common, it is clear that special care must be given to contractors in the design and implementation of an organisation's safety management system.

For example, the operator must systematically check in all elements of their safety management system to ensure that communication is in place. They must also ensure that all risks in the area and associated with the contractor's work have been identified and controlled. Risk assessments should be regularly reviewed, particularly during design changes (equipment and procedure).

It is also essential for operators to note carefully the differences between contract workers and their own employees, given the fact that contract workers might not be familiar with the site. It cannot be assumed that contract workers will have as much knowledge about the risks associated with the dangerous substances on the site as the regular employees who are usually present on the site.

Also, operators should ensure that contractors implement safe practice, such as standard control measures including wearing proper protective equipment, controlling access to process areas, and apply good practice measures for the work at hand, such as hot work permits, adequate training, verification of site safety prior to beginning work and regular oversight of the work in progress. Finally, clearly written safety procedures must be in place to avoid confusion and protect both contractors and employees.

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