ISC Safety Lore

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Key lessons from incidents related to permit to work

Introduction

Past major accidents demonstrated that permit to work system is an essential part of any non-routine hazardous activities in industrial sites. Issuing a permit to work document itself will not make the job safer, the content needs to reflect the real situation; identifying all hazards associated with the task and risks assessed. It also describes how the job must be carried out safely, introducing all precautionary measures and the expiration of the permit. After completing the task, the permit to work must be closed with checking that the job was done following the instructions in the permit.

Case 1 – Chemical plant

Two contractors were performing welding on the top of a slurry tank when hot sparks ignited flammable vapours inside the tank, causing an explosion that killed one contractor and seriously injured another. The accident occurred at a chemical plant that produces polymers and surface materials. The process for making the final product involves transferring polyvinyl fluoride slurry from a reactor through a flash tank and then into three slurry storage tanks. The three tanks (Tanks 1, 2 and 3) were inter-connected by an overflow line.

Key learning points

Days before the incident the process had been shut down for tank maintenance due to corrosion and the slurry tanks were locked out so the tanks can be cleaned and entered. Tanks 2 and 3 were repaired, reconnected the process piping and the valve locks were removed to prepare for restart. Tank 1 remained out of service because the necessary parts were not available. When the repair materials arrived, a contract welder and foreman were engaged to repair the agitator support atop tank 1. Although tank 1 remained locked out from the main process, the overflow line remained open which connected tank 1 to tanks 2 and 3. The overflow line to all three tanks was never blinded. The investigation found that flammable vinyl fluoride flowed through the overflow line into tank 1 and accumulated to explosive concentrations. While a facility hot work permit was issued for the task, the site personnel who signed it were not sufficiently knowledgeable about the chemical process. Although they monitored the atmosphere above the tank prior to authorizing hot work, no monitoring was done inside the tank to see if any flammable vapour existed there. The company's hot work permit procedure did not require testing the atmosphere inside the tank for flammable vapour.

Site personnel did not properly isolate and lock out tank 1 from tanks 2 and 3 prior to authorizing the hot work. The company's process hazard analysis incorrectly assumed that vinyl fluoride in the chemical process could not reach flammable levels in the slurry tanks. The flammable vapour was able to pass through the overflow line into the tank the welder was working on, unknown to him or to the operators who signed off the hot work permit.

Case 2 – Oil refinery

On 5 November 2005, two employees from a subcontracting firm died by suffocation during maintenance work conducted on the hydro-cracking unit, as they were raising a pipe onto a reactor inerted with nitrogen. One of the technicians fainted and fell into the reactor while attempting to pick up a roll of adhesive tape; the second victim was also asphyxiated in trying to save his colleague.

Key learning points

This hydro-cracking reactor had been shut down for maintenance; its nitrogen supply line had been temporarily closed to enable reloading the reactor catalyst. This operation required preliminary dismantling of a large-sized pipe bend. Once the reloading step had been completed, the manhole was protected by a plastic tarp and nitrogen could once again be injected. Refinery employees placed red tape around this manhole along with a sign reading "Danger: Confined space/Do not enter without permit", yet without indicating the type of hazard present or the risk of asphyxiation. A subcontracting company raised the elbow to restart unit operations after receiving the refinery's authorisation to initiate work. A permit was issued for the operation. The document did not specify that the reactor was filled with nitrogen. In response to the permit form's question whether a nitrogen purge was required as part of the operation, the "N/A" box had been ticked. One of the subcontractor's employees removed the protection and noticed plastic tape inside the reactor. Reactor cleanliness criteria prohibited leaving the tape inside the reactor, so the workers looked for a way to retrieve it. Any entry into the reactor requires a specialised team and specific approvals. The technicians assigned to this task expressed concern over the appropriate course of action: installation of the elbow had to be completed before the end of the shift but sticking closely to the procedure would have slowed their progress. Moreover, the crane needed to conduct this operation would not be available afterwards.

To avoid this inconvenience, a technician unsuccessfully attempted to pick up the tape using an iron wire. Whether accidentally or intentionally, he fell or entered the reactor and passed out. His co-worker on the exterior platform then climbed down to rescue his fellow team member and fell unconscious. The oxygen content measured by rescue workers inside the reactor was less than 1%.

The ISC believes that leadership across six key functional elements is vital to achieve good process safety outcomes. These elements are:

- systems & procedures
- engineering & design
- assurance
- knowledge & competence
- human factors
- culture

In the *What can I do* section below you can see how each of these elements plays a part.

Figure 1: The ISC Framework

What can I do?	
Management	
	• Develop a permit to work system that is implemented in the company and that it is kept up to date via a periodic review procedure.
	• Make sure to implement lead process safety metrics to measure the effectiveness of the permit to work system applied in the organisation.
	• Develop procedures to conduct confined space control and inert gas purge and make sure that training is provided for all affected personnel and contractors.
	• Make sure that the audit on the permit to work system is thorough to avoid it to become a routine administrative process.
	• Make sure that those in charge for control of the maintenance work are identified within the work permit system and that the work is properly authorised by a responsible person.
Process Engineer/Supervisor	
	• Make sure that hazards are identified, and risk assessed associating with the hazardous activity to be completed and all hazards are communicated clearly with those involved in the task.
	• Ensure that adequate process and electrical isolation are in place that no hazardous materials are introduced to the work area and no prime movers such as motors, turbines and engines can be started accidentally during work.
	• Verify that the necessary precautions are taken prior to entering confined space, to check safety at each stage and may need to remain present while work is underway.
	• High-risk activities require positive isolation by inserting spades/blinds into lines or disconnecting lines to physically separate the work-piece from any possible introduction of hazardous materials.
	• Make sure that danger signs or other equally effective means to identify the hazard are posted in the hazardous area to accurately warn workers about the asphyxiation hazards.
	• Make sure that all hazardous energy sources are identified, isolated and rendered inoperative to prevent the release of energy prior to the start of any repair or maintenance procedure.
	• Make sure that operators are equipped with proper PPE suitable for the task being performed. Only qualified and trained personnel equipped with the necessary safety equipment should attempt a rescue.
	• Pay attention to any violations of the permit to work procedure as it can increase the risk associated with the hazardous activity.
Operator	
	• Make sure you only complete work covered under the task description of the permit. Any additional job may not be checked for potential hazards.
	• Always follow the permit to work procedures without taking any shortcuts. The procedures must be adhered to all the time.
	• Obtain a permit before conducting any work that involves confined space entry; work on energy systems; hot work; ground disturbance.
	• Check if the work can be done another way to avoid entry or work in confined spaces. Ask your supervisor if there is an alternative approach that can reduce the need for confined space working.
	• Make sure that energy and material flow sources are identified and controlled; isolated and locked, tagged properly.
	• Be aware, that hazardous (oxygen-depleted) atmospheres may be present outside the confined space, near openings and that acute oxygen deprivation rapidly overwhelms the victim, without warning.
	• Unprotected entry into an oxygen-depleted atmosphere for any length of time, no matter how brief, can be deadly.