ISC Safety Lore

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Key lessons from incidents related to intermediate bulk containers (IBCs)

Introduction

The use of intermediate bulk containers (IBCs) is widespread; such as supply of raw materials such as chemicals, foodstuffs, etc. and storage of finished or intermediate products or even waste. IBCs can be moved quickly and easily with just a pallet truck or a fork lift. IBCs are sensitive to heat and impacts and this makes them susceptible to piercing or bursting and can even result in damage to their drain valves. They do not hold up well against internal overpressure and can explode if their contents expand. When ageing, IBCs become increasingly susceptible to impacts after prolonged exposure to UV light or cold weather conditions. Incidents relating to IBCs include explosions, toxic material release as a result of storage of incompatible substances or during transport or re-packaging.

Case 1 – Chemical packaging company

On 5 January 2011 a fire broke out in a chemical packaging company located in an industrial area while employees were working on a pump. Flammable, toxic and corrosive substances as well as 400,000 litres of substances classified as carcinogenic (solvents, metal powders, chlorinated and sulphur-containing substances) were stored in the warehouse building. The fire started outside the building while resin was being pumped from one IBC into another. The fire grew rapidly and caused a large number of IBCs to explode; approximately 250 IBCs were on the property that afternoon. The fire rose up to 40 m high and spread to an adjacent warehouse. Nobody was injured in the accident.

Key findings

The initial findings of the investigation indicated that the operator may not have complied with required operating conditions. For example, pumping liquids from one container into another one was not permitted by the company. However, it was completed many times before the incident, without experiencing any problems. On the day of the accident due to cold temperature (maximum 3-4°C), the pump's exhaust silencer began to freeze up causing the resin to stop flowing out of the pump. After consulting with a supervisor, an employee thawed the exhaust silencer with a gas burner; apparently, this method had been used before several times despite the use of a gas burner being against the company's rules. Xylene, which is a highly flammable substance was kept under the pump as it was used to clean the pump. When the employee started heating up the middle of the pump using the gas burner, the xylene caught fire.
Inspections conducted by government agencies between 2001 and 2010 revealed multiple violations, such as inadequate safety culture, automatic fire suppression extinguishing system ill-suited to the risks involved, and toxic chemicals stored alongside one another without any compatibility analysis being done.

Case 2 – Manufacturing plant

An IBC containing nitric acid exploded at the potassium nitrate production unit of a plant that manufactures nitrogenous substances and fertilisers. Acid vapours spread through the workshop, prompting the evacuation of 30 workers. Seven workers got sick from inhaling the vapours and were taken to hospital.
The accident occurred whilst a polyethylene IBC was being filled with nitric acid. The IBC swelled. A worker unscrewed its cap and it returned to its original shape. The IBC exploded when the worker moved it to the production workshop.

Key findings

This IBC was not designed to hold acids and contained residual amounts of hydrogen peroxide. The IBC that should have been used, and which was correctly labelled, was left in the storage area. The reaction between the residual water and the acid produced a gas that increased the pressure inside the IBC and ultimately led it to exploding.

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	
	• Ensure that written operating procedures and instructions about the loading, distribution, storage and on-site transfer of substances in IBCs and regular checks on IBCs are in place.
	• Make sure that the risks inherent to the storage of IBCs (whether full, empty or in use) are identified. The organisation and conditions of storage are important in controlling risk (e.g piling them into individual stacks, division of risk).
	• When selecting IBCs for the company make sure that they are suited to specific conditions of use and to the substances they will contain.
	• Ensure that the firefighting resources are available and effective to limit the extent and spread of fire, spills and other emergencies relating to IBCs.
	• Many incidents are the direct result of inadequate ergonomics, in particular regarding transfer of substances directly from IBCs or the lack of sufficient space to safely manoeuvre pallet jacks or forklifts. Make sure that these issues are addressed and adequate place is provided to support transport activities with IBCs.
	• Make sure that training programs involve the characteristics of IBCs highlighting their susceptibility to physical and chemical impacts together with their storage and use in a safe way.
Process Engineer/Supervisor	
	• Make sure to follow company rules and operating procedures to protect workers.
	• IBCs are fragile and have a number of vulnerabilities. In particular, their sensitivity to heat and impacts makes them susceptible to piercing or bursting and can result in damage to their drain valves. Make sure to use reinforced models as necessary and shelter IBCs from weather conditions to increase the lifespan.
	• IBCs are not designed for internal overpressure and can explode if their contents expand (vapour pressure of a substance, uncontrolled reactions, exposure to heat). It is a good practice that IBCs are fitted with special caps to vent pressure and prevent the risk of explosion.
	• When ageing, IBCs and become very susceptible to impacts after prolonged exposure to UV light or the cold. They must therefore be checked periodically.
	• Most fires are sparked by hot spots, incompatible mixtures or unstable substances inside IBCs. Make sure that IBCs are kept away from sparks, labelled correctly and that labels are visible.
Operator	
	• Inspect IBCs before using, ensuring; suitability, condition (new, used, cleaned or soiled), if any substances already inside are compatible with those to be added (leftover trace amounts of substances may have undesirable effects on substances that are added subsequently).
	• Follow safe operating procedures and avoid any deviation from the company rules.
	• During transport of IBCs make sure that there is adequate room left for manoeuvring the forklift to avoid collisions and damage to the container.
	• Make sure that IBCs are placed outside on a flat surface to make them accessible for use.