ISC Safety Lore

September 2020

Issue 11

Key lessons from incidents related to ammonium nitrate fertilisers

Introduction

Ammonium nitrate has been involved in numerous past incidents causing explosions, fires, and releasing toxic fumes, and it is known that even small scale storage of ammonium nitrate fertilisers such as 10 tonnes in some legislation may place the population at high risk if proper safety measures and procedures are not fully in place. Knowledge of the inherent hazards associated with the handling and storage of ammonium nitrate fertilisers is crucial to prevent incidents related to fertilisers to occur.

Case 1 – Storage facility

On the evening of 17 April 2013, a fire of undetermined origin broke out at a storage facility. Approximately 30 tonnes of fertiliser grade ammonium nitrate (AN) with a 34 percent total nitrogen content was stored in bulk granular form in a 7 metres high bin inside the wooden warehouse. As a consequence of the explosion, the shock wave crushed buildings, flattened walls, and shattered windows. Twelve firefighters and emergency responders were killed along with three members of the public who were volunteer firefighters. The event also resulted in more than 260 injured victims, including emergency responders and members of the public, and more than 150 buildings were damaged or destroyed in the incident.

Key learning points

The cause of the initial fire remains unknown. The only scenario which was considered as dangerous in the storage facility was the accidental release of anhydrous ammonia as the company had an ammonia storage tank on-site. Conducting comprehensive hazard identification, analysis, and risk assessment where hazardous substances are stored or handled is a basic requirement when operating dangerous establishments. For small and medium enterprises lacking expertise, stricter regulation should be applied and enforced. Separation of combustible materials from organic substances is needed to reduce potential conflagration and explosion once an ammonium nitrate fire has started. When storing ammonium nitrate in bulk quantities it is important to have proper fire prevention, protection, and mitigation measures in place. Urban development around sites that handle or store AN needs to be restricted, and in the case of existing development in close proximity to the site, appropriate prevention and protection measures should be in place to reduce the risk as much as possible.

Case 2 – Chemical plant

On 21 September in 2001 a severe explosion occurred in a chemical plant. The detonation corresponded to a magnitude of 3.4 on the Richter scale. A 7m deep crater was observed outside the plant and a large cloud of dust and red smoke drifted to the north-west. The accident resulted in 30 fatalities, with up to 10,000 people injured and 14,000 people suffering posttraumatic stress. The cost was estimated to be in the range of 1.5 billion Euro. The warehouse within the plant affected by the incident, stored 400 tonnes of downgraded, off-specification ammonium nitrate (AN) based products. The explosive properties varied as some were fertiliser grades and some were technical grades which were dedicated to explosive purpose (AN mixed with fuel oil).

Key learning points

The direct causes of the explosion are not officially established. However, the final legal expert report concluded that the explosion occurred due to an accidental combination of sodium dichloro-isocyanurate and downgraded ammonium nitrate. It is assumed that waste containing chlorinated compounds manufactured in another unit of the plant was mixed by chance with waste from ammonium nitrate-based materials. This error would have been committed by subcontractors in charge of waste management who lacked knowledge of hazards associated with AN-based materials. The investigation revealed that the safety report of the factory did not take into account the off-specification and downgraded ammonium nitrate waste storage since it was not regulated. Although the explosion risk of AN was known, fire risk was considered more probable in open storage operations, and as the reference scenario by the industry. The risk assessment should include all possible major accident scenarios including low probability high consequence ones. Operators need full knowledge of the inherent hazards associated with the handling and storage of AN fertiliser, and regularly review operating procedures to ensure they are being followed. The AN storage facility was not directly managed by the company employees but by subcontractors; twenty-five subcontracting companies worked continuously on-site, whose knowledge of the products and the site could have been incomplete. When contracting out a technical process to a third-party the operator should ensure that all risks in the area and associated with the contractor’s work have been identified and controlled.

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	
	• Make sure that all potential accident scenarios relating to AN fertilisers, based on state of the art knowledge, are included in the risk assessment and emergency response plans.
	• Ammonium nitrate may elevate combustion risks. Follow established norms for mitigating fires, such as having a sprinkler system in place to minimize the risk of spread of a fire.
	• Storage bunkers should be built at appropriate distances from each other. Different classes of fertilisers should be stored according to Dangerous Goods regulations and company policy.
	• Make sure that written procedures for the handling and treatment of AN fertilisers are in place and communicated to employees and contract workers.
	• When storing AN fertilisers in bulk quantities ensure you have proper fire prevention, protection, and mitigation measures in place. If possible, keep inventory to a minimum and for larger inventory keep in bags.
	• When storing AN fertilisers, avoid exposure to moisture or water to prevent caking which can accelerate oxidisation. It is recommended that plant or storage areas are constructed and maintained to avoid leaks, flooding, or formation of pockets of moisture in areas where the ammonium nitrate is located.
	• Hazard identification should include the sensitivity of AN to changes in operating conditions. Over the life of the plant unintended events could adversely affect storage conditions and need to be addressed in order to establish appropriate safety controls and procedures.
Process Engineer/Supervisor	
	• Ensure that both employees and contract workers possess adequate knowledge of the inherent hazards of AN fertilisers and regularly review operating procedures to ensure they are correct and being followed.
	• For indoor storage, make sure that the storage area is not congested, and proper ventilation is available as it limits the progress of decomposition should it occur.
	• Make sure that off-specification and downgraded or technical grade AN fertilisers are separated from any contaminants, such as organic materials prone to increase the explosion hazard of ammonium nitrate. Handle off-specification, downgraded or technical grade fertilizer contaminated with organic material safely and segregate them from other products
	• Fire protection strategies should be based on minimising the presence (both potential and actual) of combustibles.
	• Make sure that plant and floors for storage area are kept clean, avoiding the accumulation of deposits of fertiliser materials; good housekeeping is essential to prevent issues.
Operator	
	• Make sure you have full knowledge of the inherent hazards associated with the handling and storage of AN fertiliser and ensure that you follow operating procedures.
	• Eliminate/minimise the presence of combustible materials and incompatible substances (such as explosives) near ammonium nitrate.
	• Be aware of and follow appropriate safety precautions associated with AN fertilizer storage, including packaging stacking, temperature, and other elements.
	• Control ignition sources (e.g. hot work, smoking, vehicles) with control of the electrical system in the storage.
	• Clear spillage up promptly and put damaged bags into overpacks, using a secondary bag of sound construction that will prevent further spillage.
	• Equipment used in the handling of ammonium nitrate, such as conveyor belts, should be made of material that does not readily ignite or burn.