The Fire and Explosion at the West Fertiliser Co. Plant – An Analysis from Web-sourced Information

by

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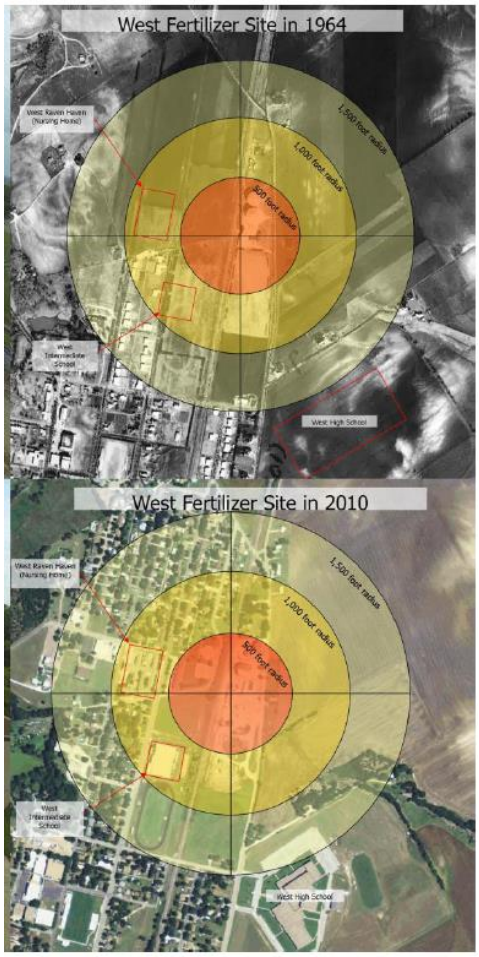
Abstract

The fire and subsequent explosion at the West Fertiliser Co. Plant in West, Texas resulted in 15 fatalities, most of who were first responders, and injured over 200 people. The US Chemical Safety Board is carrying out the investigation of the event. Preliminary observations from CSB show that ammonium nitrate, in the presence of seeds, and wooden containment was involved in the explosion. The analysis described in the paper is from web-based information. For the explosives industry, the two key learnings are a reminder to maintain the area of ammonium nitrate storage free from any combustible materials, and the need to make first responders aware of how to deal with an emergency involving ammonium nitrate.

Introduction

The West Chemical and Fertilizer plant was built in 1961 to service the farms that surrounded it. Over time the community grew around it; by the time of the accident there were a nursing home, an apartment complex, a high school and an intermediate school constructed within 2,000 ft of the facility (see adjoining figure (Ref 1)).



The West Fertilizer plant only had a blending facility, there was no manufacturing. Nine employees worked at this site. Fertilizers such as ammonium nitrate and anhydrous ammonia were delivered by rail to the site. The ammonium nitrate prills were stored in wooden bins, and the warehouse building it was stored in was also constructed out of wood. The warehouse had no sprinklers or fire suppression system.

Within the warehouse there were seeds which were also stored near the bins of AN. The liquid ammonia was stored in pressurized vessels which were situated outside. There also were several nurse tanks which are filled with the liquid ammonia and used to inject the ammonia directly into the soil.

The Event

The mass explosion was preceded by a fire, which was observed at 7:30 pm and reported to 911. The cause of the fire has not yet been

determined. The community's volunteer firefighters were dispatched to the site. The firefighters were aware of the hazard from the tanks of anhydrous ammonia but they were not informed of the explosion hazard from a fire involving ammonium nitrate. The firefighters found the warehouse building in flames and were in the process of extending hoses to fight the fire.

At about 7:51 pm an explosion occurred at the site. The blast registered as a 2.1-magnitude tremor at the US Geological Survey. At ~7:53 pm a call was received at 911 stating that there was an explosion. The resulting crater was 93 ft wide and 10 ft deep.

The Aftermath

The blast resulted in 15 fatalities, 12 of whom were first responders who were at the site. Autopsy results for the emergency responders have shown all died of blunt force trauma or blast injuries. In addition to the fatalities there were about 300 people injured.

The Nursing Home and apartment complex were completely destroyed. The High School and Intermediate School were damaged beyond repair. The Middle School was also badly damaged. Approximately 200 homes were severely damaged. The total cost of the damage has been estimated at over $230 million.

Investigation Findings

Initially the incident was treated as a criminal investigation and the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) and the Texas State Fire Marshal's Office took control of the site.

Both agencies have ruled the cause of fire as 'undetermined'. Their statement read "ATF and SFMO had eliminated the following causes: rekindling of an earlier fire, spontaneous ignition, 480 volt electrical system, anhydrous ammonia, ammonium nitrate, smoking, and weather. The following causes could not be eliminated: 120 volt electrical system, a golf cart, and an intentionally set fire."

Observations from the Chemical Safety Board

The formal investigation is still underway, being carried out by the US Chemical Safety Board. At the June 27, 2013 US Senate Hearing, Chairperson of the CSB, Rafael Moure-Eraso gave testimony on the West, Texas case, based on observations made by the CSB up to that date. There were 18 observations cited that included:

1. The explosion at West Fertilizer resulted from an intense fire in a wooden warehouse building that led to the detonation of approximately 30 tons of AN stored inside in wooden bins. Not only were the warehouse and bins combustible, but the building also contained significant amounts of combustible seeds, which likely contributed to the intensity of the fire. According to available seismic data, the explosion was a very powerful event.
2. The building lacked a sprinkler system or other systems to automatically detect or suppress fire, especially when the building was unoccupied after hours. By the time firefighters were able to reach the site, the fire was intense and out of control. Just 20 minutes after the first notification to the West Volunteer Fire Department, the detonation occurred.
3. The existing fire codes do contain some useful provisions; for example the codes do require a fire resistant barrier between AN and any stored flammable or combustible materials and have provisions to avoid AN confinement and promote ventilation during fire conditions. However, even the most current NFPA 400 standard allows AN to be stored in wooden buildings and in wooden bins, and does not mandate automatic sprinkler systems unless more than 2500 tons of AN is being stored – vastly more than the approximately 30 tons that was sufficient to devastate much of the town of West. In addition, the standard contains a "grandfathering" provision that allows existing buildings that were constructed prior to code adoption – and fail to meet all of its provisions – to continue in use.
4. West volunteer firefighters were not made aware of the explosion hazard from the AN stored at West Fertilizer, and were caught in harm's way when the blast occurred. NFPA recommends that firefighters evacuate from AN fires of "massive and uncontrollable proportions." Federal DOT guidance contained the Emergency Response Guidebook, which is widely used by firefighters, suggests fighting even large ammonium nitrate fertilizer fires by "flood[ing] the area with water from a distance." However, the response guidance appears to be vague since terms

such as “massive,” “uncontrollable,” “large,” and “distance” are not clearly defined. All of these provisions should be reviewed and harmonized in light of the West disaster to ensure that firefighters are adequately protected and are not put into danger protecting property alone.

Learnings from the Incident

While the investigation is still ongoing, there are observations already made by the CSB that provide learnings and at the very least a reminder on AN hazards to the explosives industry.

The difference between the two forms of AN, fertilizer and industrial grade, is primarily in the final physical form of the prill. Fertiliser prill is denser and as a result has no porosity compared with industrial (or technical) grade prill which is manufactured specifically with internal voidage to enable an intimate mix with fuel oil that is added to the prill to manufacture ANFO. In spite of this physical difference the chemical properties of the prill remain the same, as do its physical properties such as melting point.

In a situation such as in West, Texas, and with other industrial accidents involving AN, if there is a fire in proximity of the AN prill, there will be melting, and in some cases a mass explosion has occurred.

The controlled decomposition of AN is still used today to manufacture nitrous oxide gas. This process requires very pure AN and the process is very tightly controlled to ensure that the decomposition reaction does not runaway. In the case of industrial accidents that involve fire and AN there is typically other substances in the vicinity of the AN, which can act as fuels, and therefore burn more vigourously since the AN is an oxidizer.

(i) Materials in contact with and in proximity to AN

As stated by CSB’s Chairperson the situation in the West Texas was worsened by the presence of combustible wooden bins and seeds. In 2003 in Saint Romain-en-Jarez, France there was a barn fire involving AN, which subsequently led to an explosion. The investigators believed that the plastic crates in the vicinity would have melted and mixed with the AN melt creating an unstable mix, which may have caused the explosion. These plastic crates were within 4 inches (10 cm) of the AN.

As in the case of the West accident, at the time of the explosion about a dozen firefighters were inside and around the barn building. There were 26 people injured from the explosion, of which 18 were fire fighters, and of them 9 were seriously injured.

Thus segregating the AN from other combustible materials is one of the key steps in minimizing the risk of fire, since AN does not burn.

In addition to combustible materials, care must also be taken to segregate materials that can react with AN.

(ii) Emergency Response

While ammonium nitrate does not burn, if it is involved in a fire situation it will melt and eventually decompose. This decomposition, in certain conditions that are not very well understood, can lead to a mass explosion, as the accident in West, Texas has shown. In 2003, In Romain-en-Jarez, France, there was a similar incident, in which AN stored in a barn was involved in a fire. The fire was reported at 4:02 pm. Fire fighters arrived at the barn and began battling the blaze. At 5:12 there was a mass explosion resulting in 26 people injured: 18 fire fighter, 3 gendarmes, and 5 bystanders.

In both the Romain-en-Jarez and West, Texas fires the firefighters were not aware of the hazards associated with a fire involving ammonium nitrate. It is imperative that facilities that store, handle and use ammonium nitrate communicate with their first responders that such fires must not be fought, and evacuation is the mandated action. Note that this policy also applies to fires involving AN that are in transportation as well.

It is prudent to engage the local fire fighters and first responders at least on an annual basis to provide the necessary training which will involve information on ammonium nitrate and its hazards, and the required actions in case of an emergency. In no situation must the fire fighters attempt to fight a fire if the ammonium nitrate is involved.

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