Combustible Dust Explosions and Hazards
Case Study: CTA Acoustics, Inc.

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Executive Summary

On February 20, 2003 an explosion occurred at the CTA Acoustics facility in Corbin, KY. A combustible phenolic resin powder supplied by Borden Chemical fueled the explosion. 7 people died in this tragedy, and 37 others were injured.

The accident began when a fire on the production line ignited a cloud of dispersed dust in the production area. This explosion shook loose more dust that had settled on elevated surfaces above the production lines. As this dust fell, it caught fire, resulting in secondary explosions. The chain of explosions tore through the plant, destroying parts of the facility in addition to claiming workers' lives.

The temperature control equipment on the oven where the fire started was malfunctioning, so the oven was operated with the doors open. The open oven doors allowed the fire to ignite the dispersed dust cloud lingering outside the oven. The housekeeping methods also contributed to the large amount of dispersed dust in the production area. Additionally, the workers were unaware of the hazards involved in handling and using the resin powder, even though the management had discussed it among themselves.

CTA Acoustics missed many opportunities to take action to prevent this tragedy. Any production area using combustible dusts should be cleaned regularly with vacuums and the dust properly disposed of. These measures remove dust from the facility entirely, rather than moving it around within the facility. CTA should also have ensured that all of its equipment was functioning properly instead of allowing workaround solutions to broken and malfunctioning regulatory devices. Moreover, effective communication is necessary at all levels of employment. Managers

and supervisors must convey hazards to workers, who in turn should note and report any near-misses and accidents which occur.

As a result of this disaster, CTA had to spend $56 million to rebuild the portions of the plant which were destroyed. Ford, one of CTA's largest customers, scaled back its order causing CTA to lose business from one of its chief clients. The cumulative loss of business and capital forced CTA to lay off workers from the Corbin plant.

The explosion at CTA was one of many dust explosions that occurred around the same time period in the United States, prompting the Occupational Safety and Health Administration (OSHA) to launch a new directive in March 2008 targeting safety precautions necessary when handling hazardous particulates. Hopefully this program will be effective in reducing or eliminating explosive dust hazards, and tragedies like the one at CTA will never occur again.

1. Introduction

1.1 Overview

CTA Acoustics, Inc. is a leading manufacturer of acoustic and thermal insulation products used in many industries, including automobiles and commercial buildings [CTA]. On the morning of February 20, 2003, an explosion at the CTA plant in Corbin, KY killed 7 workers and injured 37 others.

1.2 Normal Operation

CTA used three raw materials to produce its products: fiberglass, a phenolic resin powder, and nylon facing. Blend line feeders fed fiberglass into the production lines on a conveyor system (see figure 1). A picker spread the fiberglass into webs, which were transported to a residue feeder on another conveyor. The residue feeder deposited the phenolic resin powder onto the web. The web then entered the mat-former, where air suction dispersed the resin powder throughout the web. After exiting the mat-former, the mat rolled through a facing system which applied a layer of nylon on each side of the mat. The final step in the process involved a hot curing oven which melted the resin powder, causing it to bind with the fiberglass [CSB 23-28].

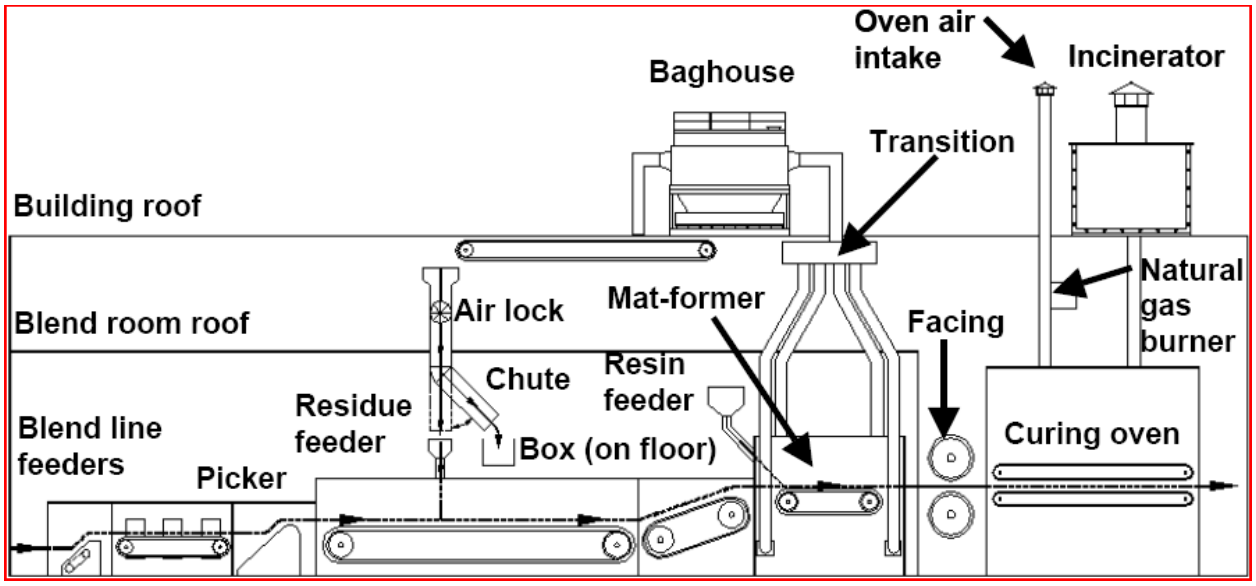

Figure 1: Schematic of production line 405 [CSB 24]

1.3 The Hazard

The explosion at the Corbin plant is believed to have been caused by a combustible phenolic resin powder used in the production of automotive acoustic insulation products. Combustible dusts can explode if particles of solid material disperse in air and ignite [Crowl 262]. The true danger of dust explosions lies in the occurrence of secondary explosions – primary explosions send a shock wave through the plant, stirring up additional dust which can ignite and cause a secondary explosion.

2. The Accident

2.1 Initial Fire

At 7:00 am on February 20, 2003, the baghouse over line 405 was turned off for routine cleaning. At approximately 7:30 am, operators turned it back on. Flames immediately shot through the baghouse system, injuring 2 operators on the roof (figure 2). The curing oven doors were open for manual temperature control. Combustible dust inside the oven caught on fire, causing the flames to shoot up through the baghouse system as it was powered on [CSB 33-34].

Figure 2: Fire damage to line 405 baghouse [CSB 35]

2.2 Primary Explosion

The flames from the curing oven ignited a combustible cloud outside the oven, where dust was suspended at hazardous levels due to poor housekeeping practices. The pressure wave from the initial explosion knocked down the firewall on the east side of line 405. One operator near the wall was killed. According to employees, after the explosion dust fell from the ceiling and roof trusses, the lights went out, and the building's sprinkler system activated [CSB 34-35].

2.3 Secondary Explosions

The initial explosion shook loose dust that had accumulated on elevated flat surfaces. This led to a secondary explosion above the blend room for line 405. The pressure wave and fireball resulting from this explosion propagated along the ceiling toward line 403. Due to this pressure wave, the firewall between lines 405 and 403 collapsed (figure 3).

Figure 3: Collapsed firewall between lines 403 and 405 [CSB 38]

The fireball reached the blend room for line 403, killing 4 more workers. Three more operators were burned between lines 403 and 402; two of them later died in the hospital from their injuries. As the fireball moved west over the line 401 blend room, it ignited another dispersed cloud of dust in a secondary explosion [CSB 36-39].

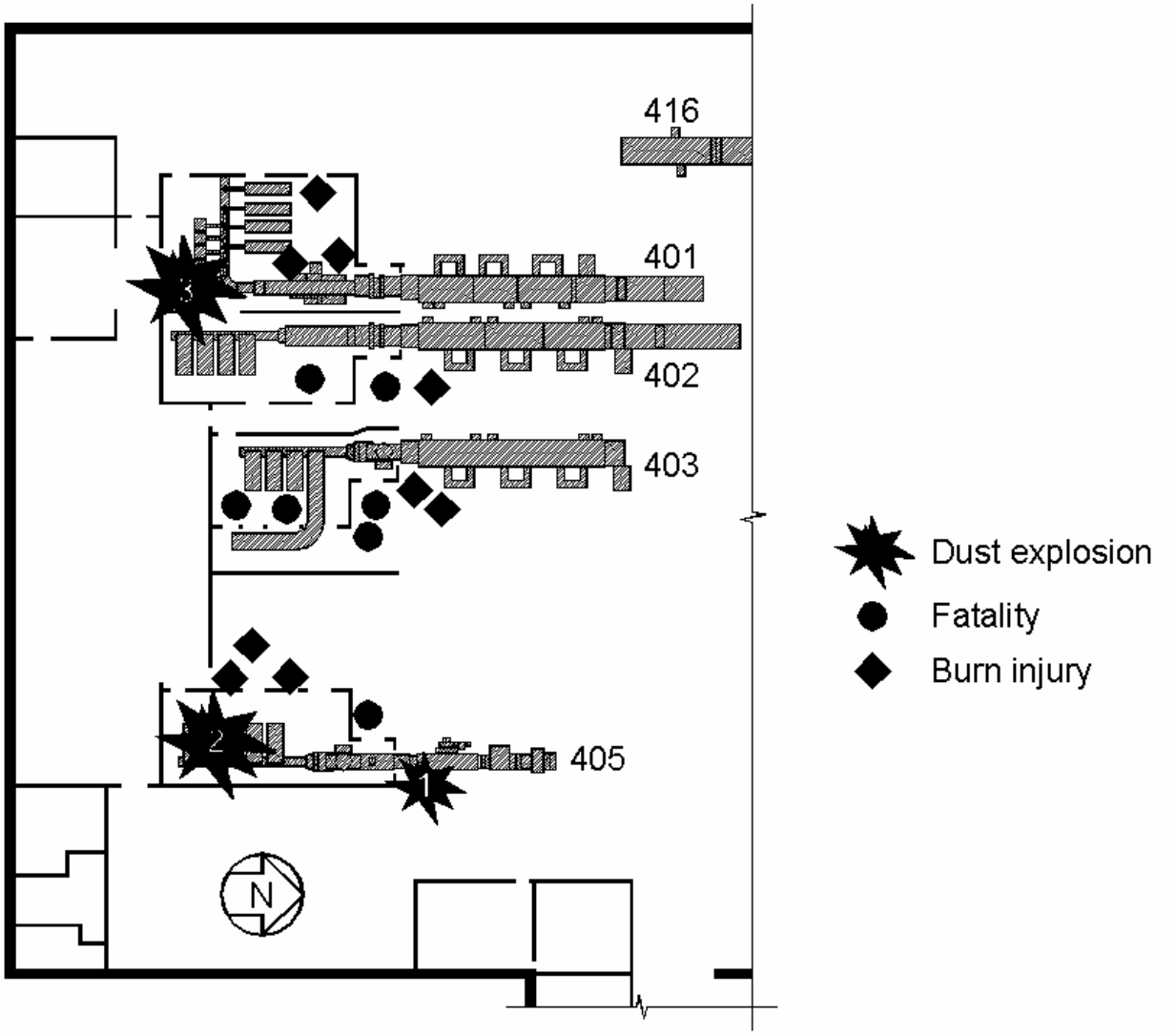

Figure 4: Sequence of explosions and locations of employees in the production area [CSB 36]

3. Aftermath

3.1 Effect on Community

The initial evacuation extended only to the plant itself, requiring all employees to leave. After discovering the nature of the chemicals being used, the Laurel County Emergency Management Director extended the evacuation zone to a 0.5 mile radius around the plant. This required police to evacuate nearby homes, businesses, and an elementary school. The Federal Aviation Administration restricted airspace above the plant. A miscommunication also prompted the Kentucky State Police to close portions of Interstate 75 after the evacuation zone was thought to have been extended to a 1.5 mile radius [CSB 41-42]. CTA's largest customer, Ford Motor Company, suspended operations at four automobile assembly plants as a precautionary measure after the incident [CSB 13].

3.2 Effect on CTA

CTA built a new facility in Corbin at a cost of $56 million. According to CTA, the new facility was designed in accordance with National Fire Protection Agency (NFPA) standard 654. After the disaster, Ford scaled back its order from CTA, causing a further loss in revenue. CTA's new plant operation began in late 2003, with fewer employees as a result of business lost following the incident [CSB 43].

4. Potential Factors Contributing to Fire and Explosions

4.1 Dust Collection and Storage

The residue feeder added resin powder to the fiberglass. After the fiberglass mat was pulled through the mat former, a vacuum system removed loose resin powder from the production line.

The vacuum system led to a baghouse on the roof, which stored dust and small fiberglass fibers on cloth bags [CSB 25].

4.2 Housekeeping and Maintenance

The housekeeping at CTA was extremely lackluster, and one of the primary contributors to fueling the explosion. Workers used compressed air and metal tools to clean the production line and floor. These cleaning procedures only served to move dust around and increase the quantities suspended in the air. Fans were also used to blow dust away from workers while they cleaned, further dispersing the suspended dust. Dust that became airborne would settle on flat surfaces above the production line, such as I-beams, process ducts and pipes, and roof trusses [CSB 28-30].

4.3 Knowledge of the Hazard

The Material Safety Data Sheet (MSDS) provided by Borden Chemical, the manufacturer of the resin powder, states that the resin is a combustible dust. Instead of providing specific safety measures, they referred consumers to NFPA 654, which CTA personnel did not have [CSB 62]. Borden also failed to notify its consumers after an explosion involving a similar Borden resin killed 3 people at the Jahn Foundry in Springfield, MA [CSB 15].

Despite the lack of clear communication from Borden, CTA was aware of the hazardous properties of black phenolic resin. CTA documents showed that supervisors and managers in multiple departments, safety committee members, and company fire brigade members discussed the explosive nature of the dust. This threat was never expressed to plant workers, who remained largely unaware of the dangers of the substances being used in the workplace [CSB 69-70].

4.4 Temperature Control Equipment

The automated temperature control equipment for the oven on line 405 was malfunctioning. Workers allowed the oven to operate with the doors open as a manual means of temperature control. This allowed flames to escape the oven and ignite a dust cloud dispersed nearby [CSB 74-75].

5. Recommendations

5.1 Housekeeping

When dealing with combustible dusts, vacuum cleaning needs to be the standard. Loose particulates need to be collected in a vacuum system, then removed from the facility and disposed of properly. Brooms, fans, and compressed air should never be used during standard cleaning procedures as an effective means of dust removal, because they serve only to disperse the dust.

Baghouse systems must be sized properly in order for vacuums to be used efficiently. If the baghouse is sized too small, it will overfill quickly, preventing removal of any additional dust from the facility. The baghouse should also be emptied frequently enough that it never reaches its full capacity. This will ensure that in case of an emergency where extra particulates become available, they can be removed from the production area and stored safely away from other hazards and ignition sources.

5.2 Communication

At CTA, communication breakdowns were a major factor leading to the disaster. The company needs to establish clear lines of communication between management and workers. Managers and supervisors must convey the hazards of every operation to the workers in order to impress upon them the necessary precautions. Workers must also notify management of each accident or near-miss that occurs in the facility. Such notification will allow managers to identify possible threats and take steps to prevent worse accidents from occurring. In order for workers to feel comfortable in reporting accidents and near-misses, safety culture must be actively promoted and rewarded by management.

5.3 OSHA Directive CPL 03-00-008

Due to the explosion at CTA and other dust-related explosions between 2000 and 2008, OSHA launched a national emphasis program targeting the elimination of dust hazards in industrial workplaces [OSHA]. OSHA does not currently have a specific standard on combustible dust hazards, which should hopefully be created once the program's investigations are complete. CTA and other dust-handling manufacturers will have to follow the new standards that arise from OSHA's directive, which will in turn lead to lower occurrences of dust-related tragedies.

6. Recent Updates and Conclusion

6.1 Recent Updates

After conducting its investigation, the CSB gave 8 recommendations to CTA Acoustics, Inc. to increase safety at CTA facilities. According to the CSB, 6 of those recommendations were followed appropriately. Since the disaster in 2003, CTA has gone largely under the radar. Even on its own website, the most recent news update comes from March 2005. It appears that they wished to remain as low-key as possible after receiving so much bad publicity.

6.2 Conclusion

Although CTA provided a prime example of poor workplace safety practices, the ability to completely remove itself from the public eye can serve as a note that it is no longer targeted by OSHA and other regulatory groups. Because of this, it seems safe to assume that CTA Acoustics, Inc. learned a valuable lesson from the disaster it suffered in February 2003. CTA can continue this trend by ensuring that safe practices are continually enforced in its facilities. Hopefully other companies and industries will take note of CTA's actions and remove this hazard from modern industry.

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