



Dust Explosion at West Pharmaceutical Services

Kinston, North Carolina January 29, 2003

On January 29, 2003, a powerful explosion and fire ripped through the West Pharmaceutical Services rubber-manufacturing plant in Kinston, North Carolina, taking the lives of six employees, and injuring 38 others including two firefighters who responded to the accident. The blast occurred without warning at 1:28 p.m. during a routine workday and could be heard 25 miles from the plant. A student at a school more than half a mile away was injured by shattered glass. Flaming debris set woods on fire as far as two miles away.

With a sound described by some employees as “rolling thunder,” the explosion blew off exterior siding from the building and sent a fireball and a cloud of smoke rising high into the air. The explosion ignited fires throughout the facility and disabled the building’s sprinkler system. Two 7,500-gallon plastic tanks of mineral oil collapsed from the heat, further fueling the blazes. The largest fire occurred in a rubber storage warehouse, which burned for more than two days. The rubber-manufacturing area of the plant was destroyed, the warehouse collapsed, and most of the building was rendered unusable. The company relocated the plant several miles away but did not resume rubber compounding, resulting in the loss of jobs in Kinston.

All the fatalities occurred on the ground level of the plant, mostly in the vicinity of the rubber-production line. In the aftermath of the explosion, many workers were dazed or buried under debris. Responders and other employees equipped with flashlights assisted them out of the plant to triage areas. The most severely injured were airlifted to burn trauma centers.

The CSB investigated the accident to determine its root causes. The investigation traced the explosion to a hazard that developed in the plant over the years: combustible dust from a plastic raw material had accumulated on hidden surfaces above the production area, creating the fuel for a massive explosion and fire.

RUBBER PROCESS CREATED HIDDEN DANGERS

West Pharmaceutical is one of the world’s largest manufacturers of rubber components for drug vials and syringes, and the Kinston facility was a major employer in North Carolina’s Lenoir County. At the plant, batches of rubber were compounded in mixers, rolled into strips, and then either molded or shipped off site. To reduce the stickiness of the rubber, the strips were conveyed through a tank containing very fine talc-like polyethylene powder mixed with water. The coated rubber strips were then blown dry with fans. Polyethylene dust became airborne in the process.

The polyethylene dust settled on surfaces around the production area. Because the facility produced supplies for medical use,

cleanliness was a high priority, and crews continuously cleaned dust from visible areas. However, dust was also drawn upward through several ventilation air intakes that were located over an acoustic tile ceiling installed above the rubber-production area. Above that ceiling — visible only to maintenance workers — the dust gradually built up to a thickness of one-quarter to one-half inch on ceiling tiles, beams, conduits, and light fixtures. As much as a ton of combustible powder could have accumulated in the area above the ceiling, just a few feet over the heads of unsuspecting production workers, investigators said.



West Pharmaceutical rubber manufacturing plant in flames after dust explosion.

WHAT IS COMBUSTIBLE DUST?

Combustible dust is any finely divided solid — such as flour, wood dust, or coal dust — that will burn when dispersed in air and ignited. When dispersed in a confined area, combustible dust can explode. Once an initial explosion occurs, the pressure from the blast can disturb dust that has accumulated on other surfaces, often leading to secondary explosions that can spread through a facility. Combustible dust is an insidious hazard, because it can accumulate in hidden areas and remain there undetected for years. The key to avoiding catastrophic dust explosions is to recognize the hazard, design facilities and work practices to prevent the spread of dust, institute effective housekeeping programs to remove dust accumulations, and control possible ignition sources.

Extensive damage to the plant made it impossible to determine what event initiated the first dust explosion, but the CSB report described several possible ignition sources, including an overheated batch of rubber, an electrical fault, a hot lighting ballast, or a spark from an electric motor. The first explosion dispersed other dust accumulations into the air around the production area and ignited them, causing a devastating cascade of fires and explosions.

COMBUSTIBLE DUST HAZARD OVERLOOKED

West installed the rubber-making process in Kinston in 1987, originally using a coating of zinc stearate to prevent rubber strips from sticking. In 1990 the company began exploring

the possible use of polyethylene as an alternative to zinc stearate. Corporate staff conducted a “new material review” — including an examination of the material safety data sheet (MSDS) provided by the polyethylene powder manufacturer. The MSDS warned of the polyethylene powder’s potential to cause a dust explosion. In 1992, West received an updated MSDS from the polyethylene manufacturer that specifically referred users to National Fire Protection Association (NFPA) Standard 654. This standard is a detailed guidance document for preventing dust explosions. A copy of this MSDS was transmitted to the Kinston facility.

However, West did not reexamine the safety of the powder or consult the NFPA standard when it began using polyethylene in the manufacturing process at the Kinston facility in 1996. The company had contracted with a small Pennsylvania company, Crystal Inc., to provide a thick paste of water and polyethylene. Crystal obtained the polyethylene powder from the same manufacturer that earlier supplied West. Crystal generated an MSDS for the paste and provided the MSDS to West. But this document did not warn of the potential hazard of a dust explosion from dried paste — even though Crystal understood the intended end-use of the product in Kinston.

The U.S. Occupational Safety and Health Administration (OSHA) requires employers to inform workers about chemical hazards by providing training and access to MSDSs. Although the Kinston plant had the MSDSs warning of the explosive properties of polyethylene powder, employees had not received any significant training about combustible dust hazards. Had maintenance workers been aware of the catastrophic nature of this hazard, they could have alerted management to the presence of dangerously large dust accumulations above the acoustic ceiling.

Several years after the Kinston plant began using polyethylene in 1996, accumulated powder ignited during a welding operation near the rubber-making equipment, causing a fire but not an explosion. West Pharmaceutical did not conduct a documented investigation of this incident, thereby missing an opportunity to reevaluate the safety of the dried polyethylene powder.

FIRE SAFETY STANDARDS NOT FOLLOWED

Good engineering practice calls for consultation with available codes and standards during project design. West was well-positioned to understand its own rubber process and the materials in use. However, the company hired outside engineering contractors to design and install the process in Kinston. That process was not suitable for handling combustible powders, such as polyethylene or zinc stearate, the CSB determined. For example, the use of fans to dry the coated rubber dispersed dust throughout the work area. The unsealed acoustic tile ceiling allowed large amounts of dust to accumulate in

concealed areas that were difficult to clean. The electrical fixtures and wiring in the production area were general-purpose and not rated for use around combustible dust.

NFPA Standard 654 includes a variety of good practices to prevent dust explosions. The standard states that dust accumulations of just $\frac{1}{32}$ of an inch thick — an amount less than the thickness of a dime and far less than what had built up above the ceiling in Kinston — create the conditions for a dangerous explosion and must be removed. Specific NFPA provisions that would likely have prevented the tragedy include segregating dust-producing operations; sealing off walls, ceilings, and partitions to prevent intrusion and accumulation of dust; installing electrical equipment suitable for explosive atmospheres; and regularly training employees on combustible dust hazards.

However, the Kinston facility was not required to comply with NFPA 654 under either North Carolina state law or federal workplace safety regulations. In addition, North Carolina workplace and fire safety inspectors had only limited knowledge of combustible dust hazards, the CSB determined.

RECOMMENDATIONS

As a result of this accident and a number of other fatal dust explosions, the Board launched a national safety study to examine the adequacy of current regulations, standards, and practices to prevent industrial dust explosions.

On September 23, 2004, the Board approved the final investigation report on the West Pharmaceutical accident and issued a series of safety recommendations to avoid similar tragedies in the future.

To West Pharmaceutical Services Inc.:

The CSB recommended that all West Pharmaceutical facilities handling combustible powders follow NFPA 654. The company should revise its procedures for reviewing new materials to ensure that hazards are identified, controlled, and communicated to workers.

To the North Carolina Department of Labor:

The Board urged the department, which oversees workplace safety in the state, to identify manufacturing industries at risk for dust explosions and develop an educational outreach program on dust hazards.

To the North Carolina Building Code Council:

The Board recommended that North Carolina require mandatory compliance with NFPA 654, the national fire code for combustible powders, and institute an appropriate training program for state and local code officials.

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NOTICE:

The CSB is an independent federal agency charged with investigating industrial chemical accidents and hazards. The CSB determines the root causes of accidents and issues safety recommendations to industry, labor, and other government agencies. CSB Investigation Digests are not intended to substitute for the official, Board-approved reports, which can be obtained from the agency’s web site, www.csb.gov. The web site also has complete, up-to-date information on the implementation status of all CSB safety recommendations. Comments or suggestions, please write to info@csb.gov.