Lessons from the West Fertilizer Company Explosion

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Board Member

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Norwegian National Seveso Conference
What is the CSB?

• The CSB is an independent U.S. Federal agency charged with investigating chemical accidents.
• CSB conducts root cause investigations of chemical accidents at fixed industrial facilities.
• Board members are appointed by the President and confirmed by the Senate.
• The agency does not issue fines or citations.
• Primary policy lever is recommendations to firms, regulatory agencies, trade associations, standards developers, and labor groups.
We are an Open, Public Agency

• Investigation reports and safety bulletins
• Safety videos
• Public meetings
• Press conferences
• Website:  www.csb.gov
Events Leading to CSB Creation

October 23, 1989
Phillips 66 (Pasadena, TX)

Release of 85,000 lbs of highly flammable gases led to explosions and fire in polyethylene unit.

23 Dead; 314 Injured; $715 million in damage

July 5, 1990
Arco Chemical (Channelview, TX)

Excessive oxygen in the vapor space of a waste water storage tank led to an explosion and fire in propylene oxide-styrene monomer unit.

17 Dead; 5 Injured; $715 million in damage
Legal Foundation of the CSB

Formed by Clean Air Act Amendments of 1990

“The Board shall— (i) investigate (or cause to be investigated), determine and report to the public in writing the facts, conditions, and circumstances and the cause or probable cause of any accidental release resulting in a fatality, serious injury or substantial property damages;” 42 USC §7412(r)(6)(C)
Legal Authorities

• Can require the production of evidence and witness testimony
• Can subpoena entities to compel compliance
• Can enter any property where an accidental release causing a fatality, serious injury or substantial property damage has occurred and do all things therein necessary for a proper investigation
• Inspect at reasonable times records, files, papers, processes, controls, and facilities and take such samples as are relevant to such investigation
• Make recommendations and conduct studies

No part of the conclusions, findings, or recommendations of the Board relating to any accidental release or the investigation thereof shall be admitted as evidence or used in any action or suit for damages.
Incident Screening Program

• Office of Incident Screening and Selection established in 2009
  - Agency data goes back to 2001
• CSB has no reporting mandate
• Incident information via media reports, National Response Center, phone calls
Deployment Criteria

- Deaths or injuries onsite or offsite
- Substantial property loss
- Offsite public or environmental impact
- Broad national significance
- Issue of interest
- Available resources
Types of Accidents That We Investigate

• Accidents in chemical plants, oil refineries and facilities using chemicals
• Toxic gas releases
• Explosions
• Other fatalities, e.g., confined space, hot work
• Major environmental releases
What Investigators Do

• Respond quickly to scene
• Gather physical evidence
• Interview people
• Test equipment
• Comb through documentary evidence
• Draft reports with proposed recommendations for Board approval
<table>
<thead>
<tr>
<th>Investigation</th>
<th>Location</th>
<th>Incident Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Williams Olefins Plant Fire and Explosion</td>
<td>Geismar, LA</td>
<td>June 13, 2013</td>
</tr>
<tr>
<td>Freedom Industries Chemical Release</td>
<td>Charleston, WV</td>
<td>January 9, 2014</td>
</tr>
<tr>
<td>DuPont Toxic Chemical Release</td>
<td>La Porte, TX</td>
<td>November 15, 2014</td>
</tr>
<tr>
<td>ExxonMobil Refinery Explosion</td>
<td>Torrance, CA</td>
<td>February 18, 2015</td>
</tr>
<tr>
<td>Delaware City Refining Company</td>
<td>Delaware City, DE</td>
<td>November 29, 2015</td>
</tr>
<tr>
<td>Enterprise Products Partners Fire and Explosion</td>
<td>Pascagoula, MS</td>
<td>June 27, 2016</td>
</tr>
<tr>
<td>Sunoco Logistics Partners Flash Fire</td>
<td>Nederland, TX</td>
<td>August 12, 2016</td>
</tr>
<tr>
<td>Airgas Fatal Explosion</td>
<td>Cantonment, FL</td>
<td>August 28, 2016</td>
</tr>
</tbody>
</table>
## Recently Closed Investigations

<table>
<thead>
<tr>
<th>Investigation</th>
<th>Location</th>
<th>Incident Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caribbean Petroleum Refining Tank Explosion and Fire</td>
<td>Bayamón, Puerto Rico</td>
<td>October 23, 2009</td>
</tr>
<tr>
<td>Macondo Blowout and Explosion</td>
<td>Gulf of Mexico</td>
<td>April 20, 2010</td>
</tr>
<tr>
<td>West Fertilizer Explosion and Fire</td>
<td>West, TX</td>
<td>April 17, 2013</td>
</tr>
<tr>
<td>Tesoro Martinez Refinery Sulfuric Acid Spill</td>
<td>Martinez, CA</td>
<td>February 12, 2014</td>
</tr>
</tbody>
</table>


West Fertilizer Company Fire and Explosion (2013)
Consequences

Less than 20 Minutes

15 Fatalities
- 12 Firefighters and EMTs
- 3 Community Members

Injuries
- Over 260
- Community Members and Emergency Responders

Community Damage
- Apartment Complex
- Schools
- Nursing Home
- Private Residences
Video Footage of Community Property Damage

West, Texas
May 3, 2013
252 Explosion-Related Injuries

- Abrasions/contusions: 141
- Lacerations/penetrating trauma: 134
- Traumatic brain injuries/concussions: 53
- Tinnitus/hearing problems: 34
- Eye injuries: 31
- Inhalation injuries: 30
- Sprains/strains: 29
- Fractures/dislocations: 21
- Blast injuries: 12
- Tympanic membrane ruptures: 12
- Burns: 6

Location of Injuries:
- Inside a Structure: 55%
- Outside: 8%
- Inside Vehicle: 13%

Source: Waco-McLennan County Public Health Department
Fertilizer Grade Ammonium Nitrate (FGAN) Hazards and Contributing Factors
Fertilizer Grade Ammonium Nitrate (FGAN)

Prills (pellets) of FGAN piled in wooden storage bin
Hazards of Ammonium Nitrate

Fertilizer Grade Ammonium Nitrate (FGAN)
- High-density Prill
- Division 5.1 Oxidizer

Technical (Explosive) Grade Ammonium Nitrate (TGAN)
- Low-density Prill
- Division 5.1 Oxidizer

Stable under normal conditions

Minimal health hazards

Will react with combustible material

Oxidizer – supports combustion
Hazards of Ammonium Nitrate

3 MAIN HAZARDS in fire situations:

1. Uncontrollable Fire
   - Oxidizing properties support combustion
   - Can increase the flammability or explosibility (or both) of other combustible substances when it decomposes after exposure to heat

2. Decomposition
   - Can produce toxic and flammable by-products during thermal decomposition
   - The reactions release gases such as nitric acid (HNO₃), ammonia (NH₃), nitrogen oxides (NO, NO₂), nitrous oxide (N₂O), nitrogen, oxygen, and water vapor

3. Explosion
   - May undergo detonation when heated under confinement
   - Contaminants such as combustible materials, metal fines, flammable liquids, and sulfurs can decrease AN stability and increase its sensitivity to detonation

AN is unpredictable when exposed to fire. Always assume an AN fire can detonate.
West Fertilizer Fire and Explosion: Contributing Factors

1. Contamination of the FGAN pile
   - Combustible construction materials
   - Storage of combustible materials near the FGAN pile
   - PVC and roofing materials

2. Heating and ventilation inside the fertilizer building
Combustible Construction
Combustible Construction

• In fires, FGAN-saturated wood burns with greater intensity

• The wood constructed bins at WFC likely led to the intensity and spread of the fire throughout the fertilizer building
Heating and Ventilation

• Oxygen depleted as the fire progressed from the seed room

Cupola with ventilation louvers on top

Limited ventilation at ground level
Heating and Ventilation

7:42 pm: Darker smoke observed
Historical FGAN Explosions

• Most explosions resulted from a massive fire
• Occurred within 20 min. to 1 hour from the initial report of the fire
• Slight variations in storage conditions, such as ventilation, construction materials, or nearby combustible storage can impact AN detonability during fires
Inherently Safer Building Design

Traditional Storage Practices

- Wooden FGAN storage bins
- Wooden construction materials

Safer Storage Options

- Concrete bins
- Concrete storage dome
Land Use Planning
Land Use Planning

Why was the City of West located so close to the WFC facility?

- The City expanded in the direction of the WFC facility over time
  - The WFC facility was constructed and began operations in 1962
- A lack of zoning regulations
  - At the local, state, and federal levels
West Through the Years

Fertilizer Facility 2013
Land Use Planning

• Zoning codes are typically adopted as ordinances at the county or local level

• However, at all levels of government there has been a failure to adopt codes concerning the siting of many types of hazardous facilities near communities
  – This includes FGAN facilities
Land Use Planning

• Land use planning and zoning codes typically **do not** apply to existing AN storage facilities

• Facilities that are covered:
  
  – Facilities constructed **after** zoning codes haven been enacted
  
  – Existing facilities which undergo significant modifications **after** code enactment
Land Use Planning

• The issue of locating AN facilities near the community is not limited to the WFC incident
  – There are over 1,350 bulk AN retail facilities nationwide

• In Texas alone, the CSB identified 19 FGAN facilities in the State being located within a half-mile of a school
AN Fertilizer Storage

Number of Facilities:
- 0-19
- 20-39
- 40-59
- 60+

The map shows the distribution of AN fertilizer storage facilities across the United States, with different shades indicating the number of facilities in each state.
Emergency Response
The explosion fatally injured emergency responders and nearby residents.

<table>
<thead>
<tr>
<th>Organization</th>
<th>Casualties</th>
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</thead>
<tbody>
<tr>
<td>West Volunteer Fire Department</td>
<td>5</td>
</tr>
<tr>
<td>Abbott Volunteer Fire Department</td>
<td>2</td>
</tr>
<tr>
<td>Navarro Mills Volunteer Fire Department</td>
<td>1</td>
</tr>
<tr>
<td>Dallas Fire Department</td>
<td>1</td>
</tr>
<tr>
<td>EMT (West Volunteer Fire Department)</td>
<td>1</td>
</tr>
<tr>
<td>Members of the public</td>
<td>5</td>
</tr>
</tbody>
</table>
Key Contributing Factors

• Incident command system
• Incident management system
• HAZMAT Training
• Pre-incident planning
• Limited and conflicting technical guidance on FGAN
  – Inconsistent firefighting measures
Regulatory Analysis
<table>
<thead>
<tr>
<th>Agency</th>
<th>OSHA</th>
<th>EPA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Requirements</strong></td>
<td>Based on prior versions of NFPA Codes (has not been revised since 1971)</td>
<td>Covered processes must follow 14 minimum performance-based elements</td>
</tr>
<tr>
<td><strong>Applicability</strong></td>
<td>Storage, use, and transportation of explosives and blasting agents</td>
<td>Chemicals at or above specified threshold quantities on the PSM list of covered chemicals</td>
</tr>
<tr>
<td>Covers FGAN</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>WFC Compliance</td>
<td>✗</td>
<td>✓</td>
</tr>
</tbody>
</table>
Key Technical Findings

- Combustible material contributed to the intensity of the fire
- Burning asphalt shingles and soot likely contaminated fertilizer-grade ammonium nitrate (FGAN) pile leading to detonation
- West Fertilizer Company (WFC) had no fire suppression system
Key Regulatory Findings

- Limited oversight for FGAN storage requirements
- Regulations covered anhydrous ammonia but not FGAN
- FGAN not on OSHA PSM or EPA RMP list of chemicals
Key Insurance Findings

- WFC dropped by previous insurance provider for non-compliance
- WFC insurance providers did not focus on FGAN hazards
Key Emergency Response Findings

- Responders had insufficient information about WFC to conduct a safe response
- Lessons learned from previous FGAN fires not shared with WVFD
- Current training curriculum places little emphasis on FGAN Emergency Planning
Key Emergency Planning Findings

- West Volunteer Fire Department did not conduct drills and exercises at the WFC facility
- No emergency response plan was in place for personnel responding to incidents
- Right-to-Know regulation lacks clear information on which facilities fall under the Agricultural Use Exemption
Key Land Use Findings

- No zoning regulations existed at the time WFC began operations
- City of West developed over the years and expanded toward WFC
- WFC facility was not subject to zoning regulations governing the siting of a FGAN facility
Selected Recommendations

- Change International Fire Code requirements for FGAN storage facilities
- Include FGAN on EPA Risk Management Program list
- Strengthen OSHA FGAN regulation through explosions standard or by adding to List of Highly Hazardous Chemicals, Toxics and Reactives
- Fund training for emergency responders on responding to fires involving FGAN
- Strengthen guidance for community notification
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