Lunch Box Safety Talks
Safety Over Sandwiches

JULY: Dust Explosion Prevention

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Outline

Elements

Characteristics/Ignition Sources

Prevention Techniques
Late 1970’s a series of devastating grain elevator explosions left 59 people dead and 49 injured.

In 1987 OSHA published the Grain Handling Standard 29 CFR 1910.272 addressing several hazards associated with the handling of grain.

Elements

Grain Dust Explosions
Heat (Ignition)
Dispersion of Dust Particles
Fuel – Combustible Dust in Suspension
Oxygen
Confinement

- Removal of any one element can prevent an explosion
Grain Dust:

- Emitted from stock handling systems.
- 425 microns or less
- As particle size decreases the risk explosion increases
The dust concentration contributes to potential for an explosion.

Minimum Explosive Concentration (MEC):
- MEC = 50 g/m³

Concentrations generally only reached in grain handling or processing equipment:
- Bucket elevators
- Conveyor housings
- Transfer/discharge points
Oxygen

- Necessary for Combustion
- Difficult to eliminate
Heat – Ignition Source

- Welding and Cutting
- Overheated Bearings
- Faulty Electrical Equipment
- Smoking
- Sparks from Tramp Metal
- Choked Legs
- Misaligned or Slipping Conveyors
## Ignition Temperatures

<table>
<thead>
<tr>
<th>Dust Type</th>
<th>Ignition Source of Cloud (F)</th>
<th>Minimum Explosive Concentration oz/cu ft.</th>
<th>Relative Explosion Hazard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>752</td>
<td>0.045</td>
<td>Strong</td>
</tr>
<tr>
<td>Corn Starch</td>
<td>716</td>
<td>0.040</td>
<td>Severe</td>
</tr>
<tr>
<td>Wheat</td>
<td>896</td>
<td>0.055</td>
<td>Strong</td>
</tr>
<tr>
<td>Wheat Flour</td>
<td>716</td>
<td>0.050</td>
<td>Strong</td>
</tr>
<tr>
<td>Grain Mixed</td>
<td>806</td>
<td>0.055</td>
<td>Strong</td>
</tr>
</tbody>
</table>
Confinement

- Often beyond the control of the operator.
- Lessen the effects by using explosion venting techniques.
Suspended Dust

- Inside grain handling equipment.

- Primary Explosion – caused by the ignition of dust under the right conditions.

- Pressure waves and fire waves are released.

- Secondary Explosions occurs when the blast wave from the primary explosion propagates and causes layers of dust to become suspended.
Dust Explosions

- The pressure wave travels away from the primary explosion at 1,000 feet per second.

- Fire wave follows at 10 feet per second.

- Rupture pressures from secondary explosions can be in excess of 100 psi.
Prevention

Grain Dust Explosions
Housekeeping

- OSHA Standard Requirements:
  - Immediately remove fugitive grain dust accumulations that exceed 1/8 inch (0.32 cm).
  - Develop a written housekeeping plan that establishes frequency and methods for removing fugitive grain dust on:
    - Ledges
    - Floors
    - Equipment
    - Exposed Surfaces
Housekeeping

- Housekeeping program must address priority areas:
  - Areas within 35 feet of inside bucket elevators.
    - Have a boot section.
    - More than 20% of leg height inside the grain elevator structure.
  - Floors of enclosed areas containing grinding equipment.
  - Floors of enclosed areas having grain dryers inside the facility.
Housekeeping

- Use of Compress Air Used for Cleaning
  - All machinery presenting an ignition source is shut down.
  - All other known potential ignition sources are removed or controlled.
  - Recommend using a compressed air cleaning permit.
Captures dust suspended in air at grain transfer points

Decreases the dust concentration to below the minimum explosive concentration (MEC)
Pneumatic Dust Control System

- OSHA Grain Handling Standard Requirements for Fabric Dust Filters:
  - Equipped with a monitoring device that will indicate the pressure drop across the filter (Magnahelic).
  - Located outside the facility (After 1988) or;
  - Located in an area inside the facility protected by explosion suppression system or;
  - Located in an area inside area separated from other areas by a one hour fire resistance rating, which is adjacent to an exterior wall and vented to the outside.
Proper Electrical Classifications

- Class II Division 1 Group G
  - Open System

- Class II Division 2 Group G
  - Closed System
Oil Addition Systems

- Application of food grade quality oil to the grain surface.
- Fine particles stick to the surface of the grain kernel rather than becoming airborne at transfer points.
- Usually positioned in receiving systems prior to transfer/discharge points.
Hot Work Permits

- Need to have a documented program to include use of the permit system.

- All efforts should be taken to remove equipment and perform hot work in areas outside of the grain handling structure.

- Engineering – eliminate hot work with the use of bolts with new installations.
Hot Work

- Plan hot work activities to ensure fire watch.
- Contractors must understand the company’s hot work policy.
- Contractors have been responsible for fires and explosions.
Smoking

- Designate smoking areas away from the handling facility:
  - Distance requirements
  - Designated areas

- Post “No Smoking” signage so that employees, customers and contractors are aware.

- Communicate and enforce the policy with employees, contractors and customers.
Ferrous (Tramp) Metal

- Metal tools, bolts, scrap, etc. are transported to grain facilities from the farm.

- Tramp metal can cause:
  - Equipment overheating
  - Sparks
  - Damage to equipment
Ferrous Metal

- Ferrous (tramp) metal can be addressed in two ways:
  - Receiving pit openings covered with grates with maximum openings of 2.5 inches (OSHA requirement)
  - Use of high powered magnets that remove metal not stopped by use of the grate.
  - Dual approach is most effective

- OSHA requires grain stream handling equipment (hammermills, grinders, pulverizers) to have an effective means of removing ferrous metal from incoming grain stream.
Receiving Pit Grating
Use of Magnet at Receiving
Equipment Issues

- Equipment Issues may include:
  - Overheated Bearings
  - Misaligned Belts – Frictional Rubbing
  - Choked Legs
  - Overloaded Belts
Equipment Issues

Two ways to address equipment issues:

- Documented Preventative Maintenance Programs
- Installation of Safety Control Equipment
Preventative Maintenance

- Outlined in the OSHA Grain Handling Standard

  - Employer shall implement preventative maintenance procedures

  - Regularly scheduled inspections of at least the mechanical and safety control equipment associated with:
    - Grain Stream Processing Equipment
    - Filter Collectors
    - Bucket Elevators
    - Grain Drying Systems
Preventative Maintenance

- Lubrication schedules and maintenance in accordance with manufacturer recommendations, or as determined by prior operating records.

- Promptly correct dust collection systems which are malfunctioning or operating below design efficiency.

- Employer shall promptly correct, or remove from service, overheated bearings, and slipping or misaligned belts associated with inside bucket elevators.

- Certification record needs to be maintained for each inspection to include:
  - Date of inspection
  - Name of person inspecting, repairing, etc.
  - Serial number or other identifier of equipment
Preventative Maintenance

- Infrared Thermography – the use of an infrared imaging and measurement camera to "see" and "measure" thermal energy emitted from an object.

- Can be used on:
  - Electrical Systems
  - Bearings
  - Motors
Control Equipment

- Bearing Monitoring Systems
- Conveyor Zero Speeds
- Belt Alignment Systems
Control Equipment

- Bearings (OSHA requirement):
  - Bearings should be mounted externally to the leg casing (Pillow Block) or;
  - Vibration monitoring, temperature monitoring or other means to monitor the condition of the bearings mounted inside or partially inside the leg casing.

- Does not apply to bucket elevators with:
  - Explosion suppression on head and boot sections
  - Bucket elevators equipped with pneumatic dust control systems that keep the dust concentration in inside bucket elevators at least 25% below the MEC during operation.
Pillow Block Bearings
Control Equipment

▶ Motion Detection (OSHA Requirement)

◦ Bucket elevators must be equipped with a motion detection device.

◦ Must shut down the bucket elevator when the belt speed is reduced to no more than 20% of normal operating speed.

▶ Does not apply to bucket elevators with:

• Explosion suppression on head and boot sections, or
• bucket elevators equipped with pneumatic dust control systems that keep the dust concentration in inside bucket elevators at least 25% below the MEC during operation, or
• Grain elevators having a permanent storage capacity of less than 1 million bushels, provided that daily inspection of bucket movement and tracking of the belt.
Belt Alignment (OSHA Requirement):

- Equip bucket elevators with belt alignment devices which initiate an alarm to employees when the belt is not tracking properly or;
- Provide a means to keep belt tracking properly.

Does not apply to bucket elevators with:

- Explosion suppression on head and boot sections.
- Bucket elevators equipped with pneumatic dust control systems that keep the dust concentration in inside bucket elevators at least 25% below the MEC during operation, or
- Grain elevators having a permanent storage capacity of less than 1 million bushels, provided that daily inspection of bucket movement and tracking of the belt.
Control Equipment

- Systems should at a minimum be connected to an audible/visual alarm to alert employees.

- Helpful to tie systems into office areas that are always staffed.
**Explosion Venting**

- Design concept is a design concept used with elevator legs to vent the pressure and fire front of the primary explosion outside of the elevator reducing the probability of the more devastating secondary explosions.

- Explosion Vents replace a portion of a leg casing.

- Designed to rupture or release at low pressures.

- Maintain the structural integrity of the leg casing.

- Can also vent bins, silos, dust collection equipment, etc.
Explosion Venting

- Venting interior legs is not easy.
- Venting should be to the outside.
- The ducting should be no longer than 10 feet and have no bends or elbows.
Explosion Venting

- Vent Panels
  - Rupture strength of no more than 1 psi.
  - Vary from aluminum to PVC.
  - Should be secured by chain or cable.
  - Make sure not positioned near work areas.
Explosion Vent Panels
Bag House
Explosion Suppression

- Detects grain dust explosion early.
- Floods area with an extinguishing agent.
- Can effectively suppress grain dust explosions in bucket elevator legs.
Grain dust explosion can be detected by sensors:
- Optical
- Thermal
- Pressure – Most Common

Diaphragm type device responds to initial pressure by quickly closing electrical contacts.
Sensor detects the pressure front and sends a signal through a control unit to a high rate discharge extinguisher

- Dispenses in 3–5 milliseconds
- Uses dry powders
  - Sodium Bicarbonate
  - Mono–ammonium phosphate

Battery powered, interlocked to equipment.
Operation of Explosion Suppression
Additional Prevention

Training

- Employer shall provide training annually on:
  - Recognition of hazards related to dust accumulations
  - Common Ignition sources such as smoking
  - Cleaning procedures
  - Housekeeping procedures
  - Preventative Maintenance
  - Properly rated tools and equipment
  - Emergency Procedures
  - PPE/Clothing
Inside Bucket Elevators

- Shall not be jogged to free a choked leg.
- All belts and lagging purchased after 1988 shall be conductive.
- All bucket elevators shall have a means of access to the head pulley to allow inspection of the head pulley, lagging, belt and discharge.
- Boot section of bucket elevator shall also be provided with a means to access for clean-out of the boot and for inspection of the boot, pulley and belt.
The Aftermath Of An Explosion
Questions?

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