Combustible Dust and OSHA Housekeeping Requirements for Grain Elevators and Feed Mills

Prepared for Grain Handling Safety Stand Down Week March 27-31, 2017
Combustible Dust and Housekeeping

- Hazards of grain dust.
- How explosions occur.
- Common ignition sources.
- Control methods to minimize or eliminate explosion hazards.
- OSHA housekeeping requirements for Grain Elevators and Feed Mills.
Combustible Dust and Housekeeping

- Combustible dusts are a serious hazard OSHA is looking at when inspecting manufacturing facilities including Grain Elevators and Feed Mills.

- All grain dusts are combustible and can cause explosions in the workplace.
Combustible Dust and Housekeeping

- The OSHA Grain Standard requires employers to keep dust accumulation under control and does not allow dust to accumulate to more than 1/8 inch in priority housekeeping areas.
Combustible Dust and Housekeeping

Why is OSHA so concerned about grain dust?
One dead after blast at Indiana grain silo

Michael Winter, USA TODAY 9:31 p.m. EDT June 24, 2013

A possible grain dust explosion knocks worker off 175-foot tower at farm co-op south of Chicago.

(Photo: Robert Franklin, South Bend Tribune, via AP)

A 66-year-old worker at an Indiana farm co-op was killed Monday afternoon when a grain silo exploded, knocking him from the top of a 175-foot tower, LaPorte County authorities said.
Cause of fatal grain elevator explosion found

5
Print Email
July 02, 2013 4:15 pm - Stan Maddux Times Correspondent

UNION MILLS | A malfunctioning pulley caused the June 24 explosion at a Union Mills grain elevator that killed a worker, according to investigators.

The Co-Op is no longer operating and may have to be rebuilt or torn down because of extensive damage primarily to the roof covering all of the 24 silos in the facility, said John Homan, fire chief of the Noble Township Volunteer Fire Department.

Homan said on the day of the explosion, a conveyor was taking grain from the basement to the top of two silos when a steel shaft on a pulley operating the conveyor came loose.

The heavy steel pulley -- about five feet in diameter -- slid into a concrete wall. Because the conveyor kept operating, the pulley continued to rotate.

The friction from the pulley rubbing against the concrete wall eventually generated enough heat to ignite grain dust in the elevator resulting in an explosion, Homan said.

The grain in two of the silos also caught fire.

"That's where the heat source that ignited the grain dust had came from," Homan said.
What is an Explosion?

An explosion is generally defined as a destructive chemical reaction that produces noise, heat, and rapid expansion of gases. It happens in milliseconds.
Combustible Dust Explosions

Explosions happen when 5 conditions occur all at the same time. They are:

1. Ignition or heat source
2. Grain dust (fuel)
3. Oxygen
4. Confined area or space
5. ????
Explosion Pentagon

- Ignition Source
- Suspension or Mixing
- Oxidant
- Fuel
- Enclosure
Control Methods

Have very little control over 3 of the 5 factors needed for an explosion.

- Oxygen always present.
- Grain (fuel) always present.
- Enclosures are present.
  - Leg
  - Distributor
  - Boot Pits
  - Conveyors
  - Bins/Silos
Ignition Source Controls

- Ignition sources can be controlled.
  - Magnets to catch tramp metal to minimize mechanical sparks.
  - Temperature sensors, belt alignment sensors and systems to prevent leg choking to minimize frictional heat buildup.
Ignition Source Controls

- Static electricity control.
- Class II Division 1 and 2 wiring and equipment.
- Hot work permits.
- Tools and vehicles.
- Preventive Maintenance.
Ignition Sources

Grain and Feed Mills

- Friction Sparks: 2.8%
- Welding: 17.2%
- Electrical Failure: 4%
- Tramp Metal: 4%
- Fire Besides Welding: 4%
- Choked Leg Friction: 3.2%
- FOD: 3.6%
- Hot Bearings: 2.8%
Dust/Fuel Controls

The fuel or dust accumulation can be controlled to prevent dust suspension or mixing from occurring.

- Ventilation and dust collection systems.
- Housekeeping programs.
- Effective preventive maintenance programs.
Excessive Dust

When dust is allowed to accumulate or “Cake” dust will shake loose during the initial or primary explosion which then causes a secondary explosion to occur. The secondary explosion causes all of the damage.
The “Typical” Explosion Event

Initial/Primary Internal Deflagration
The “Typical” Explosion Event

Initial/Primary
Internal
Deflagration

Shock Wave

Process Equipment

Time, msec.
The “Typical” Explosion Event

Initial/Primary Internal Deflagration

Elastic Rebound Shock Waves

Process Equipment

Time, msec.
The “Typical” Explosion Event

Initial/Primary Internal Deflagration

Dust clouds caused by Elastic Rebound

Process Equipment

Time, msec.

0  25  50  75  100  125  150  175  200  225  250  300  325
The “Typical” Explosion Event

Containment Failure from Initial Deflagration

Dust Clouds Caused by Elastic Rebound

Process Equipment

Time, msec.

| 0 | 25 | 50 | 75 | 100 | 125 | 150 | 175 | 200 | 225 | 250 | 300 | 325 |

The graph shows the timeline of the explosion event with key stages and events.
The “Typical” Explosion Event

Dust Clouds Caused by Elastic Rebound

Process Equipment

Secondary Explosion Initiated

Time, msec.

0  25  50  75  100  125  150  175  200  225  250  300  325
The “Typical” Explosion Event

Process Equipment

Secondary Explosion Spreads through Interior

Time, msec.
The “Typical” Explosion Event

Process Equipment

Secondary Explosion Vents from Structure

Time, msec.

0 25 50 75 100 125 150 175 200 225 250 300 325
The “Typical” Explosion Event

Secondary Explosion Causes Collapse and Residual Fires

Time, msec.

0 25 50 75 100 125 150 175 200 225 250 300 325
Housekeeping Program

In order to keep dust accumulation under control the OSHA Grain Standard requires employers to have a written housekeeping program. It must include:

- Frequency of cleaning
- Methods to reduce accumulation on:
  - Ledges
  - Floors
  - Equipment
  - Other exposed surfaces
Housekeeping Methods

Cleaning methods include:

- Sweeping
- Brushing
- Shoveling
- Vacuum cleaners can be used but must be rated for use in Class II combustible dust areas.
- Compressed air
Housekeeping Methods

In order to use compressed air for cleaning it is highly recommended that a permit be issued and signed by a member of management to ensure all safety precautions have been taken.

- All equipment and facility lighting is completely shut down.
- All lighting and tools used are approved for Class II combustible dust locations.
- Approved air nozzle is used.
- Employees wearing appropriate PPE (safety glasses, goggles, respirator, etc.)
Compressed Air Cleaning Permit

Person Completing Permit:
Date:                             Time:

Areas Where Compressed Air Will be Used to Clean:
1.)
2.)
3.)
4.)
5.)

Checklist:                      Yes Not Applicable Initials
Supervisor/Operations Manager notified?
All equipment shut down completely.
All ignition sources have been controlled or turned off (including lighting where applicable)?
All lighting and tools are intrinsically safe (explosion proof lighting, non sparking tools)?
Approved nozzle used?
Proper Personal Protective Equipment worn (safety glasses/goggles, respirators/dust mask)?

This permit shall be filled out completely prior to any cleaning work that involves the use of compressed air where explosion potential exists. The permit must be kept on file.

Signature of operations manager/supervisor authorizing work: ____________________________
Signature of person completing the Permit: ____________________________________________
Permit Cancellation Date: ____________________________________________________________

Company Name                                                                 Revised:
Housekeeping Program - Priority Areas

The priority housekeeping areas OSHA focuses on are:

- Floor areas within 35 feet of bucket elevators.
- Floors of enclosed areas containing grinding equipment.
- Floors of enclosed areas containing inside grain dryers.

**Standard requires no more than 1/8th inch dust accumulation.**
Housekeeping Documentation

OSHA expects employers to document all housekeeping activities. Therefore, housekeeping logs should be created to document housekeeping activities.
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Means Housekeeping Not Required

H = Harvest Season (Generally includes the months of August through December)
PH = Post Harvest
| PRIORITY AREAS                      | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |
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| Mill Prod. Building               |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Clean daily                       |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Initials                          |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Top/Bottom blow down              |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Initials                          |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Grinder/Roller Mill Shed          |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Clean daily                       |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Initials                          |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Top/Bottom blow down              |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Initials                          |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Roller Mill Magnet                |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Check daily                       |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Initials                          |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Clean if needed                   |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Initials                          |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Mixer Magnets                     |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Check daily                       |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Initials                          |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Clean if needed                   |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Initials                          |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| GENERAL AREAS                     |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Warehouse                          |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Check monthly                     |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Initials                          |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Clean if needed                   |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Initials                          |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Means Housekeeping Not Required   |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
Housekeeping Program - Training

- All employees are required to be trained on the requirements of the housekeeping program.
- Retraining must be done annually.
- Training documented in writing for review by OSHA if asked.
Questions???