Hazard Alert! Handling and Storage of Grain and Silage

Storage and handling of grain, feed, and other bulk materials can present hazards to agricultural workers. This article provides a brief overview of these hazards, some safety recommendations, and a list of references that provide more in-depth information about specific safety concerns.

Hazards Associated with Grain Storage and Handling

Flowing Grain
Flowing grain can quickly submerge a worker and cause suffocation. According to the National Institute for Occupational Safety and Health (NIOSH, 1995), suffocation under silage or grain was the leading cause of grain-handling fatalities between 1985 and 1989. Loading and unloading of trucks and bins, collapsing surface crusts, and collapsing steep or vertical grain piles can bring about sudden, unexpected movement of grain. A worker can be caught in the flow and can be buried in just a few seconds.

Machinery
Grain handling machinery is the second largest cause of farm machinery-related deaths and causes many severe disfiguring injuries and amputations (NIOSH, 1995). Many of these injuries result from bodily entanglement in machinery. Augers, power take-offs (PTOs), and other moving or rotating machinery should be used with caution. Be aware that loose-fitting clothing, gloves, hair, and jewelry (including wedding bands) can get caught in moving machinery. Automatic unloading machinery may activate unexpectedly. Practice good lock-out/tag-out procedures and maintain machine guards and other safety devices.

Toxic Atmospheres
Confined spaces, as defined by the National Institute for Occupational Safety and Health, have atmospheres that are likely to contain toxic substances and insufficient oxygen (NIOSH, 1987). Many deaths have occurred in grain bins, silos, manure pits, and other confined spaces. The typical scenario involves a worker entering an oxygen-deficient or toxic atmosphere and collapsing. Co-workers notice the collapsed worker and enter the same atmosphere and attempt a rescue; however, if they do not use proper precautions (respirators, ventilator fans, etc.), they also collapse.

Dusts, molds, and toxins (aflatoxin, mycotoxin, endotoxin, etc.) can cause illness or acute respiratory reactions. Fermenting silage produces "silo gases," which include nitric oxide (NO), nitrogen dioxide (NO₂), and nitrogen tetroxide (N₂O₄). Carbon dioxide (CO₂) accumulates in stored grain. Other harmful gaseous products of microbial decomposition in stored organic products include methane (CH₄), ammonia (NH₃), and hydrogen sulfide (H₂S). Fumigants used for pest control purposes may be present. Carbon monoxide (CO) and other combustion by-products may accumulate when machinery is used in or near confined spaces; accidental ignition of building materials, hydraulic fluid, etc., can release other toxic gases and fumes into the atmosphere. Oxygen in confined spaces can be displaced by accumulated gases or depleted by microbial activity in stored products, workers in the spaces, and/or combustion (internal combustion engines and fires). When flammable or explosive gases (such as methane) or dusts...
(such grain dust or cotton lint) have accumulated in the environment, special precautions should be taken.

Electrical and Automatic Equipment
Electrocuton and fire hazards associated with grain handling equipment can be minimized through preparation and precautions. Maintain electrical equipment in good condition and ensure that wiring and grounding of equipment follow recommendations of the National Electric Code (NEC). Use only the properly rated fuses, wiring, insulation, etc. Practice good lock-out/tag-out procedures to prevent accidental activation of unloading equipment when you are in the bin or silo. Avoid personal or equipment contact with overhead power lines.

Grain Dust Explosions and Fires
All that is needed for a fire or explosion are a sufficient fuel source, oxygen, and heat or spark. Grain dusts, cotton lint, and many other organic materials are flammable. Under certain conditions, they present explosion hazards. Methane, gasoline, or diesel fuels may be present in agricultural facilities.

Dust concentrations can be controlled or reduced in some conditions, and ventilation can help dissipate flammable gases and fumes. Maintenance of grain-handling equipment can reduce overheated bearings (a possible ignition source). If you are working in a possibly flammable environment, refrain from smoking or using open flames for light or heat.

Falls and Equipment Overturns
Falls from machinery and structures were the second largest single cause of grain and silage handling fatalities between 1985 and 1989, (NIOSH, 1995). Be especially careful when using ladders. Use handrails, guardrails, safety ropes, and fall-arrest devices as appropriate. Equipment overturns are possible when tractors or other vehicles are used to pack silage in bunker silos. Use only equipment with rollover protective structures (ROPS) and seat belts.

Safety Precautions
There are times when workers must enter such confined spaces as grain bins or silos. Properly trained and prepared workers and adequate maintenance of safety equipment are essential to worker safety. A few safety recommendations compiled from resources in the reference list include:
1. Never enter a bin when unloading equipment is running.
2. Do not enter a bin with automatic unloading equipment, unless the control circuit is "locked out."
3. Be especially cautious when working with grain that is in poor condition; molds, blocked flow, surface crusts over cavities, grain avalanches, and toxic gases are more common in poor-quality grain.
4. Always be cautious around surface crusts; the crust can collapse, and you can become entrapped in the grain.
5. Do not rely on one person outside a grain bin to assist one person inside the bin. Be aware that machinery noise can interfere with communication between co-workers; further, rescue of a worker inside the bin may require at least two workers outside the bin.
6. Do not work alone in heavy mold dust. Wear a respirator that can filter fine dust. Sensitivity to mold and dust increases with repeated exposure; acute reactions are possible.
7. Be cautious about steep piles of grain; unstable grain may avalanche when dislodged or disturbed.
8. Keep children away from grain-hauling vehicles and equipment that is in operation.
9. Always use a rope and safety harness when entering a dangerous bin.
10. Beware of potential oxygen deficiency and accumulation of toxic gases and fumes in confined spaces. Ventilate confined spaces before entering; verify that air in the space is suitable for worker entry or use a suitable respirator.
11. Use only appropriately rated electrical equipment. Fuses, insulation, wiring, etc., must be properly sized and protected.
12. Reduce fire and explosion hazards through equipment maintenance, ventilation (if appropriate), and refraining
from smoking near flammable dusts, gases, and fumes.

**Sources of Information**

For more information about safety in storage and handling of silage and grain, you may contact the Cooperative Extension Service and the following references.


**Midwest Plan Service** materials may be ordered from:

122 Davidson Hall
Iowa State University
Ames, IA 5011-3080
Toll Free: 800/562-3618
Fax: 515/294-9589
Customer Service: 515/294-4337

**Northeast Regional Agricultural Engineering Service** materials may be ordered from:

152 Riley-Robb Hall
Ithaca, NY 14853-5701
Phone: 607/255-7654
FAX: 607/254-8770
E-mail: nraes@cornell.edu
Web site: [http://rcwpsun.cas.psu.edu/NRAES](http://rcwpsun.cas.psu.edu/NRAES)

**National Institute for Occupational Safety and Health** information is available from:

Division of Safety Research, NIOSH
1095 Willowdale Road
Morgantown, WV 26505
Phone: 304/285-5894 or 1-800/356-4674 (1-800/35-NIOSH)
Web site: [http://www.cdc.gov/niosh/homepage.html](http://www.cdc.gov/niosh/homepage.html)

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