

Safety Measures in Handling Stored Grain

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Hazards must be identified when working around grain storage facilities. Then the necessary steps to eliminate the hazard(s) and/or protect workers from the hazards can be taken.

Several hazards that cause deaths and injuries are associated with placing grain in storage and managing the stored grain: getting caught in augers and power take-off shafts, suffocation, overexertion, falls, exposure to dust and/or chemicals, electrocution, fires and explosions.

1. Getting caught in augers or power take-offs. Open augers are extremely dangerous and only invite trouble. Augers should have protective screens or covers placed on them at all times. Trash should not be removed from an auger while it is running. And the power should be disconnected when an auger is worked on.

The power take-off should have a protective shield. Loose clothing that can get caught in machinery should not be worn.

2. Falls. Next to automobile accidents, falls kill more people in the United States each year than any other accident. Farm operators can lessen this number with a few simple precautions.

First, outside ladders should be secure. For heights over 20 feet, a cage or other approved safety device should be used on ladders that are used for ascending or descending. Tools should be raised or lowered using a rope and/or basket - never carried while climbing a vertical ladder.

Extra care should be taken when climbing ladders and walking on wet or icy grain bin roofs.

3. Electrocution. In recent years, too many fatalities have occurred from portable augers striking overhead power lines. Look up and live!

When a person samples a bin or attempts to break up a bridge or hang-up problem, a simple check for power lines within reach of the metal probe or pipe should be made. This safety precaution can save a life. Storage site wiring should be done by a qualified electrician to insure proper grounding. If 125V single phase outlets are used, three-prong, grounded outlets are required. Ground fault circuit interrupters are recommended.

4. Suffocation. The most common suffocation accident is entrapment and suffocation caused when a person is drawn under flowing grain. (Figure 1.)

When a grain bin is emptied, the grain flows in a funnel-shaped path above the outlet. The outlet for most on-farm storage bins is

located in the center of the bin bottom, so the grain flows down the center. Speed increases as grain flows from the bin wall at the top of the grain mass into a small vertical column at the center of the bin. This vertical column of grain flows down through the grain mass at nearly the same rate as the grain is withdrawn from the bin.



Figure 1. A center grain unloading auger draws grain from the top center and the grain forms a cone as the bin is emptied.

Entrapment is similar to being drawn into quicksand. Once trapped in flowing grain, the victim is drawn rapidly to the bottom of the bin where he may become entangled in the unloading auger. Near the center of the inverted cone, it takes only a few seconds to be drawn into the grain above knee depth. At that depth, with nothing to hold on to and nothing to push on but flowing grain, a person is trapped. Since an 8-inch auger can move about 3,000 cubic feet (2,400 bushels) of material per hour and the body volume of a person is about 7 cubic feet, a person can be completely submerged in 8 seconds or less. Larger unloading equipment would decrease this time.

Similar accidents have occurred in gravity unloading grain wagons. Children playing on the grain surface during unloading have become trapped and have suffocated. *Stay out of grain wagons or trucks during unloading.*

The few survivors of this kind of engulfment said they covered their mouths and noses with their hands and didn't panic. They also expressed amazement at the tremendous speed at which they found themselves buried under the grain.

The condition of the grain apparently plays a major role in the survival of someone completely submerged. Someone buried in spoiled grain may have a greater chance of surviving because caked

masses of grain form open air pockets and reduce the grain pressure on the body.

Another type of suffocation can occur when grain has spoiled in storage. Spoiled grain can crust over and a cavity will develop under the crusted surface as grain is removed from the bin. A person walking on the crusted surface could break through, become submerged in the grain and suffocate. (Figure 2).

Spoiled grain also can cake in large vertical masses on bin walls. (Figure 3). Thus, when a person tries to break the caked material loose from below, large sections of grain can break off and cover the person in the bin. This risk increases as the capacity and particularly the height of the bin increases. Grain stored in large piles or bunkers also pose this type of hazard during load out.

Spoiling grain also produces carbon dioxide as a by-product of fermentation. Since carbon dioxide is heavier than air, air is pushed out of the bin, resulting in an oxygen-deficient atmosphere. If one enters a bin or pit with carbon dioxide present, the carbon dioxide will overload the bloodstream and slow down breathing. This, in turn, can cause drowsiness, headaches and even death. Since carbon dioxide is colorless and odorless, no warning is given.

Some precautions can be taken to prevent suffocation. A key rule to remember is "never enter a grain bin alone."

Do not enter a bin when grain is being removed. The discharge system should be shut off and locked out before a bin with grain is entered. Establish a method of communication with someone outside the bin. Shouting directions to another individual is not a dependable communication method. Equipment noise can block commands or cries for action or assistance. The other person may also become excited and fall or panic when trying to help.

It is dangerous to enter a bin that has had grain removed. Don't enter a bin without knowing whether any grain has been removed - especially if crusting is evident. If a crust must be broken, a person should do so from the roof, using a wooden pole or weights attached to a rope.

If a bin with evident or potential danger must be entered, a rope and a safety harness similar to a parachute harness should be used with the rope tied off so it cannot slip from a helper's hand. Two people capable of lifting the third person out should be outside the bin. If necessary, one person can go for help.

The friction or drag on a body submerged in a grain is tremendous. Every square inch of the submerged body is in contact with the grain. Partially submerged children who have been pulled from the grain have lost their shoes in the pulling process. A person waist deep or deeper in flowing grain cannot be pulled from the grain by a rope looped under the armpits without causing severe injuries.

A person trapped in a bin but not buried has one option. That option is to walk the grain down by staying near the *outside wall* and keeping on the move until the bin empties or the flow can be stopped. Avoid the center of cone.

A person who becomes trapped and is being sucked under the grain should cup the hands in front of the face, which will prevent grain from entering the respiratory tract and blocking air flow. This, coupled with staying calm and shallow breathing, may prevent immediate suffocation.

Some grains such as flax or millet will not support a person's weight. Therefore, walking across the surface of these grains, or other unknown materials, without testing to determine whether they will



Figure 2. A potentially dangerous situation is created when grain spoils in storage and forms a crust on the surface. Removing grain will create a void if the crust remains intact.

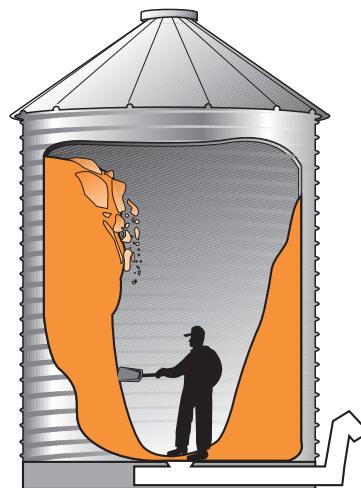


Figure 3. Spoiled grain can cake in large vertical masses which can cover a person if broken up from below.

support the weight is dangerous.

If a bin must be entered to dislodge materials adhering to the side, it should be done from a position above the grain with two other people outside the bin. The grain bin should be entered from the top and the material dislodged as the first person is lowered into the bin. A boatswain's chair and a parachute-type safety harness with a 3/4-inch manila rope or equivalent lifeline attached should be used.

If a person from a position below the lodged material attempts to loosen it, the material can break loose quickly and bury him. Likewise, standing on bridged grain or chunks adhering to the walls can cause them to collapse and bury a person under the heavy weight of the material.

Rescue procedures

If a person becomes submerged or trapped in grain, the rescuer should shut off the unloading system immediately. This will stop the victim from being pulled under further. If there is an aeration system, the rescuer should start it to move air through the grain. This will

provide fresh air to the victim. Then call the local rescue squad.

The most successful emergency rescue step is to cut large holes around the base of the bin approximately 5 feet above the base at 4 to 8 evenly spaced locations. This will reduce the volume of grain from the bin in the shortest period of time. Use an abrasive saw or cutting torch to cut the grain bin sidewalls. The fire department should be called to extinguish smoldering fires that may develop in the cutting process.

If a person is only partially submerged, normally the most efficient and safest method to extricate the victim also is to cut 4 to 8 holes evenly spaced at the ring level below the grain surface to remove the grain. If possible, a safety harness should be placed around the victim prior to removal of the grain. Two to 4 stabilizing lines connected to the harness should be attached to the bin wall. This allows for the grain to flow away from the victim. Once the grain has moved away from the victim, the person can be extricated through either the top of the bin or through one of the openings cut in the side of the bin.

Do not attempt a rescue in an oxygen-deficient atmosphere. Call the local emergency rescue team, which has training and equipment to do the job safely.

Grain Dust

Grain dust can be a mixture of particles of grain, soil, plant material, fungi, bacteria, residues of agricultural chemicals and the excreta of insects, rodents and birds. The mixture varies with the type of grain, growing conditions and how it was harvested, stored and processed.

Spoiled grain is especially contaminated with dust and bacteria.

These dusts can affect the respiratory tract in a variety of ways (Table 1) and can cause gastrointestinal problems, skin rashes and eye irritations. Individuals may react quite differently to the same dust. Each person's work history, health status and smoking history is unique. Thus, some people may be quite sensitive to the dust while others may be able to withstand several exposures prior to becoming sensitized.

To help reduce and prevent allergic reactions, a person should wear adequate protective devices, such as dust masks or helmets, and provide ventilation to remove the dusts. Those sensitive to the dusts should not enter areas where the dusts exist. "One-strap" disposable dust masks are not nearly as effective as "two-strap" models. Two-strap models fit better and allow less air leakage.

Warning! The simple dust mask will not protect a person against fumigants or areas where there is an inadequate supply of oxygen. These masks will not filter out harmful poisons nor will they add oxygen when there is an area with high concentrations of carbon dioxide resulting from the deterioration of wet grain.

NOTE: Readers are referred to grain protectant and fumigant labels and to the chapter on insects for proper use and handling of grain protectants and fumigants.

Carbon Dioxide. If the presence of CO₂ is suspected, do not enter the area. Opening manholes and all side door openings, supplemented by forced ventilation through the area, will help reduce the hazard.

Table 1. Respiratory Problems Caused by Grain Dusts

Respiratory Disease	Symptoms	Comments
1. Inflammation of the air passages - upper airways response - acute bronchitis	stuffy nose, runny nose, sore throat cough, spitting up phlegm, labored breathing	These very common reactions are bothersome but cause no permanent damage.
2. Asthma (often called grain asthma or barn allergy)	wheezing, labored breathing, cough	Asthma may be an immediate response to grain dust inhalation, may be delayed for several hours, or may recur successive nights following exposure.
3. Chronic obstructive pulmonary disease - chronic bronchitis - airways obstruction	recurring cough, phlegm production for two years or more labored breathing, wheezing	Cigarette smokers experience these same symptoms. And cigarette smoking grain handlers often get these respiratory symptoms sooner, or at a younger age, than nonsmoking grain handlers. Prolonged exposure to grain dust can lead to permanent lung damage.
4. Toxic Organic Dust Syndrome (TODS) (sometimes called grain fever)	flu-like symptoms including chills, fever, flushed face, muscle pain, general bodily discomfort	TODS follows heavy exposure to grain dusts. Symptoms occur for new workers 4 to 6 hours after exposure. Symptoms can occur in other employees after temporary removal (such as on a Monday following a weekend at home). TODS also can occur among farmers after exposure to confinement house dusts and moldy hay.
5. Farmers Lung	flu-like symptoms including cough, fever & chills, labored breathing, muscle pain, general discomfort	Caused by dusts from moldy hay, silage and grain. Symptoms start 4 to 8 hours after exposure. Even small amounts of dusts can cause illness after a person has become sensitized. Can cause permanent lung damage and death.

If ventilation is not possible, measure the oxygen concentration before entering. Do not enter if oxygen concentration in the area is less than 19.5%.

Summary

Grain-handling accidents can be reduced if you follow the appropriate safety rules. You and your family and your employees need to be trained in routine work hazards. All must be instructed to follow correct procedures when handling and storing grain.

Keep these safety measures in mind when storing and handling grain:

- Don't enter a bin of flowing grain.
- Don't enter a bin to break a crust or remove a blockage when unloading equipment is running, whether or not grain is flowing. Restarted flow can trap you.
- Before entering a bin or cleaning or repairing conveyors:
 - Lock out the control circuit on automatic unloading equipment, as on a wet holding bin.
 - Flag the switch on manual equipment so someone else doesn't start it.
- Don't enter a bin unless you know the nature of previous grain removal, especially if any crusting is evident.
- Beware of walking on any surface crust.
- Don't depend on a second person - on the bin roof, on the ground, or at some remote point - to start or stop equipment on your shouted instructions.
 - Equipment noise can block out shouts for action or assistance.
 - That person may fall or overexert in the panic and haste of getting off the bin or running to the control point.
- Be wary and alert while working with grain that has gone out of condition - there may be molds, blocked flow, cavities, cave-ins or crusting.
- When entering a questionable bin or storage, have two outside and one inside workers. Attach a safety rope to the man in the bin with the two men outside capable of lifting him out without entering the bin. One man outside cannot do this and cannot go for help while giving first aid.
- Always wear a respirator capable of filtering fine dust to work in obviously dusty-moldy grain. Never work in such conditions, even with protection, without a second person on safety standby.
- PARENTS, WATCH YOUR CHILDREN.
 - Keep them away from bins and vehicles with flowing grain.
 - Small hands and feet can penetrate even properly shielded augers, belts and PTO's.
- If a grain bin is peaked close to the roof, be extremely cautious. Crawling between roof and peak can cave grain and block the exit.
- Maintain proper and effective shields and guards on hazardous equipment.
- Do not enter the bin when the presence of CO₂ is suspected.
- Exercise caution when climbing on bins.
- Grain center wiring should be done by a competent electrician.
- Be aware of and avoid overhead power lines.
- Be prepared for emergencies.
- Have a rescue plan.

References

"Safe Storage and Handling of Grain," Aherin, R.A.; Shultz, University of Minnesota, Extension Folder 568 - 1981.

"Agricultural Respiratory Hazards Education Series," American Lung Association of Iowa in collaboration with the Institute of Agricultural Medicine and Occupational Health, The University of Iowa.

"Safety in Grain Elevators," Cooperative Extension Service, Iowa State University.

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