

# Suffocation Hazards in Grain Bins

Biological and  
Agricultural  
Engineering

Recent grain bin entrapments are reminders that grain storage, especially flowing grain, may become very dangerous. Tragedies in Arkansas have included suffocation when handling poultry feed, livestock feed, cottonseed, rice and soybeans.

Based on a review of 197 farm grain bin accidents in North America, only a few of the victims survived. Rescue rarely was successful; people that were trapped in grain died.

Consider some factors that contribute to this hazard:

- New grain bins are usually much larger and grain handling rates are much greater.
- Individuals may work alone when monitoring or moving grain, even if only for short periods.
- Workers have inadvertently filled feed bins, started grain handling equipment or failed to identify where co-workers were and what they were doing before starting grain or feed transfer.
- Grain or feed facility managers or owners may overlook the necessity of having an accident response plan that is understood by everyone before a person becomes engulfed in feed or grain.
- Unfortunately, managers or workers may not understand or place enough emphasis on flowing grain hazards, considering that a person can be completely covered with grain in less than one minute.

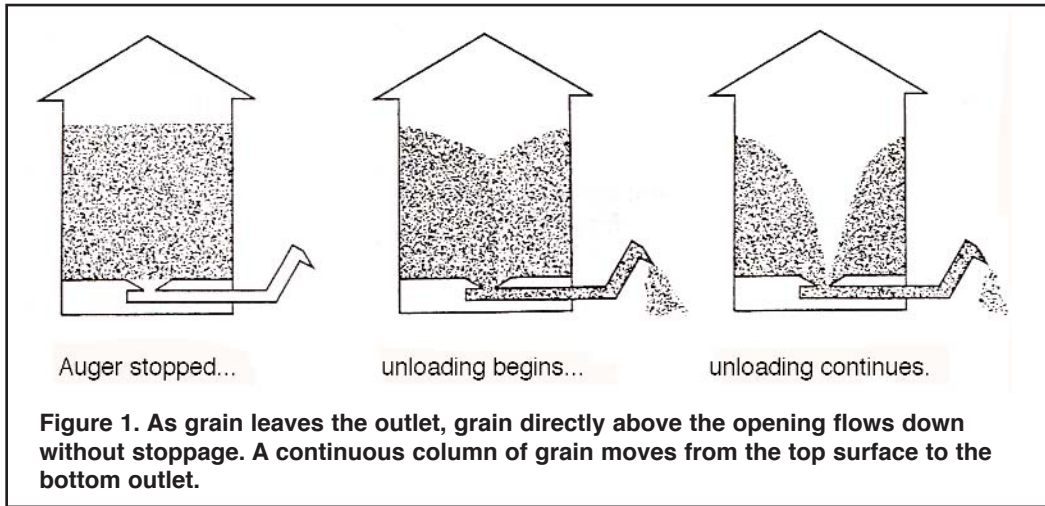
A few years ago a 22-year-old man died in a corn storage bin in Missouri after he made a cell phone call. Assistance arrived within minutes, but they were too late. **Don't make the mistake of your life. Be aware of the dangers of flowing grain or feed.**

## Why Enter a Bin?

- Successful owners/managers of stored grain or feed monitor their investment regularly. They may enter a grain bin or send someone to visually check the grain or feed condition. Some probe grain bins to determine if grain moisture is low enough for safe storage. Others may attempt to detect "hot spots" or heating due to moisture migration, poor air flow distribution or pest activity where broken kernels have accumulated.
- By entering a bin before adding feed or grain, an operator can be more confident that the bin is ready for additional feed or grain storage. The operator verifies that new (and possibly stored) product will be preserved in the bin environment.
- Grain stored for seed may be inspected or sampled for its viability.
- Children may enter a storage bin to play, or a trespasser may seek shelter.
- Someone may need to completely empty, clean the interior or spray insecticides in the bin.

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- Grain may “cake,” clump or “bridge,” hindering attempts to remove grain from a bin. If this is to be remedied, all options, other than entering the bin, should be tried first. If it is essential for a person to enter the bin to clear the obstruction, wear a **proper full body safety harness and tether manned by others outside.**

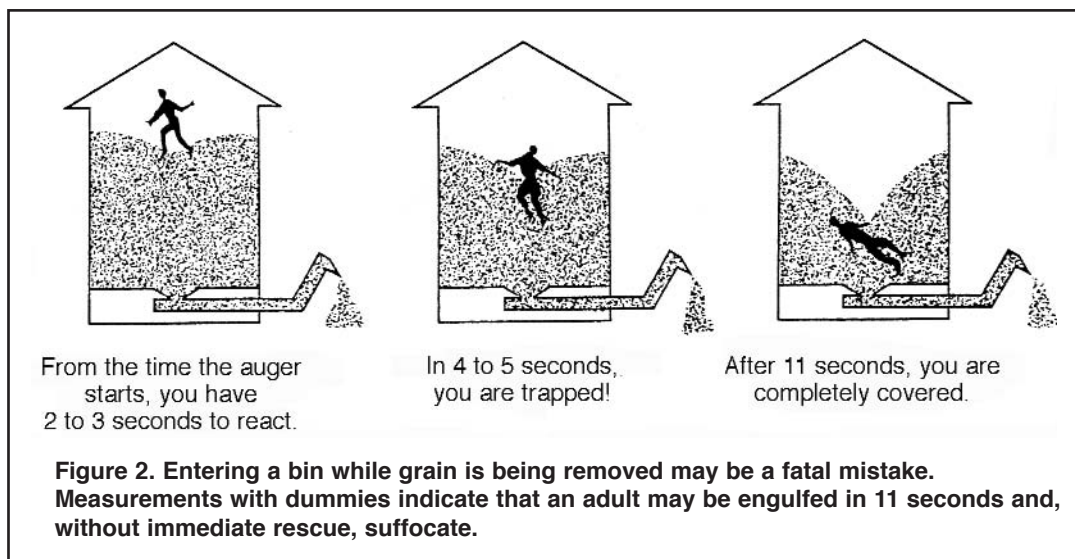
## Entering a Bin...You May Not Come Out Alive

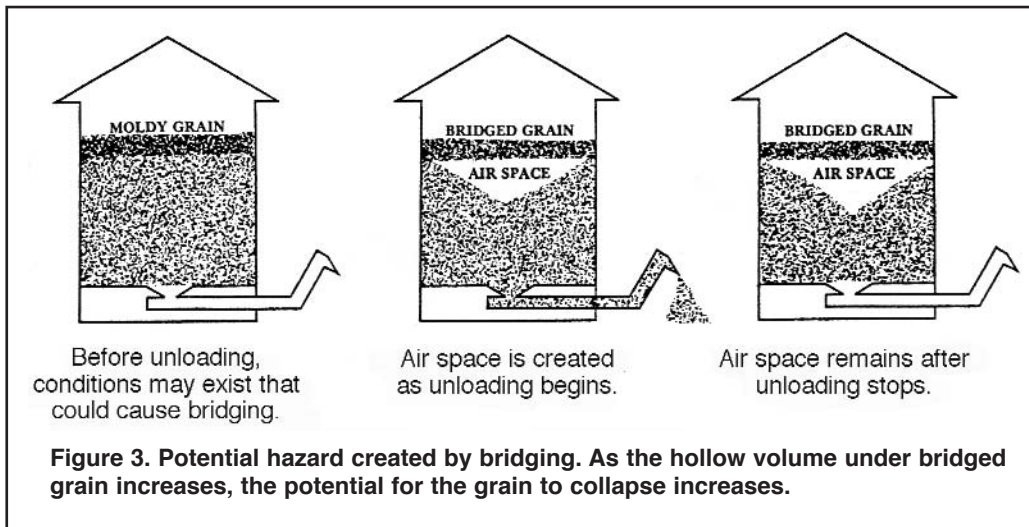
Why is flowing grain so dangerous? When the valve centered under the bottom of the bin is opened or the bottom unloading auger is energized, grain or feed flows to the outlet. Figure 1 illustrates how the grain directly above the outlet replaces the discharged grain. This downward flow pattern immediately transmits to the top grain surface, starting a column of flowing grain. Very little of the grain volume moves in the bin. The grain across the bottom and away from the center of the bin does not move. How rapidly the center column of grain leaves a bin depends on the size of the opening and/or the conveyor capacity. The weight of a person standing on

the grain forces the grain supporting him or her to flow to the outlet rapidly. This person’s weight is extra force that adds velocity to the grain underfoot and speeds the sinking victim.

The rate at which grain is removed with the unloading auger or by gravity discharge from a valve makes engulfment more likely than many grain workers may believe. Bin unloading augers typically move grain from farm storage in Arkansas at 2,000 to 10,000 bushels per hour. At the slower 2,000 bu/hr rate, this is approximately 41 cubic feet of grain moved per minute. A 6-foot tall person consists of roughly 7.5 cubic feet in volume. At 41 cubic feet of grain movement per minute, the entire body of a 6-foot tall person can be covered with grain in 11 seconds. If this happened to you in rapidly moving grain, you would be unable to free yourself before 5 seconds elapsed (Figure 2).

Grain may seem like flowing water, in that it exerts pressure over the entire surface of any submerged object. However, the amount of force required to pull someone up through grain is far greater than



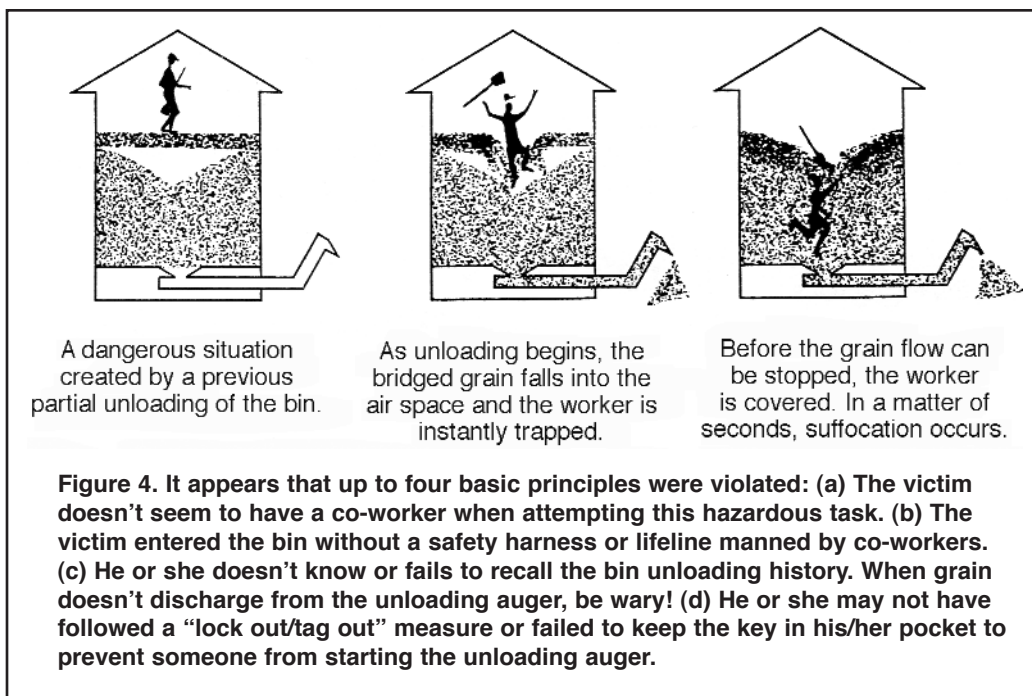


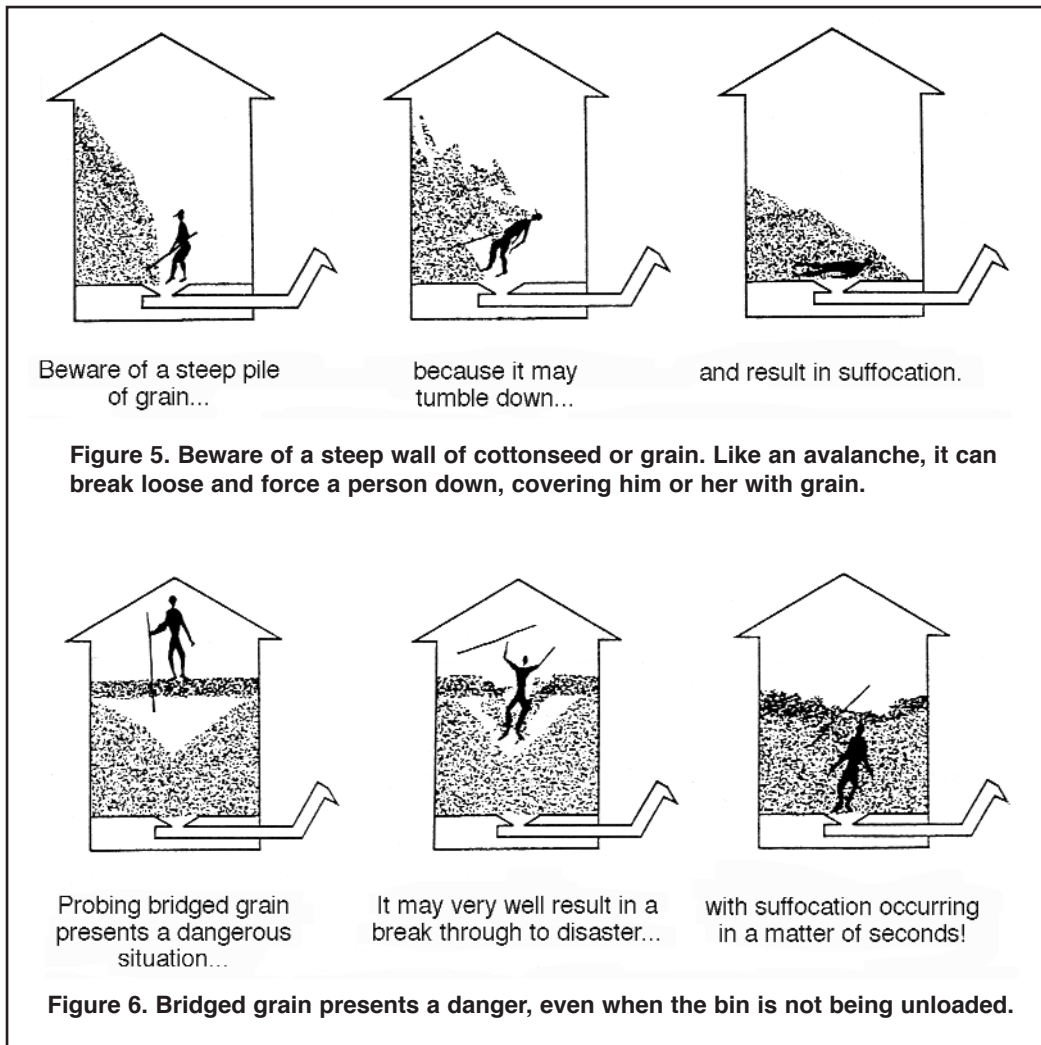
to rescue someone from under water. In fact, water has a buoyant force that “floats” ships and assists lifeguards in rescuing victims much larger than the lifeguard. Grain is much different. There is no buoyant force, and individual grains rub together to create a large friction force. The total forces resist anyone trying to remove a buried victim. Those who have pulled children **partially** covered with grain were surprised at the strength required. Typically, grain resistance pulls a person’s shoes off when he or she is drawn out. In research, it required more than 900 pounds of pull to raise an adult mannequin covered with wheat or corn. In essence, this highlights that all but very well-prepared and well-equipped rescues are doomed to fail.

A similar tragedy may occur if someone enters a bin after grain “bridges” rather than flowing as individual kernels (Figure 3). Grain spoilage may cause

grain to crust or bridge, thus resisting downward force that readily moves the loose grain to the bin outlet. Any hollow volume becomes a trap to a person who doesn’t avoid areas where there is no grain support under the surface. Grain crusts rarely become hard enough to support a person (Figure 4). If a grain handler stops the grain from flowing out of the bin before he or she enters, that person may be covered anyway when the surface collapses under the person’s weight. As grain cascades down, the victim is covered with an “avalanche” of grain that traps and suffocates him or her.

In a similar fashion, victims have died when rice or soybeans collapsed from a vertical wall. If a stack of grain does not flow to the bin outlet, a person may be prone to get a scoop or pole to poke the grain loose. Even though a wall of grain may appear perfectly safe, one scoop of grain may take away the base





support and start an avalanche (Figure 5). If you are knocked off balance by the mass of grain, you are likely to be covered and suffocate. In certain cases, bumping the grain using a pole through one of the bin access covers may release the grain. Otherwise, do not enter the bin until a crew is assembled who can rescue you should you get into trouble. Don't enter without a body harness and a lifeline manned by at least two others. Lock out and tag out the power to the unloading auger before entry. Then start breaking up the hardened grain close to the top of the pile. When the grain breaks loose, the mass of flowing grain doesn't gain enough momentum to knock you over. (Also, there is less grain to cover you!)

The risks are too great to attempt to eliminate crusting without the correct tools and a well-planned response. This includes having at least two others assisting you as a team trained to rescue you should you become covered with grain. Don't start this dangerous task until your team and appropriate tools are at hand. Even during a busy period of work,

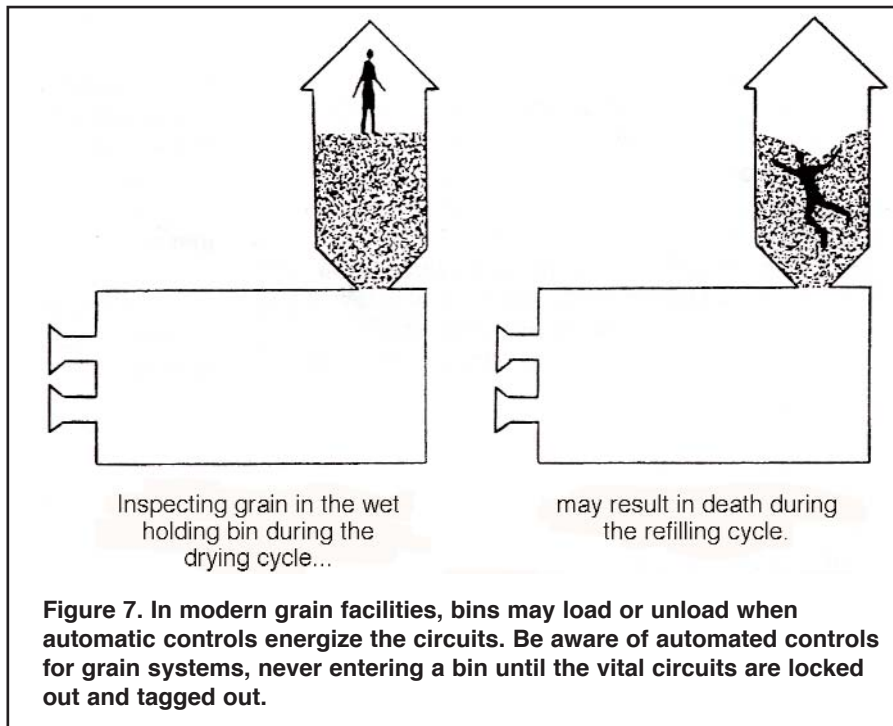
in the "heat of the moment," be wary enough to protect yourself.

Entering a bin while the auger is operating is dangerous. There is no reason to enter a bin with an auger turning. A slip, whether it is caused by flowing grain or a misjudgment cleaning around an auger with grid covers removed, may result in a traumatic entanglement. Always **advise others** of your intentions **before you enter a bin**. Equip yourself by getting others to hold a tether attached to your body harness while you work in the bin safely.

Personally ensure that no one will engage power to activate augers or load into the bin while you are inside. Lock the lever "off" on the electric control box with **your** padlock and place the key to the padlock in **your** pocket. Padlocks are readily available for this purpose at local electrical supply businesses. OSHA 29 CFR 1928.57 regulations require employees\* to follow this procedure called "lock out/tag out."

\*Farms are not covered by OSHA jurisdiction unless they employ more than 10 employees. The Federal Occupational Safety and Health Administration (OSHA) has confined space entry regulations under 29CFR, article 1910.146, that may apply to workers.





Engulfment is less common in gravity-unloaded systems, but it can occur when grain or feed is discharged into or “dumped” onto an unsuspecting person in a bin. Not working alone, coordinating with a rescue team and not entering a bin without a safety harness are necessary precautions for avoiding these tragedies.

## How to Enter a Bin

### Confined Space Entry

**Airborne grain dust, microbial spores and inadequate oxygen to sustain breathing can cause the death of a person entering a grain bin (confined space). Persistent exposure to these airborne particles may cause “farmer’s lung” which may become an irreversible lung condition, eventually causing death.**

Flowing grain hazards and mold and dust health hazards may exist when working with grain that has gone out of condition or has bridged into a precarious stack. Those who enter should wear NIOSH-approved dust filtering respirators to protect their lungs. Other more effective filtering equipment may prove to be a better alternative for extended exposures.

## How to Reduce the Risk

### Rule 1

A worker entering a grain or feed bin should have a body harness tethered to a lifeline that is manned

by two others outside the bin. One worker should be able to see the worker inside the bin through an access. This support crew can retrieve the one who entered the bin. One rescuer can get aid, if necessary, after the victim is retrieved, while the other is treating the victim.

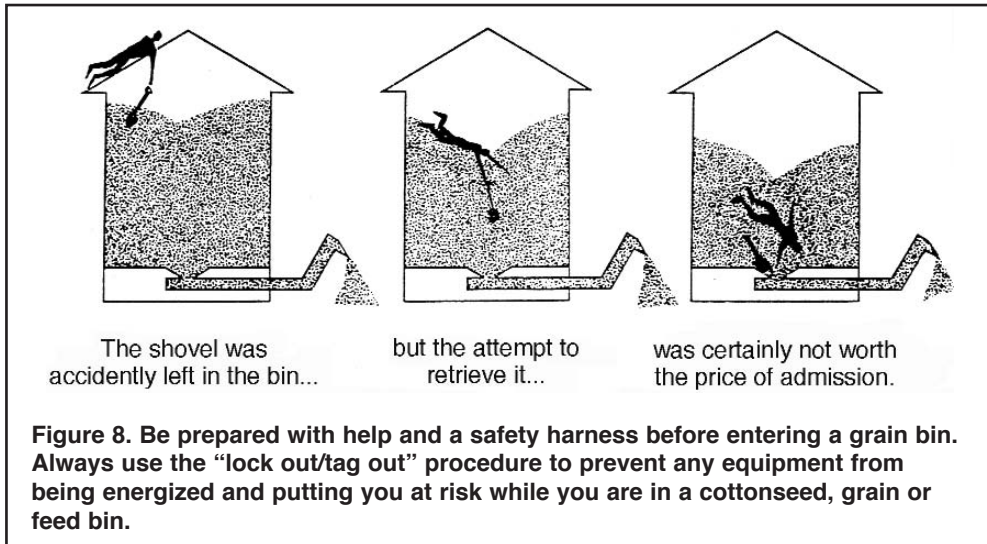
Don’t depend on being able to communicate from the inside to the outside of the bin. The use of prearranged arm and hand signals is one suggestion for these conditions. It is difficult to hear under any circumstances, but especially when grain handling or drying equipment is operating.

### Rule 2

Never enter a bin of flowing grain. If you drop a grain probe or shovel, **first stop the flow of grain**, take the precautions given in Rule 1, then retrieve the lost item. Remember, no piece of equipment is worth a human life (Figure 8, page 6).

### Rule 3

You should know or be wary about a grain bin’s history before entering. Get help if the grain surface appears moldy or caked. Get at least two helpers and have a tether and a safety harness. Strike the grain surface hard with a pole or long-handled tool before entry. Probe through the top layer and determine if there is a crusted surface; never get out of communication with your co-workers.



### Rule 4

Don't fail to lock out/tag out related power equipment before entering any bin. It may also be wise to post a sign on the control box if it is possible that others may arrive after you padlock the control levers. If a bin is unloaded by gravity flow, padlock the control gate to keep it closed.

### Rule 5

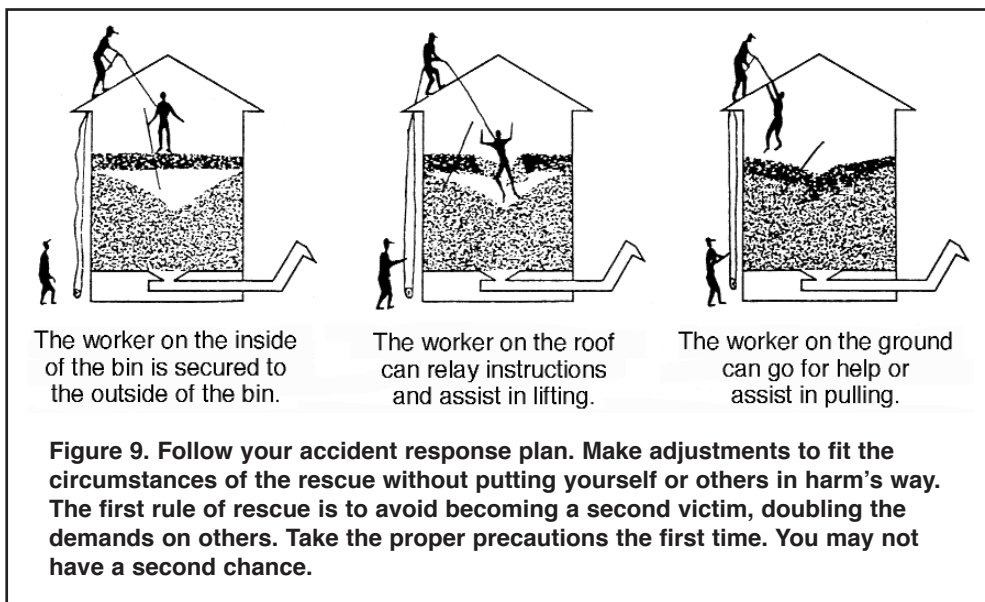
An accident response plan was mentioned toward the beginning of this publication (Figure 9). Any adjustments to rescue another should not endanger a second victim. A rescue should not increase the number of or the severity of injury to victims.

Having appropriate breathing apparatus is essential if the victim has been unable to get sufficient oxygen or has been breathing air containing

grain toxins. Use adequate dust protection and take a rope to **remove the victim from the bin without using your tether. Again, an adequate crew is essential to retrieve a victim without placing yourself in the same danger! Before concluding that you should enter a bin, assure that adequate help is available to pull you out with your tether and safety harness.**

### Rule 6

Preventative safety measures should include proper ladders, scaffolds, etc. Modern bins have an interior ladder, and these can be installed in older bins. Have a body harness, tether, breathing apparatus and a minimum of two others in your crew if you have reason to enter a bin. Remember, always try other means first to alleviate a problem without entering the grain bin. Do not enter without following all accident prevention measures, having a trained crew and using the recommended equipment.



## Please...Before It's Too Late

Discuss the safety hazards of grain dryers and bins and feed handling and storage facilities with your family. Make specific accident response plans with employees and anyone, such as a trucker, who frequently works around the facility. Each has the responsibility to be aware of potential unsafe conditions and to take steps to remedy them. By working together as a team, more of the dangers will be identified and more practical remedies will be taken. If you use a team approach, the potential of entanglement or suffocation is almost eliminated.

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