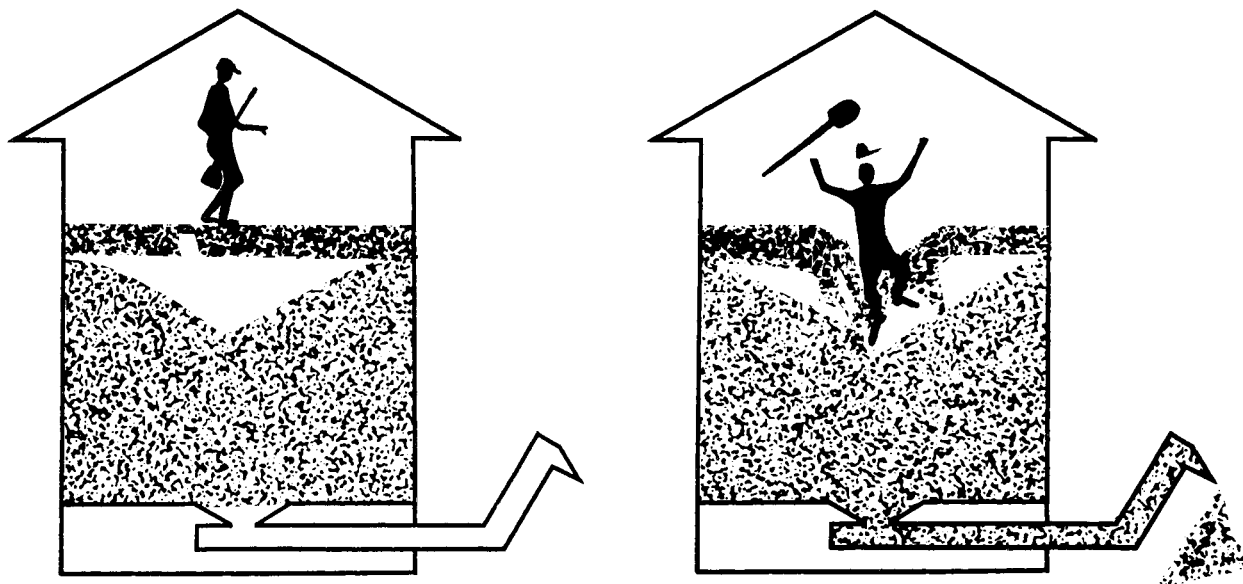




# Suffocation Hazards in Grain Bins



The number of suffocations in grain storage systems has been increasing over the past several years. There appear to be at least five basic reasons:

1. the increase in harvesting and handling of grains,
2. grain bins on the farm are getting bigger,
3. grain handling rates are faster,
4. more operators are working alone due to increased mechanization, and
5. most operators are not aware of how grain flows from bins and therefore do not understand the dangers involved.

Don't make the mistake of your life. Be aware of the dangers of flowing grain.

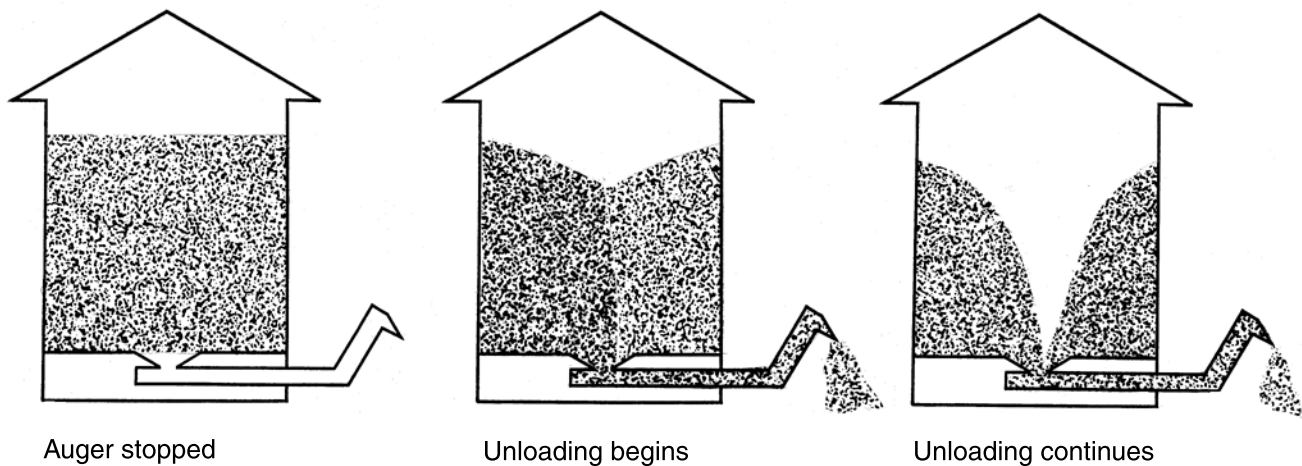
## **There are several reasons why you might enter a bin filled with grain . . .**

1. The successful manager of stored grain checks this investment closely and frequently. You may enter a grain bin to visually check the grain's condition, and may probe the bin to determine the grain's temperature and moisture content to ensure that there are no "hot-spots" developing in the center of the bin.

2. Grain being removed from a bin equipped with a bottom unloading auger may fail to flow because of clogging or bridging. The operator may feel that the only option is to go inside the bin and remove the obstruction or break up the bridged grain.
3. When drying grain, the successful operator will check the incoming grain closely. You may feel that the wet holding bin is the best place to make observations.
4. Children may find that a storage bin filled with grain is an ideal place to play .

## **. . . and there are several reasons why you may not come out alive.**

Why is flowing grain so dangerous? To better comprehend the hazard, the way in which most farm storage bins unload must be understood. Grain storage structures should be, and usually are, unloaded from the center. When a valve is opened in the center of the bin or a bottom unloading auger is started, grain flows from the top surface down a center core to the unloading port or auger. This is called "enveloping flow" and is illustrated in Figure 1. The grain across the bottom and around the sides of the bin does not move. The rate at which the grain is

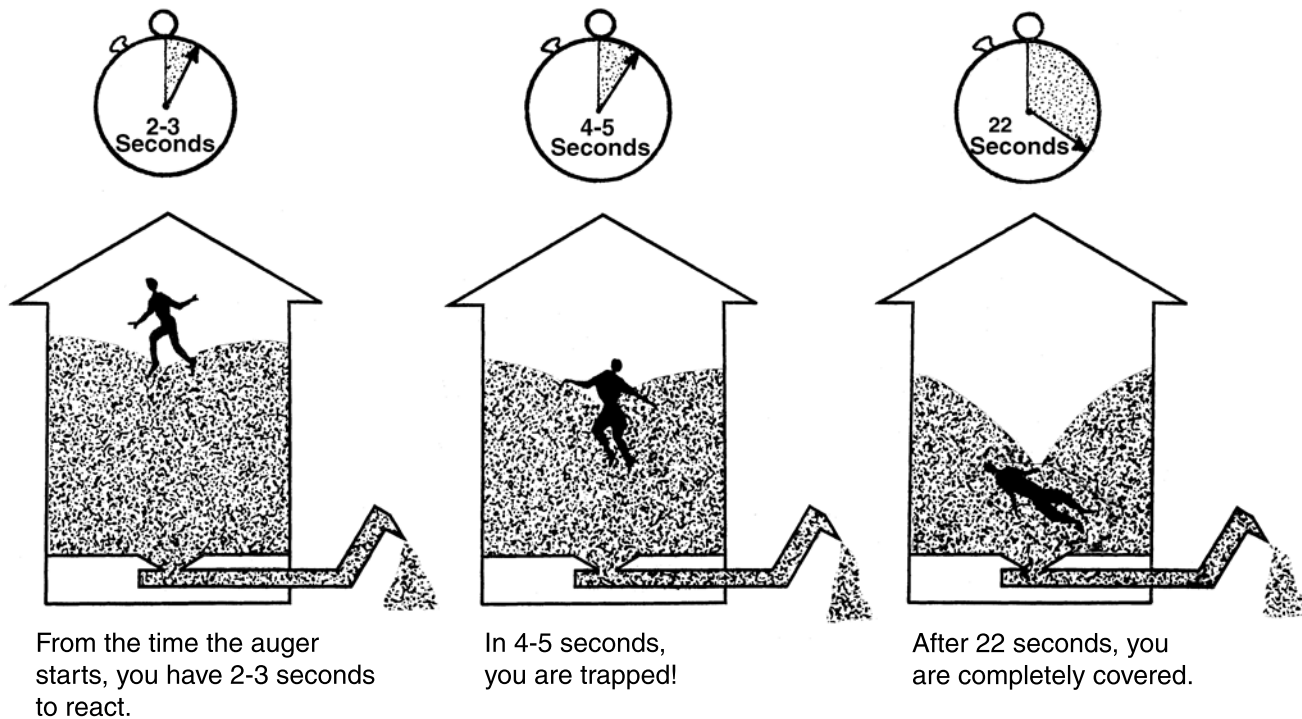


Auger stopped

Unloading begins

Unloading continues

Figure 1. When bins unload, the grain at the top of the bin is removed first.



From the time the auger starts, you have 2-3 seconds to react.

In 4-5 seconds, you are trapped!

After 22 seconds, you are completely covered.

Figure 2. Twenty-two seconds to suffocation.

removed is what makes the enveloping flow so dangerous. A typical rate for a bin unloading auger is 1000 bu/hr. This is equivalent to 1250 cubic feet per hour or approximately 21 cubic feet per minute. A person 6' tall displaces about 7.5 cubic feet, assuming an average body diameter of 15 inches. This means that the entire body could be submerged in the envelope of grain in approximately 22 seconds. Even more importantly, you could be up to your knees in grain and totally helpless to free yourself in less than 5 seconds (Figure 2).

You must remember that flowing grain is like water in that it will exert pressure over the entire area of any object that is submerged in it. However, the amount of force required to pull someone up through grain is much greater than required in water because grain exerts no buoyant force and has much greater internal friction. People who have helped pull partially submerged children from grain have commented on how hard they had to pull and, frequently, that shoes were pulled off in the grain. This may mean that rescue efforts will fail unless the movement of grain is stopped.

Grain that bridges across a bin can be another hazard. Bridging grain may create air spaces in a partially unloaded bin (Figure 3). This situation presents several dangers. The first is that the person may break through the surface and be trapped instantly in the flowing grain (Figure 4). Another danger is that a large void may be created under the bridged grain by previous unloading so that a person who breaks through the crust may be buried under the grain and suffocate even though the unloading auger may not be in operation at the time (Figure 5). A third

hazard is that, if the grain is wet enough to mold and bridge across a bin, there may be little oxygen present in the cavity because of microbial action. Therefore, a person falling into this void may be forced to breathe toxic gases and microbial spores even if the head stays above the level of the surrounding grain.

Safety hazards in grain bins are not limited to those with bottom unloading augers. Gravity unloaded bins may present a similar danger through bridging or unloading. A definite danger exists

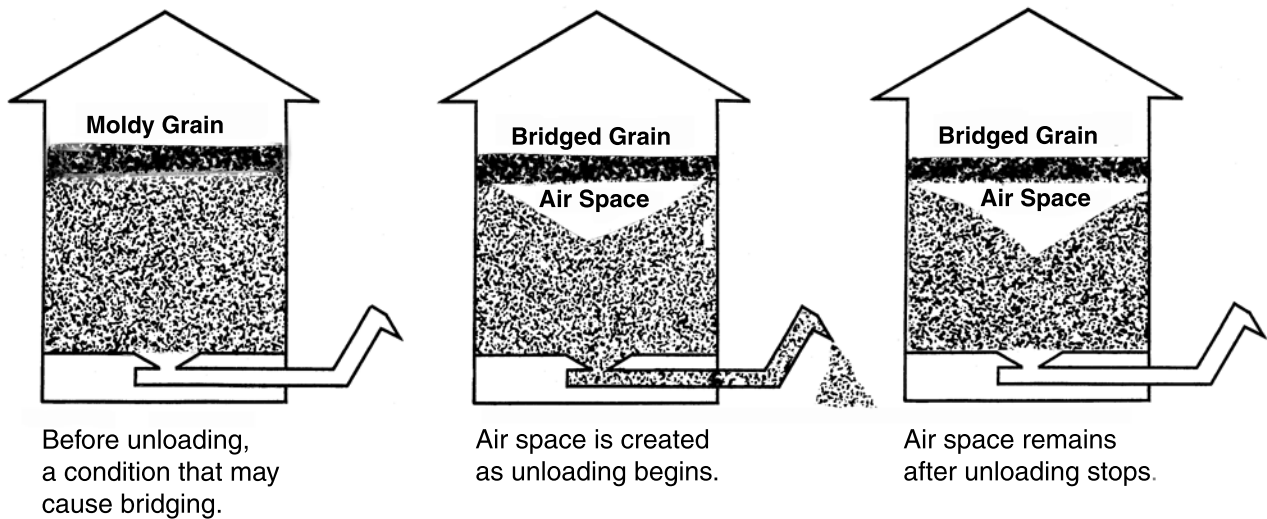


Figure 3. Potential hazard created by bridging. Note also that when the air space becomes large enough, the bin walls may buckle.

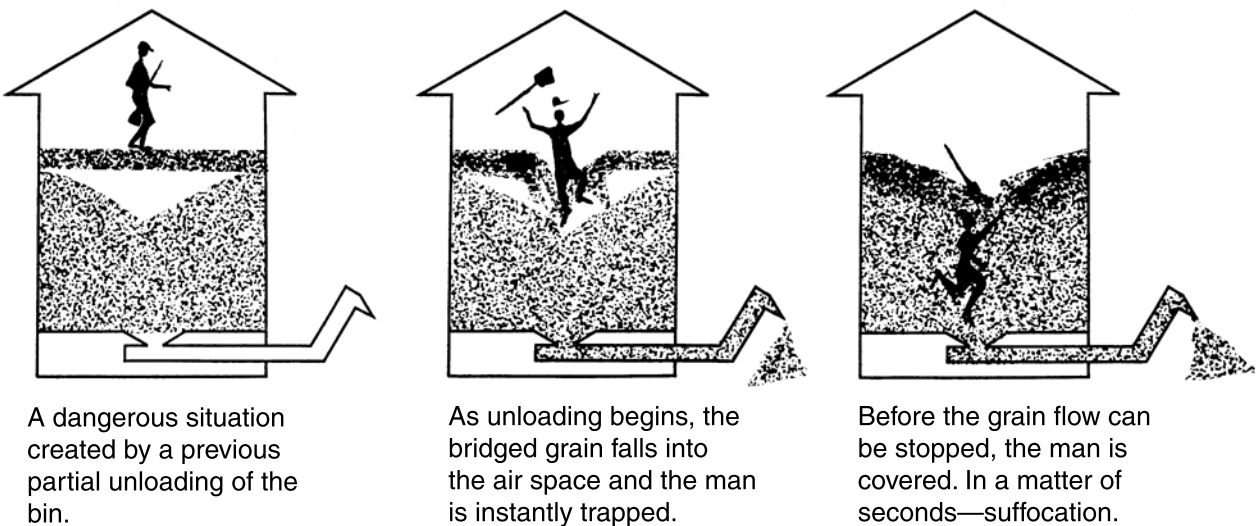


Figure 4. Two basic principles were violated. First, the person entered a bin of grain that was out of condition without seriously considering its previous unloading history. Second, he didn't ensure that unloading could NOT occur while he was inside.

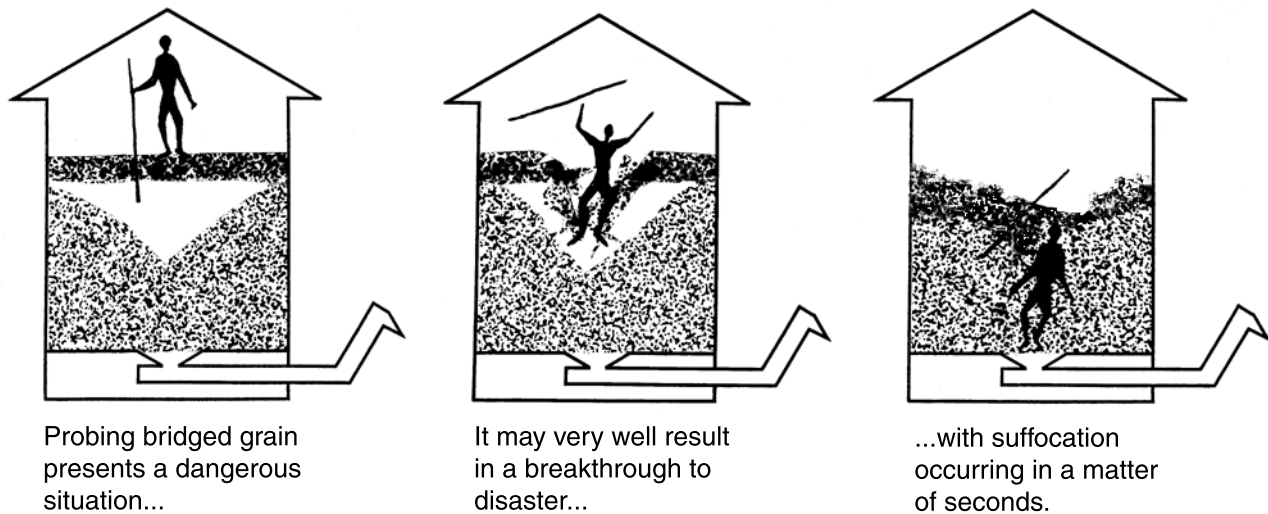


Figure 5. Bridged grain presents a danger, even when the bin is not being unloaded.

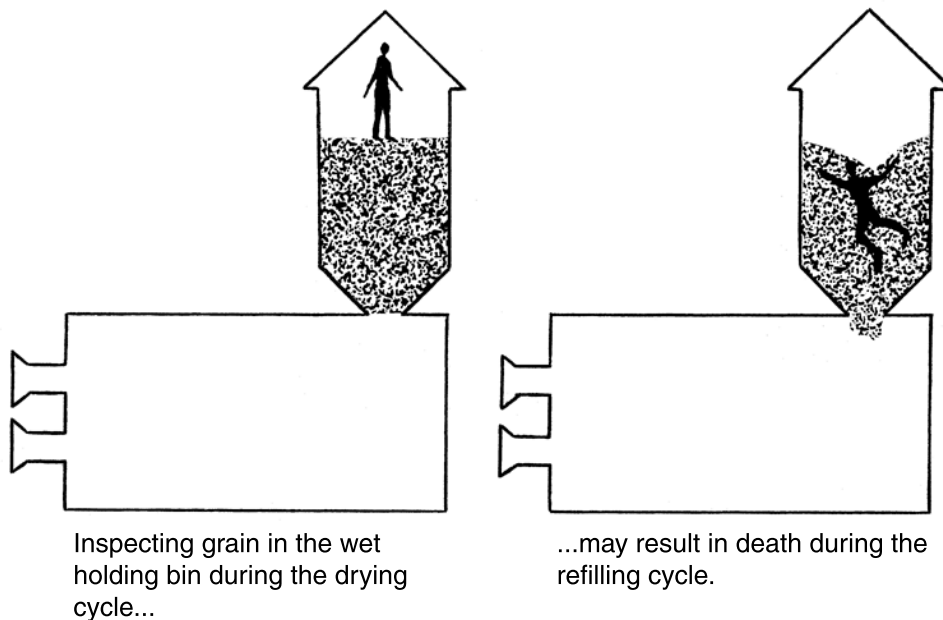


Figure 6. In a modern grain facility, bins may load or unload automatically, thereby adding to the suffocation hazard.

with wet holding bins that feed automatic-batch grain dryers. When the dryer completes its drying cycle and reloads, a person in the wet holding bin can be drawn below the surface of the grain in a matter of seconds (Figure 6).

Flowing grain hazards, in addition to mold and dust health hazards, exist when working with grain that has gone out of condition or has built up in a tall pile. A wall of grain may look

perfectly safe but one scoopful could pry out the “foundation” and start an avalanche or “cave-off” (Figure 7). Grain is heavy. For example, a 6' tall person, prone and covered by 1 foot of corn, will be under about 300 lbs. of corn. People who hear of suffocations like this are often surprised to learn that the victim was under only a shallow pile.

## How to Reduce the Risk

### Rule 1:

A person entering a grain bin should be fastened to a safety rope or harness that is tied to a point outside the structure. Two additional people should be involved—a second person who can see the person inside the bin and a third on the ground who can (1) assist in lifting the inside person to safety, (2) quickly go for aid without the danger of falling off the bin in a panic to climb down, and (3) ensure that no one starts the unloading equipment (Figure 8). Don't depend on being able to communicate

from the inside to the outside of the bin. It is difficult to hear under any circumstances, especially when unloading equipment or drying fans are in operation. The use of prearranged arm and hand signals is suggested under these conditions.

### 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 9).

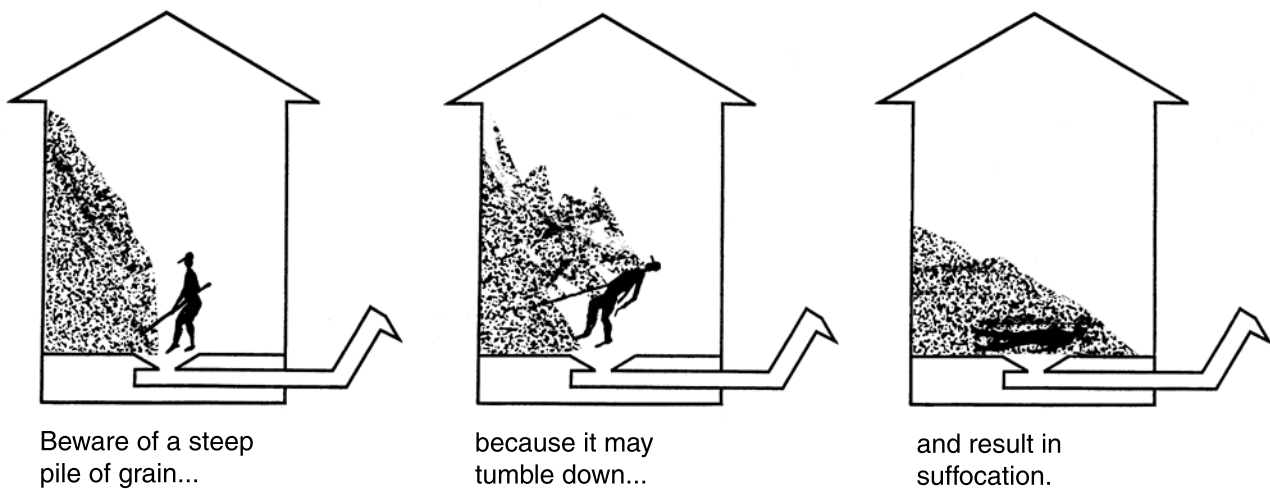


Figure 7. Beware of a tall pile of grain. A person lying prone and covered by 1 foot of grain will be subjected to a force of over 300 pounds.

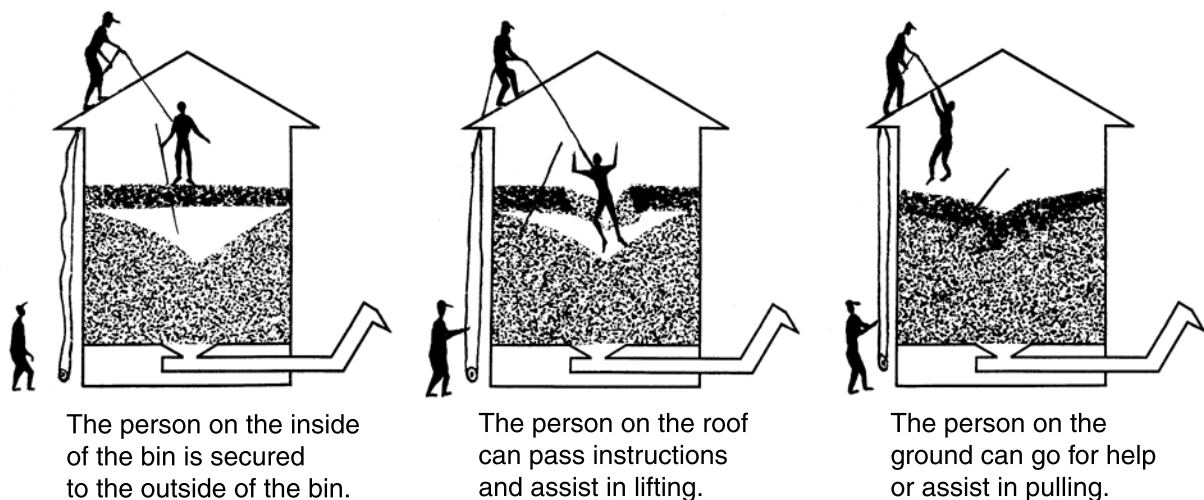


Figure 8. You should use three people when investigating a questionable bin, one inside, one in direct communication with the person inside, and one on the outside to go for help or assist in lifting.

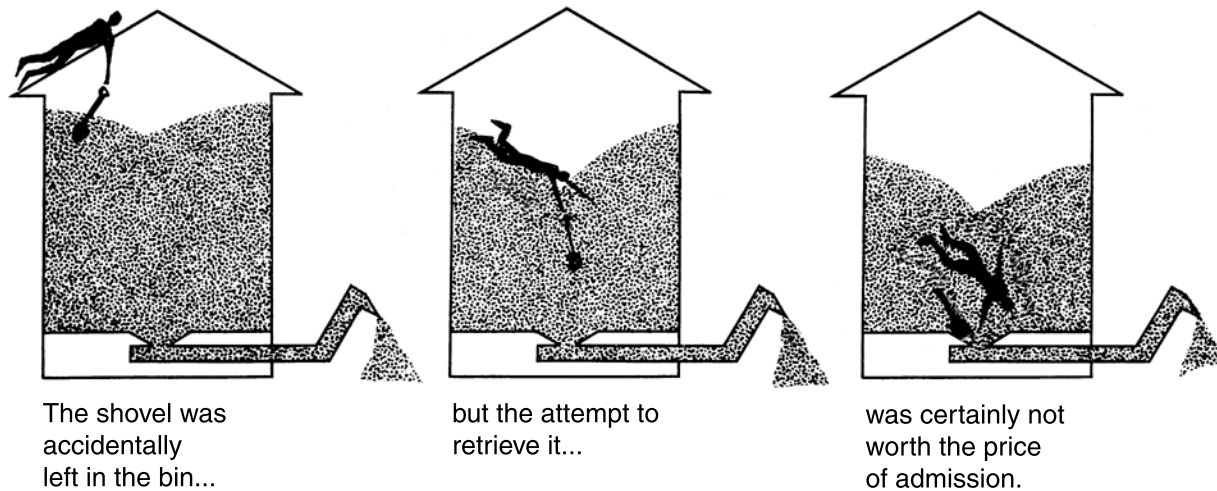


Figure 9. Never enter a bin of flowing grain for any reason. Always stop the flow of grain and "lock-out" the unloading system before entering.

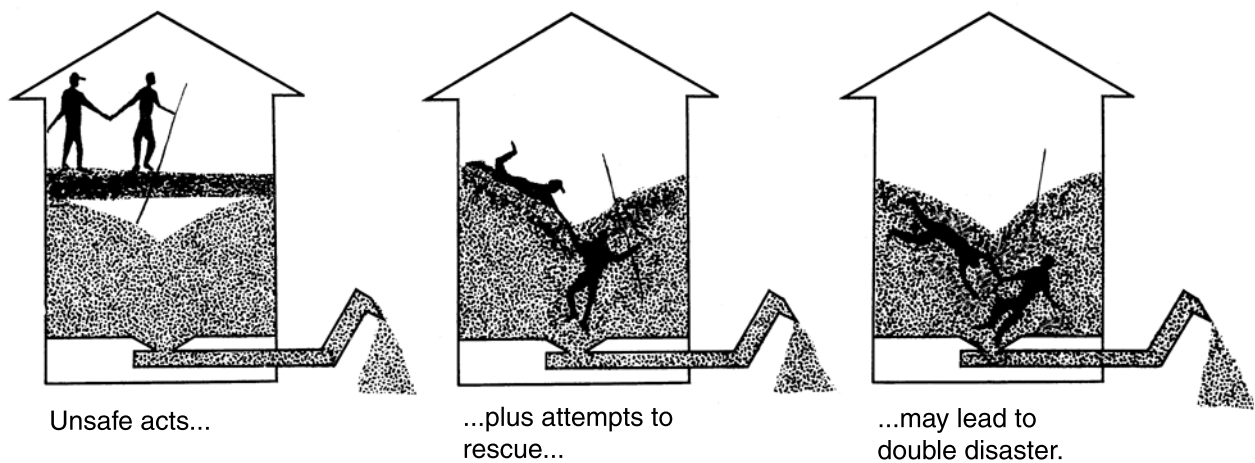


Figure 10. Take the proper precautions the first time. You may not have a second chance.

**Rule 3:**

Don't enter a bin without knowing its previous unloading history. This is especially true if the surface appears crusty because that may mean that the grain has bridged. Always be cautious before walking on any surface crust. If the bin has been out of condition, be sure it is well ventilated and enter slowly because of the danger from toxic gases, microbial spores and a reduced oxygen content. For this situation, be sure to follow the procedure suggested in Rule 1.

**Rule 4:**

If you feel you must enter the bin alone and the bin has unloading equipment, you should lock out the control circuit, tell

someone what you are doing and post a sign on the control switch informing other workers that you are in the bin. Otherwise, a fellow worker may start the unloading equipment with you inside. Likewise, check each bin before you begin to unload it to be sure that no one is in the bin.

For bins that unload by gravity flow, lock out the control gate and follow the same general procedure as with bins that have unloading equipment.

**Rule 5:**

Be careful in any rescue attempt to avoid being pulled into the flowing grain and becoming a second accident (Figure 10). Likewise, be especially cautious when attempting to rescue some-

one who has been overcome by toxic gases or by breathing air with a reduced oxygen content. In these circumstances it will probably be impossible for you to enter the bin and pull the individual to safety without your being overcome in the same way. To avoid placing yourself in this situation, it is imperative that the bin be well ventilated, that you enter cautiously and that you follow the instructions given in Rule 1.

**Rule 6:**

Safety measures should include the installation of ladders and ropes on the inside of the bin. Note that you can possibly “walk down” a bin if you stay near the outside of the bin wall and keep moving although walking in the soft grain will be very difficult. However, the best preventive measure is to avoid being caught in a potentially dangerous situation by practicing the rules of safety when working with grain.

**Please—Before It’s Too Late**

Discuss the safety hazards of flowing grain with your family, employees or fellow workers. It is the responsibility of each of us to keep informed of possible unsafe situations and take the necessary precautions to prevent their occurrence. The dangers associated with suffocation in flowing grain are no exception.

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