



# NGFA Safety Tips: Angle of Repose Hazards

...Committed to promoting safety and health in the workplace...

## Grain Engulfment

Unstable grain can move suddenly within a grain storage structure, such as a bins, silo, or tank, a flat storage structure, or on a grain storage pile. Entrapment occurs when a worker is partially submerged and cannot free themselves. Engulfment occurs when a worker is completely buried within the grain. Engulfment incidents often result in loss of life.

## Angle of Repose

When grain is piled on a flat surface, it naturally rests without sliding at a certain angle to the horizontal surface. This is referred to as the angle of repose.

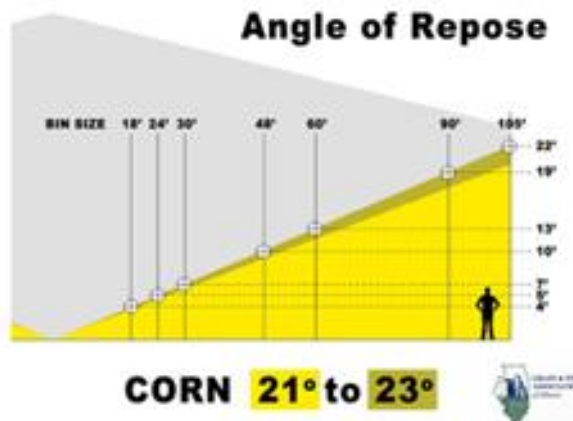
The factors which determine the angle of repose include:

- **Granule Size:** material with smaller kernels have a smaller angle of repose versus larger kernels.
- **Friction:** rough materials move slower than smoother materials.
- **Density:** heavier materials create more friction and are more stable.
- **Conveyance:** the speed and angle of conveyance can also impact the angle of repose.

The approximate angle of repose for common grains is:

- Corn:** 21 to 23 degrees
- Soybeans:** 25 degrees
- Wheat:** 25 degrees
- Oats:** 28 degrees

Grain that forms angles steeper than the angle of repose indicates a potential problem with grain condition and poses entrapment and engulfment hazards. If grain with a high angle of repose starts to slide, a worker can be entrapped within seconds.



A worker can be totally engulfed in as little as 20 seconds. A worker buried waist deep in grain requires a force equivalent to their own body weight plus 600 lbs. to free them. The force required to remove a worker buried under grain can exceed 2,000 lbs.

- The NGFA is committed to promoting safety and health in the workplace and shares the Occupational Safety and Health Administration's (OSHA's) commitment to protecting employees.
- The NGFA's extensive efforts to enhance safety include unprecedented research and education efforts launched in the early 1980s that helped lead to a dramatic reduction in the number of fire and explosion incidents in commercial grain-handling facilities.
- Each year, NGFA jointly sponsors regional safety seminars with affiliated state and regional grain and feed associations. The one-day conferences focus on keeping grain handling employees safe.

## Engulfment/Entrapment Prevention

To prevent engulfment and entrapment incidents:

- Manage grain quality to prevent spoilage by using aeration and temperature monitoring.
- Restrict access to grain storage structures (bins, silos, tanks), flat storage structures and grain storage piles.
- Train employees on the hazards associated with flowing grain, bridged grain, vertical grain wall avalanches, and the dangers of grain stored at angles higher than the commodity's angle of repose.
- Never allow employees into grain storage structures (bins, silos, or tanks), flat storage buildings, or onto grain storage piles where grain exceeds its approximated angle of repose.
- Implement a permit system before entering grain storage structures (bins, silos, and tanks).
- Deenergize, disconnect, block off, or lockout and tagout mechanical, electrical, hydraulic, and pneumatic equipment which presents a danger to employees inside a grain storage structures (bins, silos, tanks), and flat storage buildings with mechanical reclaim systems.
- Never walk down grain or use similar practices where a worker walks on grain to make it flow within or out from a grain storage structure (bins, silos, tanks).
- Never allow employees to enter grain storage structures (bins, silos, tanks) underneath bridging conditions where buildup of grain products on the side walls could fall and bury them.
- Use a body harness or boatswain's with a lifeline positioned and of sufficient length to prevent and employee from sinking further than waist deep in grain entering a grain storage structure (bins, silos, tanks) from a level at or above the level of stored grain or grain products or whenever an employee walks or stands on or in stored grain at a depth which poses an engulfment hazard.  
**Remember, employees are prohibited from being on moving grain.**
- Ensure that an observer is present when entering a grain storage structure (bin, silo, tank).



## Rescue

Prepare for engulfment and entrapment emergencies by:

- Training observers on rescue procedures, including the methods for obtaining additional assistance.
- Ensuring that equipment for rescue operations is available. The equipment must be specifically suited for the bin, silo, or tank being entered.

More safety information at [www.ngfa.org](http://www.ngfa.org)

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