

**98IA035**

**TO: Director, National Institute for Occupational Safety and Health**

**FROM: Iowa FACE Program**

**SUBJECT: Farmer suffocates under grain while using a grain vacuum.**

### **SUMMARY**

A 64-year-old farmer and owner of a grain vacuum service died while vacuuming corn out of a grain bin. He was hired by another farmer to empty a 10,000 bushel bin because the unloading auger had malfunctioned. He was using his grain vacuum, powered by a 150 horsepower tractor power take-off (PTO). He was working alone inside the bin, vacuuming out the fifth truckload of corn from this bin. The normal procedure is to keep the intake nozzle inserted in the grain at a shallow angle and frequently move it to different locations in the bin to keep the grain surface fairly even. Momentarily the farm owner went to check on the victim and noticed he was missing, and after searching the area, assumed he was still in the bin. The victim was located by probing with a rod, found submerged under three feet of grain. His body position was horizontal, lying a few feet from the vacuum tube, with his feet pointed towards the tube. The vacuum had been in this location long enough to create a fairly deep cone depression. The vacuum was left running, and was used by the farm worker to remove grain from above and around the victim. Rescue workers cut holes in the sides of the bin, yet it still took ~ 40 minutes to rescue the man. Resuscitation efforts failed and the farmer was declared dead upon arrival at the hospital. Autopsy results ruled out heart attack and could not confirm or rule out other loss of consciousness. The farmer had been doing this type of work for 11 years and was very experienced with the vacuuming work and hazards involved. The official cause of death was from suffocation.

### **RECOMMENDATIONS based on our investigation are as follows:**

**#1** *Employers and grain handlers should ensure that safe confined space entry practices are*

*followed while entering grain bins.*

**#2** *Grain vacuums should have an emergency stop device.*

**#3** *Grain vacuum operators should be made aware of hazardous conditions caused by spoiled*

*/ clumped grain.*

**#4** *Grain vacuum operators must follow manufacturer's guidelines for safe operation,*

*including working at a shallow angle, and moving the vacuum intake frequently.*

### **INTRODUCTION**

In May of 1998, a 64-year-old Iowa farmer and owner of a grain vacuuming service was killed while vacuuming corn from a bin. The Iowa FACE program was notified the following day by the County Sheriff via our 800 phone line. The main sources of

information were newspaper articles, the County Sheriff who shared photographs, the County Medical Examiner, an interview with the farm worker first on the scene, the manufacturer of the grain vacuum, and members of the victim's family who continued operating the grain vacuum service. A site visit was conducted in mid-summer by two FACE investigators and an EMT who teaches agricultural rescue. We interviewed family members and observed and photographed the vacuum machine in operation at a different farm location.

The victim was a grain and cattle farmer and operated the grain vacuuming service part-time. He shared work duties with his wife and grown daughter. His vacuum business was a year-around endeavor, requiring sometimes several hours per day during the busy months, early and late summer. He had been in this business for the last 11 years, using this vacuum since its purchase in 1994. This was a family business, and members of the family worked as a team. The farmer was working alone on the day of his death, assisted by his customer. The actual job of vacuuming inside the bin is a one-person job, yet installing and uninstalling the equipment requires help from another person, usually the customer. Typically the vacuum is hauled to job sites with a pick-up truck and the customer's tractor is used as a power source. The vacuum has an intake nozzle, six inch intake piping of flexible and fixed sections, cyclone, air pump, silencer, and truck loading outlet piping.

There was no official safety program in place at the victim's farm for operating his vacuuming service. However, the victim and his family were aware of safety guidelines that came with the vacuum, and were careful to observe them during operation. They were experienced with this type of work and there did not appear to be anything unusual at this job site. From known circumstances in this fatality, the family members did not have a clear understanding how this injury could have occurred.

## **INVESTIGATION**

The victim was hired by a farmer to empty one of his grain bins of corn. It was a 10,000 bushel, 30-foot diameter round bin, and it was full to maximum capacity. The bin had been filled in the fall of 1997 with #1 corn at 14-15% moisture. It was filled with a spreader and the corn was reported to be in excellent storage condition, with minimal fines and no evidence of molding, clumping, or residual grain stuck to the walls. The bin had a bottom-unloading auger system which was malfunctioning at the time. It was discovered later that the auger was jammed with a piece of metal from its flighting.

The two men set up the vacuum in a normal fashion; connected it to the 1000 RPM PTO from the customer's 150 hp tractor, and aligning it with the bin roof access door. Sections of six-inch solid metal pipe were attached to the vacuum and connected to a flexible rubber pipe as it entered the bin's top access door. There was a side door on the bin, but at this time it was still blocked by grain. This vacuum has no operating controls; the tractor PTO must be engaged and disengaged to operate and shut off the vacuum. This was the third vacuum machine used in the victim's business. It was four years old and was in excellent condition. It could move a semi-trailer load of corn, 8-900 bushels, in about 15 minutes.

The farm owner worked outside the bin to coordinate filling of the semi-trailers and a gravity-flow grain wagon, which was filled alternately to keep grain flowing at all times while changing trucks. The victim had climbed into the bin from its top access door, and had already vacuumed four semi loads of grain. This was his fifth load. He was working inside the bin, guiding the vacuum intake nozzle around the bin to evenly vacuum out the grain. He could not leave the vacuum tube and walk away, because the tube would eventually suck its way too deep and be impossible to control. Also, this would cut off the air inlet port and cause the vacuum to suck inefficiently. The vacuum system needs a critical amount of air to flow with the grain, and an air inlet hole is positioned approximately five feet from the intake nozzle. The worker is to keep the suction tube slightly under the grain surface at a shallow angle. When operated correctly, grain is moving only next to the vacuum tube, and there is little settling or grain movement next to the operator, or elsewhere in the bin. This was confirmed during our site visit when we observed little discernable grain movement while standing several feet from the vacuum tube, yet the grain surface is quite soft and fluid close to the tube.

During filling of the fifth load, the farm owner climbed the bin to check on things and noticed that the victim was missing, although the vacuum was still running. He assumed he had gone to the restroom and went to the farmhouse looking for him. After not finding him there or anywhere else on the farm, he assumed he was still in the bin and went back to look for him. He probed the corn with a metal rod, and on the first attempt located the victim a few feet from the vacuum tube, totally submerged 2-3 feet under the grain, with his feet pointing towards the vacuum tube.

The farm owner ran to call 911 and returned to help the victim. The vacuum tube was not in the center of the bin, but halfway between center and the outside edge. The tube was deep in the corn, and grain was moving underfoot all around the bin. The farm owner pulled the vacuum tube out of the corn with great difficulty, and sunk himself deep in grain in the process. He then used the vacuum to remove grain off the victim. The victim was submerged at the base of a large cone depression in the grain, therefore it was very difficult to get to him because grain kept falling back upon the co-worker. Even after firefighters arrived and cut holes in the bin to let out the grain, it still took about 40 minutes to get the victim out. The man was declared dead when taken to the hospital.

From some sources there was speculation that the victim may have fainted while working. This cannot be ruled out, however the temperature was in the low 80's, and the injury occurred about 9:45 A.M., which indicates that conditions were not exceptionally hot. Another speculation was that he may have slipped off the ladder inside the bin and fell into the moving grain, but there was no evidence to support this. Another possibility is that he may have left the vacuum tube for too long in one spot creating a deep cone depression where the grain at some point became impossible to manage.

The victim's horizontal body position may suggest that he was not conscious when the engulfment happened. However, this could also be a result of a sudden movement of a large amount of corn, or the movements of corn after he was submerged. Since the victim was quite deep submerged in corn, the vacuum must have been working for some time after he became engulfed. It seems unlikely that the grain was bridged and suddenly gave way under him. This was a routine vacuum job and the victim was in good physical condition, very accustomed to working inside grain bins. From the evidence and circumstances of this fatality, it is not possible to draw definite conclusions of the chain of events.

## **CAUSE OF DEATH**

The official cause of death taken from the Medical Examiner's report was: *suffocation due to farming accident*. Autopsy revealed no undiagnosed natural illness that might have caused the man's death.

## **RECOMMENDATIONS / DISCUSSION**

**Recommendation #1** *Employers and grain handlers should ensure that safe confined space entry practices are followed while entering grain bins.*

**Discussion:** As stated in 29CFR 1910.272 (g)(2), when employees are entering bins

from the top, they should wear a body harness with a lifeline. They should have an observer stationed outside the bin maintaining communications with the worker inside the bin, and this observer should be equipped to provide assistance, having the proper equipment and training for rescue procedures. No employee should enter a bin underneath bridging conditions or where a buildup of grain on the sides could fall and bury the worker. While the owner/operator of the grain vacuum service was not an employee but self-employed, the same principles should be followed. Having an observer outside the bin with a reliable communication system would probably have prevented this fatality. The vacuum air pump is very noisy and therefore voice communication is not reliable. Alternative methods must be used, possibly having the observer up on top of the bin at the access door where he/she can observe the vacuuming as well as the loading situation outside the bin.

**Recommendation #2** *Grain vacuums should have an emergency stop device.*

**Discussion:** There is no emergency shut-off for this grain vacuum; it can be stopped only by disengaging the PTO control in the tractor cab. In an emergency situation, the operator relies on the outside observer to shut off the PTO. Due to the noise, obstructed vision and/or distances between the worker, observer and the tractor, this emergency shut-off system is not reliable. Grain vacuum manufacturers should develop an emergency stop device which could be easily activated by the operator handling the intake nozzle inside the bin. This could be a mechanical device blocking the air flow, an electric switch activating a clutch or other type of device. The operating principle of the device could be both active and passive. The operator could activate the shut-off when needed and it would be also activated automatically if the

operator gets separated from the vacuum tube due to fainting or other reason. Alarm devices could also be considered to improve communication.

**Recommendation #3** *Grain vacuum operators should be made aware of hazardous conditions caused by spoiled / clumped grain.*

**Discussion:** Training and education of employees and vacuum operators should address the hazards in working with spoiled grain. The manufacturer of the vacuum stated that over 95% of grain vacuuming is done when grain is partially spoiled and therefore flows poorly with auger systems. Therefore, grain vacuum operators are at risk of being submerged and suffocated due to bridging and collapse of the grain. Grain handlers should never enter a grain bin, stand, or walk on grain that has stopped flowing due to suspected spoilage or clumping / bridging of the grain without precautions described in recommendation 1. Another consideration when working with spoiled grain is the respiratory exposure to grain dust, mold spores, and endotoxins. Although the vacuum removes large amounts of air, dust is introduced to the air constantly. Dust exposure is heavy also outside at the unloading end of the vacuum and the observer and other workers may also need respiratory protection.

**Recommendation #4** *Grain vacuum operators must follow manufacturer's guidelines for safe operation, including working at a shallow angle, and moving the vacuum intake frequently.*

**Discussion:** It is not evident whether the vacuum operator moved the vacuum tube from place to place and kept the grain surface fairly even in the bin. It appears possible that he may have let the vacuum be in one position long enough to create a large cone depression which could have lead to the unmanageable movement of grain. The alternative chain of events is that he became unconscious and/or fell down and the vacuum continued sucking grain from around him, creating the cone depression and eventually engulfing him. While operating the grain vacuum, it is important to avoid situations where a large grain depression develops. The grain surface must be kept fairly even to prevent hazardous movement of grain.

---

Wayne Johnson, M.D.  
Trauma Investigator (FACE)  
Institute for Rural & Environmental Health  
Agricultural Health  
University of Iowa -- Iowa City, Iowa  
Health

Risto Rautiainen, M.Sc.Agr.  
Coordinator  
Great Plains Center for  
  
Institute for Rural & Environmental  
University of Iowa -- Iowa City, Iowa

# Fatality Assessment and Control Evaluation FACE

FACE is an occupational fatality investigation and surveillance program of the *National Institute for Occupational Safety and Health* (NIOSH). In the state of Iowa, *The University of Iowa*, in conjunction with the *Iowa Department of Public Health* carries out the FACE program. The NIOSH head office in Morgantown, West Virginia, carries out an intramural FACE program and funds state based programs in Alaska, California, Iowa, Kentucky, Maryland, Massachusetts, Minnesota, Missouri, Nebraska, New Jersey, Ohio, Oklahoma, Texas, Wisconsin, Washington, and Wyoming.

The purpose of FACE is to identify all occupational fatalities in the participating states, conduct in-depth investigations on specific types of fatalities, and make recommendations regarding prevention. NIOSH collects this information nationally and publishes reports and Alerts, which are disseminated widely to the involved industries. NIOSH FACE publications are available from the NIOSH Distribution Center (1-800-35NIOSH).

Iowa FACE publishes case reports, one page Warnings, and articles in trade journals. Most of this information is posted on our web site listed below. Copies of the reports and Warnings are available by contacting our offices in Iowa City, IA.

The Iowa FACE team consists of the following: Craig Zwerling, MD, PhD, MPH, Principle Investigator; Wayne Johnson, MD, Chief Investigator; John Lundell, MS, Coordinator; Lois Etre, PhD, CIH, Co-Investigator; Risto Rautiainen, MS, Co-Investigator.

CCCCCCCCCCCCCCCCCCCC CCCCCCCCCCCCCCCCCCCC

Additional information regarding this report or the Iowa Face Program is available from:
--

**Iowa FACE Program  
105 IREH, Oakdale Campus  
The University of Iowa  
Iowa City, IA. 52242-5000**

**Toll Free 1-800-513-0998  
Phone: (319)-335-4351      Fax: (319) 335-4225  
Internet: <http://info.pmech.uiowa.edu/face/face1.htm>  
E-mail: [wayne-johnson@uiowa.edu](mailto:wayne-johnson@uiowa.edu)**