

TO: Director, National Institute for Occupational Safety and Health

FROM: Iowa FACE Program

Case No. 04IA06

Report Date: 22 June 2005

SUBJECT: Farmer Dies When Entangled in Old Flight Elevator PTO Shaft

SUMMARY

During late winter 2004, a 45-year-old farmer was killed while helping to unload ear corn from a corn crib. The man was working with two others to load the corn into a wagon to feed cattle. The men were using a horizontal bottom conveyor to move corn out of each end of the corn crib, then, using a flight elevator to load the corn into a wagon. The elevator was powered by a typical tubular PTO (power take-off) shaft from the tractor. After emptying one side of the crib, two of the



Photo 1 – Overview photograph of the area, showing the east end of the corn crib, the chain drag conveyor, and the flight elevator with half of the PTO driveshaft attached.

men were cleaning out the tunnel on that side while the victim was unloading corn from the other end of the crib (Photo 1). They heard the tractor engine slow down momentarily and went to investigate. The victim was found wrapped around the unshielded PTO shaft powering the elevator, with obvious severe injuries to one arm, leg, and his chest. After rescue crews arrived, the victim was transferred to a local hospital, where he was pronounced dead.

RECOMMENDATIONS based on our investigation are as follows:

- *All PTO drivelines and other exposed drivetrain components on farms should be completely shielded to prevent accidental contact by workers or helpers.*
- *Farmers should ensure that workers and helpers are trained and alerted to recognize the hazards of working near PTO drivelines and other hazardous machine parts.*

INTRODUCTION

During late winter of 2004, an Iowa farmer was killed while helping to unload corn out of a corn crib. The Iowa FACE program was alerted to this incident a few days later by a newspaper article, and began to gather information. A detailed Sheriff's report and photographs were obtained and contact was made with the man who owned the equipment and the farm where the incident occurred. Due to excellent cooperation, information, and available photographs, a site visit was not conducted.

The three men were all farmers. Each owned their own farm in the immediate area. They had been friends for over 20 years and frequently shared labor to help one another, which was the case on the morning of this incident. The three men had been working together that morning for about two hours. The farm was 850 acres, all and planted in a crop rotation of corn and soybeans. In the past the farmer had also raised hogs and cattle.

There was no safety program or written policies in place at this small farm, which is typical for family operations of this size. All workers were very experienced farmers, accustomed to working with all types of farm machinery and farming operations. Safety was always an obvious concern, with common sense rules in place.

INVESTIGATION

On the morning of this incident, the three men were loading ear corn out of a wooden corn crib into a wagon for one of the men to feed his cattle. The men started early, about 7:00 AM, hoping to finish work before the sun had risen enough to melt the surface of the farmyard. It was an early start to spring, the type of sunny day where the surface of the frozen ground will easily melt the farmyard into a muddy, slippery mess as the morning sun continues to shine.

The old wooden corn crib was divided into two sections, with a capacity of 2,500 bushels on each side. It had a metal roof, with a concrete floor and tunnels for

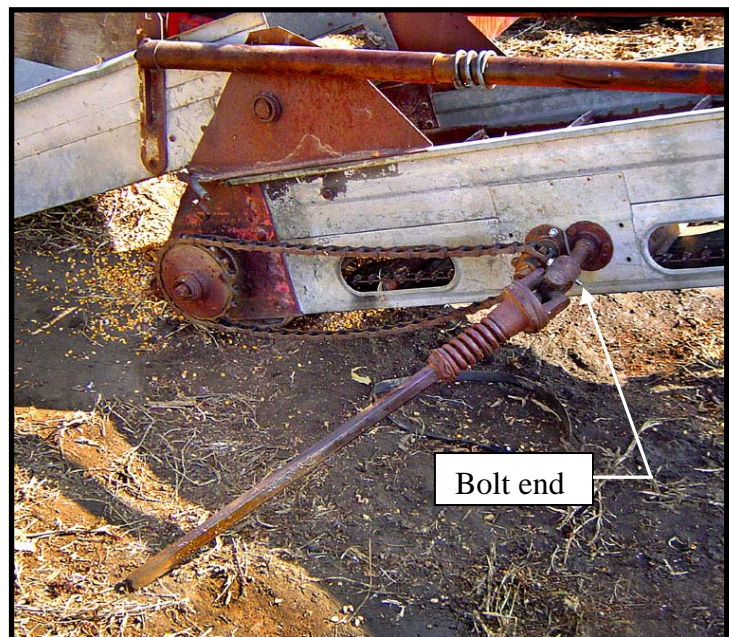


Photo 2 – Close-up of the implement end of the PTO driveline shaft showing the spring clutch and the protruding bolt.

unloading grain (Photo 1). The access door opening into the crib above the tunnel was adjustable with several wooden crib boards slid into slots. A horizontal conveyor, commonly called a chain drag, was used to bring the corn from underneath the crib to a flight elevator (Photo 2) which then dumped the corn into a wagon. All this equipment was quite old, yet very functional, and typical for family farms in this area.

The tractor used to power the elevator was a utility model purchased new in 1981. It was a diesel model 63 PTO horsepower, but the throttle was set to idle while it was operating the flight elevator. This old elevator had its original PTO (power take-off) driveline in place, which had a tubular design, was unshielded, and included a spring-loaded clutch at the implement end of the shaft (Photo 2). A bolt with its protruding, threaded end was used to secure the driveline yoke to the input shaft of the elevator. When the driveline is rotating, this bolt could easily snag someone's coat or jacket if they got too close while, for example, inspecting the movement of corn up the flights of the elevator.

At approximately 9:30 that morning, the three men had already emptied the west end of the corn crib. The chain drag had been moved to the east end of the crib, and the victim was working inside the crib, helping to unload this section. While cleaning out the tunnel under the west end of the building, the other two men heard the tractor engine slow down momentarily. Curious, they went to investigate. The victim was not in the crib, but was found entangled around the PTO shaft with significant



Photo 3 – Tractor end of PTO driveline, with no evidence of shielding.

injuries to one arm, one leg, and to his chest. The men immediately shut down the machinery and called for emergency help. The victim was transferred to a local hospital where he was pronounced dead.

Upon returning to the scene, the farm owner noticed one of the crib boards $\frac{3}{4}$ of the way up the flight elevator. Perhaps the victim was trying to retrieve this board before it dumped into the wagon. He would likely have been in a hurry to catch the board, and may have slipped on the ground near the elevator, falling into or otherwise being caught in the spinning PTO shaft.

CAUSE OF DEATH

The cause of death was described as “excessive blood loss due to traumatic amputation of upper extremity and lacerations to leg and groin, including the femoral artery”.

RECOMMENDATIONS / DISCUSSION

Recommendation #1 *All PTO drivelines and other open drivetrain components on farms should be completely shielded to prevent accidental contact by workers or helpers.*

Discussion: The PTO driveline for this elevator was not shielded, representing a threat to life and limb whenever anyone came near it while it was in use on this farm. Regardless of the speed of rotation or apparent hazard risk, exposed rotating machine components are dangerous. They must be identified and covered to protect workers from serious injury. It takes only a moment for a worker to be caught and killed by a rotating PTO driveline shaft which, at 540 RPM (revolutions per minute), revolves 9 times each second. Too many farm workers have been injured or killed in this kind of PTO entanglement incident. Rotating drivelines perform in demanding use situations and, over time, can develop sharp protrusions or spurs, and may be modified in ways which can snag a pant leg, sweat shirt, or sleeve of a jacket.

Old and rusty drivetrains are very common on many farms, as are old machines of many types. These older machines are usually entirely functional, and they are costly to replace. Farmers often make do with what they have and, many times, this means using dangerous equipment that has not been maintained well, much less brought up to current safety standards (ASAE S493). Due to repeated repairs or adjustments over time, machinery guards have often been damaged, removed, discarded and long since forgotten. An individual farmer may consciously continue to use these machines feeling comfortable about their ability to manage the associated risk. Too often problems arise when someone else, who is unfamiliar with the equipment and its hazards, inherent or created, arrives on the scene to help.

It is assumed the victim in this case, rushed to snatch the wooden crib board out of the elevator when he was caught by the moving PTO. With his eyes on the board, he was probably distracted from the known hazard of the rotating PTO, a common sequence of injury that underscores the need for PTO shields and other guards on farm machinery. Frequently, it is a young person, helper, or a neighbor who gets injured on the farm, for they are not familiar with the equipment, or they underestimate the power and danger of a machine.

A total shielding system for a PTO driveline includes a tractor master shield, the PTO driveline shield(s) and an implement shield. These shields must be kept in place and properly maintained to guard against entangling a worker. Additional shielding may also be necessary to protect workers from exposure to other rotating or moving machinery components such as drive belts, pulleys, flywheels, and protruding ends of shafts that rotate.

Recommendation #2 *Farmers should ensure that workers or helpers are trained / alerted to recognize the hazards of working near PTO drivelines and other hazardous machine parts.*

Discussion: The situation on this farm was quite typical. Farmers trade labor and help each other complete farming tasks. There is no official employer-employee arrangement. Each farmer is independently knowledgeable about the equipment being used. However, it is always advisable to remind any helpers of hazardous conditions that are present, especially something out of the ordinary and as serious as an unshielded PTO driveline. In temporary situations some farmers rig special

protections or fixed barriers to shield an unguarded PTO driveline, but the hazard remains, and should be addressed by a more permanent solution.

Farmers use PTO drivelines, which are often easily interchangeable, to power many types of equipment. They should always be mindful of the power these drivelines transmit, even at idle speed. At engine idle speed (about 700 RPM), a PTO shaft can turn as slowly as 200 RPM or 3.3 revolutions per second. Visually, this appears relatively harmless compared to a high-speed PTO yet the torque is still very high. A worker's life can end in an instant when entangled in a 4 inch (100 mm) diameter rotating PTO driveline that will wrap a foot (300 mm) or more of loose clothing in a second.

REFERENCES

ASAE *Standards*. 2004. S493.1: Guarding for Agricultural Equipment, St. Joseph, Mich.: ASAE.

ADMA. 1997. Agricultural Implement Drivelines – Safety Manual for Owners and Operators: Agricultural Driveline Manufacturers Association.

Wayne Johnson, M.D.
Chief Trauma Investigator, IA FACE
Institute for Rural & Environmental Health
University of Iowa – Iowa City

Risto Rautiainen, Ph.D.
Deputy Director, Great Plains Center (GPCAH)
Co-Investigator, IA FACE
University of Iowa – Iowa City

Murray Madsen, MBA
Trauma Investigator, IA FACE
Program Consultant, GPCAH
University of Iowa – Iowa City

Fatality Assessment and Control Evaluation

FACE

Fatality Assessment and Control Evaluation, FACE, is a program of the *National Institute for Occupational Safety and Health* (NIOSH), which is part of the *Centers for Disease Control and Prevention* of the *U.S. Department of Health and Human Services*. Nationally, the FACE program identifies traumatic deaths at work, conducts in-depth studies of select work deaths, makes recommendations for prevention, and publishes reports and alerts. The goal is to prevent occupational fatalities across the nation.

The NIOSH head office in Morgantown, West Virginia, carries out an intramural FACE case surveillance and evaluation program and also funds state-based programs in several cooperating states. In Iowa, *The University of Iowa* through its *Injury Prevention Research Center* works in conjunction with the *Iowa Department of Public Health* and its *Office of the State Medical Examiner* to conduct the Iowa FACE program.

Nationally, NIOSH combines its internal information with that from cooperating states to provide information in a variety of forms which is disseminated widely among the industries involved. NIOSH publications are available on the web at <http://www.cdc.gov/NIOSH/FACE/> and from the NIOSH Distribution Center (1-800-35NIOSH).

Iowa FACE also publishes its case studies, issues precautionary messages, and prepares articles for trade and professional publication. In addition to postings on the national NIOSH website, this information is posted on the Iowa FACE site, <http://www.public-health.uiowa.edu/FACE/>. Copies of FACE case studies and other publications are available by contacting Iowa FACE, too.

The Iowa FACE team consists of the following specialists from the University of Iowa: Craig Zwerling, MD, PhD, MPH, Principal Investigator; John Lundell, MA, Co-Investigator; Murray Madsen, MBA, Chief Trauma Investigator; and Co-Investigator/specialists Risto Rautiainen, PhD, and Wayne Sanderson, PhD, CIH. Additional expertise from the Iowa Department of Public Health includes Rita Gergely, Principal Investigator, and John Kraemer, PA, from the Office of the State Medical Examiner.

For additional information regarding this report or the Iowa FACE Program contact:

Iowa FACE
The University of Iowa
100 Oakdale Campus, #203 IREH
Iowa City, IA 52242-5000

Toll free within Iowa: 800-513-0998

Phone: (319) 335-4481

Fax: (319) 335-4290

Internet: <http://www.public-health.uiowa.edu/FACE>

E-mail: murray-madsen@uiowa.edu