TO: Director, National Institute for Occupational Safety and Health

FROM: Iowa FACE Program

SUBJECT: Wife is pinned between tractor loader bucket and foundation wall while helping husband build new home -- Iowa.

SUMMARY

In the fall of 1996, a 51-year-old Iowa farmwife was killed while helping her husband and son build a new home on their farm. The woman and her 21-year-old son were standing next to the exterior foundation of the home covering drainage tubing with gravel. The woman was holding down the tile with her feet while her son was shoveling gravel out of a partially-filled front end loader bucket on a tractor his father was driving. The edge of the bucket was approximately three feet from the foundation wall when this work began. The father had the tractor in gear with the clutch pushed in, and his foot on the brakes, sitting on a slope of about 18 degrees downwards towards the house foundation. When he began to raise the bucket, suddenly the farmer heard his son yell at him and realized the tractor was creeping forward towards the foundation despite his pressure on the brakes. He saw his son being pinned to the wall with his back towards the tractor, then realized that his wife was also being pinned to the wall with the other corner of the bucket. He immediately put the tractor in reverse and backed off, at which time both his wife and son fell to the ground. The son received only minor injuries to his back, but the farmer's wife was killed instantly from internal vascular rupture.

RECOMMENDATIONS based on our investigation are as follows:

1. *Workers should not be positioned in a narrow space between a powered vehicle and a stationary object.*
2. *Owners / operators of tractors should be made aware of necessary precautions related to front-end loader use.*
3. *Independent testing is needed to determine whether there is a possibility of malfunction of brakes when this type of tractor is used on an incline.*

INTRODUCTION

During the fall of 1996, a 51-year-old wife of an Iowa farmer was killed while building a new farmhouse. The Iowa FACE program became aware of the incident by a telephone call from the county Sheriff. Additional information was gathered from newspapers and the police, and a site visit was conducted later in the fall by the Iowa FACE investigator and a farm safety specialist. They interviewed the farmer, saw the home still under construction, and photographed the tractor, which was being used daily on the farm. The family farm consisted of the farmer, his wife, and two of their sons, one of whom was injured in this incident. They produced corn, hogs and cattle. The farmer, his wife, and their 21-year-old son were working together when the fatal injury occurred.

The tractor the farmer was operating was purchased new in the spring of 1995. It had four-wheel drive with spring-engaged hydraulic brakes on the front wheels also, 66 hp, an open driver station with roll-over protective structure (ROPS), and was equipped with a front-end loader. The farmer was familiar with this tractor and all aspects of its operation, having used the tractor daily since it was purchased.

INVESTIGATION

The farmer and his wife were building a new house on their farm, planning to give the older house to their son, who worked the farm with them. The concrete foundation of the home was completed and the three of them were in the process of laying drainage tile around the inside and outside perimeter of the foundation.

The farmer was operating the tractor which had a front-end loader bucket half-filled with gravel. The tractor was situated on an 18-degree slope pointing downward with the edge of the bucket about three feet away from the foundation. His wife and son were standing in front of the bucket, next to the foundation, holding down drainage tile with their feet. The son was shoveling gravel off the tractor bucket in front of them, covering the tile.

The tractor was in low gear forward (B-2), the clutch was pushed in, and the farmer had his foot on the brake. Then the farmer told his wife and son to stand back as he prepared to raise the bucket and dump the remainder of gravel from the loader. While raising the bucket he reports the machine began to creep forward uncontrollably. The brakes seemed ineffective and in a few seconds the son was yelling at his father because he was being pushed against the foundation wall. When the farmer was aware of the tractor moving towards the wall, he immediately put the tractor in reverse and backed off. When he backed off, his son and wife, who was also pinned against the wall by the bucket, both fell to the ground. He rushed to his wife's aid, but she was unresponsive. CPR was attempted by both men, but was unsuccessful. The woman had her back to the foundation and was crushed across the chest by the front of the loader bucket. Tests later revealed that she suffered an aortic rupture which killed her instantly. The son had his back towards the loader bucket, and being taller than his mother, received only superficial injuries to his lower back.

Later that same day, the farmer checked the hydraulic oil in the tractor looking for an explanation for the apparent malfunction. The oil level was normal. He tried to reproduce the circumstances that occurred earlier in the day. With the tractor in gear and his foot on the brake, he noticed that the brake pedal would move in when he raised the bucket at the same time, although he didn't lose braking ability. This happened only when the oil was cold, never when the oil was warm, and he could not reproduce the malfunction that occurred earlier. Since then, he reported receiving calls from three other farmers who had experienced the same or similar brake malfunctions with this type of tractor. In this case, the farmer is convinced that brake failure was responsible for this fatality.

Initially, the farmer suspected that the bucket was too full of gravel, or that the ground may have been slippery, which would have contributed to forward movement. Photographs taken at the scene immediately after the accident show the tractor sitting on a slope of dry dirt and the

bucket less than half full of gravel.

We examined the tractor which was being used at the home construction site. All controls seemed to be in proper working order during our visit. The loader and bucket appeared large for the size of tractor, however, this is a typical combination for this tractor model. Three dealer representatives we interviewed were not aware of any similar brake problems with this tractor model, and had not heard complaints from any tractor owners. Without further testing, it is not possible to conclude that the brakes malfunctioned, nor demonstrate that they were working in atypical fashion at the time of the accident.

A contributing factor in this case is the loader geometry (see Figure 1). The pivot point of the loader is high, approximately at the same level as the tractor's steering wheel. When lifted from a position lower than the pivot point, the bucket also travels forward considerably. This loader bucket had a self-leveling system, which further increases the forward travel. Adding the effect of being on a slope next to the wall, this forward movement is augmented. According to our estimation, when lifting the bucket from 24" level to 48" level, the bucket edge moves about 12 inches closer to the wall in the higher position. When lifting from 6" level to 48" the forward travel is more than two feet on the same slope. This principle of loader geometry on an 18-degree slope next to a foundation is demonstrated in Figure 1. Although the exact positions of the tractor and the loader before the injury are not known, simply raising the bucket produces considerable forward movement also, and this likely contributed to the fatal injury.

Other possible contributing factors include the characteristics of using a loader while positioned on a fairly steep downward slope. If lifted quickly, any loader momentarily shifts some weight from the rear wheels to the front wheels. The fact that this bucket moved forward at the same time also would shift more weight to the front. Brakes usually work on rear wheels only, and shifting weight to the front can cause the wheels to slip on a steep slope momentarily, even if the ground is dry. This tractor had hydraulically-controlled front brakes which appeared to be in normal operating condition after the incident.

CAUSE OF DEATH

The cause of death was listed as aortic rupture due to traumatic compression of the chest. All other tests were negative.

RECOMMENDATIONS / DISCUSSION

Recommendation #1 W*orkers should not be positioned in a narrow space between a powered vehicle and a stationary object.*

Discussion: Both the victim and her son were working in the three-foot space between the loader bucket and the foundation wall. This is inherently dangerous because machine malfunction or operator error can occur. The tractor positioned on a downward slope further increased the risk in this case. The farmer told his wife to stand clear when he started to raise the bucket, but perhaps she did not hear or was unaware of the danger. All workers, supervisors, and machine operators should make sure that no one works between a powerful machine and a stationary object. This also applies to working under hydraulically-supported machine parts where workers could be injured due to machine failure, operator error, or

changing conditions of the working environment.

Recommendation #2 *Owners / operators of tractors should be made aware of necessary precautions related to front-end loader use.*

Discussion: Operators should be keenly aware of the position of workers when using a front-end loader, and make sure they do not enter the dangerous areas in front or under the loader. Operators should also be aware of loader geometry, knowing that the loader bucket will move forward considerably while being raised from ground level, especially on an incline. This specific hazard, as presented in Figure 1, should be emphasized in safety training and educational literature. When working in an open area, this movement may not be a significant safety issue, but in close quarters, forward movement of the bucket is potentially dangerous. Also, when raised quickly, a loader with a heavy load momentarily reduces the weight on the rear wheels and may cause slipping, especially if weight is already increased on the front wheels due to forward sloping terrain. This can be very significant, since most tractors have brakes only on the rear wheels. It is also hazardous to keep the transmission in a forward gear, when people are working near the bucket. If the operator's foot would slip off the clutch pedal, dangerous forward movement of the tractor would occur. When the tractor is on an incline, as in this case, it would be better to have the transmission in park or in a reverse gear, so that in case of malfunction or operator error, the tractor will stay in place or move backwards, away from the workers.

Recommendation #3 *Independent testing would be needed to determine whether there is a possibility of malfunction of brakes when this type of tractor is used on an incline.*

Discussion: The farmer is convinced that the brakes malfunctioned on his tractor. He reported receiving calls from other farmers regarding similar problems using this type of tractor. It is not in the scope of the FACE program to test and determine whether the malfunction took place or whether it is typical for this tractor model. There may be a possibility of varying hydraulic oil levels when using a tractor on an incline, and this may affect performance of the tractor hydraulics and the brakes. Further testing would be needed to prove or exclude this possibility.

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

Risto Rautiainen, M.Sc.Agr.
Coordinator
Great Plains Center for Agricultural Health
Institute for Rural & Environmental Health

University of Iowa -- Iowa City, Iowa

Fatality Assessment
&
Control Evaluation Program
(FACE)

The University of Iowa, in conjunction with the National Institute for Occupational Safety and Health (NIOSH), investigates the causes of work-related fatalities in the State of Iowa. FACE is a surveillance program that identifies all occupational fatalities, conducts in-depth, on-site investigations on specific types of fatalities, and makes recommendations for employers, employees, self employed persons, manufacturers and others to help prevent similar fatal accidents in the future.

NIOSH funded state-based FACE Programs include: Alaska, California, Colorado, Indiana, Iowa, Kentucky, Maryland, Massachusetts, Minnesota, Missouri, Nebraska, New Jersey, Wisconsin, and Wyoming.

Additional information regarding this report or the Iowa Face Program

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

Phone: (319)-335-4351 or Toll Free 1-800-513-09
Fax: (319) 335-4225
E-mail: wayne-johnson@uiowa.edu
Internet: http://info.pmeh.uiowa.edu/face/face1.ht