

TO: Director, National Institute for Occupational Safety and Health

FROM: Iowa FACE Program

Case No. 04IA36

Report Date: 10 June 2005

SUBJECT: Metalworking Shop Owner Crushed Between Skid Steer and Forklift Attachment

SUMMARY

Midsummer 2004 a 52-year-old owner-operator of a metalworking shop was killed in the shop on his rural residential farm site. He was crushed between the front frame of his skid steer loader and the back of the forklift attachment mounted to the machine's lift arms (Photo 1). The machine was being repaired, and the loader's seat, battery cover, and battery were removed from the floor of the operator's station. Hand operated controls had been disconnected from their control rod linkages, which connect them to the valves that govern hydraulic flow to the power lift arms, forklift, and skid steer movement. The lift arms, with mounted forklift attachment, were partially or fully raised. The tall repairman was in the zone bounded by the frame across the lower front of the skid steer loader, the back frame of the raised forklift attachment, and the lift arms extending forward along each side of the protective metal structure around the operator's station. He was leaning forward into the operator's station to accomplish his repair tasks.

The repairman was working alone inside his shop in the middle of the afternoon. A customer had stopped by sometime after noon with additional work to be performed, and planned to return in an hour and a half. Upon returning to the shop, the customer discovered the repairman pinned against the front of the skid steer frame by the back of the forklift attachment, which was now



Photo 1 - Skid steer loader with forklift attachment on lift arms.

resting near the ground. The repairman, nearly to his knees on the dirt floor, was found facing into the operator's station with his head tilted outward near the left lift arm. The customer ran to the repairman's residence adjacent to the shop to summon Emergency Medical Services. He returned and placed a floor jack under the forklift attachment in an attempt to extricate the repairman, who was subsequently pronounced dead at the scene. Actuation of the control linkage allowing the lift arms to lower is the key contributing factor in this unwitnessed incident.

RECOMMENDATIONS based on our investigation are as follows:

- ***Skid steer loader operators should lower lift arms to the ground before exiting the operator's station. Operator's and those repairing skid steer loaders should always use lift arm locking mechanisms provided by the manufacturer and ensure that they perform properly before exiting or working under any portion of the raised lift arms of the loaders.***
- ***Operators and repair personnel should be educated and trained to recognize, assess, and act to avoid the risks of lift arm movement during skid steer loader operation, maintenance, and repair.***
- ***Skid steer loader manufacturers should consider means to prevent lift arm lowering when the control to lower lift arms is actuated and the skid steer's engine is not running.***
- ***Means to secure skid steer loader lift arms such as capable blocks, jacks, and hoists, which prevent unintended movement of lift arms during repairs performed with the lift arms in a raised position, should be employed prior to performing such repair tasks.***

INTRODUCTION

Midsummer 2004, a tall, 52-year-old, owner-operator of a metalworking shop, who was also a farmer, died while repairing his skid steer loader. The loader was a midsized 1998 model with lift capacity of nearly 2650 lbs (1,200 kg) and wheelbase, height, and length (without an attachment) approximately 3.0 ft x 6.5 ft x 9.5 ft (0.9 m x 2.0 m x 2.9 m), respectively. The farmer was leaning forward into the operator's station from in front of the machine, under the raised lift arms, which had a forklift attachment mounted to them at the front. While performing repair work in the area behind or below where the operator's seat had been removed, and with control linkages disconnected, the lift arms with their forklift attachment lowered, crushing the repairman against the front cross frame member of the skid steer loader's chassis.

The Iowa FACE program became aware of this event through the media within days after it occurred, and began investigative work immediately. Information was gathered from newspaper accounts, the County Sheriff's office, the Medical Examiner's office, the victim's wife, and representatives of the skid steer loader manufacturer. An interview with the victim's wife was combined with a site visit in early summer 2005. At that time additional photographs were taken of the machine, which had been returned to the victim's shop after being repaired and checked at a local dealership.

There was no safety program at this small, combination metalworking shop and farming enterprise. The owner-operator was very familiar with all types of farm machinery, and owned the skid steer loader involved in this incident.

INVESTIGATION

This incident occurred in a metalworking shop on a rural farm site in east central Iowa in midsummer of 2004. This tall repairman combined metal shop work while farming, and worked alongside other family members. He farmed his own land, and managed the metalworking shop as a separate business.

The shop was a newer, pole and wood-framed structure with vertical metal sheeting extending to the eave of a high, gabled roof with a ridge that ran east-west. The shop's length ran nearly perpendicular to the home, affording easy access to and from the house through the small entrance door along the shop's north wall. It was just a few yards from the south side of the garage attached to the residence on this rural farm site. Large sliding doors at both ends of the shop created a vertical seam where they met and hung on rollers to open wide for large equipment to enter onto the dirt floor. Around the interior walls were stored and standing pieces of metal and shop store items with tools, equipment, and materials between open areas that allowed room to work.

The skid steer loader with its forklift attachment was parked inside the west door of the shop on the day of the incident. A customer had stopped by early in the afternoon with additional work for the metalworking shop repairman, and planned to be back in an hour and a half. This customer returned to find the shop owner motionless and breathless, caught between the front of the skid steer frame and the back of the forklift attachment mounted on the skid steer loader lift arms. There were no witnesses to the incident, and the exact circumstances and events at the time are not known.

Midday on the day following the incident, Sheriff's deputies viewed and photographed the skid steer loader, which had been taken to a local dealership, and was reportedly unchanged since the incident. The operator's seat had been loosely placed back into the operator's station of the machine. It was removed before the incident as was the battery cover and battery. Battery cables hung loosely in the open cavity where the battery had been removed.

Controls for the skid steer loader involved in this incident are hand operated (Photo 2). Left and right levers ahead of the operator are moved forward and backward to change the loader's speed and direction. Pushing one forward and pulling the other back causes the left and right drive wheels to rotate in opposite directions in a quick, skidding turn of the tandem wheels on each side. The handgrip areas at the top of these control levers are, themselves, additional controls that are hinged to move left and right. At the top or head of the left lever is the control for the hydraulic functions of the attachment on the lift arm's mounting frame—in this case the forklift. At the head of the right hand control lever is the control for raising and lowering the lift arms, which move together as a single framework. Across the lap of a seated operator is a seat bar which not only helps restrain the operator during skid steer operation, but also (automatically)

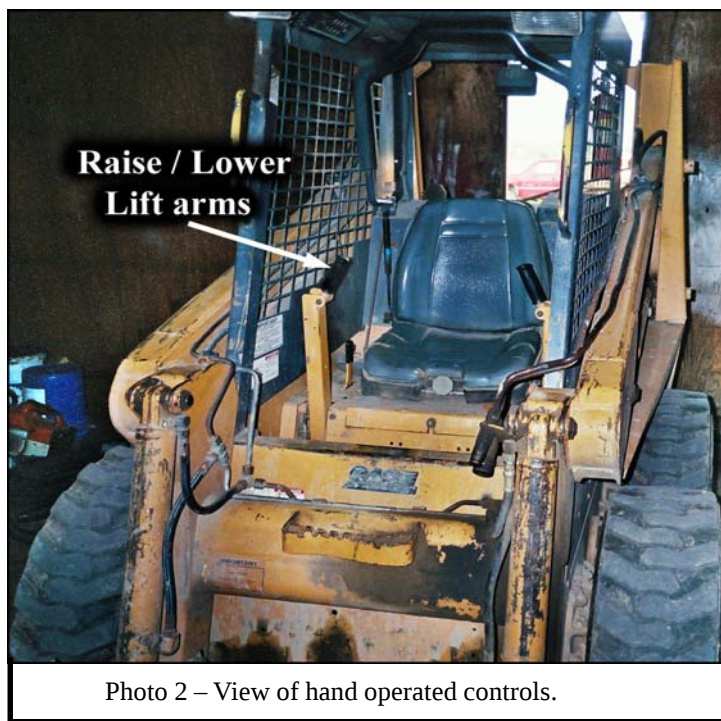


Photo 2 – View of hand operated controls.

mechanically blocks movement of controls when the seat bar is pivoted upward and out of the way, to allow the operator to exit the operator's station.

Mechanical linkages transfer movement of the controls to hydraulic valves that shuttle hydraulic power to the respective controlled functions of the skid steer, such as motors and hydraulic cylinders. Several bolts, nuts, and pins were found laying loose on the ledge part way up along the left inside of the operator's station. The speed and direction levers were disconnected from their control rod linkages. The seat bar in this incident had also been disconnected from its control rod, and that rod disconnected from the mechanical linkage intended to block inadvertent movement of the hand controls while the seat bar is raised.

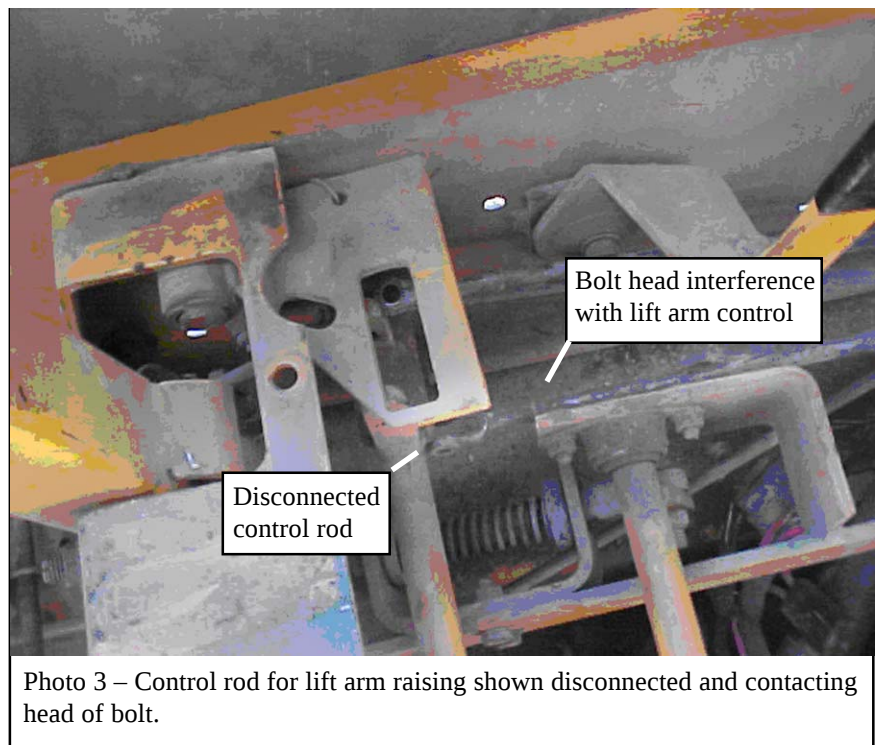


Photo 3 – Control rod for lift arm raising shown disconnected and contacting head of bolt.

The control linkage from the head of the right hand lever acts to cause upward or downward movement of the lift arms. Lifting or lowering the lift arms under hydraulic power requires the engine to be running. In this case, the engine was not running and its throttle linkage was disconnected. The linkage to raise or lower the lift arms includes two rods located under the platform of the operator's station (Photo 3). One rod actuates the hydraulic valve to pressurize the cylinders and raise the lift arms. This rod was connected and observed to be in an actuated position, although the lift arms cannot be raised without the engine running. The second rod causes the lift arms to move downward, either under hydraulic power and/or due to their geometry and weight, including that of the attachment. The control rod to lower the lift arms was disconnected.

In addition to being disconnected, the rod in the linkage to control lowering of the lift arms was out of position and in contact with the head of a bolt which would interfere with the proper, free movement of this linkage. Attempting to free or otherwise cause this control rod to move could have allowed the lift arms to lower with the engine not running in the same way as if the control itself were actuated.

A metal channel lock is provided on the right-hand lift arm cylinder mount (Photo 4). When properly positioned in use over the exposed rod of the hydraulic cylinder, this channel serves as a rigid mechanical means that prevents lift arms held above a height, which is a function of the length of the channel, from lowering under power or by gravity.



Photo 4 - Hydraulic cylinder lock in stowed position.

It is not known why the repairman in this incident did not engage the hydraulic cylinder lock (Photo 4), which can be put into position from the operator's station when the lift arms are raised. This mechanically blocks movement for the lift arms. Movement of the lift arm lowering control rod, and having it stay in the actuated position, allowed the lift arms to fall. The lanky repairman (6' 6", 2.0 m) leaning into the operator's station from the front, had too little time to escape. The lift arms of a representative skid steer fall from full raised height to the ground in about four seconds with the engine off. The time would be less when the lift arms are in a partially raised position before they fall, and with attachments mounted on the lift arm attachment frame.

Upon returning to the shop, the customer discovered the repairman pinned against the front of the skid steer's frame by the back of the forklift attached to the lift arms, which were now resting near the ground. The repairman, nearly to his knees on the dirt floor, faced into the operator's station with his head tilted outward near the left lift arm. The customer ran to the repairman's residence adjacent to the shop, summoned Emergency Medical Services, and returned to place a floor jack under the forklift attachment in an attempt to extricate the victim. A local fire department volunteer soon arrived on the scene and assisted in freeing the victim. CPR was being administered as Sheriff's deputies and emergency crews responded and was subsequently discontinued based on their assessment.

CAUSE OF DEATH

The cause of death from the Medical Examiner's report was ventricular dysrhythmia and hypoxia resulting from trauma to the chest.

RECOMMENDATIONS / DISCUSSION

Recommendation #1 *Skid steer loader operators should lower lift arms to the ground before exiting the operator's station. Operator's and those repairing skid steer loaders should always use lift arm locking mechanisms provided by the manufacturer and ensure that they perform properly before exiting or working under any portion of the raised lift arms of the loaders.*

Discussion: Lowering lift arms to the ground before exiting a skid steer is a primary safe operating practice that minimizes the risk of lift arms lowering during entry and exit as well as while work is being performed on the skid steer. Attachments mounted to the lift arms are designed to be easily and quickly removed, and they should be removed when it would make repair work with the lift arms on the ground easier. When the operator must exit with the lift arms raised, the lift arms must be locked securely, such as by a rigid mechanical strut or pins barring linkage movement. Leaving a skid steer unattended with unsecured, raised lift arms presents a risk of the lift arms lowering on anyone re-entering the machine or attempting to lower its lift arms from outside the operator's station.

Recommendation #2 *Operators and repair personnel should be educated and trained to recognize, assess, and act to avoid the risks of lift arm movement during skid steer operation, maintenance, and repair.*

Discussion: Operators and others who maintain or repair skid steer loaders should read and follow the manufacturer's recommended procedures in the operator's manual and safety signs on the skid steer loader. Additional information is available in various forms, such as publications and videos by the industry, farm safety

organizations, and government agencies. The manufacturer, dealer, or a knowledgeable independent repair shop should be consulted before attempting non-routine service or repair tasks that may require special precautions.

Recommendation #3 *Skid steer loader manufacturers should consider additional means to prevent lift arm lowering when the control to lower lift arms is actuated and the skid steer's engine is not running.*

Discussion: Newer model skid steer loaders produced since the early 1980s have interlocked control systems. Models such as the one in this incident have a bar that must be lowered in front of the operator for the controls to be operated and their rigidly connected linkages to move the skid steer or its attachment. This interlocking, and its associated protection, are circumvented when linkages are disassembled.

There is value in skid steer loader attachments, that in combination with lift arms moving up and down during operation with the engine running, to follow the contour of the ground without continuous control actuation, a so-called "float" mode. Some circumstances may favor the ability to lower raised lift arms while the engine is not running. Though locking means and lift arm restraints are provided, such systems can be disabled or otherwise rendered ineffective, so skid steer loader manufacturers should consider additional means to prevent lift arm lowering when the control is actuated and the engine is not running.

Recommendation #4 *Means to secure skid steer loader lift arms such as capable blocks, jacks, and hoists, which prevent unintended movement of lift arms during repairs performed with the lift arms in a raised position, should be employed prior to performing such repair tasks.*

Discussion: Repair tasks performed with skid steer loader lift arms in a raised position that does not allow them to be locked securely, should be supported as recommended by the machine manufacturer. The lift arms should be lowered to rest on wooden blocks or jack stands. Blocking, jacks, and hoists must be in good condition and capable of supporting the lift arm and any attachment or load on them.

REFERENCES

AEM. Skid Steer Loaders Safety Video & Manual. Milwaukee, WI: Association of Equipment Manufacturers. Available at: www.aem.org. Accessed 14 June 2005.

CDC-NIOSH. February 1998. Preventing Injuries and Deaths from Skid Steer Loaders. DHHS(NIOSH) Publication No. 98-117. Morgantown, WV: National Institute for Occupational Safety and Health.

NASD. Skid Steer Loader Safety. Atlanta, GA: Centers for Disease Control. National Agricultural Safety Database available at: www.cdc.gov/NASD. Accessed 14 June 2005.

SAE. June 2003. Personnel Protection – Skid Steer Loaders. Detroit, MI: SAE International. Available at: www.sae.org. Accessed 13 June 2005.

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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.

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