
Operator Pinned Between the Hydraulic Tilt Cylinder Housing and the Frame of a Skid-Steer Loader

SUMMARY

On January 10, 2001, a 43-year old male died from injuries sustained when he was pinned between the hydraulic tilt cylinder housing and the frame of a skid-steer loader. The skid-steer loader was being used to clear snow from a parking lot. On the night of the incident, there was an accumulation of packed snow and ice that completely surrounded the foot pedals. The foot pedals controlling the operation of the loader arms and bucket are located on the floor near the front frame of the loader. The left foot pedal raises and lowers the skid-steer loader arms and the right foot pedal controls bucket tilt. It appears that the operator was attempting to clean the snow from around these pedals. Snow and ice had been cleared from in front of and behind the right foot pedal controlling bucket tilt. The front "toe" portion of the left foot pedal controlling the loader arm had been partially cleared of ice and snow, but snow was still present behind the "toe" area as well as surrounding the remainder of the foot pedal. With the lift arm/bucket in the raised position, the deceased was apparently cleaning the left foot pedal. While clearing the snow from around the foot pedal, the deceased evidently pressed the "toe" of the foot pedal, which lowered the lift arm/bucket. The deceased was found standing on the ground facing the loader, pinned between the hydraulic tilt cylinder and the skid-steer loader frame. The seat bar was in the down position, and the ignition key, which was bent, was in the cab seat. The Fire Department used the Jaws of Life to raise the lift arms to provide access to the deceased. Figure 1 courtesy of New Jersey FACE.

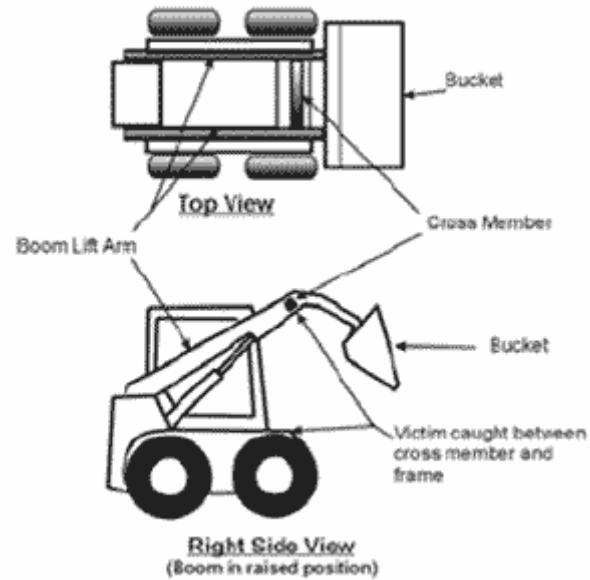


Figure 1. Skid-steer loader.

RECOMMENDATIONS

- Operators of skid-steer loaders should be trained in and follow the manufacturer's recommended procedures to safely operate, service, maintain, and exit the skid-steer loader.

- **Employers should prohibit skid-steer loader operators from working underneath raised lift arms if an approved lift arm support is not available.**
- **Operators who are under the influence of drugs and/or alcohol should not operate machinery since their ability to recognize and respond appropriately to hazardous situations can be impaired.**
- **MIFACE suggests that manufacturers review the design characteristics of skid-steer loaders to ensure that operators may not routinely exit or perform service activities when the lift arms are raised without a properly installed approved lift arm support in place.**

INTRODUCTION

On January 10, 2001, a 43 -year old male died from injuries sustained when he was pinned between the hydraulic tilt cylinder and the frame of a skid- steer loader. On January 11, 2001, MIFACE investigators were informed by the Michigan Occupational Safety and Health Administration (MIOSHA) 24-hour fatality report system that a work-related fatal injury occurred on January 10, 2001. On January 12, 2001, a MIFACE researcher accompanied the MIOSHA compliance officer to the interview conducted with the owner of the skid-steer loader. The skid-steer owner agreed to participate in the MIFACE project, and the MIFACE researcher observed the MIOSHA interview. Following the MIOSHA interview, the MIFACE researcher interviewed the skid-steer loader owner. The incident site was visited on January 17, 2001. The MIFACE researcher did not interview the owner of the parking lot. The death certificate, autopsy results, and municipal police report, and a copy of the citations issued to the employer were obtained during the course of the investigation. Copies of the skid-steer loader Operation and Maintenance Manual (Manual), Operator's Handbook (Handbook), and an employee training program that included an instructional video were also obtained from the equipment manufacturer.

INVESTIGATION

A literature search produced many examples of work-related fatalities occurring when an individual was working under the unsupported raised lift arms of a skid-steer loader. In 1994, a worker in Massachusetts died while working underneath unsupported lift arms while clearing snow from the foot pedals of the cab of a skid-steer loader. To assist employers and workers in increasing their awareness of the hazards of operating or working near skid-steer loaders, the National Institute for Occupational Safety and Health (NIOSH) published NIOSH Alert #98-117, "Preventing Injuries and Deaths from Skid Steer Loaders". Six fatalities involving skid-steer loaders are described, and the Alert makes recommendations to prevent similar incidents. The Skid Steer Loader Alert can be downloaded from the NIOSH website:

www.cdc.gov/niosh/skidalt.html.

The skid-steer loader was a small front-end bucket loader, and was used by the owner for light earth moving, snow removal, etc. The skid-steer loader was manufactured in 1991, and the owner purchased the skid-steer loader "used" with 840 hours of use. The skid-steer loader houses a single operator in a small cab. Foot pedals control the raising and lowering of the hydraulically powered lift arms (left pedal) and bucket tilt (right pedal). The skid-steer loader has a seat bar, controlled by the operator, that acts as a secondary operator restraint and is connected to interlocks on the foot pedals. When the operator raises the seat bar to the fully raised position, the seat bar locks the operating foot pedals in a neutral position. In this position, the lift arms can not be raised or lowered, nor the bucket tilted forward or back. When the seat bar is lowered and is in front of an operator, the seat bar releases the foot pedals from the locked neutral position and the operator can activate the lift arms and bucket. To raise and lower the lift arms, the operator "heels" the pedal to raise the arms and "toes" the pedal to lower the lift arms.

All manufacturer's safety and warning decals were in place and readable in the operator's compartment and on the outside of the loader. The Operator's Handbook (Handbook) was in the skid-steer loader cab. The seat bar was functional when tested after the incident. The parking brake was non-functional. The skid-steer loader did not have a lift arm support available to the operator.

The skid-steer owner occasionally employed the deceased during the year. According to the skid-steer owner, the deceased had familiarity with operating a skid-steer loader. The deceased had used this type of loader in the past, and had cleared snow previously for the owner with the same skid-steer loader. Prior to the deceased using the skid-steer loader, the owner had been clearing snow at various establishments using the same loader for approximately 6-7 hours. The last job to be completed that day was at the parking lot, where the deceased arrived at approximately 7:00pm to relieve the skid-steer loader owner and finish the snow clearing work.

At some point during the late evening or early in the morning of the next day, snow accumulated around the foot pedals and may have interfered with the smooth operation of the lift arms and/or bucket. The parking lot lighting was dim, and the prior to cleaning the foot pedals, the operator oriented the skid-steer loader to take advantage of the light, although not directly under a light.

The skid-steer owner stated the deceased had a "bad" knee. Wearing appropriate clothing to protect him from the cold weather, the deceased was wearing a heavy winter coat and substantial work boots. The combination of the clothing, "bad" knee and size of the cab may have prevented the deceased from cleaning the accumulated snow from around the foot pedals from inside the cab. All service and maintenance work on the skid-steer loader involved in this incident can be performed with the lift arms fully lowered and the bucket placed flat on the ground.

This was an unwitnessed event so the actual sequence of events cannot be reconstructed. MIFACE has proposed three possible event sequences, and each is explained below. Each of the event sequences described below contains two assumptions. The first assumption is that the operator kept the lift arms/bucket in the raised position while cleaning the packed snow and ice from around the foot pedal controlling lift arm movement. This action allowed him to stand closer to the body of the skid-steer loader, making it easier for him to clear the snow and ice from around the foot pedal. The second assumption is that the operator turned the engine off

prior to exiting the cab, either leaving the key in the ignition switch or removing it from the ignition switch and taking it with him. The owner of the skid-steer loader stated that he did not think that the deceased would exit the cab with the skid-steer loader engine running. He also indicated that key was not bent when the operator relieved the owner and began to clear the parking lot that evening. If the engine was left running, the deceased would not have a need to touch the key; all of the deceased's effort would have been directed trying to reach the lift arm foot pedal to raise the fallen bucket. The bent key suggests that the deceased was trying to start the engine, to provide power to raise the bucket from his body.

Possible Event Sequence #1 - When the deceased exited the cab, he left the lift arms/bucket in the raised position with the engine turned off. Upon exiting the cab, he lowered the seat bar. Under this possible event sequence, with the seat bar in the lowered position, the pedal interlocks were not engaged, and the pedals were operational. Standing on the ground facing the skid-steer loader, the deceased leaned over the front frame bending at the waist to reach into the cab to clean the snow away from the foot pedals. Following the snow and ice removal from the bucket tilt pedal, he began to clear the lift arm pedal. During cleaning of the "toe" portion of the lift arm pedal, he exerted enough force to move the pedal and activate the lowering of the lift arm. Unable to react quickly enough to get out of the way of the lowering bucket, he was pinned between the hydraulic tilt cylinder and the skid-steer loader frame. During an attempt to start the engine so he could raise the lift arms, he bent the key, and it eventually landed on the cab seat.

Possible Event Sequence #2 – When the deceased exited the cab, he left the lift arms/bucket in the raised position with the engine turned off. The deceased raised the seat bar prior to exiting the cab, keeping the bar in the raised position. Due to the accumulation of snow and ice around the foot pedal and seat bar linkages, the raised seat bar did not lock the pedals in neutral. Standing on the ground facing the skid-steer loader, the deceased leaned over the front frame bending at the waist to reach into the cab to clean the snow away from the foot pedals. Following the snow and ice removal from the bucket tilt pedal, he began to clear the lift arm pedal. During cleaning of the "toe" portion of the lift arm pedal, he exerted enough force to move the pedal and activate the lowering of the lift arms. Unable to react quickly enough to get out of the way of the lowering bucket, he was pinned between the hydraulic tilt cylinder and the frame of the loader. While attempting to restart the engine, he lowered the seat bar. During the attempt to start the engine, he bent the key, and it eventually landed on the cab seat.

Possible Event Sequence #3 – The deceased properly shut down the engine and lowered the lift arms/bucket flat to the ground. The deceased leaned over the front frame of the skid-steer loader at his waist, reaching into the cab to clean the snow away from the foot pedals. He cleaned around the bucket tilt pedal, but had difficulty cleaning around the lift arm foot pedal with the bucket lowered. He entered the skid-steer loader, started the engine, raised the bucket, and stopped the engine. He exited the skid-steer loader with the bucket in the raised position. Either of the possible event sequences described above could have occurred while cleaning the lift arm foot pedal.

The deceased's autopsy report stated there was a measurable level of a non-active cannabis (i.e., marijuana, hashish or hash oil) metabolite in the deceased's blood. The non-active metabolite found indicates past cannabis use and does not affect an individual's ability to function. An

analysis was not made for the active cannabis metabolite indicating recent use. The non-active metabolite can be at measurable levels in the blood for several days to weeks following a single cannabis exposure. An accurate prediction of the time of the deceased's marijuana exposure cannot be determined, so it is unknown if the deceased had recently used cannabis and was under its effects at the time of the accident.

Blood analysis was negative for alcohol, opioids, barbiturates, amphetamines, and all other screened drugs and drug classes.

CAUSE OF DEATH

The cause of death as stated on the death certificate was traumatic asphyxia due to crushing injury to the back.

RECOMMENDATIONS/DISCUSSION

- Operators of skid-steer loaders should be trained in and follow the manufacturer's recommended procedures to safely operate, service, maintain, and exit the skid-steer loader.**

Although the deceased was reportedly familiar with the operation of the skid-steer loader, and had previously used the skid-steer loader without incident, the employer was still required by MIOSHA to provide the appropriate employee education and training. Operator training is necessary to enhance the operator's understanding of the basic concepts of safe skid-steer loader operation.

In violation of the manufacturer's recommended safety procedures, the operator exited the cab with the lift arms in a raised position, and performed service work (cleaning the foot pedals) with the lift arms in a raised position, without the use of a lift arm support. The Operator's Handbook (Handbook) and all safety decals were present in the skid-steer loader cab if the operator had any questions about recommended procedures to allow for safe exiting of the cab or performing service on the skid-steer loader. The Handbook states "Do not service the loader without using a lift arm support when the lift arms are raised."

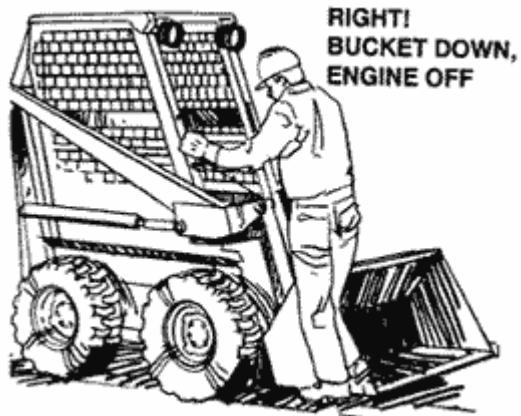
The manufacturer's Operation and Maintenance Manual (Manual) also expressly indicates that work should not be performed when lift arms are unsupported. The Manual states "Never work on loader with lift arms up unless lift arms are held by a lift arm support. Failure to use an approved lift arm support can allow the lift arms or attachment to fall and cause injury or death." The Manual describes the procedure necessary to safely perform maintenance and service work when the lift arms are raised.

Employers should take advantage of training materials offered by the equipment manufacturers and/or other organizations to inform and teach employees about the equipment, hazards and machine safeguards in place for their protection. Although the deceased only did occasional work for the employer, it was the employer's responsibility to ensure that the deceased was properly trained.

- **Employers should prohibit skid-steer loader operators from working underneath raised lift arms if an approved lift arm support is not available.**

The skid-steer loader manufacturer offers an approved lift arm support as an item that the owner can purchase at the time of sale. The manufacturer's policy is that the customer is in the best position to decide what accessory items are required for the owner's skid-steer loader application. These items could include tires, attachments, stabilizers, cab enclosures, and lift arm supports.

The owner of the skid-steer loader did not purchase a lift arm support approved for his skid-steer loader. An approved lift arm support is required by the manufacturer to work under raised lift arms. If an employer does not have available an approved lift arm support, the employer's safety program should strictly prohibit employees from working underneath the raised lift arms of a skid-steer loader.



- **Operators who are under the influence of drugs and/or alcohol should not operate machinery since their ability to recognize and respond appropriately to hazardous situations can be impaired.**

Although it cannot be determined if the deceased was under the influence of cannabis, many studies have concluded that cannabis use reduces coordination, impairs balance, perception, judgement, memory and learning. Cannabis use interferes with the ability to perform simple or complex tasks, and slows a user's reflexes. Many drugs, such as over-the-counter medications, alcohol and other illegal substances may affect an individual's performance, reaction time and judgement. Individuals should not engage in hazardous activities such as operation of automobiles or dangerous machinery while under the influence of or taking medications that may put them at risk of injury.

- **MIFACE suggests that manufacturers review the design characteristics of skid-steer loaders to ensure that operators may not routinely exit or perform service activities when the lift arms are raised without an properly installed, approved lift arm support in place.**

The manufacturer of the skid-steer loader repeatedly emphasizes the danger associated with exiting the operator cab and/or performing service work with the lift arms in the raised position without using an approved lift arm support. The manufacturer has designed the skid-steer loader so that all service and maintenance work may be performed with the lift arms in the fully lowered position and the attachment flat on the ground. For the skid-steer loader involved in this fatality, the operator could exit the cab and perform service on the skid-steer loader with the lift arms in a raised position without an approved lift arm support properly installed. Manufacturers should provide built-in protection, inherent in the skid-steer loader design, that prevents the operator from routinely exiting the operator cab and/or performing service work with unsupported, raised lift arms.

RESOURCES

1. MIOSHA Standards cited in this report can be found at the Consumer and Industry Services, Bureau of Safety and Regulation Standards Division website at http://www.cis.state.mi.us/bsr/divisions/std/std_rule.htm. The Standards can also be obtained for a fee by writing to the following address: Department of Consumer and Industry Services, MIOSHA Standards Division, P.O. Box 30643, Lansing, MI 48909-8143. MIOSHA phone number is (517) 322-1845.

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