MIFACE INVESTIGATION REPORT: #10MI067

Subject: Volunteer Mowing Grass Pinned by Overturned Tractor

Summary

In the Summer of 2010, a male volunteer in his 70s was killed while mowing grass for a youth organization's camp using a tricycle-type Allis Chalmers Model L59AC farm tractor, retrofitted with an after-market, home-installed underbelly power rotary mower attachment. The tractor overturned to the side on an approximately 30-degree hill and pinned him beneath it. The tractor was not equipped with a rollover protection structure (ROPS) and seat belt (Figure 1). The decedent had mowed the property for over 30 years. The following scenario has been developed since his death was not witnessed. The decedent arrived at the camp and drove the tractor to the top of the hill behind the building. Starting from the tip of the hill, he drove the tractor downhill between the two trees and then turned north toward the bottom stairs leading to the building. He then ascended the 30-degree hill and as he was turning the tractor southbound at the top of the hill, the outside wheel lost its traction and the tractor overturned to the side. His tractor, according to his family members was in first gear. His tractor speed was unknown. A neighbor found him pinned under the overturned tractor's seat. The neighbor ran to the nearest residence where emergency response was called. The homeowner and neighbor ran back to the incident scene and attempted to render aid. The fire department arrived, removed the tractor from the decedent, and performed resuscitative measures. He was pronounced dead at the scene.

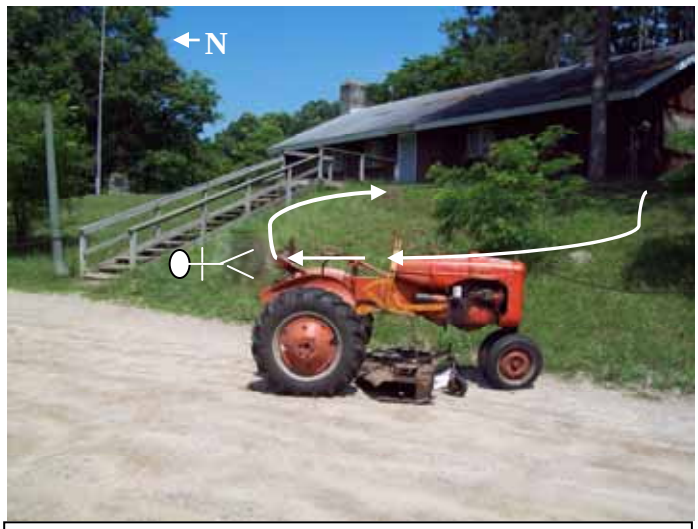

Figure 1. Overview of incident scene showing mowing path and position of decedent on hill. Tractor had been removed from decedent by emergency response.

RECOMMENDATIONS

- When cutting lawn grass on a slope, use a rollover protective structure (ROPS) equipped riding mower or agricultural tractor.
- Vintage tractor owners should determine if their vintage tractors can be retrofitted with an approved ROPS and seat belt and do so if a ROPS is available.
- Tractor owners, and especially vintage tractor owners, need to be sure that the modification of their tractor with non-original manufacturer's attachments does not increase injury risk to the operator.

- Service organizations should develop a comprehensive safety and health program or safety management system that addresses management leadership and worker/volunteer involvement. As part of the safety and health program, the organization should conduct a hazard assessment of the workplace and volunteers/employee training.
- Develop and post Rules of Mowing on the organization's grounds. The Rules should include two specific increased hazard situations: 1. Mowing on slopes and hills and 2. Mowing near the edge of lakes, ponds and dry gullies.
- Convert tricycle-configured tractors to a wide front-end configuration.
- Ensure any implement of husbandry, such as a tractor, when used on a public roadway has a slow moving vehicle sign.

INTRODUCTION

MIFACE personnel were notified of this incident by a Michigan State University Extension agent. MIFACE contacted the decedent's spouse and was granted permission to conduct a site visit on October 1, 2010. With the decedent's spouse was the decedent's son-in-law, who also provided information during the MIFACE interview. The police report, medical examiner case report, and the death certificate were reviewed. The decedent's son-in-law accompanied the MIFACE investigator to the incident site and explained a likely scenario of events. The picture used in Figure 1 is courtesy of the responding police department. The picture used in Figure 2 and the video were taken by the MIFACE investigator at the time of the site visit. The picture used in Figure 3 is courtesy of John Deere's Farm & Ranch Safety Management Manual (Figure 45, page 162). The picture used in Figure 4 is courtesy of Pennsylvania State University. The picture used in Figure 5 is courtesy of Farm Safe Vermont (http://farmsafevt.wordpress.com/page/4/?pages-list).

The decedent grew up on a farm and was familiar with tractor operation and maintenance. He had back surgery in 2009. He was taking medications for his heart.

INVESTIGATION

The camp was located at the end of a road on the east side of a cul-de-sac. The camp building was five feet away from the nearest tree. There was 16 feet 6 inches between the two trees shown in Figure 2. The ground was fairly level approximately 16 feet from the building and then the slope of the hill commenced. The hill undulates and there was a knoll approximately 10 to 12 feet from the edge of the road. The decedent had mowed this property for over 30 years.

Figure 2. At top of hill, facing north looking through two trees near the building.

A 360-degree view of the camp property he was mowing can be seen here.

The responding police identified the tractor as an Allis Chalmers Model L59AC farm tractor in a tricycle configuration. The tractor had been modified the tractor to mow grass by attaching a powered rotary mower under the body of the tractor. The mower was raised and lowered by a hand lever and chain that he utilized while sitting in the tractor seat. He had been mowing the camp property the morning of the incident day. According to his family, a bolt on the mower came loose when he struck something, so he returned home and replaced the bolt. He ate lunch and then returned to the property at approximately 2:50 p.m. At approximately 3:00 p.m., the decedent exchanged greetings with a neighbor and his family who were on a walk as he was driving the tractor back to the camp property.

Using the police photos indicating the pattern of the mowed grass, the following scenario has been developed. The decedent arrived at the camp and drove the tractor to the top of the hill behind the building. Starting from the top of the hill, he drove the tractor downhill between the two trees and then turned north toward the bottom stairs leading to the building. He then ascended the 30-degree hill and as he was turning the tractor southbound at the top of the hill, the outside wheel lost its traction and the tractor overturned to the side (Figure 2). His tractor, according to his family members was in first gear. His tractor speed was unknown.

Several minutes later, the neighbor's family arrived at the cul-de-sac. The neighbor saw the overturned tractor and told his family to remain where they were and he would investigate. The neighbor approached the overturned tractor and yelled to the decedent. Upon arriving at the incident scene, he observed that the decedent was "blue". He returned to his family member and advised that they needed to get help. They then ran to the nearest house and called for emergency response.

The home owner and neighbor who found the decedent ran back to the scene to see if they could render help. When they arrived back at the decedent's location, the decedent did not have a pulse.

The decedent was found face down on the side of the hill with the tractor seat pinning his right shoulder blade to the ground. His head was pointed in a northern direction and the nose of the tractor was pointed in a southeastern direction (tractor direction as shown in Figure 1). Emergency response arrived and rendered aid. The decedent was declared dead at the scene.

CAUSE OF DEATH

The cause of death as stated on the death certificate was traumatic asphyxia. Toxicology was negative for alcohol, prescription or illegal drugs.

RECOMMENDATIONS/DISCUSSION

- When cutting lawn grass on a slope, use a rollover protective structure (ROPS)/seatbelt equipped riding mower or agricultural tractor. The operator should use the seatbelt.

The lower center of gravity of a riding mower may increase stability on a slope compared to an agricultural tractor which has a higher center of gravity. Both the lawn tractor and agricultural tractor should be equipped a ROPS/seatbelt. Many riding mowers/lawn tractors have a foldable ROPS and seat belt as standard equipment to keep the operator within the "zone of protection" (See Figure 3). The foldable nature of the ROPS facilitates mowing under low-hanging obstacles and in storing of the mower/tractor.

- Vintage tractor owners should determine if their vintage tractors can be retrofitted with an approved ROPS and seat belt and do so if a ROPS is available.

Some, but not all, older vintage tractors can be retrofitted with ROPS. Some tractors cannot be retrofitted with a ROPS/seatbelt according to the manufacturer or the cost of the retrofit is excessive in relation to the value of the tractor. In these cases, MIFACE recommends that the operators discontinue the use of the non-ROPS/seatbelt-equipped tractor.

Tractor rollovers are likely to occur on hilly terrain when the center of gravity on the tractor becomes unbalanced. The field slope, tractor speed, turning radius, rear axle torque and center of gravity are all interrelated factors that impact the stability of a tractor. ROPS are designed to help limit a tractor overturn to 90 degrees and to provide the operator a "zone of protection" (Figure 3). The operator stays within this zone only if they also wear the seat belt. The operator will not be protected by the ROPS during an overturn if the operator is not wearing a seatbelt since the operator may be totally or partially thrown off the tractor. Even inside a cab, seat belts are important to keep the operator from being thrown against the frame, through a window, or out a door. Therefore, when an older tractor is retrofitted with a ROPS, approved seatbelts must also be installed. Seat belts may not be included with an available ROPS package and will have to be purchased separately.

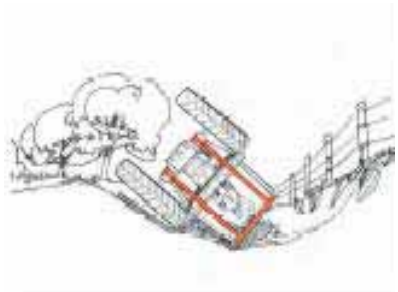

Figure 3. ROPS/Seatbelt providing zone of protection

The University of Kentucky's College of Agriculture maintains a Web guide *"The Kentucky ROPS Guide"* to ROPS tractor retrofits (http://warehouse.ca.uky.edu/rops/ropshome.asp). The ROPS listed in the guide are organized by tractor make and model. Another option for owners of older tractors to obtain information about ROPS retrofits is to contact their local extension office or tractor dealership. ROPS should be certified to meet at a minimum the standards and

regulations of various agencies that ensure that the frame or enclosure is designed to provide overturn protection.
http://weblogs.nal.usda.gov/infofarm/farm_safety/index.shtml

Seat belts should not be used on tractors that do not have a ROPS. Additionally, ROPS should not be manufactured in the farm machine shop. OSHA requires that ROPS are labeled/marked, therefore, tractor owners should look for a label on the frame or enclosure stating it meets rollover protection standards.

- Tractor owners, and especially vintage tractor owners, need to be sure that the modification of their tractor with non-original manufacturer's attachments does not increase injury risk to the operator.

Due to the high center of gravity of some vintage tractors, custom or modifying non-original manufacturer's attachments to fit could be a misapplication of the intent of the original tractor's use. Aftermarket attachments for agricultural equipment are common on some models of older agricultural tractors. Although the weight of the belly mower may help to stabilize this tractor, operators need to review the owner's manual for proper attachment to the specific tractor and user techniques. Engineering factors unknown to the modifiers may add risk to any user of such equipment.

- Service organizations should develop a comprehensive safety and health program or safety management system that addresses management leadership and worker/volunteer involvement. As part of the safety and health program, the organization should conduct a hazard assessment of the workplace and volunteers/employee training.

The service organization relied on the pre-existing safety knowledge of the decedent. The difficulty in relying on the experience a volunteer brings to a task is that the volunteer may use unsuitable equipment, have developed unsafe work practices, become comfortable or complacent, or be using their work skills in a new setting and be unfamiliar with hazards of new tasks.

MIFACE recommends that the organization develop a comprehensive safety and health program, or safety management system that addresses management leadership and volunteer involvement and conduct a workplace analysis including hazard assessment. The hazard assessment will provide information to develop hazard prevention and control strategies and volunteer (and paid staff if indicated) safety and health training and education. A hazard assessment may have identified the slope of the hill as a safety issue. Any organization should review the risks of permitting workers/volunteers to use non-ROPS equipped equipment, such as tractors or riding lawn mowers due to rollover and stability issues

The service organization should develop safe work practices and procedures to reflect the nature of their unique working environment and job tasks. With the assistance of their volunteers, the organization should evaluate tasks performed, identify all potential

hazards, and then develop, implement, and enforce safe work procedures, conduct necessary training, and periodically evaluate the effectiveness of the hazard mitigation addressed by the procedures. Additionally, the organization could set policy regarding training, health and/or vision requirements of volunteer labor, as well as age limitations for equipment operators.

In this incident, the decedent was performing what was considered groundskeeping duties. The MIOSHA General Industry Safety Standard, Powered Groundskeeping Equipment, Part 54 would apply and should be used to ensure that groundskeeping work is performed safely. Rule 5443(4) of Part 54 states: "Riding groundskeeping equipment shall not be operated up or down a slope of more than 26 degrees or move across the face of a slope of more than 17 degrees. In addition, Rule 5443 (5) states that "a deviation from the requirements of subrule (4) may be obtained from the department of labor by presenting special design or modification criteria which shows an ability to perform safely on a specific slope of a greater degree without slipping or tipping.

Although the tractor may have been suitable for mowing the level area in back of the lodge, it was unsuitable for mowing the hill. Utilizing a ROPS-equipped riding lawn mower may have been a more suitable piece of equipment for that job task.

MIOSHA health and safety standards as well as best industry practices can be utilized to support this effort. MIOSHA Consultation, Education and Training Division has many resources for an organization to use and adapt to their needs. The Non-Profit Risk Management Center (http://www.nonprofitrisk.org/) has an online tutorial and an online safety and health toolkit to assist non-profit organizations in the development and implementation of a health and safety program.

- Develop and post Rules of Mowing on the organization's grounds. The Rules should include two specific increased hazard situations: 1. Mowing on slopes and hills and, 2. Mowing near the edge of lakes, ponds and dry gullies.

There are a number of websites that highlight the safety issues involved when using riding lawn mowers. For example:

- West Virginia University Extension Service: http://safetyandhealth.ext.wvu.edu/r/download/22008
- Exmark: http://www.exmark.com/pdfs/SafetyTips.pdf
- Kansas State University Extension: http://www.ksre.ksu.edu/library/ageng2/mf2714.pdf

The information contained on these and other websites can be used by any organization to develop Rules of Mowing to ensure the operator understands the safety issues inherent in using the mower.

- Owners using tricycle-configured tractors should convert them to a wide front-end configuration.

The victim was using a vintage tricycle-configured tractor. Tricycle-configured tractors, with the narrow-front wheel design are inherently less stable than tractors with a wide-wheel configuration. Tricycle tractors also have stability baselines which leave little room for error (Figure 4). The stability baseline of a tractor is made up of imaginary lines drawn between the points where the tractor tires contact the ground. Front, rear, and side stability baselines are established. To avoid turnover, the center of gravity must stay within the tractor's stability baseline. The tractor's center of gravity does not move, but its relationship with stability baselines may change due to:

- Added weight from attachments and items being hauled (center of gravity will shift to the front or rear of the tractor depending on what is attached or is being hauled),
- Driving on a slope (center of gravity shifts to the downhill side),
- Lifting a load (center of gravity shifts towards the load),
- Turning too fast (center of gravity shifts to the opposite direction you are turning in).

A tractor's center of gravity is the point where all parts balance one another. On a two-wheel drive tractor on level ground, the center of gravity is typically 10 inches above and two feet in front of the rear axle (in the center), which is about where the operator's feet are located. The center of gravity on a four-wheel drive and center-articulating tractor is located slightly more towards the front of the tractor.

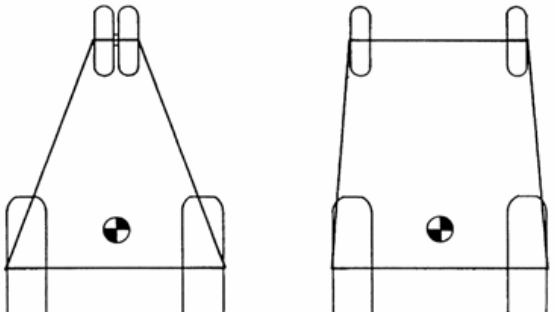

Figure 4. Stability baselines for tricycle and wide-front tractors

Converting a tricycle tractor to a wide-front configuration and setting the wheel tread at the widest setting suitable for the task will provide the widest possible base of stability. This should also be done in a manner that doesn't create a bigger hazard. Use approved retrofits only.

- Ensure any implement of husbandry, such as a tractor, when used on a public roadway has a slow moving vehicle sign.

Although not a factor in this incident, the decedent's tractor was operated on a public roadway and thus should have been equipped with a slow moving vehicle (SMV) emblem. The Michigan Motor Vehicle Code holds the tractor driver "at fault" if another vehicle rear-ends a tractor without a SMV emblem.

A SMV emblem is a reflective orange triangle bordered with red that warns other road users that the vehicle displaying the sign is traveling slower than the normal speed of traffic. The American Society of Agricultural Engineers (ASAE) has developed new

recommendations for lighting and marking equipment (ASAE S276.6, January 2005). Although the SMV emblems meeting the old ASAE standard are still available, MIFACE encourages owners of implements of husbandry operated on the roadways to purchase SMV emblems meeting the new recommendations. SMV emblems meeting the recommendations in ASAE 276.6 are in packages labeled with S276.5 or a higher number.

Figure 5. Center SMV emblem equipped with ASAE 276.6 recommendations

The new SMV emblems have fluorescent material aiding daytime visibility and reflective material aiding nighttime visibility (Figure 5). Replacing worn SMV emblems is important because the orange fluorescent center portion of the SMV emblem fades and turns color over time, changing from orange to yellow, pink or white. This portion is the most vulnerable to light and moisture degradation because fluorescent dyes decompose.

Retro-reflective material as found in the outer border of the SMV emblem reflects the headlights of vehicles approaching from the rear at night. Retro-reflective material holds up longer than fluorescent material. The retro-reflective readings on SMV emblems meeting the new ASAE standard are over ten times greater than most of the readings on SMV emblems currently in use. Figure shows a comparison of older and newer SMV emblems. The SMV on the left is a new sign under the old standard, the SMV in the middle is a new sign under the new standard, and the SMV on the right is an old sign under the old standard.

REFERENCES

MIOSHA standards cited in this report may be found at and downloaded from the MIOSHA, Michigan Department of Licensing and Regulatory Affairs (MDLARA) website at: www.michigan.gov/mioshastandards. MIOSHA standards are available for a fee by writing to: Michigan Department of Licensing and Regulatory Affairs, MIOSHA Standards Section, P.O. Box 30643, Lansing, Michigan 48909-8143 or calling (517) 322-1845.

- MIOSHA General Industry Safety Standard, Part 54: Powered Groundskeeping Equipment
- *Farmer Dies when Tractor rolls over on sloped Terrain*. Wisconsin FACE Program. http://www.dhs.wisconsin.gov/dph_boh/face/PDF/04WI019TractorRollover.pdf
- *Tractor Safety*. Virginia Tech, Environmental Health and Safety. http://www.ehss.vt.edu/programs/FAR_tractor_safety.php
- *Tractor Stability*. HOSTA Task Sheet 4.12. Hazardous Occupations Safety Training in Agriculture. National Safe Tractor and Machinery Operation Program. http://www.nstmop.psu.edu/tasksheets/4.12%20Tractor%20Stability.pdf

- *Riding Lawn Mower Safety.* West Virginia University Extension Service. http://safetyandhealth.ext.wvu.edu/r/download/22008
- *Mowing Safety Tips.* Exmark. http://www.exmark.com/pdfs/SafetyTips.pdf
- *Mowing and Trimming Safety for the Landscaping and Horticultural Services Industry.* Kansas State University Extension. http://www.ksre.ksu.edu/library/ageng2/mf2714.pdf

Key Words: Tricycle tractor, Mowing Slope, Service Organizations, Powered Rotary Mower, Other Services

10/7/2011