KENTUCKY State FACE Program
Fatality Assessment & Control Evaluation

Kentucky Injury Prevention and Research Center
Bona fide agent for Kentucky Department for Public Health
333 Waller Avenue, Suite 242 • Lexington, KY 40504 • 859-257-5839

REPORT#: 22KY083 **REPORT DATE:** March 28, 2023

Equipment operator crushed by skid-steer attachment—Kentucky

INCIDENT HIGHLIGHTS

DATE:
September 29, 2022

TIME:
7:50 a.m.

VICTIM:
46-year-old equipment operator

INDUSTRY/NAICS CODE:
Water and Sewer Line and Related Structures Construction/237110

EMPLOYER:
Geothermal system installation

SAFETY & TRAINING:
Some elements existed

SCENE:
Geothermal field installation

LOCATION:
Kentucky

EVENT TYPE:
Struck by

SUMMARY

On September 29, 2022, a 46-year-old skid-steer operator was killed when he was struck by his skid-steer's twin-fork attachment with a gravel bucket secured to it. The operator had raised the skid-steer's arms and exited the cab. While the operator was beneath the attachment, it separated from the skid-steer's lift arms and fell onto him.

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CONTRIBUTING FACTORS

Key contributing factors identified in this investigation include:

- *Bypassing equipment safety features*
- *Workplace substance use*
- *Inadequate knowledge of hazards*
- *Inadequate training and communication*

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RECOMMENDATIONS

Kentucky investigators concluded that, to help prevent similar occurrences, employers should:

- Ensure that employees do not bypass equipment safety features;
- Implement measures that contribute to a drug-free work environment;
- Identify and understand the hazards that may be presented by the equipment their employees operate;
- Provide education and training to employees to recognize hazards and methods to mitigate and/or eliminate them.

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Fatality Assessment and Control Evaluation (FACE) Program

This case report was developed to draw the attention of employers and employees to a serious safety hazard and is based on preliminary data only. This publication does not represent final determinations regarding the nature of the incident, cause of the injury, or fault of employer, employee, or any party involved.

This case report was developed by the Kentucky Fatality Assessment and Control Evaluation (FACE) program. Kentucky FACE is a NIOSH-funded occupational fatality surveillance program with the goal of preventing fatal work injuries by studying the worker, the work environment, and the role of management, engineering, and behavioral changes in preventing future injuries. The FACE program is located in the Kentucky Injury Prevention and Research Center (KIPRC). KIPRC is a bona fide agent for the Kentucky Department for Public Health.

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INTRODUCTION

At 7:50 a.m. on September 29, 2022, a 46-year-old equipment operator was killed when he was struck by his skid-steer's twin-fork attachment with a gravel bucket secured to it. The operator was using the skid-steer to fill the pipes of a geothermal water system with gravel. The operator had raised the skid-steer's arms and then exited the cab with the machine still running. While the operator was beneath the attachment, it separated from the skid-steer's lift arms and fell onto him. He was crushed against the cab and died of his injuries.

EMPLOYER

The employer was a geothermal systems installation contractor that had been in business for approximately 18 years. The employer had a total of 19 employees, with three working at the scene at the time of the incident.

WRITTEN SAFETY PROGRAMS AND TRAINING

Upper management declined participation in this investigation, so information regarding written safety programs and training was limited to details provided by foremen and employees. Interviewees indicated that skid-steer operators were informed that the operator's manual for the skid-steer was located behind the operator's chair in the cabs of all skid-steers on site. Interviewees also indicated that newly hired employees were assessed for competency of skid-steer operation by a process in which they were briefly observed operating the equipment by a foreman before being authorized to operate it independently. No written or formal training or safety program was reported.

WORKER INFORMATION

The 46-year-old skid-steer operator who was killed was not wearing any type of personal protective equipment (PPE) at the time of the incident. Likewise, worksite observations indicated that other employees were not using PPE and use was not required at the site. Several employees did wear brightly colored shirts and jackets (i.e., yellow and orange), but these items would not meet the specifications for high visibility apparel required by recent editions of ANSI/ISEA 107 American National Standard for High Visibility Safety Apparel and Accessories [ANSI/ISEA 107, 2023].

The skid-steer operator had worked for the geothermal systems installation contractor for a short time several years prior, then left to work for a different company and returned to the geothermal contractor approximately two years before the incident. It is unknown if the skid-steer operator received training upon his return to the company.

EQUIPMENT

A geothermal system was being installed in a field adjacent to a larger construction project. The process involved drilling holes into the ground vertically, installing a pipe into each hole, and installing a water line into each open pipe. Pipes were then filled with gravel from a gravel bucket carried by a skid-steer. The work area, with several pipes filled with gravel, are shown in Photo 1.

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Photo 1. Geothermal system pipes (Property of KY FACE)

The gravel bucket involved in the incident was secured to a twin-fork attachment of the skid-steer through fork slots and chain was used to provide additional stability. Gravel buckets similar to those involved in the incident are shown in Photo 2, and a gravel bucket secured to a twin-forks attachment in a configuration similar to the one involved in the incident is shown in Photo 3. The combined weight of the attachment, bucket, and gravel involved in this incident are estimated to be 2,000 pounds [EPA, 2016].


Photo 2. Gravel buckets (Property of KY FACE)


Photo 3. Twin-forks attachment with gravel bucket (Property of KY FACE)

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INCIDENT SCENE

The scene was an outdoor area on level grade, estimated at 150 yards long by 75 yards wide. At the time of the incident a geothermal system was being installed. Processes underway included the drilling of vertical holes, insertion of vertical piping into the drill holes, installation of water lines into the vertical pipes, and filling of the pipes with gravel. The scene on November 1, 2020, is shown in Photo 4.

Photo 4. Incident Scene (Property of KY FACE)

WEATHER

The weather at the time of the incident was approximately 45 degrees Fahrenheit, with a 3 mph north northeasterly wind speed and 3 mph wind gusts [Weather Underground 2022]. There was a substantial amount of mud and standing water present, and the stability of the ground under the skid steer is unknown. These conditions are not considered to have played a significant part in the incident.

INVESTIGATION

Work was conducted over two 12-hour shifts (i.e., day/night). The incident occurred toward the end of the night shift, at 7:50 a.m. Visibility is not considered to have been a factor in the incident, as interviews indicated that there were adequate levels of light by virtue of temporary area lighting units and natural daylight. The coroner's report included a drug screen that indicated the presence of amphetamines, methamphetamine, alprazolam, and fentanyl.

Three employees were on site at the time of the incident. The decedent was operating a skid-steer, using it to fill vertical pipes of the geothermal system with gravel. The pipe-filling process required the coupling of the twin-forks attachment to the skid-steer lift arms, followed by the navigation of the skid-steer to insert the twin-forks into the fork slots of the gravel bucket. Chains were then used to secure the bucket to the twin-forks attachment. Next, the bucket was filled with gravel for filling vertical pipes. The pipe filling was accomplished by navigating the skid-steer into a position where the lift arms and bucket could be lowered close enough to the pipe opening to allow the gravel to be poured into the pipe opening. The skid-steer operator could perform most of these work processes from inside the cab. The coupling of the twin-forks attachment, for example, was performed from inside the cab using an operator's switch that allowed automatic coupling. However, the operator would have to lower the lift arms and exit the cab to secure the chains. The operator would then have to re-enter the cab to drive the skid-steer with bucket attachment to an area where the bucket would be filled with gravel.

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Filling was likely accomplished using a backhoe bucket to scoop gravel from a pile and drop it into the top of the gravel bucket. That process would have required the operator to again lower the lift-arm and bucket and exit the skid-steer cab to operate the backhoe. Once the bucket was filled with gravel, the skid-steer operator would have to re-enter the cab, raise the lift-arm, and navigate the skid-steer to the vertical pipes. The pipe filling would proceed until all pipes were filled or the gravel bucket was empty and had to be refilled.

Two other employees were operating drilling equipment located on the far side of the work area from the skid-steer operator's activities. The drill operators did not witness the incident, but at some point one of them noticed that the skid-steer operator had exited the skid-steer and had become pinned against the cab. The twin-forks attachment had detached from the lift arms of the skid-steer, and the twin-forks attachment and gravel bucket had fallen onto the skid-steer operator. The skid-steer, detached twin-forks attachment, and bucket are shown in Photo 5.

Photo 5. Skid-steer with twin-fork attachment and bucket (Courtesy of coroner).

The operator was struck by the twin-forks attachment and bucket because he was located in the *crushing zone* when the twin-forks attachment separated from the lift arms. The crushing zone is illustrated in red in Diagram A.

Diagram A. Crushing Zone (KYSAFE [n.d.]. Hazard Alert: Skid-Steer Loader video).

When the drill operators became aware of the incident, they walked over to help the skid-steer operator but could not remove the twin-forks attachment and bucket by hand. At the same time, a foreman from the day shift had arrived at the site and the drill operators walked over to tell him of the incident. The foreman directed one of the drill operators to call 9-1-1 for help. The three employees then worked to free the skid-steer operator, using a second skid-steer to lift the twin-forks attachment and gravel bucket off of him.

The skid-steer was designed to accept a variety of attachments. The twin-forks attachment involved in the incident secured to the skid-steer using a *quick hitch* built into the skid-steer's lift arms that inserted into slots on the twin-forks attachment. Once the quick hitch was inserted, two locking pins on the quick hitch were engaged to fully secure the attachment to the lift arms. A scoop attachment, which is attached to the lift arms in a similar fashion as the twin-fork attachment involved in the incident, is shown in Photo 6. The locking pins are detailed in Photos 7 and 8.

Photo 6. Skid-steer with scoop attachment (Courtesy of KY FACE).

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Photo 7. Skid-steer locking pin (Courtesy of KY FACE).

Photo 8. Detail of locking pin (Courtesy of KY FACE).

Employee interviews indicated that an equipment malfunction had likely occurred such that one or both of the two locking pins that secured the forks onto the arms of the skid-steer were not properly in place. Interviewees speculated that the presence of mud, rock, and other debris may have prevented the pin(s) from being securely locked into place. A visual inspection of the equipment, after coupling the attachment to the lift-arm, is necessary to ensure that the pins are properly secured in place.

It is not known why the skid-steer operator exited the cab with the lift arms in the raised position. The skid-steer operator did not engage the skid-steer's lift arm stopper brace, indicated in Photo 9. The lift arm stopper is a safety device provided as original equipment by the skid-steer manufacturer. The stopper serves to safely brace the lift arm, should it be necessary to leave it in a raised position. The stopper brace did not play a direct role in the incident.

When the skid-steer operator was found pinned against the cab, the safety bar was in the lowered position and the engine was running. The safety bar is a feature found on the type of skid-steer involved in the incident that serves to disengage power to the machine's engine and controls whenever the safety bar is raised. When an operator enters the cab and sits in the operator's chair, they must first lower the safety bar to start the engine and proceed with operation. Conditions noted by the coroner indicate that after exiting the cab, the skid-steer operator lowered the safety bar and started the skid-steer's engine, bypassing the safety feature. It is not known why the safety bar was lowered.

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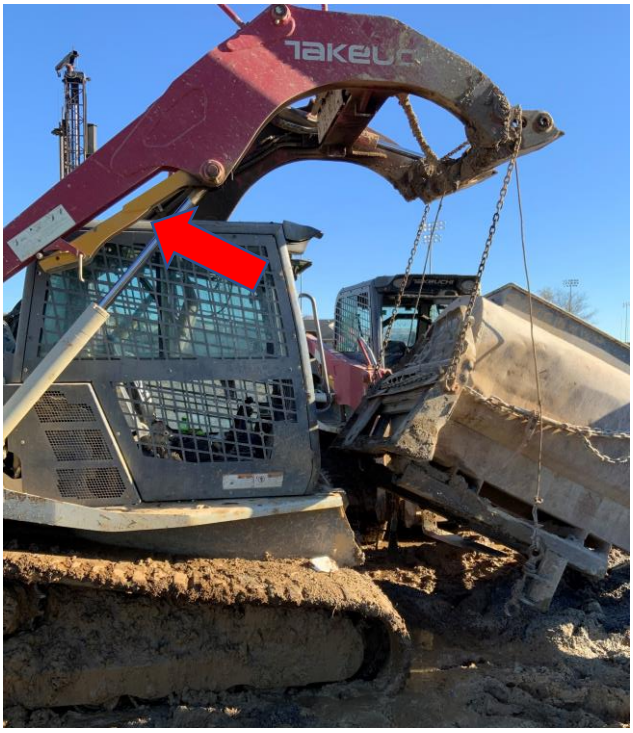

Photo 9: Lift arm stopper brace (Courtesy of coroner)

CAUSE OF DEATH

According to the coroner's report, the cause of death was multiple blunt force/crush injuries.

CONTRIBUTING FACTORS

Occupational injuries and fatalities are often the result of one or more contributing factors or key events in a larger sequence of events that ultimately result in the injury or fatality. Kentucky FACE has identified the following unrecognized hazards as key contributing factors in this incident:

- *Bypassing equipment safety features*
- *Workplace substance use*
- *Inadequate knowledge of hazards*
- *Inadequate training and communication*

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should ensure that employees do not bypass equipment safety features.

Discussion: Employers should ensure that their employees utilize equipment safety features rather than bypass them. The *seat bar*, also referred to as *safety bar*, is an essential safety device for skid-steers that should be used in accordance with the manufacturer's instructions. The operator's manual for the skid-steer directed that the operator should raise the safety bar before standing up from the operator's seat and lower the lift arms to the ground before exiting the cab. If the lift arms were needed to be left in the raised position, then the lift arm stopper was to be engaged.

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OSHA [2009] has issued guidance that specifically focuses on the hazards presented by bypassing skid-steer safety devices, providing several case studies in which the safety bar was bypassed and serious or fatal injuries resulted. In this incident, the protective quality of the safety bar was negated because the device was not utilized. Regarding the lift arms, the National Institute for Occupational Safety and Health (NIOSH) [2011] recommends: "Use the lift-arm support device provided by or recommended by the manufacturer any time it is necessary to work or move around the machine with the lift arm in a raised position."

Recommendation #2: Employers should ensure that employees follow equipment manufacturer's instructions.
Discussion: Employers should ensure that employees follow the instructions provided by the equipment manufacturer for the specific type of equipment that they operate. The operator's manual for the skid-steer involved in this incident provided explicit directions and safe operating procedures, such as provisions that any operation of any lever, pedal, or switch should only be performed when the operator is sitting in the seat. It was the employer's practice to keep the operator's manual in a designated storage slot behind the seat in the cab. Also, generic guidance on safe skid-steer operation is available to reinforce and supplement manufacturer's guidance. For example, guidance published by the Association of Equipment Manufacturers (AEM) requires that the operator should "never leave the operator's seat without lowering the bucket or other attachment flat on the ground" [AEM, 2009].

Recommendation #3: Employers should implement measures that contribute to a drug-free work environment, including the development and implementation of an alcohol- and drug-free workplace program, particularly for jobs related to machine operation.
Discussion: A post-mortem blood test from the skid-steer operator reported the presence of amphetamines, benzodiazepines, and opioid analgesics. Interviewees did not indicate that they had noticed that the skid-steer operator exhibited any signs of intoxication. Employers should consider designing and implementing an appropriate alcohol- and drug-free workplace program that matches the needs of their organization. Such programs are often unique to the individual company and include measures that are feasible, applicable, and beneficial to that workforce.

Employers may find it useful to research how similar businesses and industries in their local area have addressed this issue. Drug testing is only one component of a comprehensive drug-free workplace program and may or may not be appropriate according to applicable federal and state laws and regulations. Other components that are important to consider in a comprehensive program include a clear drug-free workplace policy that specifies prohibited behaviors and consequences, supervisor training, an Employee Assistance Program, and employee education.

Recommendation #4: Employers should effectively identify and understand the hazards that may be presented by the equipment their employees operate and are exposed to.
Research by NIOSH [2011] suggests that that many employers and workers likely do not understand the hazards associated with operating skid-steers. In order to adequately address, identify, and understand workplace hazards, OSHA [2016] recommends that employers first collect information about job site hazards from sources such as equipment operating manuals, input from employees, and job hazard analyses; second, employers should "conduct frequent and regular inspections of the job site to identify new or recurring hazards." It is best if such hazard identification and assessment measures are incorporated with the other key elements of a safety and health program e.g., management leadership, employee participation, hazard prevention and control, education and training, and program evaluation and improvement).

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Recommendation #5: Employers should provide education and training to employees to recognize actual or potential hazards and methods to mitigate or eliminate hazards.

Discussion: Specific details regarding worksite hazards and control measures should be effectively communicated to employees through education and training. OSHA [2009] recommends that employers "train personnel on the proper inspection, use, maintenance, and repair of skid-steer loaders according to the manufacturer's instructions. Train supervisory personnel to identify hazards, such as safety systems that have been bypassed, disabled, or that require maintenance." Education and training programs should include a means by which a minimum level of proficiency of trained employees can be assured. OSHA [2015] guidance notes that workplace safety training should include an evaluation to ensure that workers received the level of knowledge and skill needed. Assessment of student learning "can be accomplished through activities such as demonstration skills or testing." When equipment safety features are utilized, employers should provide clear and explicit information regarding how such equipment provides protection to employees from hazards including the possible consequences of bypassing safety features.

DISCLAIMER

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INVESTIGATOR INFORMATION

This investigation conducted and report prepared by Dr. David Stumbo, OHST, CSP.

ACKNOWLEDGMENT

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