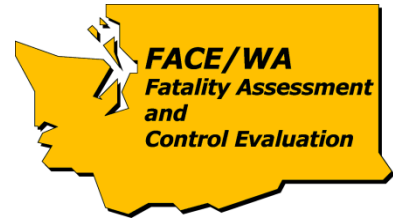


Operator Dies after Being Caught between Bulldozer's Track and Fender



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SUMMARY

In February of 2010, a 68-year-old male construction crew supervisor and heavy equipment operator died of injuries he received after being crushed between the track and fender of his bulldozer. The operator was employed by a contractor that does site development, single family home construction, and commercial construction work. He had previously owned a construction contracting business and had 48 years of experience operating bulldozers and other heavy construction equipment.

On the day of the fatal incident, the operator was supervising a crew. The crew was working at a job site zoned for commercial development, where structural fill was being brought in and dumped and then leveled and compacted. As dump trucks hauled fill onto the site, the operator was using a Caterpillar D4H Series II bulldozer to level the fill and was also directing the drivers as to where they should deposit their loads.

At 7:40 AM, the operator exited the bulldozer on its right side to speak with a truck driver about where the driver should deposit his load of fill. When he did this, he left the bulldozer running and did not set the parking brake. After giving instructions to the truck driver, he walked to the bulldozer's left side and then walked up its track to return to the operator's seat. As he was standing on top of the track his elbow hit the transmission lever shifting the dozer out of neutral into reverse. When the bulldozer began moving backward, his left foot became caught between the moving track and the underside of the fender. As the bulldozer continued moving backward his left leg was pulled in and crushed. The operator was carried several yards before being ejected onto the ground.

The truck driver with whom the operator had just spoken used his radio to call emergency medical services and then went to aid the operator. Emergency responders arrived within three minutes and the victim was taken to a hospital where he died of his injuries 15 days later.

RECOMMENDATIONS

To prevent similar occurrences in the future, the Washington State Fatality Assessment and Control Evaluation (FACE) investigation team recommends that bulldozer operators and employers who use bulldozers should follow these guidelines:

- **Before leaving a bulldozer unattended, operators should follow manufacturer recommended operating procedures to ensure that the equipment is secured from movement.**
- **Employers should develop, implement, and enforce a written safety program that includes, but is not limited to, procedures for operators entering, exiting, and securing bulldozers against unintended movement.**

- **Employers should consider buying mobile construction equipment installed with an interlock safety system or operator presence sensing system which will prevent inadvertent movement of equipment.**

Additionally:

- **Bulldozer manufacturers should consider design features of bulldozers so as to minimize or prevent injuries and fatalities of operators.**

INTRODUCTION

In February of 2010, the Washington State FACE Program was notified by the Division of Occupational Safety and Health (DOSH) of the death of a 68-year-old male construction site supervisor and heavy equipment operator who died from injuries he received when his leg was caught between the moving track and fender of a bulldozer he was operating.

In November of 2011, Washington State FACE investigators traveled to the employer's office to interview the business manager and the development manager, who is also in charge of managing company safety. During the course of the investigation documents reviewed included the operator's death certificate, and DOSH investigation file.

Employer

The employer is a construction contractor that does single family home construction, commercial construction, and site development. The business was started in 2001 and its office is located in the incident city in Washington State. At the time of the incident the employer had 15 employees working either full-time or part-time, with some working in the office and others in the field. There were four employees at the incident site who were working full-time for the length of the project. The number of employees and the hours they worked varied depending on the number and nature of the projects. The crew had been working at the incident site operating heavy equipment to level and compact fill for a week and a half prior to the incident.

Employer Safety Program and Training

The employer had a written health and safety program; however, there was no specific language about safe equipment operation. The employer trained employees in the safe operation of a particular piece of heavy equipment that they had not used before. The employer hired experienced equipment operators who had to demonstrate to the employer their knowledge of how to safely operate heavy equipment. All of their equipment operators were long term employees and were considered safe and

competent operators. Occasionally the employer would hire an outside safety consultant to ensure that their employees were operating safely.

The employer has a safety officer who, depending on the number of jobs the employer has, oversees employee safety for 3 to 4 hours or more per week. Safety meetings are held once a week by the safety officer. Typical topics at these meetings include discussions of specific safety relating to their planned activities, potential safety hazards, and the planned work and what everyone will be doing. On the day of the incident there was no safety meeting, as they had held one two days previously. The safety officer was not present at the time of the incident.

Victim

The victim (hereafter referred to as the “operator”) was a 68-year-old male construction site supervisor and heavy equipment operator. He had operated a bulldozer and other heavy construction equipment for the past 48 years. Previously, he had owned his own construction contracting business. For the past ten years, he had been working with this employer both full- and part-time. A self-taught heavy equipment operator, he could run every piece of equipment the employer owned. His employer and coworkers knew him to be an experienced and capable equipment operator who always stressed the importance of working safely.

As a job site supervisor he directed the work being done at the job site. He often combined operating a piece of heavy construction equipment with supervision of employees and other trades workers entering the job site to perform work, such as truck drivers delivering fill to the job site.

Equipment

The equipment involved in the incident is a 1991 Caterpillar D4H Series II track-type tractor, also known as a bulldozer. The employer purchased the bulldozer used about eight years previous and made no modifications to it. The bulldozer is powered by 4-cylinder turbocharged diesel engine rated at 95 hp at 2,200 rpm (see photo #1).



Photo 1: Caterpillar D4H bulldozer at incident site.

The transmission is engaged by a planetary power shift with three gears forward and three gears in reverse (see photo #2). It is a type of bulldozer known as a “high track.” The high track type of bulldozer has a high sprocket configuration for the track and the cab is higher from the ground than other bulldozers of comparable size.

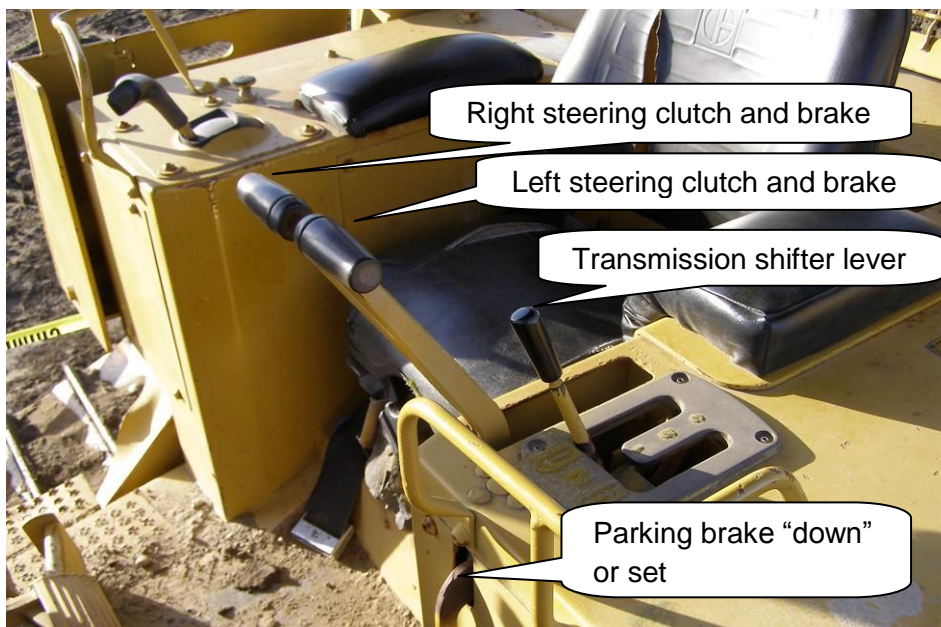


Photo 2: Cab and operator controls. Note: the parking brake is in the “down” position, which locks the transmission in neutral, thereby preventing movement of the equipment.

The manufacturer's operation and maintenance manual was kept in a compartment on the back of the operator's seat. The bulldozer was well maintained and in good operating condition. Employees who did not like having to climb up and down the high tracks to get into and out of the operator's cab did not use the machine often.

INVESTIGATION

In February of 2010, a construction crew supervisor and heavy equipment operator died of injuries he received while attempting to re-enter the cab of a bulldozer he had been operating at a job site. His employer was acting as the general contractor at a job site where they had been contracted to place about 40,000 yards of structural fill on a five acre site and then level and compact it. The site was zoned for commercial development of an unknown nature. The operator was overseeing a crew of three employees. In addition, he was directing truck drivers where to dump their loads of fill.

The operator and three other employees arrived shortly before 7AM on a sunny, cool morning to drink their coffee and talk about what they would be doing that day. They did not start the day with a safety meeting, as they had held one two days before. The members of the crew began their job duties at the site at 7AM. Employees of a contractor hired by the general contractor to bring in fill started to arrive with their loaded dump trucks. One employee was spotting the arriving dump trucks that would then line up and wait to back up and dump their loads. Another employee was operating a bulldozer to spread and level the fill. A third employee was operating a roller compactor to compress the soil. The fourth employee, the operator, was operating a D4H Caterpillar bulldozer to spread fill and, as the site supervisor, was also directing the newly arriving truck drivers to another part of the job site where they were to dump their loads of fill.

At approximately 7:40 AM, a dump truck carrying the second load of fill that morning drove onto the site. The operator needed to tell the driver where to go on site to dump his load of fill, so he drove the bulldozer toward the truck. The dump truck stopped and the operator drove the bulldozer alongside the cab of the truck. The bulldozer and the truck were now facing in opposite directions. The operator stopped the bulldozer on flat ground, did not set the parking brake, did not lower the blade to the ground, and left the machine running.

On this type of bulldozer, if the parking brake lever (also known as the safety lever) is set, then the transmission shifter lever is locked in neutral, preventing the equipment from movement. If the parking brake is not set, then the equipment is able to move when in gear. The parking brake is engaged by a lever to the left of the operator's seat. If the brake lever is in the engaged position, the lever is in the "down" position, which

allows the operator to safely exit the cab on the left side (see photo #2). If the brake is not set, the lever is in the “up” or horizontal position, which obstructs the operator from easily exiting (without having to step over the lever) from the left side of the cab (see photo #3).

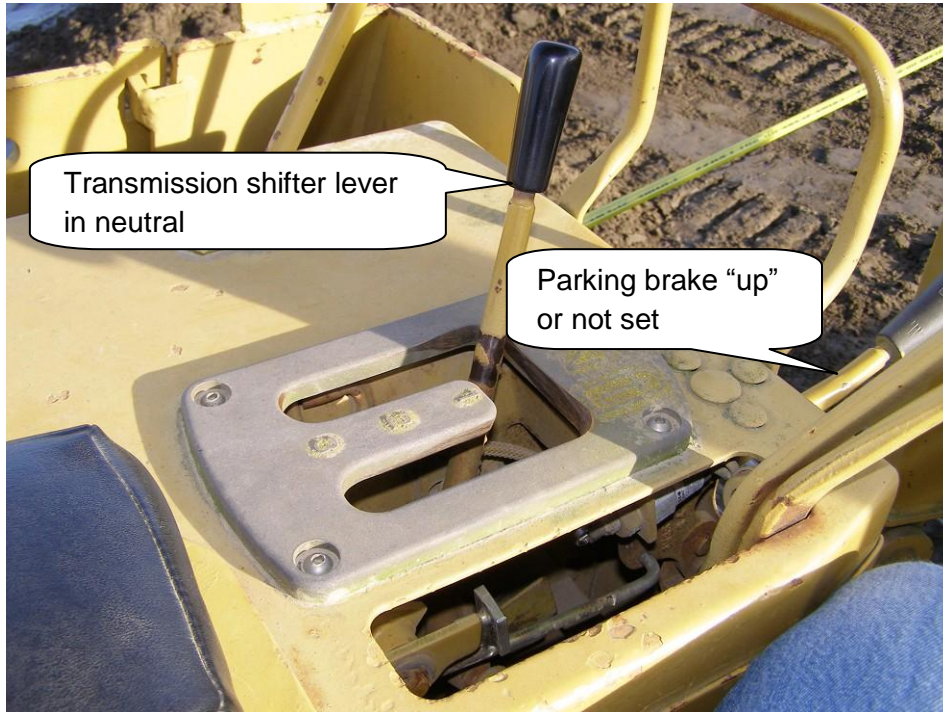


Photo 3: The parking brake is in the “up” or not set position and the transmission is in neutral and unlocked, as viewed from the operator’s seat. The transmission lever may now be shifted into “forward” or “reverse”, allowing for movement of the bulldozer.

According to the employer, the safe method of entering and exiting the cab in this bulldozer is by the left side, as it reminds the operator to engage the parking brake in the “down” or set position. This model bulldozer has steps and handholds on both sides of the equipment, allowing cab ingress and egress from either side.

The operator exited the right side of the cab and walked a few feet over to the driver’s window of the truck to speak with the driver. After giving instructions to the driver as to where to dump the fill, the operator walked to the left side of the bulldozer and walked up its left track, starting at the front of the track. There are several handholds positioned on the bulldozer to aid in climbing up and down from the operator’s cab. As he was standing on the top of the track and about to enter the cab, he reached with his left hand toward the support handhold near the transmission shifter lever and his elbow hit the transmission shifter lever, knocking it out of neutral into reverse, causing the bulldozer to start moving backward. When the track started to move his left foot became caught between the track and the underside of the fender (behind which is the battery box). His

left leg was pulled in and crushed between the track and the underside of the fender and he was thrown on his back, landing on the track (see photos #4 and #5). He was carried away by the dozer and was ejected from the equipment and landed on the ground about 5 to 6 feet in front of the truck.

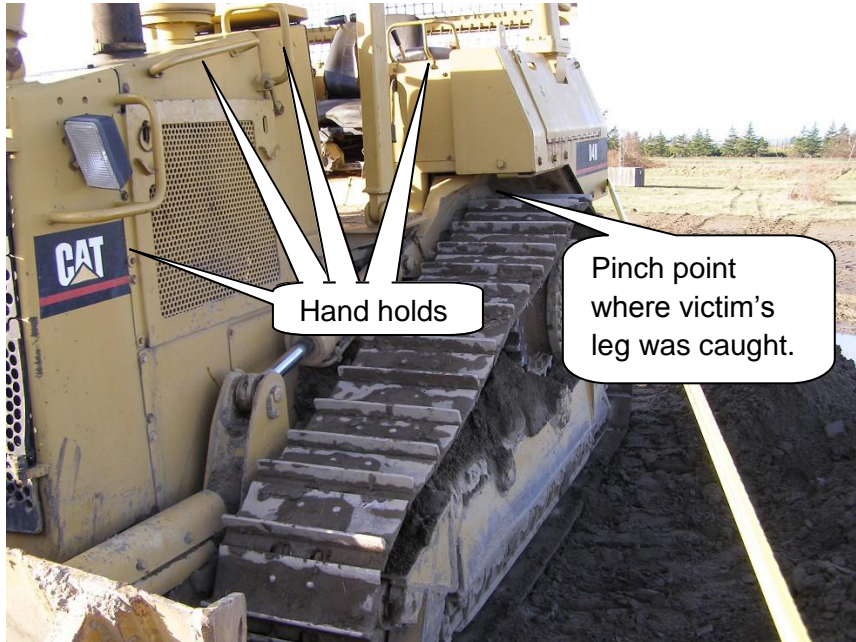


Photo 4: Left side of bulldozer showing track, access system handholds, and pinch point between track and fender where the victim's left leg was caught and crushed.



Photo 5: Left side of bulldozer where the victim's left leg was caught between the track and fender. Note that the parking brake lever is in the "down" position, which locks the transmission shifter lever in the neutral position, thus preventing unintended movement of the bulldozer. In this incident, the parking brake lever was in the "up" or horizontal position and the bulldozer's engine was running, so that when the victim attempted to re-enter the cab he inadvertently knocked the transmission shifter lever into reverse, causing the bulldozer to move.

The truck driver with whom the operator had just spoken made a call from his truck radio to a second driver who was on site to call emergency medical services (EMS) and then he went to aid the operator. Another truck driver went to stop the bulldozer that had continued to travel in reverse (see photo #6). The employer's safety officer, who also works as an emergency medical technician at the local fire department and was on duty, heard the call over his radio and arrived at the scene within three minutes, just ahead of the fire department EMS responders. The operator was taken by ambulance to a hospital where he died of his injuries 15 days later.



Photo 6: Incident scene showing where the bulldozer came to rest after an employee turned it off.

CAUSE OF DEATH

The medical examiner listed the cause of death as multiple lacerations and long bone fractures, traumatic amputation of the left leg, and pelvic fracture with secondary bacterial sepsis due to or as a consequence of blunt force injury of the extremities and pelvis.

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. Washington FACE investigators identified the following factors that may have contributed to the worker being crushed between the moving tread of a bulldozer and the equipment's fender:

- Failure to set the parking brake before exiting the cab.
- Failure to shut down the machinery.

RECOMMENDATIONS AND DISCUSSION

Recommendation #1: Before leaving a bulldozer unattended, operators should follow manufacturer recommended procedures to ensure that the equipment is secured from movement.

Discussion: After the incident, the operator was conscious and told the employer's safety manager that he forgot to set the bulldozer's parking brake. Setting the parking brake locks the equipment in neutral which prevents it from moving. The employer's safety manager reported that the victim liked to work quickly and believes that his haste played a role in his not following the proper procedures when leaving the equipment unattended. Though the operator had 48 years experience operating a bulldozer and was very aware of the procedures used to safely operate a bulldozer, in this instance he did not follow those procedures.

Ensuring that the equipment manufacturer's guidelines for parking a bulldozer are followed is critical in order to prevent unwanted movement of the equipment while the operator is outside the cab or entering and exiting the cab.

The operator's manual for the Caterpillar D4H bulldozer recommends the following steps when parking the machine:¹

1. Park on a level surface. If it is necessary to park on a grade, block the tracks securely.
2. Apply the service brake to stop the machine.
3. Move the transmission control lever to neutral and the speed control to low idle.
4. Engage the parking brake control.
5. Lower all attachments to the ground.
6. Stop the engine.
7. Turn the engine start switch key to off and remove.
8. Turn the battery disconnect switch key to off and remove.

On this bulldozer when the parking brake control lever is in the “down” position the parking brake is set and the machine will not move (See photo 2). Unfortunately, in this incident, the operator left the parking brake lever in the “up” position when he left the cab, and when he attempted to return to the cab he inadvertently moved the transmission shifter lever from neutral to reverse, causing the machine to move (See photos 3).

Washington State occupational safety and health standards for construction work require that when parked, a bulldozer must have the parking brake set and its blade on the ground.²

Recommendation #2: Employers should develop, implement, and enforce a written safety program that includes, but is not limited to, procedures for operators entering, exiting, and securing bulldozers against unintended movement.

Discussion: The employer hired experienced equipment operators and provided training to them on the safe operation of a piece of equipment as was necessary. The employer observed the new employees operating equipment to make sure that they were operating the equipment properly. The employer’s written safety program did not address safe equipment operation procedures, but instead depended on the professional knowledge and experience of their employees to operate equipment safely. Despite the employees’ knowledge of proper procedures, the employer’s safety manager noted that operators will get on and off their equipment many times per day, often just for a few seconds, and that it was not uncommon for them to not set the parking brake every time.

After the incident, employer equipment operators now follow the parking guidelines provided by the manufacturer.

Employers should have a written safety program that incorporates the employer’s safety expectations and procedures for employees operating bulldozers and other heavy mobile equipment.³ This safety program should specifically address procedures for operators securing bulldozers from unintended movement when entering and exiting the operator’s cab. Initial safety training and periodic refresher training should reinforce the need for safe work practices. The employer should enforce employee compliance with these procedures.

Recommendation #3: Employers should consider buying mobile construction equipment installed with an interlock safety system or operator presence sensing system which will prevent inadvertent movement of equipment.

Discussion: Interlock safety systems or devices prevent unintentional movement of a machine's controls or the machine itself when the operator is not in a position to safely operate the machine. An operator presence sensing system that keeps the parking brake engaged would have prevented this fatal incident. For example, a newer model of a Caterpillar track-type tractor or bulldozer has an operator presence detection feature that, according to the manufacturer, "locks out the powertrain and hydraulics to avoid unintentional movement when the operator is mounting and dismounting from the machine."⁴

Recommendation #4: Bulldozer manufacturers should consider design features of bulldozers so as to minimize or prevent injuries and fatalities of operators.

Discussion: Older makes and models of bulldozers have fewer safety features than more recently manufactured ones. For example, some older types of bulldozers, such as the Caterpillar D4H, which was manufactured from 1986 to 1997, were designed to allow the operator to enter and exit from either the left or right side of the operator's cab. Due to the configuration of the operator controls in the cab, this could present a safety issue by allowing the operator to more easily leave the cab with the engine running and the parking brake not set, as happened in this incident. If there had been just one way to exit and enter the cab, that is to the left of the operator's seat, the victim would have had to step over the brake lever which was in the "up" or horizontal position; it would have served as a reminder to him that the parking brake was not set.

After the incident, the employer fitted a metal barrier to the right side of the cab so as to restrict the operator from exiting on that side (see photos #7). This design modification to the cab does not necessary solve the problem of an operator leaving the cab without following proper safety procedures for parking the bulldozer. However, at best, it potentially channels the operator to exit to the left and hopefully set the parking brake.



Photo 7: Post incident the employer added this barrier to the right side of the bulldozer cab so as to restrict the operator from exiting on this side. Photo shows the parking brake in the “down” position which locks the transmission in neutral, preventing the machine from moving. The operator can now properly exit by the left side of the cab. If the parking brake is not set the lever is in the “up” or horizontal position which restricts the operator’s path of exit from the left side of the cab, thereby serving as a reminder to set the parking brake.

Manufacturers of mobile construction equipment, tractors, forklifts, and riding mowers have begun to install operator presence sensing systems that will stop the equipment from operating or shut off the power and apply the brake system when the operator has left the operator’s seat (as mentioned in recommendation #3). These systems are not presently in widespread use on all makes and models of bulldozers. The feasibility of designing and implementing these systems on bulldozers and other mobile construction equipment should be explored by equipment manufacturers. Equipment manufacturers should also investigate other design safety improvements so as to ensure against the unintended movement of a bulldozer when the operator leaves the equipment unattended.

REFERENCES

1. Caterpillar, Operation & Maintenance Manual, D4H Series II Track-Type Tractor <http://safety.cat.com/Home>
2. Washington Administrative Code. Safety Standards for Construction Work, Part M Motor Vehicles, Mechanized Equipment, and Marine Operations, Chapter 296-155-605 and 296-155-615. <http://apps.leg.wa.gov/WAC/default.aspx?cite=296-155&full=true#296-155-605>
3. Washington State Department of Labor and Industries, Accident Prevention Program. <http://www.lni.wa.gov/Safety/Basics/Programs/Accident/default.htm>
4. Caterpillar D9T Track-Type Tractor. <http://www.cat.com/cda/layout?m=464458&x=7>

Investigator Information

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Washington State FACE Program Information

The Washington State Fatality Assessment and Control (WA FACE) program is one of many workplace health and safety programs administered by the Washington State Department of Labor & Industries' Safety & Health & Research for Prevention (SHARP) program. It is a research program designed to identify and study fatal occupational injuries. Under a cooperative agreement with the National Institute for Occupational Safety and Health (NIOSH), WA FACE collects information on occupational fatalities in WA State and targets specific types of fatalities for evaluation. WA FACE investigators evaluate information from multiple sources. Findings are summarized in narrative reports that include recommendations for preventing similar events in the future. These recommendations are distributed to employers, workers, and other organizations interested in promoting workplace safety. NIOSH-funded, state-based FACE programs include: California, Iowa, Kentucky, Massachusetts, Michigan, New Jersey, New York, Oregon, and Washington. WA FACE does not determine fault or legal liability associated with a fatal incident. Names of employers, victims and/or witnesses are not included in written investigative reports or other databases to protect the confidentiality of those who voluntarily participate in the program.

Additional information regarding the WA FACE program can be obtained from:

Washington State FACE Program

www.lni.wa.gov/Safety/Research/FACE/default.asp

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