

**PUBLIC HEALTH SERVICE/CDC/NIOSH/DSR
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TO: Director, National Institute for Occupational Safety and Health

FROM: Division of Safety Research, NIOSH

**SUBJECT: Bulldozer Operator Crushed by Bulldozer During Construction of Oil
Exploration Island - Alaska**

SUMMARY

A 49-year-old male bulldozer operator (the victim) was crushed to death while compacting earthen fill with a bulldozer during the construction of an oil exploration island. The victim was operating the bulldozer on level ground, alternately in forward and reverse at half throttle. With the blade completely down, the victim presumably shifted the transmission control lever to or toward neutral. The transmission may have been partially disengaged, but not fully in neutral. Assuming the bulldozer transmission to be in a stable neutral position (and without shifting the transmission control safety lever into the neutral lock position), the victim exited the cab on the right side, and stepped down onto the track of the bulldozer to give directions to a truck driver. Investigative information suggests that at this moment the transmission may have slipped back into the first gear of reverse, causing the bulldozer to move suddenly in reverse. As a result, the victim was pulled between the underside of the fender and the top of the track cleats. As the bulldozer continued in reverse, the victim was fatally crushed beneath the track cleats. NIOSH investigators concluded that, in order to prevent future similar occurrences, employers should:

- *ensure that mobile equipment is not left unattended unless all precautions necessary to prevent motion have been taken*
- *ensure that compliance with safe work procedures are enforced through frequent inspections and observation of employee work habits*
- *ensure that employees receive regular training that addresses safe work procedures*
- *consider installing two-way radios inside the cabs of trucks and heavy equipment so that operators can communicate without leaving their cabs.*

Additionally, equipment manufacturers should:

- *consider equipment engineering designs and controls to prevent machine-related injuries*
- *develop and affix appropriate safety signs inside the cabs of bulldozers and other heavy equipment, listing necessary precautions.*

INTRODUCTION

On February 1, 1992, a 49-year-old male heavy equipment operator (the victim) was fatally crushed by the bulldozer he was operating. On February 3, 1992, officials of the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) notified the National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research, Alaska Activity, of the death. On the same day, a safety specialist from the Alaska Activity traveled to the incident site with the OSHA compliance officer and conducted an investigation. The incident was reviewed with the OSHA compliance officer, police, and coroner, and their reports were obtained. The subcontracting company owner (the employer), the safety manager, coworkers, and representatives for the general contractor were interviewed. Photographs and diagrams of the incident site were also obtained during the on-site investigation.

The employer in this incident was a construction company that had been in business for 4 years. The company had 60 employees, including 26 heavy equipment operators. Most of the company's construction projects involved constructing access roads and islands for companies engaged in oil exploration. To complete a single island project, heavy equipment was operated continuously with two operators working alternate shifts on each piece of equipment. Operators typically worked 10 to 12 hours a day, 7 days a week, for periods ranging between 2 to 4 months. The company had a safety policy, a safety program, and written basic safe work procedures at the time of the incident. The company employed a full-time safety manager, and safety meetings were conducted weekly to discuss various safety issues pertaining to the current construction project. A safety planning meeting was normally conducted prior to the start of each construction project.

INVESTIGATION

The company had been subcontracted by an oil company to construct an oil exploration island in the Beaufort Sea, 2 1/4 miles from shore. Several types of heavy equipment were used during the construction project. After constructing a road of ice to the designated location of the island, an ice-cutting ditcher was used to cut 5-cubic-foot blocks of ice. A track-type backhoe removed the ice blocks and a front-end loader carried them from the construction site. Haulage trucks then dumped gravel fill near this area and a bulldozer pushed the fill into the sea water void (a total depth of about 8 feet) created where the ice blocks had been removed. The company had previously built 11 islands of this type using this same construction technique. All of the islands had a finished surface, 8 feet above sea level, with approximate dimensions of 325 by 300 feet.

On the first day of constructing this island (the day of the incident), the victim and the other heavy equipment operators for the second shift arrived at the construction site, and began working at 7:00 p.m. The temperature was between -41 and -50 degrees Fahrenheit. The site was illuminated by three light banks approximately 200 to 250 feet from the heavy equipment. Each bank contained four 1500-watt bulbs positioned 16 feet above the ground, and each piece of heavy equipment was equipped with front headlamps. After each load of gravel fill was dumped, the victim pushed and compacted the fill, operating the bulldozer alternately in the first gears of forward and reverse at half throttle [an approximate speed of 1 mile per hour (mph)].

Investigative information (interviews with eyewitnesses, coworkers, close examination of the bulldozer involved in this incident and other similar types, and information provided by bulldozer operator and mechanic instructors familiar with this type of bulldozer) suggests the following scenario (Figures 1-4):

With the blade completely down in the “float position,” the throttle at half, and the bulldozer on level ground, the victim attempted to shift the transmission control lever out of the first reverse gear into neutral. However, in doing so, he may have moved the lever to an unstable neutral position (at a point between the first reverse gear and the neutral position) where it remained only temporarily. Assuming that the bulldozer transmission was in a stable neutral position (and without pushing the transmission control safety lever down to the vertical, neutral lock positions), the victim exited the cab on the right side, and stepped down onto the track of the bulldozer. He then waved both hands above his head, presumably to attract a truck driver’s attention in order to give him directions on where to dump his next load of fill. (According to coworkers, this had been a regular practice of the victim, and he had been cautioned to stop this practice during a safety meeting several months before the incident.) At this moment the transmission may have slipped back into the first gear of reverse (since the transmission control safety lever was not engaged in the neutral lock position), causing the track on which the victim was standing to move suddenly backwards. Presumably, as a result, the victim’s feet were caught between the underside of the fender and the top of the track cleats, causing him to fall onto the track. As the bulldozer continued in reverse at approximately 1 mph, the victim was pulled between the underside of the fender and the top of the track cleats, then beneath the track itself, where he was fatally crushed.

[It should be noted that the backhoe operator (who was about 30 feet from the victim), and the truck driver (who was about 100 feet from the victim), observed the victim exit the bulldozer cab, wave while standing on the track, and fall when the bulldozer lunged suddenly in reverse. However, because of their respective positions inside the cabs of the backhoe and truck, neither one was able to see the victim after he fell onto the track of the bulldozer.]

Information obtained from a bulldozer operator instructor and a bulldozer mechanic instructor suggests that since the transmission control safety lever had not been engaged in the neutral lock position, the transmission control lever was not in a stable neutral position. Thus, any bulldozer left running in this unstable neutral position could slip back into gear.

The backhoe operator was able to stop the bulldozer (after it had traveled approximately 40 feet) by moving the backhoe into its path. The backhoe operator then ran to the bulldozer, climbed up into the cab, shifted the transmission control lever out of reverse and into neutral, and put the transmission control safety lever into neutral lock. Company officials notified state and local police of the incident, and a state trooper who arrived several hours later, pronounced the victim dead at the scene.

CAUSE OF DEATH

The medical examiner listed the cause of death as massive crushing and severing trauma to the head and body.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should ensure that mobile equipment is not left unattended unless all precautions necessary to prevent motion have been taken.

Discussion: The bulldozer involved in this incident, and other models, are equipped with a “transmission control safety lever” designed to lock the transmission into neutral, thereby guarding against unexpected and sudden motion, and ensuring that the transmission will stay in neutral. However, the victim did not engage this device before exiting the cab. The manufacturer’s Operator’s Guide recommends the following procedures prior to the operator dismounting the machine:

1. Stop the tractor on level ground and reduce engine speed.
2. Move the transmission control level to neutral.
3. Engage the transmission control safety lock.
4. Apply the brake pedals and engage brake lock.
5. Lower blade (or attached equipment) to ground level.

If these procedures had been followed, the fatal injury probably would have been prevented.

Recommendation #2: Employers should ensure that compliance with safe work procedures are enforced through frequent inspections and observation of employee work habits.

Discussion: According to statements by coworkers, the victim had been observed on several occasions dismounting from the bulldozer cab with the engine running, and without engaging the transmission control safety lock. (The position of the red transmission control lever is visible from outside the cab when either door is open.) This practice was a violation of written company safety procedures for operation of this type of equipment, and the victim had been cautioned about it during a safety meeting several months before the incident. Frequent inspections, both scheduled and unscheduled, coupled with observation of work habits by qualified management officials would help ensure that company safety procedures are being followed. Inspections also clearly demonstrate that the employer is committed to preventing occupational injury. Strong disciplinary action should be considered for employees who knowingly and habitually disregard written company safety policies.

Recommendation #3: Employers should ensure that employees receive regular training that addresses safe work procedures.

Discussion: The employer’s policy is to hire only fully experienced and qualified equipment operators. However, the victim, an experienced heavy equipment operator, failed to follow established safe work procedures before exiting the bulldozer cab. Even experienced employees

can benefit from periodic refresher training which reinforces the need to follow written basic safe work procedures.

Recommendation #4: Employers should consider installing two-way radios inside the cabs of trucks and heavy equipment so that operators can communicate without leaving their cabs.

Discussion: In this incident none of the trucks or heavy equipment were equipped with two-way radios. Because it was necessary for operators to communicate on this job, the victim exited the bulldozer cab, apparently to tell a truck driver where to dump his next load of fill. Doing so proved fatal. If the victim had been able to communicate with the truck driver by two-way radio, this fatality might have been prevented.

Recommendation #5: Equipment manufacturers should consider equipment engineering designs and controls to prevent machine-related injuries.

Discussion: In this incident, the victim stepped out of the bulldozer cab onto the track without shifting the transmission control safety level into the neutral lock position. This resulted in fatal injuries. Consideration should therefore be given to engineering design changes and/or modifications that will reduce the risk of operator injuries. These changes could be incorporated in the design and manufacture of new heavy equipment, and in the retrofitting of existing heavy equipment. The following are examples of passive engineering controls which might have prevented the incident, and should therefore receive careful consideration:

- A dead-man control or interlock device which would automatically lock the transmission into neutral if the operator's position was unoccupied
- Extended fenders or boarding platforms having non-skid surfaces which cover the entire top of the track. This would prevent an operator from standing or falling on the track, and would further prevent him from being pulled between machine parts by the track as it moved. As shown in Figures 2 and 3, the fender or boarding platform (which is the same on both sides of the cab) does not have a non-skid surface and only covers a small portion of the track.
- A transmission control safety lever on both sides of the cab (serving also as "hazard warning bars," and not to prohibit the operator's egress) whose purpose would be to remind an operator to shift this lever into neutral lock before exiting the cab. The bulldozer in this incident and other models have a transmission control safety lever which is installed on the left side of the cab (Figure 1). The safety lever is designed such that it must first be pulled up to a horizontal or disengaged (unlocked) position before the transmission control lever can be shifted into any gear. When the safety lever is in the unlocked position, it juts out into the cab in order to restrict (but not prohibit) the operator from exiting the cab. Conversely, pushing the safety lever down to a vertical or engaged (locked) position makes it easier to exit the cab. In this way the safety lever is designed to also function as a type of "hazard warning bar" or reminder to the bulldozer operator before exiting the cab, even though the safety lever is only on the left side. Consideration might be given to designing a neutral locking device with dual safety levers - one on each side of the cab - so that moving the

safety lever on either side (to engage or disengage the neutral safety lock) would engage both levers.

- The neutral position on bulldozer transmissions might be evaluated (as part of a systems safety approach) for possible engineering design modifications to ensure that the transmission control lever cannot be moved to an unstable neutral position.

Recommendation #6: Equipment manufacturers should develop and affix appropriate safety signs inside the cabs of bulldozers and other heavy equipment, listing necessary precautions.

Discussion: Safety signs should stress safe work practices such as shifting the transmission control safety lever into the neutral lock position before exiting the cab. This sign should be placed in a conspicuous location inside the bulldozer cab.

REFERENCES

Safety Information Profile, Mobile Earth Moving Equipment - Non-Mining, U.S. Department of Health, Education and Welfare (HEW), NIOSH contract Publications number 210-78-0130-000 (12), April 1979.

Caterpillar Operators Guide, D9H Tractor, Publication Code SEBU5228, December 1974.

Crawler Tractor/Loader Safety Manual for Operating and Maintenance Personnel, Construction Industry Manufacturers Association, 1973.

Jan C. Manwaring
Safety Specialist
Alaska Activity
Division of Safety Research

Michael L. Klatt
Acting Chief
Alaska Activity
Division of Safety Research

James C. Helmkamp, Ph.D.
Acting Chief
Trauma Investigations Section
Investigations Branch
Division of Safety Research

Thomas R. Bender, M.D., M.P.H.
Director
Division of Safety Research

Fatal Accident Circumstances and Epidemiology (FACE) Project

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatal Accident Circumstances and Epidemiology (FACE) investigations when a participating state reports an occupational fatality and requests technical assistance. The goal of these evaluations is to prevent fatal work injuries in the future by studying the working environment, the worker, the task the worker was performing, the tools the worker was using, the energy exchange resulting in fatal injury, and the role of management in controlling how these factors interact.

States participating in this study: Alaska, Georgia, Indiana, Kentucky, Maryland, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia, and West Virginia.

Additional information regarding this report is available from:

Division of Safety Research
National Institute for Occupational Safety and Health (NIOSH)
944 Chestnut Ridge Road
Morgantown, West Virginia 26505-2888
Phone: (304) 291-4885
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