



FACE

Fatality Assessment and Control Evaluation Program

Division of Safety Research

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Equipment Operator Dies From Burns After a Hydraulic Line Burst on a Bulldozer and Sprayed Hydraulic Fluid Across the Exhaust Manifold – Tennessee

SUMMARY

On September 29, 2005, a 67-year-old male machine operator (the victim) died from burns sustained the day before when a fire ignited between the engine and the cab of a bulldozer he was operating. The victim was removing shale at a fill-dirt site. As the victim reversed the bulldozer, a hydraulic line burst, spraying hot hydraulic fluid across the exhaust manifold. A fire resulted and ignited the victim's clothing while he was seated in the cab. The victim bailed from the bulldozer. The 76-year-old owner, working nearby, rolled the victim on the ground and extinguished the fire by smothering it with loose dirt and shale. The owner helped the victim to his truck and called the office to have them call 911. Emergency Medical Services (EMS) arrived approximately seven minutes after receiving the call and transported the victim to an area hospital. After being treated at the hospital for approximately three hours, the victim was airlifted to another hospital and died the next day.

The owner returned to check on the bulldozer and found it in a ravine with some light fire visible. After turning the bulldozer off and realizing he was burned, the owner drove himself to the hospital. The owner was admitted to the hospital for second and third degree burns over twenty percent of his body. He was airlifted the following day to another hospital, where he remained for three weeks before being discharged to a rehabilitation hospital for an additional three weeks.

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

- *ensure that mobile construction equipment is inspected daily and that defective equipment is reported and removed from service until all needed repairs have been made*
- *ensure that safety service notices issued by equipment manufacturers are followed and that the necessary modifications are performed*

Fatality Assessment and Control Evaluation (FACE) Program

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatality Assessment and Control Evaluation (FACE) investigations when notified by participating states (Maryland, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia and West Virginia) by the Wage and Hour Division, Department of Labor; or when a request for technical assistance is received from NIOSH-funded state-level FACE programs in California, Iowa, Kentucky, Massachusetts, Michigan, New Jersey, New York, Oregon and Washington. The goal of FACE is to prevent fatal work injuries by studying the work 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. FACE investigators evaluate information from multiple sources that may include interviews of employers, workers and other investigators; examination and measurement of the fatality site, and related equipment; and review of records such as OSHA, police, medical examiner reports, and employer safety procedures and training records. The FACE program does not seek to determine fault or place blame on companies or individual workers. Findings are summarized in narrative reports that include recommendations for preventing similar events in the future. For further information visit the FACE website www.cdc.gov/niosh/face or call toll free 1-800-35-NIOSH.

- *develop, implement, and enforce a comprehensive written safety and health program for all workers which includes training in hazard recognition and the avoidance of unsafe conditions*

INTRODUCTION

On September 29, 2005, a 67-year-old male machine operator (the victim) died from burns he received the previous day when a hydraulic line burst and sprayed hydraulic fluid across the exhaust manifold while he was operating a bulldozer. On September 29, 2005, officials of the Tennessee Occupational Safety and Health Administration (TOSHA) were notified of the incident by the city fire department. On August 16, 2006, officials of the TOSHA discussed the incident with the National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR).

On September 12, 2006, a DSR safety and occupational health specialist traveled to Tennessee and reviewed the incident circumstances with the TOSHA safety compliance manager. Photographs of the incident site and witness statements taken by TOSHA shortly after the incident were reviewed. The city police report was reviewed. On September 13, 2006, the victim's employer was interviewed and a site visit was conducted. The medical examiner's report and death certificate were reviewed.

Employer: The victim's employer was a grading and excavation contractor. The company had been in business for approximately 55 years, and primarily worked in the state of Tennessee. The company employed 8 full-time workers and 3 part-time truck drivers. This was the company's first workplace fatality.

Victim: The 67-year-old male victim had been working as a full-time heavy equipment operator for the company for 30 years. On the day of the incident, the victim was operating a bulldozer. He wore a long sleeved shirt, blue jeans and work boots. The victim had been an equipment operator for approximately 35 years. During his time with the employer, he operated a wide variety of heavy equipment.

Training: The company did not have a written safety program. The employer or the office manager provided all the training. On-the-job training was provided when needed and provided to the workers verbally and by handing out safety information packets, along with placing safety reminders on an office bulletin board. Training was not documented by the company.

Incident Scene: The incident occurred at the employer's fill-dirt site, which was located less than a mile from the office. The site was on a hill and was accessed by a dirt road that was approximately 2,000 feet from a paved road. During operations at the fill-dirt site, the victim used a bulldozer to retrieve dirt and shale from the ground surface and embankment areas. The dirt and shale were placed into one of two stockpiles. The stockpiles were piled approximately twelve feet high. The owner operated a loader and loaded the shale into a dump truck.

Equipment: The bulldozer involved in this incident was purchased new in 1966. The bulldozer was used to push and carry dirt and shale at the fill-dirt site. The bulldozer was equipped with a universal blade on the front (Photo 1).

Prior to use, operators were individually responsible for looking over the equipment they were to operate each day. There was no equipment checklist used or any documentation of the inspections. When repairs were made by the employer the work was documented. When equipment was in need of repair, a company mechanic/operator completed the repair work or the equipment was sent to the equipment distributor for repairs.

Review of the employer's service documentation for repair work performed by a company mechanic indicated that the bulldozer had received an oil change, a new filter and a battery on March 3, 2004. Service documentation from the area equipment dealer was unavailable.

Weather: It was sunny at the time of the incident and the temperature was in the 60's.

INVESTIGATION

On September 28, 2005, at approximately 8:00 a.m., a heavy equipment operator (victim) and the owner began work at the company's fill-dirt site. The victim was operating a bulldozer to remove shale. After removing the shale, the victim used the bulldozer to push or carry a load of shale to one of two stockpiles. The owner operated a loader to load shale into the dump trucks. There were three dump trucks intermittently picking up loads at the fill-dirt site. The dump trucks carried the loads of shale to another work site four miles away.

At approximately 12:00 p.m., the victim and owner stopped work for lunch. Following lunch, the victim resumed work with the bulldozer as the owner loaded shale. Approximately thirty loads of shale had been picked up between the three dump trucks over the course of the day.

The victim attempted to remove shale from an embankment, while approximately 30 feet away, the owner operated the loader. Unable to retrieve any shale due to the hardness of the embankment, the victim placed the bulldozer into reverse. The bulldozer began reversing towards the loader, and after backing approximately six feet, a hydraulic line on the left side (east) leading from the engine compartment to the lift cylinder tube assembly at the front of the dozer burst, spraying hot hydraulic fluid across the hot exhaust manifold. The owner was using the loader and looked over and observed a fine mist spraying from the hydraulic line on the bulldozer and several seconds later a fire erupted. As the mist continued to spray, the owner stated that it resembled a blow torch effect, with the fire in the engine region extending back towards the open cab area. As the bulldozer continued reversing, the victim bailed off the left (east) side of the bulldozer with his clothes on fire. The victim fell to the ground and the owner jumped off the loader and ran to help him.

The owner rolled the victim on the ground for approximately five minutes as he raked dirt and loose shale over him to smother the fire. According to the owner, one fire extinguisher was located under the seat of the bulldozer and a second extinguisher was in his work truck. After extinguishing the victim's clothes, the owner helped him walk approximately twenty five feet to his work truck. When they arrived at the truck, the owner called the office on his mobile phone at approximately 3:09 p.m., and told them to call 911. He told them to have the responders meet him at the intersection below the work site. The owner drove the victim to the intersection. At approximately 3:10 p.m., Emergency Medical Services (EMS), the city police, and the fire department, were dispatched to the incident. At approximately 3:17 p.m., EMS arrived and checked the victim and found him to have multiple burns.

The victim was transported via ambulance to an area hospital. The victim remained at the area hospital for approximately three hours and was later airlifted to another hospital, where he died the next day.

The owner returned to the site to check on the bulldozer. He found the bulldozer, approximately 100 feet down a ravine, still running and with some light fire visible. He ran down to the bulldozer and turned it off. After getting off the bulldozer, he realized he was burned, so he drove himself to the area hospital. The owner was admitted to the area hospital for second and third degree burns. He was airlifted the following day to another hospital and remained there for three weeks, before being discharged to a rehabilitation hospital where he remained for an additional three weeks.

During operation of the bulldozer, a fire ignited between the engine compartment and the cab. According to TOSHA, the fuel source was identified as the bulldozer's hydraulic system oil. The hose assembly span was approximately ten inches from the engine compartment to the lift cylinder tube assembly. This hose failed and subsequently the hydraulic oil was forced out across the exhaust manifold.

CAUSE OF DEATH

The medical examiner's report stated that the cause of death was severe thermal injuries due to a bulldozer on fire.

RECOMMENDATIONS

Recommendation #1: Employers should ensure that mobile construction equipment is inspected daily and that defective equipment is reported and removed from service until all the needed repairs have been made.

Discussion: Mobile construction equipment and their operating components must be maintained in a safe operable condition.¹ All construction equipment in use is required by OSHA 1926. 601(b)(14) to be checked at the beginning of each shift.¹ The employer did not require the bulldozer involved in this incident to be formally inspected with a checklist prior to each shift. Each operator was expected to look over their equipment prior to use. The bulldozer was equipped with hydraulic hoses, tube lines and fittings that must be inspected.² Any deterioration must be carefully examined to determine whether use of the component would constitute a hazard. The following are examples of conditions that should be sufficient for consideration of hydraulic hose replacement: 1) Any evidence of hydraulic oil leakage at the surface of a flexible hose or its junction with the metal and couplings; 2) Any blistering or abnormal deformation to the outer covering of a hydraulic hose; 3) Hydraulic oil leakage at any threaded or clamped joint that cannot be eliminated by normal tightening or recommended procedures; 4) Evidence of excessive abrasion or scrubbing on the outer surface of a hose, rigid tube, or hydraulic fitting.³ Modification must be made to eliminate the elements that are in contact with the engine, or otherwise protect the components. According to a service center for the equipment manufacturer, due to the location of the hydraulic hose that burst in this incident, the hose was considered to be subjected to punishment during bulldozer blade operations. Therefore, the hydraulic hose needed to be continually checked and inspected for any damaged or worn conditions, and to be replaced following every 2,000-3,000 hours of use.

Employers should designate a supervisor and/or a competent person^a to be responsible for daily pre-shift equipment checks and for verifying that any problems are corrected. Although mobile construction equipment may also be inspected by other workers, the employer must be responsible for ensuring that inspections are performed daily, that all the necessary repairs are made, that scheduled maintenance is performed, and that records of all inspections are maintained. A requirement that all mobile construction equipment be removed from service until the required repairs are made must be implemented and consistently followed.

Recommendation #2: Employers should ensure that safety service notices issued by equipment manufacturers are followed and that the necessary modifications are performed.

Discussion: In March 1999 and in March 2002, the bulldozer manufacturer issued and mailed a service letter indicating that the hydraulic hose assemblies that run from the engine compartment to the lift cylinders needed to be replaced, and routing needed to be modified on this model of bulldozer. According to the service letter, a problem exists with bulldozers that are equipped with two dozer lift cylinders that have hydraulic hoses that run from the manifold on the crosstube in the engine compartment to each lift cylinder tube assembly. “These hydraulic hoses can be damaged by rubbing on the bottom edge of the hood. Failure to replace damaged hoses can result in serious injury or death if one of these bursts and sprays hot hydraulic oil onto hot engine parts and the operator. Lift cylinder hoses contacting the hood results in fraying and wearing of the hydraulic hoses. A frayed hose can be weakened as the hood wears into the steel reinforcement layers or as moisture causes the steel reinforcement to corrode. When a hose is sufficiently weakened, high pressure oil in the system can cause the hose to fail. High pressure oil can then spray onto hot parts of the engine and cause a fire resulting in serious injury or death. A modification needs to be made to prevent the crosstube manifold cylinder tube assembly hoses from rubbing on the bottom edge of the hood and redesigned hoses need to be installed.”⁴

Hydraulic oil becomes hot during operations. Heated petroleum based hydraulic fluid presents a considerable fire hazard particularly in those processes where ignition sources are usually present. A typical petroleum-based hydraulic fluid has a flash point that ranges from 300 to 600 degrees Fahrenheit; auto ignition temperature’s range from 500 to 750 degrees Fahrenheit.⁵ When hydraulic fluid is accidentally discharged under high pressure, an easily ignited fine oil mist is sprayed over the surrounding area. The working pressure on this line was approximately 3,000 psi^b and the hydraulic fluid capacity is approximately 30 gallons. When the oil mist reaches an ignition source, the result can be a torch-like ball of fire. The likely ignition source was determined by TOSHA to be the exhaust manifold.

According to TOSHA, the equipment manufacturer’s service letter that applied to the bulldozer used in this incident was not acted upon by the employer, therefore the bulldozer in this incident did not

^a “Competent person” means one who is capable of identifying existing and predictable hazards in the surrounds or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has the authorization to take prompt corrective measures to eliminate them.

^b Pounds per square inch.

receive the prescribed corrective action. The investigating TOSHA compliance officer determined that the hose failed approximately 2-inches away from the exact area cited in the service letter.

Following this incident, the bulldozer was sent to the local equipment manufacturer to be refurbished and to receive the necessary service modification.

Recommendation #3: Employers should develop, implement, and enforce a comprehensive written safety and health program for all workers which includes training in hazard recognition and the avoidance of unsafe conditions.

Discussion: According to 29 CFR 1926.21(b)(2)⁶ “the employer shall instruct each employee in the recognition and avoidance of unsafe conditions and the regulations applicable to their work environment to control or eliminate any hazards or other exposure to injury or illness.” The victim had not received any type of formal training from the employer. A comprehensive written safety and occupational health program should be developed for all workers and should include training in hazard recognition and the avoidance of unsafe conditions.⁷ It should then be noted in a company’s safety and health program that certain types of site-specific training (i.e., working with mobile construction equipment) must be conducted and documented. The safety and health program should include, at a minimum, worker training in hazard identification, and the avoidance and abatement of these hazards. Employers should evaluate all tasks performed by workers, identify all potential hazards, then develop, implement, and enforce a written safety and health program that meets applicable Occupational Safety and Health Administration standards and addresses these hazards.

Operating mobile construction equipment exposes a worker to multiple and complex hazards. It cannot be assumed that employees can recognize hazards such as a potential hydraulic hose bursting to which they could be exposed. Training in recognizing and avoiding hazards should be given to all workers, coupled with employer assessments that workers are competent in the recognition of hazards and safe work practices.

REFERENCES

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INVESTIGATOR INFORMATION

This investigation was conducted by Nancy T. Romano, Safety and Occupational Health Specialist, Fatality Investigations Team, Surveillance and Field Investigations Branch, Division of Safety Research.

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Photo 1. Photo of bulldozer after being refurbished and receiving the necessary service modification.



Photo 2. Photo of the incident site.