TO: Director, National Institute for Occupational Safety and Health

FROM: California Fatality Assessment and Control Evaluation (FACE) Program

SUBJECT: Operating engineer is crushed by a backhoe attachment when it disconnects from its tractor in California

SUMMARY
California FACE Report #97CA008

A 25-year old operating engineer (decedent) died when he was crushed between the grab bar of a backhoe attachment and the Roll Over Protective Structure (ROPS) of a skid steer loader (small tractor). When the backhoe attachment disconnected during a test of the equipment, the decedent was thrown forward onto the left side operating stick. Pushing this stick forward caused the boom to move down and the attachment to come further into the cab of the tractor. The left side grab bar pinned the decedent against the ROPS, crushing his chest. The CA/FACE investigator concluded that, in order to prevent future occurrences, employers should:

- develop written instructions for investigating equipment problems.
- establish and implement company equipment inspection procedures that focus on the safety of the equipment.
- Additionally, manufacturers should provide instructions to the maintenance department of their dealership for determining the safe wear tolerances of attachment connections.

INTRODUCTION

On May 8, 1997, at 10:15 a.m., a 25-year old male operating engineer was fatally injured when he was crushed between a tractor's Roll Over Protective Structure (ROPS) and the grab bar of a backhoe attachment. He was testing his equipment because during its operation the decedent suspected the equipment was not functioning properly. During the testing the backhoe attachment disconnected from the tractor which caused the attachment to swing back toward the c b of the tractor. This caused the operator to fall onto the left side operating lever which activated the boom into downward motion. This caused the disconnected attachment to protrude further into the tractor and crush the decedent.

The CA/FACE investigator learned of this incident from a district office of the Division of Occupational Safety and Health (Cal/OSHA) on May 20, 1997. On May 30, 1997, the CA/FACE investigator traveled to the yard where the tractor and backhoe attachment were stored and met with a representative of the employer. The CA/FACE investigator interviewed the representative, who was supervising at the site of the incident, and photographed the machinery involved. The employer, a pipeline excavation contractor, operated small tractors on a contract basis and had been in business for 10 1/2 years. The company had 9 employees with 5 working on site at the time of the incident. The decedent had been working for the company for 4 years, 2 years and 2 months as a laborer and the remaining time as an operating engineer. The

decedent had worked at the site of the incident as well as other sites since January 15, 1997. Company safety responsibilities were defined in the company Injury and Illness Prevention Program (IIPP). In addition, the decedent was trained as a competent person in excavation work. The company did not have specific written procedures for the task being performed. The decedent was familiar with the type of machinery involved in this incident through experience and on-the-job training.

Employees were instructed and supervised until it was determined by the company that they were ready to undertake a task, such as operating a backhoe. Safety meetings were held weekly. The employer's tractors and their attachments receive frequent and comprehensive maintenance. Although the employer performed minor maintenance on occasion, almost all maintenance was performed at the dealership. According to the employer's maintenance records the tractor/backhoe received maintenance and was released on February 28, 1997. Included in this maintenance was the replacement of the taper pin, bushings and locking lever tension hardware. Dealer maintenance was also performed on March 6th, 10th, 25th, 27th and April 17th. No repair of the backhoe attachment plate was made on these dealer visits.

INVESTIGATION

The scene of the incident is a city street near an intersection. The job the decedent was performing was excavation of the street in order to access a water pipe. The employer was hired by a municipal utility to excavate a main line water pipe as part of a cement relining project. Excavation was done with a skid steer loader (small tractor) to which a backhoe attachment was connected. (**see exhibits 1 and 2)** The backhoe had an articulating arm with a bucket at the end. The arm to which the bucket was attached was made by the employer, but was attached the same way as the factory's arm. The tractor had a safety lap belt and a pull down bar. The backhoe attachment had an operator's seat on top of the attachment (**see exhibit 3).** It had no safety belt. In order to operate the attachment, the operator had to get out of the tractor and climb up to the top of the backhoe attachment.

The backhoe attachment is connected at four points. The tractor is driven up to the attachment and two spring-loaded taper pins are lined-up with and drop down into two square holes in the backhoe attachment plate. The backhoe attachment is then moved up and two hooks, one on each side of the tractor, catch the backhoe attachment arms. All four attachment points are locked into position with individual levers (**see exibits 4 and 5).** Seven weeks prior to this incident another incident occurred in which an attachment point broke and caused a lost time injury. However, the job supervisor had successfully used this tractor/backhoe combination the just prior to this incident without any problem. The decedent was assigned to use the same tractor/backhoe on the day of the incident.

As the decedent was excavating he suspected that the equipment was not operating correctly. He informed his supervisor that something felt loose. His supervisor asked him to move to the side and check for a problem with the machine. The supervisor then took over the excavating the street with another backhoe. The decedent began to check the backhoe attachment in an attempt to discover the problem. A co-worker was stationed at the left side of

the tractor to assist. The decedent's initial method of checking the equipment was, with the rear outriggers down, to swing the backhoe arm back and forth and up and down from the operator's station. He then placed the backhoe bucket on the ground to do a simulated dig. The decedent pushed a control lever forward to make the bucket go down. As he was continuing with this operation, the taper pin (or pins) came out of the backhoe attachment plate.

When the pins released, the decedent was thrown forward (toward the bucket). He struck the control lever that causes the bucket to go down. This caused the backhoe attachment to come up and nearer to the cab area of the tractor. As the attachment came up the decedent was crushed between a grab bar on the backhoe attachment and the rollover protective structure (ROPS). As the decedent continued to be crushed, he was pushed to the right. This caused the control lever to be pushed right and the backhoe arm and bucket swung quickly to its maximum right position. **(see exhibit 6)**

When the backhoe arm and bucket swung to the right the supervisor looked over. When he saw the situation, he immediately got out of his machine and ran to the decedent's machine. He saw that the decedent was caught between the backhoe grab bar and the ROPS. He assessed the situation and reached between the decedent's legs to operate the outrigger lever. When he lowered the outriggers the tractor settled and the decedent was freed. Subsequent investigation determined that the taper pins had released the bottom of the backhoe attachment where they go through the attachment plate. This allowed the backhoe attachment to swing in an upward direction. Because it was still attached by the arms to each side of the tractor, the backhoe attachment also swung back toward the tractor. The holes through which the taper pins protruded on the attachment plate were worn, with the wear on the left side hole being more pronounced **(see exhibit 7).**

A reenactment of the testing performed by the decedent just prior to the incident was completed by the employer and the CA/FACE investigator at the employer's storage yard. Using a nearly new loader/backhoe combination (5% wear), revealed that the taper pins ride up as much as 1 1/2 inches. This backhoe attachment was externally connected to the loader to prevent its detachment. Upon release of the pressure of the bucket, a loud pop could be heard as the taper pin fully reengaged. Worn holes in a backhoe attachment plate could allow the full release in a digging and simulated digging situation. Following this fatality, the manufacturer has issued a safety recall notice which addresses the unintended detachment of the backhoe attachment from the skid steer loader. The modification has not yet been designed, but the notice warns of the danger of detachment. When the modification is properly engineered, the backhoe attachments will be retrofitted at no cost to their owner.

CAUSE OF DEATH

The death certificate stated the cause of death to be laceration of the heart due to blunt chest trauma.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should develop written instructions for investigating

equipment problems.
Discussion: The employer had no written instructions for investigating problems with his equipment. When the decedent determined that his equipment was not operating properly, he decided to investigate the problem by operating the equipment. While this procedure may be necessary at some point, the first part of an inspection for equipment problems should be visual. If the decedent had visually inspected the equipment before continuing to operate it, he may have found the problem. The most likely cause of the looseness he felt was that the left taper pin had already come out of the backhoe attachment plate due to the worn hole. When the decedent operated the boom and bucket in the down mode, the right taper pin then disengaged which released the bottom of the backhoe attachment and lead to the events which caused the fatality. Written instructions on the procedure for investigating equipment problems, if followed, may have prevented this fatality.

Recommendation #2: Employers should establish and implement company equipment inspection procedures that focus on the safety of the equipment.
Discussion: The employer did not have written instructions which would help determine if his equipment was safe or unsafe for use. While the manufacturer does not provide such instructions, employers should implement such inspection instructions. With their experience, employers could work with the manufacturer to develop such instructions. Although this employer's equipment was professionally maintained, the backhoe attachment plate was worn beyond what could be considered safe. Employer inspection, if properly carried out, could have noted the wear of the taper pin attaching holes. The equipment could have been deemed unsafe for use and taken out of service before an incident, such as the fatality in this case, happened.

Recommendation #3: Manufacturers should provide instructions to the maintenance department of their dealerships for determining the safe wear tolerances of attachment connections.
Discussion: The manufacturer does not provide to its dealerships information on how much wear of equipment attachment points is safe. Dealerships contacted stated that they could tell by looking, but they had no instructions on what to look for. The employer had taken the equipment involved in this incident into the dealership for maintenance on numerous occasions in the three months just prior to the incident. The dealer had not noted the wear on the taper pin mounting holes in the backhoe attaching plate. If the manufacturer had provided their dealerships with inspection procedures and attachment point wear standards, the dealership would have noted the excess wear on the plate and called it to the employers attention. If the employer had the plate repaired prior to it next use, this fatality may not have happened.

References:
Barclays Official California Code of Regulations, Vol. 9, Title 8, Industrial Relations, South San Francisco, 1990

Operating Techniques for the Tractor. Loader, Backhoe, Gary Ober, Ober Publishing, Northridge, CA

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FATALITY ASSESSMENT AND CONTROL EVALUATION PROGRAM

The California Department of Health Services, in cooperation with the California Public Health Foundation, and the National Institute for Occupational Safety and Health (NIOSH), conducts investigations on work-related fatalities. The goal of this program, known as the California Fatality Assessment and Control Evaluation (CA/FACE), is to prevent fatal work injuries in the future. CA/FACE aims to achieve this goal 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.

NIOSH funded state-based FACE programs include: Alaska, California, Colorado, Georgia, Indiana, Iowa, Kentucky, Maryland, Massachusetts, Minnesota, Missouri, Nebraska, New Jersey, Wisconsin, and Wyoming.

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Additional information regarding the CA/FACE program is available from:

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California Department of Health Services
Occupational Health Branch
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