



Mechanized Equipment

Module Purpose

The purpose of this module is to provide participants with an overview of the hazards associated with construction vehicles and equipment in congested construction work zones. The module also describes ways to prevent, control, or abate these hazards.

Time

70 minutes (8:00 - 9:10 am)
(A 10-minute break follows this module)

Objectives

Upon completion of this module, participants will be able to:

Show slides 6.1 – 6.2.



- Identify specific types of hazards that exist at a highway construction site involving heavy construction vehicles and equipment
- Recognize the key characteristics of these hazards
- Identify prevention, control, or abatement methods associated with both types of hazards and be able to recommend those best suited to particular situations
- Develop and implement an *Internal* Traffic Control Plan (ITCP) for vehicles operating within the work zone

Materials and Resources

PowerPoint Slides: Module 6

Activity: Appendix 6-A.

Relevant OSHA standards, Appendix 6-B.

Module 6: Mechanized Equipment

Instructional Strategy and Course Content

Facilitator Notes

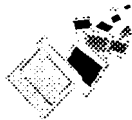
Lecture



1. What hazards are created by construction vehicles and equipment? *Show Slides 6.3 – 6.6.*



2. What hazards do vehicle and operators face? *Show Slides 6.7 – 6.20.*



Lesson

1. What hazards are created by construction vehicles and equipment?

Along with motorists, construction vehicles and motorized equipment present a major hazard to highway construction workers. Recent studies by the Laborers International Union of North American and NIOSH indicate that workers are killed just as often by vehicles and equipment operating *within* the work zone as from motorists that cross the barricades and strike workers.

Construction vehicles and equipment endanger:

- Drivers and operators
- Workers on foot
- Motorists/ Public

The three main types of construction vehicle hazards are a) operating hazards, b) parking hazards, and c) maintenance hazards.

2. What hazards do vehicle and equipment operators face?

There are three major hazards presented by construction vehicles and equipment in motion:

Roll over hazards occur when:

- Operating heavy equipment too fast or on too steep a grade
- Exceeding the manufacturers load or operating limits
- Using inadequate methods for loading the machinery onto a transport trailer
- Setting equipment on soft spots/soft shoulders

Striking WOFs (either with the vehicle or with its equipment, such as a bucket, shovel, clamshell, etc.) is most likely to happen if the equipment or operator has:

- Inadequate brakes
- Malfunctioning backup alarm
- Blind spots and operators fail to check around the vehicle for WOFs
- Failed to properly barricade the swing area of the equipment
- Failed to communicate with WOFs

Striking overhead objects and buried objects can easily occur if vehicles are operated without proper clearance. Construction vehicles and equipment can endanger workers by:

- Knocking down overhead wires or tree branches
- Making contact with overhead wires or buried utility cables and causing the equipment to become energized

Additional hazards to both pedestrians and operators arise when heavy equipment contains blades and/or scissor points.

3. What are some general precautions that can be taken to prevent, control or abate hazards around construction equipment and vehicles? Show Slides 6.21 - 6.23.



3. What are some general precautions that can be taken to prevent, control or abate hazards around construction equipment and vehicles?

As with any dangerous situation, one should attempt to eliminate hazards first by administrative or engineering controls, secondly by training, and finally by use of personal protective equipment (PPE).

Administrative/Engineering Controls

- / Limit access by WOFs to areas where construction vehicles and equipment are in operation.
- / Create a traffic control plan for vehicles and equipment so operators and WOFs know where to watch for each other.

Training

- Operators must be trained on safe operation of construction equipment, including following the manufactures guidelines.
- Workers must be trained about the hazards of working around heavy equipment, including visibility limitations and areas where workers can be caught or crushed.

PPE

- Workers should be required to wear hard hats where there are possibilities of head injuries. Hard hats with reflective materials are also useful to increase worker visibility.
- Workers should be provided, and required to use high-visibility garments. This clothing is not only important for flaggers and during night work, but is also important for worker visibility within the work zone.

4. What can be done to assist operators reduce dangers to themselves? Show slides 6.24 - 6.28.



4. What can be done specifically to assist operators reduce dangers to themselves?

To prevent rollover injuries, the following steps must be taken:

- Install and use rollover protective structures (ROPS), detailed in OSHA standard 1926.1001
- Install and use seat belts that meet the Society of Automotive Engineers (SAE) requirements
- Maintain a safe speed

Case Study



5. Vehicle Rollover.
Slides 6.29 – 6.38; see Appendix 6-A.

6. What can be done specifically to prevent injuries to WOFs?
Show slides 6.39 – 6.42.



7. How can workers be protected from hazards around blades and scissor points in equipment? *Show slides 6.43 – 6.46.*



8. What can be done to reduce the likelihood of striking overhead or buried utilities with equipment? *Show slides 6.46 – 6.47.*



- Refine methods used in loading and unloading transport trailers, such as
 - Use of spotters
 - Use of ramps that are the right size and stable
 - Painted guidelines or other markings to guide operators and indicate hazardous areas

5. Case Study: Vehicle Rollover

6. What can be done specifically to prevent injuries to WOFs?

To minimize dangers to workers on foot, proper equipment maintenance and operating procedures must be performed regularly. Examples of proper maintenance and procedures include:

- Inspect brakes and other stopping devices to ensure they are operating properly and able to stop and hold equipment when fully loaded
- Check to ensure backup alarms work
- Use mirrors, closed circuit television, sensors and alarms, or spotters to look for workers and other hazards
- Make certain cab glass is not cracked or broken and does not distort the operator's view
- Have operators check for other workers before starting the machine
- Warn WOFs when vehicles or equipment with rotating cabs are in use

7. How can workers be protected from hazards around blades and scissor points in equipment?

- Limit the use of blades as a brake on downgrades
- Guard scissor points when necessary

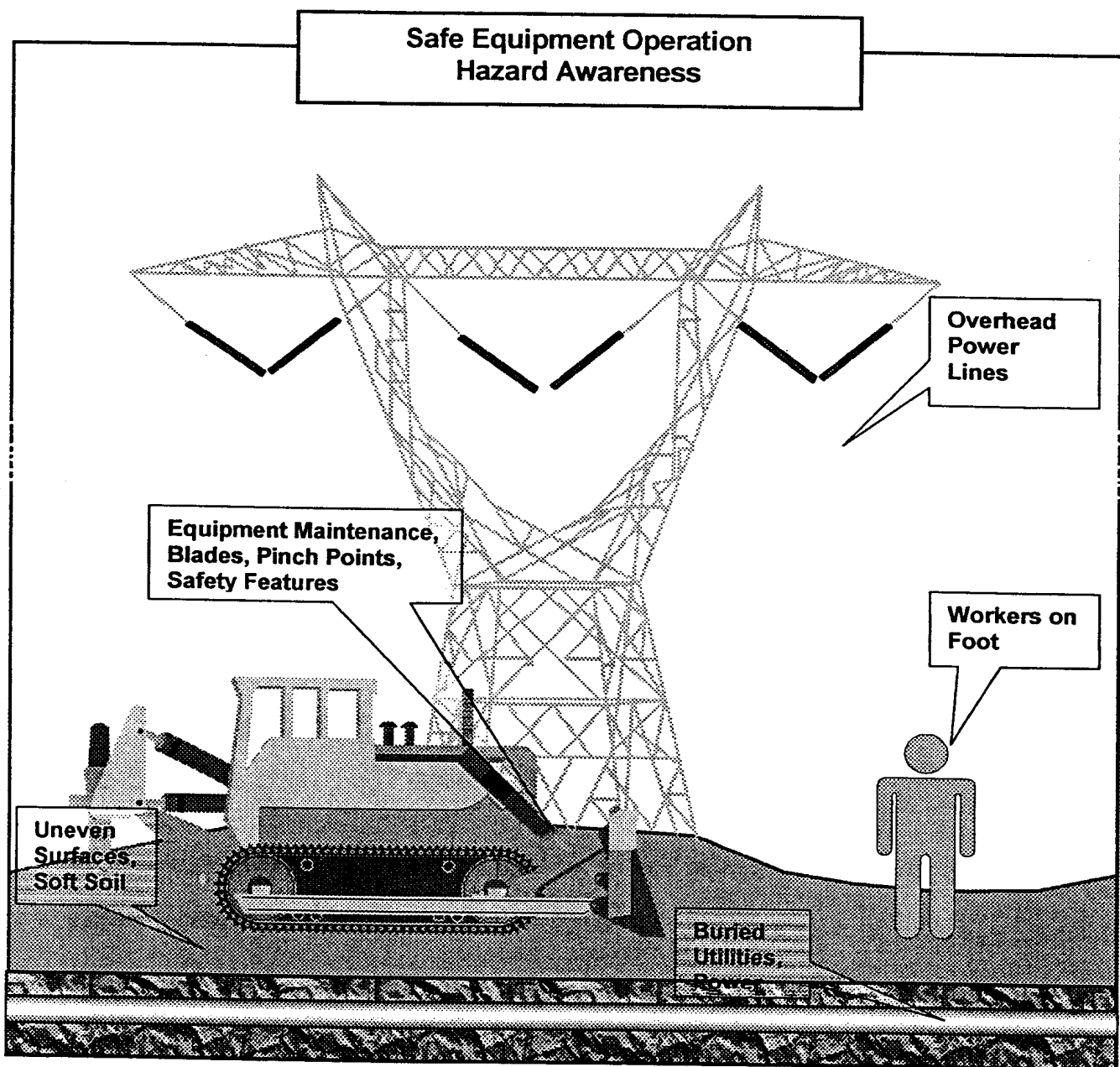
8. What can be done to reduce the likelihood of striking overhead or buried objects with equipment?

- Operators should be trained to regularly check for clearance before moving or operating the machine

Facilitator Notes

Lesson

- Flag electric lines to ensure visibility; Use ground-level markers to remind operators of overhead or buried utilities
- Maintain a safe distance from utility lines, as required by local, state, or federal codes or standards
- De-energize or elevate electric lines whenever possible



Facilitator Notes

9. Are there hazards around equipment when it is not being operated? *Show slides 6.48 – 6.59.*



Lesson

9. Are there hazards for workers around equipment when it is not being operated?

There are two general situations where hazards exist when equipment and vehicles are not in operation. They are *parking* and *maintenance*.

Parking Hazards

The major hazards presented by parked construction vehicles and equipment are:

- They may be struck by traffic if they are close to, or not completely out of the traffic area
- They may start to move if parked on an incline or on loose ground
- They may begin to move if unattended and left running while parked on an incline or on loose material. Vibration could put the machine in motion
- The brake is not set when the vehicle is out of use
- The wheels are not chocked when a vehicle is parked, especially on an incline
- The bucket or blade is not lowered when the vehicle is parked. (Lowered blades and buckets help keep equipment from moving)

To prevent/control/abate these hazards, operators should:

- Park construction equipment entirely off the road – 35 feet from active public traffic, if possible.
- Clearly barricade any portion of the equipment that projects into the road
- Day time: red flags and barricades
- Night time: red lights, flashers, or reflective barricades

Maintenance Hazards

The major hazards presented by construction vehicle maintenance are related to:

- Refueling
- Performing maintenance and repairs
- Taking vehicles or equipment out of service

Facilitator Notes

Lesson

10. How can I prevent hazards during non-operation of vehicles and equipment? Show slides 6.60 – 6.62.



11. What OSHA provisions are applicable to equipment operations? Show slides 6.63 – 6.65.



12. Elicit additional questions and summarize. Slide 6.66.

13. Transition to prepare participants for Module 7.



Failing to turn off the motor during refueling and maintenance can put drivers and other workers in danger of

- Fire or explosion during refueling
- Injury during maintenance

10. How can I prevent hazards during non-operation of vehicles and equipment?

- Provide training on best practices, as well as OSHA's and the manufacturers' procedures for refueling, maintenance, and repair
- Lockout equipment
 - Place an energy-isolating device over the energy source
 - Bleed off stored energy with hydraulic or pneumatic equipment
 - Lock it until the repair/maintenance work is completed
- Tag out the equipment
 - Place a tag over the energy source and start-up mechanisms
 - Label it with a written warning that remains in place until the work is done
 - Block disabled equipment

11. What OSHA provisions are applicable to equipment operations? (See *appendix 6B*)

- OSHA Standards
 - Powered Industrial Truck
 - Wheels Choked
 - Brakes Set
 - Rear View Obstruction
 - Alarms or Signaler
 - Inspections and Maintenance
- Materials Handling Equipment
 - Earthmovers
 - Seatbelts
 - Roll Over Protection
 - Scissor Point Guards
 - Lift Trucks- rated capacity
- Pile Driving Equipment
 - Stop Blocks
 - Sheave Guards

12. Question and summary period.

13. Transition to Module 7.

Vehicle Roll-Over

Objective: This case study reviews an actual incident where a worker was killed when the vehicle he was operating rolled over, and he was crushed. Instructor should explain what happened in this incident using the Power Point slides and then solicit class participation as to actions the employer/workers might have taken to avoid the incident.

Materials:

- Power Point Slides 6.29 – 6.38.
- Flip chart, markers and easel or white board or chalkboard

Time: 10 minutes

Note: Instructor should become as familiar as possible with the incident so as to be able to answer student's questions. A detailed report follows this page.

Instructor is encouraged to substitute a personal experience, of a similar nature, for this incident. This case study is to be used if instructor does not have a similar experience and/or the instructor does not have appropriate slides, diagrams or information to share his/her experience with the class.

Administrative Report
December 13, 1999

PUBLIC HEALTH SERVICE/CDC/NIOSH/DSR
FACE 00-05

TO: Director, National Institute for Occupational Safety and Health

FROM: Division of Safety Research, NIOSH

SUBJECT: Truck Driver Dies After the Off-Highway Truck He was Operating Rolled Over an Embankment and Came to Rest on Its Top-Pennsylvania

SUMMARY

A 48-year-old male truck driver (the victim) died after the Caterpillar 773B off-highway truck he was operating rolled 49 feet over an embankment and came to rest on its top in 4 feet of water. The victim was hauling dirt that was being cut from a bank to clear ground for a 3-mile stretch of a new freeway project. After the off-highway truck was loaded with dirt, the victim would travel down a slight grade, across a two-lane state road, up a 25-foot-wide haulage road where he dumped his load, and then continue around the haulage road back to the loading point in an oval pattern. As the victim was traveling up the haulage road, a road grader was scraping mud from the road, traveling in the opposite direction. The victim steered the truck to the right to allow the grader to pass. As he did, a portion of the built-up haulage road gave way under the truck's right-side tires, causing the truck to overturn. The truck rolled over twice while traveling 49 feet down the embankment, and came to rest on its top in 4 feet of water. The grader operator immediately ran to the truck and pulled the victim clear. With the help of two flaggers, they placed the victim on the bottom of the truck cab. The two flaggers initiated cardiopulmonary resuscitation (CPR) on the victim while the emergency medical service (EMS) was called from a company truck. The EMS transported the victim to the hospital where he was pronounced dead approximately 1 1/2 hours after the incident occurred. NIOSH investigators concluded that, to prevent similar incidents, employers should:

- ✓ • ensure that employees adhere to established standard operating procedures
- ✓ • ensure that heavy-equipment operators are properly trained and proficient in the operation of the equipment they are assigned to operate
- ✓ • evaluate the possibility of installing video equipment in the cabs of heavy equipment or installing hood-mounted mirrors that would allow operators to clearly see how close their equipment was to road edges

INTRODUCTION

On December 1, 1999, a 48-year-old male truck driver (the victim) died after the off-highway truck he was operating rolled 49 feet over an embankment and came to rest on its top in 4 feet of water. On December 3, 1999, the Division of Safety Research was alerted of the incident by a newspaper article, contacted the Occupational Safety and Health Administration (OSHA) compliance officer assigned to the case, and initiated an investigation. On December 6, 1999, two DSR Occupational Health and Safety Specialists traveled to the incident site to conduct an investigation. The incident was reviewed with the OSHA compliance officer, the company's corporate safety director, and two company safety department personnel who were on site.

The company specialized in site clearance and preparation for highway/street construction. The company had been in operation for 75 years and employed 850 workers in their construction division. The company had a written safety policy, a comprehensive written safety program, and a drug-screening program. Training was provided in the classroom and on the job. When the company purchased a new piece of heavy equipment, manufacturers' representatives were brought to the site to train operators. This past summer representatives from two manufacturers were on site to train operators of their off-

highway trucks. Since the victim's usual job was driving the water truck, he had not attended the training. Weekly safety meetings were conducted on site by safety department personnel. Every 2 years, workers' yearly audiograms were scheduled to coincide with the company safety expo. During the safety expo, workers can be trained by manufacturers' representatives or company representatives for jobs other than those they usually perform. The victim had worked for the company for 31/2 years and had operated off-highway trucks on previous occasions; however, the amount of experience the victim had operating these trucks could not be determined. This was the fifth fatality experienced by the company in the past 9 years.

INVESTIGATION

The company had been contracted for site clearance and land preparation for a new 3-mile section of a four-lane expressway. Eight and one half million cubic yards of earth had to be moved for the project. Much of the roadway had to be built up well above ground level and much of the earth moved was used for that purpose.

The portion of the project where the incident occurred was thought to be completed; however, when company engineers surveyed the site, it was discovered that a corner of a hillside, containing approximately 50 cubic yards of earth, still had to be removed.

On the day of the incident, the victim, whose usual occupation was water truck driver, was asked by his supervisor to operate an off-highway truck to haul earth from the loading area to a dumping point approximately 1/4 mile away. The entire trip was approximately 1/2 mile. The route was laid out in an oval configuration. The operators would take on their load, travel down a slight grade and across a two-lane state road, then up a built-up hill to the dumping point. They would then travel back down the return route, across the state road and back to the loading point. The built-up road leading up to the loading point was 25 feet wide and had a 49-foot-high bank on its right side. Approximately halfway up the hill was a large turnaround area on the left side of the haulage road. Flaggers were positioned on each side of the state road.

Two off-highway trucks, a Euclid and a Caterpillar 773B (Figure 1), were used. The load capacity of each truck was 5 cubic yards. The victim asked to operate the Caterpillar since he had operated it previously. It could not be determined at the time of the investigation how much experience or training the victim had operating off-highway trucks; however he had not operated a piece of equipment recently, nor had he attended the most recent training session conducted by manufacturer representatives.

It had snowed the night prior to the incident and there was a slight dusting of snow on the already wet ground. The first driver to use the haulage road told the supervisor that the portion of the road from the loading point up the hill to the dumping point was particularly "greasy" and slick and that the entire haulage road needed to be scraped. The supervisor directed the grader operator to scrape the haulage road. The grader operator started at the loading point and began scraping the haulage road up the hill to the dumping point. Standard operating procedures called for one-way traffic on the haulage road; however, when the grader operator reached the dumping point, he turned the grader around and started scraping the remainder of the haulage road coming back down the hill. The victim was hauling his load up the hill as the grader was traveling back down the hill. The two pieces of machinery approached each other approximately halfway up the hill at the turnaround area. The victim steered the off-highway truck toward the right-side embankment to allow the grader to pass. As he did, a portion of the right side of the haulage road gave way, causing the off-highway truck to overturn (Figure 2). The truck rolled over twice, coming to rest on its top in approximately 4 feet of water that had gathered at the bottom of the embankment.

The grader operator, the two flaggers, and a safety consultant for the state department of transportation immediately ran to the victim's aid. The grader operator waded through the water, reached into the cab of the truck, and pulled the victim free. The victim's head was submerged and he was not belted in when he was pulled from the cab. The grader operator and the flaggers placed the victim on the bottom of the truck's cab and the flaggers immediately initiated cardiopulmonary resuscitation (CPR) while the emergency medical service (EMS) was summoned by phone from a company truck. The EMS arrived at the scene within 8 minutes and summoned the county coroner, who pronounced the victim dead at the scene.

During the investigation the seatbelt was examined and found to be operational. A NIOSH investigator also sat in the operator's seat and looked through the side mirror on the truck's right side. The investigator could only see about halfway down the truck's 6-foot-high rear tires. The area around the base of the tires could not be seen. It is very likely that the victim could not determine how close he was to the right-side edge of the road.

CAUSE OF DEATH

The coroner listed the cause of death as multiple skull fractures. Autopsy results identified no water in the lungs.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should ensure that employees adhere to established standard operating procedures.

Discussion: Standard operating procedures called for one-way traffic flow on the haulage road. In this instance, the grader operator began scraping the haulage in the same direction the off-highway trucks were traveling. Once the grader operator passed the dumping point however, he turned the grader around and made a second pass back down the haulage road to scrape the mud off the other side of the haulage road. When the victim tried to give the grader additional room by pulling over, the truck overturned. Employers should ensure that one-way traffic flow is maintained on haulage roads, particularly on built-up roads. If for some reason it is necessary for a piece of equipment to travel against the established flow of traffic, all other traffic should be removed from the road until that piece of equipment completes its run.

Recommendation #2: Employers should ensure that heavy-equipment operators are properly trained and proficient in the operation of the equipment they are assigned to operate.

Discussion: The amount of experience the victim had operating the off-highway truck could not be determined during the investigation. The victim's usual job was driving the water truck, a truck with a water tank mounted on it that was used to wet down haulage. The two trucks were different in design and mechanical operation. Because the area around the base of the off-highway truck's tires could not be seen by an operator, it is unlikely the victim knew how close he was to the right-side edge of the haulage road. Workers should be adequately trained to operate equipment and should demonstrate proficiency in operating that equipment prior to operating it in a work situation.

Recommendation #3: Employers should evaluate the possibility of installing video equipment in the cabs of heavy equipment or installing hood-mounted mirrors that would allow operators to clearly see how close their equipment is to road edges.

Discussion: During the investigation, a NIOSH investigator sat in the operator's seat of the truck and looked through the mirrors mounted on the sides of the truck. The investigator could not see the area around or underneath the 6-foot high rear tires. This suggests that an operator could not accurately determine how close he was to the side or edge of a road. Employers should evaluate the feasibility of installing surround-view camera systems on large heavy equipment. The monitor in the operator's cab would allow equipment operators a clear view of the area surrounding the equipment and allow them to determine if they were approaching a dangerous area. Such surround-view systems are available. Additionally, mirrors could be mounted on a truck's hood in a manner that would assist the operator in determining where a truck's tires were in reference to a road's edge.

Module 6
Appendix 6-B

Relevant OSHA Standards

1. 1926.600 General Requirements
 - a. Powered industrial truck operator training
 - b. On inclines, wheels chocked and the parking brake set.
 - c. Maintenance
 - d. Obstructed view to the rear
 - e. Reverse signal alarm audible above the surrounding noise level/worker desensitization to alarms
 - f. Use of a signal person

2. 1926.602 Material Handling Equipment
 - a. Earthmoving equipment (e.g., scrapers, loaders, crawler or wheel tractors, bulldozers)
 - b. Seat belts.
 - c. Rollover protective structures (ROPS)
 - d. Guarding scissor points
 - e. Lift trucks, stackers - rated capacity clearly posted

3. 1926.603 Pile driving equipment
 - a. Stop blocks
 - b. Sheave guards