OSHAcademy™
Occupational Safety & Health Training

Heavy Equipment Safety

This course covers the safe operation of heavy equipment such as excavators, loaders, graders, rollers, and bulldozers, which should always be done by highly skilled operators who have demonstrated the ability and necessary skills to operate safely. Unsafe practices by either the operator or those around the equipment can create very dangerous situations.

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OSHAcademy Course 814 Study Guide

Heavy Equipment Safety

This study guide is designed to be reviewed off-line as a tool for preparation to successfully complete OSHAcademy Course 814.

Read each module, answer the quiz questions, and submit the quiz questions online through the course webpage. You can print the post-quiz response screen which will contain the correct answers to the questions.

The final exam will consist of questions developed from the course content and module quizzes.

We hope you enjoy the course and if you have any questions, feel free to email or call:

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Course Introduction

According to OSHA, falls are the leading cause of death in construction jobs. However, close behind, the #2 cause is being struck by a vehicle or other object. About 75% of these fatalities involve trucks, cranes, and other heavy equipment.

Operation of heavy equipment such as excavators, loaders, graders, rollers, and bulldozers should always be done by highly skilled operators who have demonstrated the ability and necessary skills to operate safely. Unsafe practices by either the operator or those around the equipment can create very dangerous situations. Serious injuries can occur if the equipment strikes a worker, or if the equipment is rolled over.

In this course, we will take a look at the various types of heavy equipment and important controls and safe work practices for heavy equipment operations.

Module 1: Heavy Equipment Basics

The use of heavy equipment is an important part of residential, commercial, and roadway construction and maintenance operations. A variety of heavy equipment are used in construction and maintenance.

Types of Heavy Equipment

Heavy equipment can be classified into the following categories based on the type of operation:

- excavating equipment
- lifting equipment
- loading and hauling equipment
- compaction equipment
- grading and finishing equipment
- paving and surface treatment equipment

Depending upon their versatility, heavy equipment may be used for multiple purposes. For example, backhoes are normally used for excavating but they can also load the excavated materials into trucks.

Excavation Equipment

An excavator is a power-driven machine mostly used in earthmoving operations. Heavy equipment typically used for excavating include the following:

- **Backhoes:** Backhoes are used for surface or subsurface excavation of solids and sludge. Backhoes are used to dig below the surface, such as trenches, building footings and foundations. The backhoe is attached to the loader frame with a ridged coupling.
- **Excavators:** Excavators are large backhoes. They can be truck mounted, truck carrier mounted, or self-propelled wheel mounted. They are hydraulic powered and consist of three structures: the revolving unit, the travel base and the attachment.
- **Front-End Loaders:** The front-end loader is a self-contained unit mounted on rubber tires or tracks and is one of the most versatile and capable pieces of equipment used in

excavation work, as well as loading. The front-end loader can be equipped to operate as a loader, dozer, scraper, clamshell, forklift, backhoe, crane, auger, or sweeper.

Lifting Equipment

Cranes are used for raising, shifting and lowering loads by means of a projecting swinging arm or with the hoisting apparatus supported on an overhead truck. An appropriate capacity of crane shall be chosen to work for a specified size of load. The use of a crane for loads beyond its capacity poses several hazards to workers, as well as operators.

Note that coverage is limited here. For detailed information, refer to the OSHA standard (Subpart N 1926.550) for cranes.

For more information about crane and derrick safety see OSHAcademy Courses 820 and 821.

Loading and Hauling Equipment

Loaders: Loaders are used to excavate and move soft materials and load/unload trucks.

Dozer (Bulldozer): Dozers are used for pushing and pulling loads typically in earthwork operations and demolition work.

Scrapers: Scrapers are used for loading, hauling, dumping, and spreading loose materials.

Dump Trucks: Dump Trucks are the most common type of hauling equipment due to their versatility.

Wagons: Wagons are earth moving trailers pulled by tractors.

Compaction Equipment

Rollers: Rollers are used for compacting road bed materials like earth, aggregates and bituminous mixtures. There are various types of rollers. The selection of rollers for a particular job depends upon the types of material to be compacted.

The following are the types of rollers commonly used in highway and street construction/maintenance:

- static steel-wheeled rollers
- vibratory steel-wheeled rollers
- pneumatic (rubber-tired) rollers

Grading and Finishing Equipment

Graders are commonly referred to as road graders, or motor graders. They have a long blade used to create a flat surface during the grading process. Graders are multi-purpose equipment used for:

- finishing
- shaping
- bank sloping
- ditching
- mixing
- spreading
- side casting
- leveling and crowning
- site striping operations
- earth road maintenance

Paving and Surface Treatment Equipment

Paving equipment (paving machine, paver finisher, asphalt finisher) is used to lay asphalt on the surfaces of roads, parking lots, bridges, etc. Here is an expanded list of paving equipment operations:

- aggregate spreaders
- asphalt distributors
- asphalt kettles
- asphalt pavers
- rotary power brooms

- blowers or water sprays
- pavement profilers

Module 1 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **Which of the following is a power-driven machine mostly used in earthmoving operations?**

   a. Crane
   b. Excavator
   c. Dozer
   d. Grader

2. **Which of the following has a long blade used to create a flat surface?**

   a. Roller
   b. Crane
   c. Dozer
   d. Grader

3. **Which of the following is used for pushing and pulling loads typically in earthwork operations and demolition work?**

   a. Dozer
   b. Excavator
   c. Crane
   d. Grader

4. **Which of the following is used for compacting road bed materials like earth, aggregates and bituminous mixtures?**

   a. Roller
   b. Crane
   c. Dozer
   d. Grader

5. **Which of the following equipment is used to lay asphalt on a surface?**

    a. Roller
    b. Paver
    c. Dozer
    d. Grader

Module 2: Heavy Equipment Hazards

The use of heavy equipment on a jobsite is vital and necessary to the overall success of the construction project. However, unauthorized or unwise use of heavy equipment can result in personal injury, loss of life, or severe loss to materials needed to complete the project. Today we will discuss some key points to keep in mind when working around heavy equipment.

Poor Repair or Service

Poor repair or service of equipment is a common hazard. Poor repair may include repairing by an unauthorized person. Such repairs or servicing of equipment may jeopardize the safety of operators and others due to mechanical failure of heavy equipment.

Obstructed View While Backing

Due to the size of heavy equipment, equipment operators have obstructed view and blind spots while backing. Dirty or broken windows may also block an operator's view of people or objects posing potential hazards.

Striking People and Collision with Other Equipment

Heavy equipment usually operates in close proximity to other heavy equipment and on-foot workers. The path of the equipment within the work space constantly changes. The interactions between the heavy equipment and on-foot workers are not always coordinated.

Caught Between Equipment and Objects

Many incidents have occurred in work areas where on-foot workers are caught between heavy equipment and other fixed objects or crushed between the equipment. This happens more often when the turning radius for the equipment or trucks is not wide enough at the entry and exit points of the work space within the work zone.

Riders Falling Off Equipment or Buckets

Although not permitted, casual riding of the equipment by workers (other than the operators) has been the cause of many construction workplace accidents.

Overturning of Equipment

Overturning of equipment can occur when the load on the equipment is more than the capacity of the equipment. Overturning also occurs when one side of the equipment is on unstable or loose ground or on a depressed area.

Driving at Excessive Speeds

Heavy equipment is not designed for excessive speeds. However, if they are not loaded, the operators may have a tendency to drive at higher than normal speeds causing hazards to on-foot workers and others on site.

Unexpected Electrical Shock

Heavy equipment can come in contact with overhead and underground power lines that cause electrical shock or electrocution.

Failure of Lifting Mechanisms/Operational Failures

Such failures can occur in lifting equipment either due to the mechanical failure or lack of proper knowledge of the lifting mechanism.

Injuries to Operators Due to Ingress/Egress Difficulties

Poor ergonomic design and improper ingress and egress practices (e.g. jumping out of the cab instead of coming down slowly) can cause injuries to equipment operators.

Runaway Machines

Runaway occurs when the wheels are not blocked upon parking or when operators are not able to control the equipment. Parking along a steep surface without proper blocks on the downgrade side of wheels will most likely cause such a hazard.

Overhead Obstructions

Being struck by limbs of trees or other overhead obstructions, and moving equipment can occur when the operators are unaware of the limbs of trees or other fixed overhead objects. Another cause of such hazard can be due to the poor judgment of operators on the horizontal and vertical clearances.

Accident Summary

Tractor without ROPS at scene of overturn.

A man died when the tractor he was operating overturned upside down pinning him underneath. The old tractor had a narrow (tricycle) front axle. It did not have a rollover protective structure (ROPS). A frontend loader was attached to the tractor's frame but no counter-weights had been installed for ballast. The loader with its bucket full of rocks was raised to nearly hood height. The tractor leaned to the right as the man steered it forward at a slight upward angle on a slope. The position of the heavy load, the absence of ballast, the tractor's configuration, the dynamics of the tractor-loader combination and its load in transport on the sloping, uneven terrain contributed to the sudden overturn of this tractor. ROPS and use of the seat belt would likely have prevented this man's death.

Source: Iowa FACE Program

Module 2 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **Unauthorized persons servicing equipment may jeopardize the safety of operators and others due to _____ of heavy equipment.**

    a. mechanical failure
    b. incorrect classification
    c. improper signaling
    d. electrical designation

2. **Which of the following is a hazard due to the size of heavy equipment?**

    a. Over-exertion and heat stress
    b. Obstructed view and blind spots
    c. Improper handling of equipment
    d. Reduced awareness of hazards

3. **Which of the following is a hazard which might cause heavy equipment to collide or strike on-foot workers?**

    a. Over-exertion and heat stress
    b. Close proximity of heavy equipment operations
    c. Paths for equipment work spaces never change
    d. Too much operator-worker coordination

4. **What is the most likely cause for workers getting caught or crushed between heavy equipment and objects?**

    a. The turning radius for the equipment is not wide enough at entry and exit points
    b. The interactions between the heavy equipment workers are not always coordinated
    c. The path of the equipment within the work space constantly changes
    d. Dirty or broken windows may also block operators' view

5. **What can happen if heavy equipment operators are not familiar with their equipment's vertical and horizontal clearances?**

   a. A runaway situation may develop
   b. An injury may occur due to poor ergonomic design of equipment
   c. The equipment may strike overhead and other obstructions
   d. The equipment may overturn

Module 3: Controls and Best Practices

Key Engineering Controls and Work Practices

To ensure safe operation of heavy equipment, follow these controls and best work practices:

- All vehicles must have:
  - a service brake system, an emergency brake system, and a parking brake system;
  - working headlights, tail lights, and brake lights;
  - an audible warning device (horn); and
  - an intact windshield with working windshield wipers.
- Ensure all operators have been trained on the equipment they will use.
- Check vehicles at the beginning of each shift to ensure that the parts, equipment, and accessories are in safe operating condition. Repair or replace any defective parts or equipment prior to use.
- Do not operate vehicle in reverse with an obstructed rear view unless it has a reverse signal alarm capable of being heard above ambient noise levels or a signal observer indicates that it is safe to move.
- Vehicles loaded from the top (e.g., dump trucks) must have cab shields or canopies to protect the operator while loading.
- Ensure that vehicles used to transport workers have seats, with operable seat belts firmly secured and adequate for the number of workers to be carried.
- Equipment should have roll-over protection and protection from falling debris hazards as needed.
- Prior to permitting construction equipment or vehicles onto an access roadway or grade, verify that the roadway or grade is constructed and maintained to safely accommodate the equipment and vehicles involved.
- Do not modify the equipment's capacity or safety features without the manufacturer's written approval.

- Where possible, do not allow debris collection work or other operations involving heavy equipment under overhead lines.

Materials Falling from Vehicles

Key engineering controls and work practices include:

- Do not overload vehicles.
- Ensure that loads are balanced and are fully contained within the vehicle. Trim loads, where necessary, to ensure loads do not extend beyond the sides or top of the vehicle.
- Cover and secure loads before moving the vehicle.

Diesel Exhaust/Diesel Particulate Matter (DPM)

Diesel engines provide power to a wide variety of vehicles, heavy equipment, and other machinery used in a large number of industries including mining, transportation, construction, agriculture, maritime, and many types of manufacturing operations.

The exhaust from diesel engines contains a mixture of gases and very small particles that can create a health hazard when not properly controlled.

For more information on the hazards posed by diesel exhaust, visit OSHA's Hazard Alert - Diesel Exhaust/Diesel Particulate Matter webpage.

Silica, Nuisance Dust, Dried Mud, or Silt

When inhaled, the fine crystalline silica particles contained in the dust can become lodged deep in the lungs, which can lead to silicosis and other respiratory illnesses.

Key engineering controls and safe work practices to protect against the hazards associated with inhalation of silica include:

- Stay upwind of or away from dust-generating activities, in particular those involving crystalline silica-containing materials like concrete, brick, tile, drywall, mortar, sand, or stone.
- Use water spray or mist to suppress dust generation, especially during operations that may create a lot of dust, such as cutting or sawing silica-containing materials, jack hammering, impact drilling, using heavy equipment, and demolishing structures.
- Avoid using compressed air for cleaning surfaces.
- Sample worker exposures to silica during dust-generating activities.

Use the following personal protective equipment as necessary:

- At a minimum, use respirators with N, R, or P95 filters for work with crystalline silica-containing materials (e.g., concrete, brick, tile, mortar). The use of N, R, or P100 filters may provide additional protection. Higher levels of respiratory protection may be needed for some operations (e.g., cutting concrete, sandblasting, mixing concrete).
- N, R, or P95 respirators may be used for nuisance dusts (e.g., dried mud, dirt, or silt) and mold (except mold remediation). Filters with a charcoal layer may be used for odors.

Noise and Hearing Protection

Key engineering controls and safe work practices to protect against the hazards associated with excessive noise include:

- Use heavy equipment with enclosed, temperature-controlled cabs when available.
- Place generators, compressors, and other noisy equipment at a distance or behind a barrier when possible.
- Use hearing protection when working around potential noise sources and when noise levels exceed 90 dBA. Generally, if you cannot hold a conversation in a normal speaking voice with a person who is standing at arm's length (approximately 3 feet), the noise level may exceed 90 dBA.

Fueling Heavy Equipment

Key engineering controls and work practices include:

- Ensure that ignition sources are at least 25 feet away from fueling areas.
- Prohibit smoking in fueling areas.
- Ensure that vehicles are attended while being fueled.

Hazardous Chemicals

Key engineering controls and work practices include:

- Do not use spark-producing devices (e.g., engines, tools, electronic, and communications equipment) in the immediate area.
- Take self-protective measures (i.e., move to a safe distance upwind).
- Contact hazardous material response personnel for evaluation/removal before continuing work in the area.

Use the following personal protective equipment as necessary and evaluate the need to revise:

- protective clothing
- respirators
- gloves

Servicing Multi-Piece Rim Wheels

Employers should develop standard operating procedures (SOP) for servicing multi-piece rims and provide training on these procedures. Safety procedures include:

- Ensure employees are never positioned in the trajectory of (in front of or over) inflated tires mounted on multi-piece rims while servicing any wheel or tire component.
- Use a restraining device (cage or barrier) when inflating tires.

- Ensure employees do not rest or lean any part of their body or equipment on or against a restraining device being used when inflating tires.
- Do not attempt to correct the seating of side and lock rings by hammering, striking or forcing the components while the tire is pressurized.
- Never rework, weld, braze or heat cracked, broken, bent or otherwise damaged rim components.
- Do not apply heat to a multi-piece wheel or wheel component.

The employer should routinely provide employees training on the SOP. Even employees who are not assigned to service multi-piece rims should be provided the training so they will be aware of the potential hazards of these wheels, including never attempting to inflate flat tires.

Check out this WorkSafeBC video: Workers killed while servicing tires.

Heat Stress

Construction workers who are exposed to extreme heat or work in hot environments may be at risk of heat stress. Heat stress can result in heat stroke, heat exhaustion, heat cramps, or heat rashes. Heat can also increase the risk of injuries in workers as it may result in sweaty palms, fogged-up safety glasses, and dizziness. Burns may also occur as a result of accidental contact with hot surfaces or steam.

- When possible, acclimatize response and recovery workers to hot and humid environments by gradually increasing their work period or workload over the course of several days.
- Reduce physical exertion levels by providing extra individuals.
- Schedule heavy work for cooler periods of the work shift (e.g., early mornings, cool/overcast days).
- When possible, provide temperature-controlled cabs for equipment operators.
- When possible, and where appropriate, use fans/ventilation to provide air movement for cooling.
- Take frequent rest/water breaks in areas that are shaded or air conditioned.

- Drink 4 to 8 ounces of water or sports drink every 20 minutes while working in hot, humid conditions.
- Limit fluids to no more than 1 ½ quarts per hour when working in hot, humid conditions.
- Do not drink more than a total of 12 quarts of fluid in 24 hours.
- Limit the intake of caffeinated and alcoholic beverages.
- Wear light-colored clothing.
- Know the signs and symptoms of heat stress; use the buddy system to monitor one another for these signs/symptoms.
- If someone shows signs of heat stress (exhaustion or stroke), request immediate medical attention, move the individual to a cooler area in the shade, loosen or remove restrictive or heavy clothing, provide cool drinking water, and fan and mist the person with water.
- Consider the use of personal cooling devices. Examples of cooling devices include cooling vests or suits that use circulating water or ice packs, and venturi cooling systems for air-supplied respirators or encapsulating suits.

Sunburn

- Wear suntan lotion with a sun protection factor (SPF) of 15 or greater. Reapply as necessary to ensure protection throughout the work shift.
- When possible, wear a wide brim hat to protect exposed skin on face, head, and neck.
- When possible, set up work area in a shaded location.
- When possible, schedule tasks when individuals will not be exposed to direct sunlight such as during the early morning or late afternoon.

Cold Stress

During construction, workers may be required to work in cold environments, and sometimes for extended periods of time. When the body is unable to warm itself, cold-related stress may

occur. This may include tissue damage and possibly death. It's important to take the following precautions when working in the cold:

- Plan work activities so that outside work is conducted during the warmer parts of the day or rescheduled for days that are predicted to be warmer.
- When possible, move work indoors or to an area that is protected from the wind/precipitation.
- Wear layers of clothing that are windproof and waterproof. Consider keeping additional clothing with you and changing into dry clothing as soon as possible after work clothing becomes wet.
- Take frequent rest breaks in warm, sheltered spaces.
- Drink plenty of fluids to prevent dehydration and limit the intake of caffeinated beverages.
- Know the signs and symptoms of cold stress (pain and numbness in extremities, excessive fatigue, severe uncontrollable shivering, drowsiness, irritability) and use the buddy system to monitor one another for these signs/symptoms.
- If someone shows signs of cold stress (frostbite or hypothermia), request immediate medical attention, move the individual to a warmer area in a sheltered space, remove cold or wet clothing, provide warm fluids, and monitor the person.

Safety Basics: Personal Protective Equipment

Accident Summary

A male laborer died from heat stroke while sawing boards to make concrete forms for an addition to a factory. He worked until 5:00 pm that day without eating or drinking. The temperature reached 90 deg. F. and the day was quite humid. He was in the parking lot on his way to his vehicle when he apparently collapsed beside his vehicle. When EMS arrived, they recorded the laborer's body temperature as 107 degrees F. The laborer was transported to a local hospital where he died the next day with an internal body temperature of 108 degrees F. Death was listed by the coroner as due to heat stroke.

The victim helped make wooden forms for concrete pad.

Module 3 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **Which of the following is not required on all heavy equipment?**

    a. Side and backup mirrors
    b. Working headlights, tail lights, and brake lights
    c. Audible warning devices
    d. Service, emergency, and parking brake systems

2. **Who must approve any modification to the heavy equipment's capacity or safety features?**

    a. Safety staff
    b. Manufacturer
    c. OSHA
    d. Underwriter's Lab (UL)

3. **Which of the following should be accomplished to keep materials from falling from heavy vehicles?**

    a. Install roll-over protection.
    b. Ensure roadway grade is level.
    c. Do not modify the equipment's capacity.
    d. Ensure loads are balanced.

4. **Heavy equipment operators should ensure that ignition sources are at least _____ feet away from fueling areas.**

    a. 20
    b. 25
    c. 15
    d. 10

5. **To help prevent heat stress, limit fluids to no more than _____ when working in hot, humid conditions on construction sites.**

   a. 2 quarts a day
   b. 6 quarts a day
   c. 12 quarts a day
   d. 8 quarts a day

Module 4: Equipment Operator Safety

It is the operator's responsibility to know how to operate heavy equipment safely. Operators without proper license to operate specific equipment must not be allowed to. Operators must know the proper use and limitations of specific equipment. If the equipment is not designed for a specific task, it should not be used for that job. Operators should know the safe operating practices of specific equipment available in the manufacturer's instructions. If manufacturer's instructions are not available, the manufacturer should be contacted to get it.

Safety features such as kill switches, guards, shields, reverse alarms, roll bars, or control bars must not be modified or removed. The transmission shafts should be covered. For details, refer to the manufacturer's instructions for specific equipment.

If an operator is sick, fatigued, or taking medication that may affect his/her ability to safely operate heavy equipment, he/she should notify the supervisor. Such situations can cause physical or mental impairment to operate heavy equipment.

Operators Proper Training

Only highly skilled operators who have demonstrated adequate knowledge, ability and skills to safely operate heavy equipment should be authorized for operation. In addition:

- Only authorized persons should operate the heavy equipment (with appropriate training and/or licenses).
- Operators should know and understand the limitations of the machinery.
- They should follow safe operating procedures, utilize safety features, and heed the manufacturer's warnings.

Operator Equipment Safety Checks

Operators should follow the procedures below before the start of each shift (a check list is recommended):

- Approach equipment, walk fully around it and look for hazards on or near equipment.
- Inside the cab, remove trash, make sure cab windows are clean, adjust mirrors, check the fire extinguisher, turn on all exterior lights, and make sure seatbelt is ready to use.
- Outside again, check lights, tires, suspension and steering system, exterior hoses and filters. Look for cracks in the metal structure, unguarded moving parts, or other unsafe conditions. Check engine compartment and belts. Make sure fluid levels are correct.
- Inside again, check all gauges and warning lights before starting. Make sure parking brake is set and other manufacturer's engine start-up guidelines are followed. Start engine; check gauges and warning lights again. Check engine sounds.
- Before moving, warn people in the area. Test your equipment's movements and make sure the backup alarms can be heard.

Working Around Heavy Equipment

Safety is a collective effort. The on-foot workers working around the equipment should also be trained for safe working practices and avoiding potential hazards and resulting injuries. Several kinds of potentially hazardous interactions occur with the equipment in the work area.

Effective communication between operators and other workers is essential. The operators and the signal person should use a standardized set of hand signals. Operators should always know exactly where all on-foot workers are located, and the wearing of high visibility vests will help the operator to locate them quickly.

The equipment should have a back-up warning alarm that can be heard by all nearby workers. Two-way radios are also very useful communication tools.

General Safety Measures When Working Around Heavy Equipment

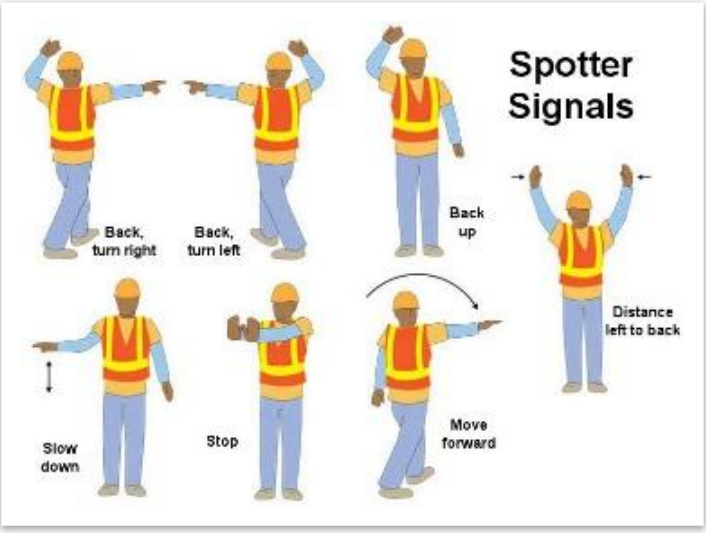
All workers should use the following safe work practices when working around heavy equipment.

- Wear high visibility clothing.

- Do not assume operators can see you.
- Keep back up alarms working properly at all times.
- Make sure heavy equipment is equipped with rollover protective measures (e.g., outriggers).
- Use a seat belt and required PPE when operating your equipment (e.g., hard hats, gloves, steel toe shoes, reflective clothing, etc.).
- Use appropriate hearing protection when working on or around loud equipment.
- Do not wear loose fitting clothes that may get caught in moving parts.
- Never jump onto or off the equipment.
- Never operate any of the controls from any position except the operator's seat.
- Never permit anyone to ride on the equipment.
- Never refuel when the engine is running.
- DO NOT SMOKE when refueling.

Signal Persons/Spotters

The use of signal persons or spotters is a proven method of protecting employees on foot behind heavy equipment and vehicles with an obstructed view, but spotters themselves can be at risk for injury or even death. Employers can implement the following actions to help keep spotters safe:



- Spotters and drivers should agree on hand signals before backing up.

- Spotters should always maintain visual contact with the driver while the vehicle is backing.
- Drivers should stop backing immediately if they lose sight of the spotter.
- Spotters should not have additional duties while they are acting as spotters.
- Spotters should not use personal mobile phones, personal headphones, or other items which could pose a distraction during spotting activities.
- Spotters should be provided with high-visibility clothing, especially during night operations.

Accident Summary

A contractor was operating a backhoe when an employee attempted to walk between the swinging superstructure of the backhoe and a concrete wall. As the employee approached from the operator's blind side, the superstructure hit the victim, crushing him against the wall. Employees had not been trained in safe work practices, and no barricades had been erected to prevent employee access to a hazardous area.

Crane Operations Safety Measures

Following safety precautions for cranes should be exercised in conjunction with the general safety precautions for heavy equipment.

- Never hoist objects with unknown weights. It may be difficult to judge the load in some cases (e.g., an object in water). When hoisting a load from water below, the crane takes on the added load imposed by the displaced water as the load is hoisted out of the water.
- When handling a heavy load, raise it a few inches to determine whether there is undue stress on any part of the sling and to ensure the load is balanced. If anything is wrong, lower the load at once and do not attempt to move it until the necessary adjustment or repair has been made.
- Before hoisting a near-capacity load, make sure the hoisting line is vertical. Move the crane instead of lowering the boom, since swinging a capacity load increases the chance of tipping.

- When lowering the boom under load, use extreme caution. Check the load chart with attention to radius changes and observe the radius indicator. These charts are posted in the operator's cab. Never lower the hoisting line and the boom simultaneously. When lowering loads, use a low speed not to exceed the hoisting speed of the equipment for the same load. The ordinary hoisting speed of a 30-ton, motor-operated crane is about 18 feet per minute with a rated load. Stopping the load at such speeds in a short distance may double the stress on the slings and crane.

- Be careful to guard workers, other equipment or objects against being hit from swinging loads. Do not swing loads over workers. If it is necessary to move loads over occupied areas, give adequate warning (by bell or siren) so workers can move into safe locations.

  Here's a short video that shows what can happen when a lift goes wrong.

- Do not attempt dual lifts unless absolutely necessary and only with competent supervision throughout the operation. Dual lifts are extremely dangerous. Shifting of the load can cause overloading and failure of one crane. This throws the entire load onto the second crane causing it to fail. Before making a dual lift, carefully determine the position for the cranes and the location of the slings to balance the load properly.

- After repair or alteration of a crane or derrick involving its hoisting capacity or stability, its safe working load should be determined by a competent person. Have this person issue a written statement specifying the safe working load.

- Test the brakes at the beginning of each new shift, after a rainstorm, or at any other time when brake linings may have become wet. When hoisting a capacity load, check the brakes by stopping the hoist a few inches above the ground and holding it with the brake.

- Equip all cranes with an appropriate fire extinguisher. Keep the extinguishers maintained and ready for use.

Safety Measures for Asphalt Paving Operations

General prevention measures for heavy equipment are also applicable for paving and surface equipment. In addition, asphalt paving operations involve exposure to bituminous materials that pose several hazards to workers.

Asphalt is a blackish-brown solid, semi-solid or liquid depending on the formulation or mixture of asphalt being used. Asphalt fumes are produced during the manufacture and heating of asphalt, which is used for road building.

One of the most dangerous hazards is associated with the heating required to convert the solid or semisolid materials to a degree of fluidity, which will permit their application or mixing.

The following safety measures should be exercised during asphalt paving operations:

- Make sure fire-extinguishing equipment (foam type) is present at all times.
- Ensure that an asphalt distributor or asphalt kettle are in a level position (before heating) and are located at a safe distance from buildings and other flammable materials.
- Avoid exposure to fumes from hot bituminous material by staying on the windward side of the operation. Breathing asphalt fumes can irritate the nose, throat and lungs, which can cause coughing, wheezing and/or shortness of breath. It can also cause headache, dizziness, nausea and vomiting. Contact can irritate and cause severe burns of the skin and may cause dermatitis and acne-like lesions.
- Wear gloves and full body clothing to avoid prolonged skin contact or burns from hot bituminous material. Clothing should be closed at the neck; sleeves should be rolled down over the tops of gloves. Workers should wear cuffless trousers that extend well down over the top of safety shoes. Goggles should be worn to prevent eye burns from bubbling or splashing asphalt. In addition, workers should always wear a safety hard hat.
- Wash thoroughly immediately after exposure to asphalt and at the end of the workshift.

Check out this classic video: Caterpillar General Safety Video

Accident Summary

A construction worker died after being run over by an asphalt road-widening machine when it ran backwards over him. The man was part of a crew widening a state highway. The victim's job was to walk to the side and rear of the road widener, visually adjusting the machine's side-mounted spreader arm. After the first layer of asphalt was applied, the victim apparently jumped on the machine as it was backing up, slipped off and was run over by the right front tire.

Asphalt machine runs over and kills worker in Iowa.

Fresh asphalt on the bottom of his boots may have contributed to his fall. The machine weighed 40 tons and amputated his left leg and injured his hemipelvis. The man was flown to a regional hospital and had major complications, including significant internal bleeding and cardiac arrest. The worker died nine days later.

Source: Iowa Face Program

Module 4 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **When operating heavy equipment, operators and the signal person should use _____.**

    a. a specialized set of hand signals
    b. a standardized set of hand signals
    c. flags to convey direction of motion
    d. common sense when signaling

2. **Which of the following is true regarding safe practices for spotters?**

    a. Drivers should back up slowly if they lose sight of the spotter
    b. Spotters may also act as drivers while spotting
    c. Spotters may not be used during night-time hour
    d. Spotters and drivers should use the same hand signals

3. **Which of the following is the correct procedure to get a crane's hoisting line vertical?**

    a. Move the crane instead of lowering the boom
    b. Lower the boom instead of moving the crane
    c. Lower the boom and move the crane
    d. Move the crane and lift the boom

4. **Which of the following must occur before performing a crane dual lift?**

    a. Permission from the site supervisor
    b. Approval for the lift from a competent person
    c. Permits obtained from OSHA
    d. Test the loads by lifting a few feet and holding

5. **Which of the following is one of the most dangerous hazards in asphalt paving operations?**

    a. Hazardous atmosphere due to evaporating materials
    b. Exposure to excessive noise
    c. Heating solids prior to application or mixing
    d. Being struck by machinery

Module 5: Work Zone Safety and Traffic Control

Safety in construction work zones is of great concern since it is one of the most hazardous occupations in the USA.

Workers are subjected to possible accidents from:

- movement of equipment and vehicles within the work zones
- hazards from general construction work
- passing motor vehicles intruding in the work zone
- flaggers and other construction workers being struck by vehicles or construction equipment
- overturning vehicles and equipment
- collision, or being caught in running the equipment and others

Protecting Workers from Vehicular Traffic

According to the Bureau of Labor Statistics (BLS), traffic zone workers are roughly as likely to be struck by construction- or maintenance-related equipment (dump trucks, bulldozers, graders, etc.) as by cars, vans, tractor-trailers, buses, and motorcycles. The BLS says between 2003 and 2010, U.S. workers were fatally struck 152 times by construction- or maintenance-related equipment and 153 times by the other vehicles.

Most of the fatalities are due to:

- on-foot workers struck by passing vehicular traffic
- on-foot workers struck by construction vehicles
- construction vehicle operator and occupant events (e.g., rollovers)
- highway traffic accidents caused by crashes involving motorists from the passing traffic that intrude into the work area

Key Engineering Controls and Work Practices

- Develop and use a site plan that provides traffic flow details (See traffic flow diagrams. Other Manual on Uniform Traffic Control Devices (MUTCD) model plans are also available).
- Use flaggers, traffic cones, and/or highway channeling devices to steer traffic away from response and recovery workers along the roadway.
- Use flaggers, standard road signs (e.g., "work zone ahead"), or message boards to warn approaching vehicles of a work area.
- Give motorists plenty of warning of upcoming work zones. Place the first warning signs at a distance calculated as 4 to 8 times (in feet) the speed limit (in MPH). Use a higher multiplier for higher speed areas (e.g., a 15 MPH road under construction should have its first warning sign at least 60 feet from the work zone, while a work zone needed in a 65 MPH zone should have its first sign approximately 520 feet away).
- Ensure the work zone is well lit, but control glare to avoid temporarily blinding response and recovery workers or passing motorists.

High Visibility Safety Apparel and Headwear

ANSI/ISEA 107-2004 specifies four performance classes of apparel or headwear that have different amounts of reflective and background material to enhance pedestrian worker visibility under a variety of work and traffic conditions.

Employers should perform a hazard analysis to decide which performance class is needed based on the work conditions anticipated (e.g., closeness of the work area to traffic, time of day/night, weather, complexity of the background environment, pedestrian worker's task load (need to divert attention to complete other tasks), and traffic speed). This analysis is part of the PPE assessment required by 29 CFR 1910.132(d).

- **Class E garments** are pants and shorts that have retroreflective and background materials, but may not meet minimum area or placement requirements outlined in the standard. Class E garments are not intended to be worn without a Class 2 or 3 garments
- **Class 1 garments** provide the minimum amount of required material needed to tell the pedestrian worker apart from the work environment. Class 1 garments are appropriate for activities where pedestrian workers can pay full attention to the approaching traffic,

there is enough separation between the pedestrian worker and the vehicle traffic, the work background is not complex, and vehicles and equipment are traveling at speeds less than 25 mph.

- **Class 2 garments** are appropriate for most hurricane response and recovery work because of the complex work backgrounds, closeness of pedestrian worker to the traffic, the need for the pedestrian worker to divert his/her attention to complete other tasks, or vehicles/equipment are traveling at speeds of 25 miles per hour (mph) or more. Class 2 garments provide better visibility than Class 1 garments by providing additional coverage of the torso.

- **Class 3 garments** offer the greatest level of visibility in both complex work backgrounds and through a full range of body motion. Class 3 garments should be considered for activities where a pedestrian worker may be exposed to higher vehicle speeds and/or reduced sight distances, the pedestrian worker and vehicle operators have high task loads, or the wearer must be identifiable as a person at least one-quarter mile away.

Traffic Control Within a Worksite

Make sure you follow these key engineering controls and work practices:

- Develop and use a site plan that provides traffic flow details.

- Limit access, barricade, or set up controlled access zones where the equipment will be used. For equipment that rotates and/or carries/dumps loads, create an access zone that extends beyond the maximum rotation/swing radius of the equipment and/or beyond the area where loads will be carried/dumped.

- Illuminate the work area and its approaches to provide better visibility for drivers to safely travel through the work zone.

- Establish/follow traffic control patterns (e.g., cones, barrels, barricades) in work areas.

- Use spotters where visibility is limited.

- Do not drive in reverse gear with an obstructed rear view unless the vehicle has an audible alarm or a signaler is used.

- Ensure that spotters and heavy equipment operators have communications equipment or agree on and use hand signals.

- Workers and pedestrians should make eye contact with heavy equipment operators before proceeding near equipment or operating areas.
- Use ANSI/ISEA 107-2004 compliant high visibility safety apparel and headwear.
- Provide signaling, slow/stop signs, or wands/flashlights for flaggers providing traffic control outside the work zone.

Check out this short video by Caterpillar: Off Highway Trucks - Fatal Mistakes

Accident Summary

A worker was cutting concrete along the white center line on a four-lane highway. Orange reflective barrels closed the left lane to traffic, which was routed to a single lane from approximately 8 miles. To accommodate the worker, three to four barrels had been moved into the active traffic lane, and a flagger was slowing down traffic and directing it slightly onto the berm area. An approaching semi-tractor and trailer rig were exceeding the speed limit when the driver hit the guardrail and lost control of his vehicle. The tractor and trailer bounced back through the barrels and struck the worker from behind, killing him.

Module 5 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **A 15 MPH road should have its first warning sign _____ from the work zone.**

    a. at least 30 feet
    b. at least 60 feet
    c. at least 90 feet
    d. at least 20 feet

2. **Which of the following provide the minimum amount of required material needed to tell a pedestrian worker apart from the work environment?**

    a. Class E garments
    b. Class 1 garments
    c. Class 2 garments
    d. Class 3 garments

3. **Which of the following offer the greatest level of visibility in both complex work backgrounds and through a full range of body motion?**

    a. Class E garments
    b. Class 1 garments
    c. Class 2 garments
    d. Class 3 garments

4. **What should workers and pedestrians do before proceeding near heavy equipment or operating areas?**

    a. Give the operator a shout to disclose their position
    b. Walk at least 10 feet from rotating platforms
    c. Wear highly visibility apparel
    d. Make eye contact with heavy equipment operators

5. **To give motorists plenty of warning of upcoming work zones, place the first warning signs at a distance calculated as _____.**

   a. 2 to 4 times (in feet) the speed limit (in MPH)
   b. 4 to 8 times (in feet) the speed limit (in MPH)
   c. at least five times (in feet) the speed limit (in MPH)
   d. equal to or greater than the speed limit (in MPH)

Endnotes

1. 29 CFR 1926.600, Equipment OSHA. Retrieved from: https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10767

2. Heavy Equipment and Powered Industrial Truck Use, OSHA. Retrieved from: https://www.osha.gov/SLTC/etools/hurricane/heavy-equip.html#index

3. SafetyWorks! Toolbox Talks, Maine Dept. of Labor. Retrieved from: http://www.maine.gov/tools/whatsnew/index.php?topic=Safetyworks_Tips&id=75056&v=toolboxpage

4. Pocket Guide for the Construction Industry, CAL/OSHA (October 2013). Retrieved from: http://www.dir.ca.gov/dosh/dosh_publications/constguideonline.pdf