• This training course is intended for those who operate and/or work with excavators. The training material is designed to allow the trainer to add or delete material in order to tailor the course to their particular situation.

• Course Outline: The following topics are covered in the course material:
  – Basic components of the excavator
  – Inspecting the excavator
  – Operator responsibilities and safety precautions
  – Moving the excavator about the worksite
  – Hand signals
  – Excavating and trenching
  – Lifting with the excavator
  – Transporting the excavator
Purpose of Slide: To discuss the need for inspecting the machine.

Prior to the excavator being placed into service at the beginning of a shift, the operator should conduct a basic inspection of the machine. That inspection may include:

- All safety devices: Horns, lights, guards and shields, fire extinguisher, glass and wipers.
- Engine and hydraulic fluid levels
- Boom, stick, and bucket
- Hydraulic leak
- All controls for proper function

A more thorough inspection should be conducted on a periodic basis. Typically, this is on a monthly basis, but depending on the amount of time the machine is being used and under what conditions more or less frequent inspections may be necessary. The inspection check list shown on the slide is an aid in conducting the thorough inspection. The operator’s manual should be consulted to identify any additional inspection requirements.
The Car Body consists of the frame and rotation bearing.

**Purpose of Slide:** To discuss the inspection of the frame and rotation bearing of the excavator.

- The frame of the excavator needs to be inspected for cracked welds and loose bolts. This will require crawling under the machine to perform this inspection. Often because of wet or muddy conditions, these inspections are overlooked. As the machine gets older, the potential for failed welds or fasteners increases. An illustration of a typical rotation bearing is shown in the slide. One half of the bearing is attached to the frame and the other half is attached to the upper structure. The only thing holding the two halves of the bearing together are the ball bearings. When digging and lifting with the excavator, this bearing experiences tremendous loads and therefore needs to lubricated regularly. Excessive bearing wear can be detected by first observing the relative location of the two bearing halves with each other with the bucket off the ground. Next, place the bucket on the ground and slightly lift the tracks off the ground with the boom. Again, observe the relative location of the two bearing halves. If the bearing halves separate more than .060 of an inch, the manufacturer should be consulted to determine the amount of allowable play.

**Inspect the car body components for cracks and bearing wear.**
• Purpose of Slide: To discuss the inspection of the track sprocket and idler.

• Inspect the drive sprocket for worn or cracked teeth. A broken tooth on the sprocket will cause excessive wear to the pad sockets. Check the drive seals for leaks.

• The front idler needs to be checked for wear and flat spots. Depending on the type of material the excavator has been working in, the perimeter of the idler can be chipped or nicked which can result in wear to the pad sockets.
• Purpose: Review the inspection of the engine compartment.

• At the beginning of a shift, the level of all fluids should be checked. Depending on the condition of the engine, it may be necessary to check fluids throughout the shift. Check belts for proper tension and wear. A broken belt can result in a project being shut down for several hours.

• Check radiator and other hoses for cracks.

• The engine compartment, especially the radiator, can become very dirty. Frequent cleaning may be necessary to keep dirt from building up in the radiator and on the engine itself. Excessive dirt can cause the engine to run hotter than normal which will reduce its life.
CAB

The cab glass needs to be cleaned frequently to ensure good visibility.

Keep the cab floor clean & free of debris.

All controls should be tested before using the machine to verify their proper function. All controls need to be properly labeled.

• Purpose: To review the inspection and maintenance of the operator’s cab.

• The operator’s cab needs to be kept clean of dirt, grease and objects which could interfere with the safe operation of the machine. It is recommended that basic housekeeping items be kept on the machine to facilitate keeping it clean. The glass in the machine needs to be free of cracks that would impair the vision of the operator. Clean the glass regularly to increase visibility and to avoid reflection in sunlight. The windshield wipers need to work and the blade should be replaced periodically to avoid streaking.

• All controls need to be properly labeled with their function and direction of motion. Test each control before starting work to confirm they are in proper working order.

• The cab should have a fire extinguisher that has a current inspection label.
Purpose of Slide: This slide discusses the inspection and maintenance of the bucket.

- Inspect the bucket for cracked welds, particularly where the hinge gussets are attached.
- Inspect bucket hinge pins and linkages for excessive wear, missing keeper pins and other damage.
- Make sure the pins or bolts used to attach the teeth to the bucket are in place and not excessively worn. Also, evaluate the wear on the teeth for planning the next change out.
- If the excavator is fitted with a thumb, inspect the hinge pin and associated linkages for wear and damage.
- The frequency of greasing the bucket hinge pins is dependent on weather conditions and the type of material being excavated. In sandy or powdery material it may be necessary to grease these components two to three times a shift. The fine material will have a tendency to work their way into the hinges and accelerate wear. Frequent greasing will keep pushing this material out. Buckets that will be digging below water need frequent greasing to keep it fresh. At the end of the shift where the machine will sit overnight, grease all these areas again to prevent corrosion. After greasing, exercise the bucket to distribute the grease.
SEAT BELTS

• Inspected Each Day

• Should Be Worn When Operating The Machine

Purpose of Slide: To discuss the use of seat belts.

Seat belts are a safety device and as such must be kept in operating condition. Worn or damaged belts need to be replaced.

When moving the machine over rough terrain or on steep slopes, the seat belt will help keep the operator in the seat allowing him to maintain control of the machine.

Some manufactures recommend replacing the whole seat belt assembly every three years regardless of appearance.
**OPERATOR RESPONSIBILITIES**

- **Operator:**

- **The Machine:**

- **People Around Machine:**

- **Property:**

**Purpose of Slide:** To review the operator’s responsibilities.

The operator of an excavator is responsible for safe operation of the machine and the safety of those working in the vicinity of it. The next few slides will cover these responsibilities in greater depth.
• Purpose of Slide: To discuss how different factors can affect an operator’s awareness while operating an excavator.

• Several factors can affect an operator’s ability to stay focused on operating their machine.

• **Fatigue & Hunger**: Fatigue can result from working too many hours, lack of sleep, hunger or monotonous, repetitive work. When an operator shows signs of fatigue, they should be relieved to get rest or exercise to refresh their alertness.

• **Weather**: Some excavators are open to the elements. An operator needs to dress appropriately for the weather to prevent stress on their body.

• **Emotional Level**: Operators under emotional stress may not be able to stay focused. It may be necessary at times to remove such an operator from a machine until emotional equilibrium is restored.

• **Physical Health**: Operators suffering from health problems affecting their machine operating ability should not be allowed on a machine. Even workers taking cold medicine may have their alertness compromised.

• **Working Conditions**: Some worksites that have many activities occurring simultaneously can distract an operator. Operators must be able to block out such distractions while operating a machine.

• **Other People**: People should not attempt to talk to or in any way distract an operator who is operating a machine. Wait until they are finished with an operation before approaching or talking to the individual.
• Purpose of Slide: To discuss what should be done in case of a power line contact.

1. When the excavator comes in contact with a live power line, the whole machine becomes electrified. Due to the different current paths that the electricity can flow, parts of the machine could be at different voltages. If the operator touches different parts of the machine, his body could create a current path which could result in electrocution.

2. The ground around the excavator can also become electrified. The voltage in the soil nearest the machine will be greater than that further away from it. When moving away from the excavator, individuals should shuffle to avoid creating a current path from one foot to the other.

3. The operator should remain with the excavator if at all possible until the power company indicates it is safe to leave the machine. This is because the excavator components could be at different voltages and touching parts of the machine could result in being electrocuted.

4. No one should be allowed to approach the excavator or to touch it. If the operator is unconscious, no attempt should be made to rescue him until the power company indicates it is safe to do so.

5. If the operator must leave the excavator due to fire, he should move slowly to the edge of the cab without touching it and carefully jump to the ground. Once on the ground, he should shuffle away from the machine.
To prevent people from entering the danger area of the machine, this area may need to be barricaded to limit access. This is particularly true when working in a public area.

• Purpose of Slide: To discuss requirements for controlling access to a worksite.

• Before excavating work begins, access to the worksite by unauthorized persons needs to be controlled. Barriers of cones, barrels or other structures can establish the work area perimeter. Caution tape, barricade safety fencing or other well-marked material should be placed between the vertical barriers to prevent people from accidentally entering the work area.
MOVING UP A SLOPE

When preparing to move the excavator up a slope, make sure the seat belt is fastened.

• At the base of the slope extend the boom and stick up the slope. This will help place more weight on the front to increase traction.

• The tracks should be in line with the slope to prevent the machine from traversing up the slope at an angle.

Purpose of Slide: To review the basics for moving an excavator up a slope.

Before moving the excavator up a slope, the operator should make sure that his/her seat belt is properly fastened.

When approaching the slope the position of the drivers either in front or in the rear is a matter of opinion. Some prefer them in the rear but others, including some manufacturers recommend them to be in the front.

As the excavator starts up the incline the boom will need to be lowered to keep the bucket a foot or so off of the slope. When the machine is on the slope and climbing, the operator needs to monitor the traction of each track and make sure the machine is traveling in a straight line up the slope. If one track has less traction than the other the machine will tend to veer to one side causing the downhill track to dig in which may make the machine unstable. On soft material, the excavator tracks may tend to dig in at the rear which will tip the machine backwards and could result in a rear roll over.
MOVING UP A SLOPE

• Continue to pull the machine with the stick, raising the boom to keep the machine level.

• When the machine comes close to the bucket, raise the boom and reach out for another bite.

• If the slope is too steep, only track half way before taking another bite.

Purpose of Slide: To review the basics for moving an excavator up a slope.

The operator will need to watch the front of the tracks to make sure the machine is not being tipped backwards as the stick is pulled in. The operator will need to raise the boom as the stick is pulled in to keep the full surface of the tracks in contact with the slope.

When the bucket comes close to the machine, the bucket will need to be extended up the slope for another bite. As the bucket is pulled out of the hill to get another bite, the operator needs to watch the machine to make sure it will not slide back down the hill. On steep slopes, the bites need to be made more frequently so as to keep boom and stick uphill for better traction and stability.
MOVING DOWN A SLOPE

When preparing to move the excavator down a slope, make sure the seat belt is fastened.

- If possible, remove some of the material at the crest of the slope where the excavator will break over the top.
- Extend and lower the boom and stick out over the slope to place the bucket on the surface of the slope. Slowly track forward and keep the bucket in contact with the slope by lowering the boom.

**Purpose of Slide:** To review the basics for moving an excavator down a slope.

- Before moving the excavator down a slope, the operator should make sure that the seat belt is properly fastened.
- When approaching the crest of the slope, position the machine so that both tracks will go over the crest at the same time. If possible, to reduce the teetering of the excavator as it moves over the crest, cut the top off at two places where the tracks will break over the crest.
- With the machine at the crest, extend the boom and stick over the slope and put the bucket on the ground. As the machine tracks forward, the boom will need to be lowered to keep the bucket on the ground.
MOVING DOWN A SLOPE

- The excavator should slowly nose over the crest. Gently lower the machine with the boom until the tracks are in contact with the surface of the slope.

Purpose of Slide: Review the basics for moving an excavator down a slope.
HAND SIGNALS

STOP

EMERGENCY STOP

LOAD UP SLOWLY

LOAD DOWN SLOWLY

• Purpose of Slide: To review the basic hand signals used with the excavator.

• Communication between the operator and those directing the excavation work is extremely important.

• All hand signals should be given in a big and bold manner and visible to the operator. Makeshift signals can be confusing and have been the cause of serious accidents.
• Purpose: To review the basic hand signals used with the excavator.

HAND SIGNALS

STICK (DIPPER) IN

STICK (DIPPER) OUT

BOOM UP

BOOM DOWN
HAND SIGNALS

SWING/MOVE MACHINE TO THE RIGHT

SWING/MOVE MACHINE TO THE LEFT

GO THIS FAR

- Purpose: To review the basic hand signals used with the excavator.
EXCAVATING

- Is the work site on a slope?
- What other work will be taking place in the area of the excavation?
- If compaction is required, how will it be done?
- Will the excavator be required to place objects in the excavation?

Purpose of Slide: To continue to discuss the need for assessing the job site prior to beginning work.

Besides excavating, the excavator is often used to perform other tasks at the job site. If the machine will be used for lifting, the type and size of the lift load needs to be considered to ensure the excavator is adequate.
EXCAVATING

AVOID UNDERCUTTING!

- Purpose of Slide: To review the safety requirements for excavating.

- When excavating, the operator must always be alert to where the machine is in relationship to the edge of the excavation. Even if no undercut is made, the edge of the excavation may not be strong enough to support the weight of the machine.
GENERAL TRENCH PRECAUTIONS

- Keep material & equipment a minimum of 2 ft. from edge of excavation. Greater distance may be required, based on soil stability.
- Provide barricades or equivalent to prevent people from falling into trench.

Purpose of Slide: Review precautions which should be observed when a trench is under excavation.

Material excavated from a trench should be placed a minimum of two feet from the edge of the trench. This distance may need to be greater depending on soil type. The slope of the spoil pile should be flat enough to prevent material from sliding into the trench.

Also note in the above picture that there are workers in the trench without having adequate shielding or shoring in place.
Cave-ins may occur requiring the excavator to clean or dig the trench back to grade.

One way is to clean the trench from the top edge.

If the soil is soft sand or loam, position the excavator with the tracks perpendicular to the trench. This will distribute the weight of the machine back away from the edge reducing the possibility of more cave-ins. The disadvantage to this approach is the machine will need to be repositioned frequently.

- Purpose of Slide: To discuss basic for clearing out trench cave-ins.
- Occasionally, it will be necessary to remove cave-in material from a trench. The ideal method is to approach the trench with the tracks perpendicular to the trench. This reduces the potential for additional material sloughing into the trench.
STRADDLING A TRENCH

Vertical Walls

When the trench walls are vertical and the soil is firm the excavator can be positioned over the trench to do cleaning or addition excavations. Make sure the trench width is less than the length of the machine’s tracks.

Position the excavator with the tracks perpendicular to the trench and back a few feet from the edge. Extend the boom and stick and place the bucket on the opposite side of the trench, a minimum of 6 feet from the edge.

- Purpose of Slide: To discuss the method for straddling a vertical wall trench.
- The next slide will describe the basic method for straddling a vertical wall trench.
STRADDLING A TRENCH

Vertical Walls

Continue this forward motion process until the tracks are evenly positioned on each side of the trench. While straddling the trench, all movements should be slow to prevent disturbing the trench walls.

To move the excavator off of the trench, reverse the process. Start backing up slowly to prevent the trench wall at the rear of the machine from being pulled into the trench.

- Purpose of Slide: To discuss basic method for straddling a vertical wall trench.
When the front of the tracks reach the other side of the trench the rear of the machine may begin to settle. Adjust the boom and stick to level the machine. Once the excavator has settled into the ‘V’ of the trench, excavating can begin.
STRADDLING A TRENCH
Sloping Walls

Continue the reverse process until the machine is back on the surface of the trench edge.

• Purpose of Slide: To discuss the process and method for straddling a sloping wall trench, continued.
The principle of leverage is used to determine the excavator's rated capacities. The machine’s leverage is its weight times its leverage arm. The load’s leverage is its weight times its leverage arm. When the load’s leverage exceeds the machine’s the excavator tips over.

The teeter totter is an example of the leverage of one weight off setting the leverage of an opposite weight. When both have equal leverage, they are in balance.

- Purpose of Slide: To discuss the principle of leverage as used to determine the stability and lifting capacity of an excavator.

- For riders on a teeter totter to be in balance, the leverage created by one rider has to equal that of the other rider. The leverage of each rider is the result of the rider’s weight times his distance from the tipping point. If one rider is heavier than the other, then he will have to be closer to the tipping point than the other rider.

- For an excavator, the tipping point is the point of the tracks which is under the boom. This could be at the end of the tracks or at the side of the tracks. The excavator’s leverage is the weight of that part that is behind the tipping point times the distance from the tipping point to its center of gravity. This leverage is basically fixed. The load’s leverage is the weight of the load and that portion of the boom, stick and bucket plus the load attached to the bucket. The load’s leverage is not fixed. When the boom and stick extend the load away from the machine, the load’s leverage increases due to its increased leverage arm.

- Based on the dimensions of the excavator’s tracks, the machine typically will have more lifting capacity over the ends of the tracks than over the side.
### LIFTING WITH THE EXCAVATOR

#### The Lift Capacity Chart

The Lift Capacity chart has a section for “Over the Front” and for “Over the Side”.

If the load is lifted over the front and will be swung to over the side, use the over the side chart for determining maximum capacity.

#### Over the Front

<table>
<thead>
<tr>
<th>Load Point Height</th>
<th>Radius (Horizontal distance rotation centerline)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10 ft</td>
</tr>
<tr>
<td>25 ft</td>
<td></td>
</tr>
<tr>
<td>20 ft</td>
<td>6895 lbs</td>
</tr>
<tr>
<td>15 ft</td>
<td>13218 lbs</td>
</tr>
<tr>
<td>10 ft</td>
<td>13030 lbs</td>
</tr>
<tr>
<td>5 ft</td>
<td>14778 lbs</td>
</tr>
<tr>
<td>Ground level</td>
<td>15206 lbs</td>
</tr>
<tr>
<td>-10 ft</td>
<td>8768 lbs</td>
</tr>
<tr>
<td></td>
<td>16281 lbs</td>
</tr>
<tr>
<td></td>
<td>13790 lbs</td>
</tr>
</tbody>
</table>

#### Over the Side

<table>
<thead>
<tr>
<th>Load Point Height</th>
<th>Radius (Horizontal distance rotation centerline)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10 ft</td>
</tr>
<tr>
<td>25 ft</td>
<td></td>
</tr>
<tr>
<td>20 ft</td>
<td>6895 lbs</td>
</tr>
<tr>
<td>15 ft</td>
<td>13218 lbs</td>
</tr>
<tr>
<td>10 ft</td>
<td>9688 lbs</td>
</tr>
<tr>
<td>5 ft</td>
<td></td>
</tr>
<tr>
<td>Ground level</td>
<td>6913 lbs</td>
</tr>
<tr>
<td>-10 ft</td>
<td>8797 lbs</td>
</tr>
</tbody>
</table>

Note the difference in capacity. This is because of machine stability.

#### Purpose of Slide:

- To demonstrate how a load capacity chart is used to determine maximum lifting capacity for various radii.
- To show how the capacity for lifts made at the same radius decreases as the machine is swung to the side. Maximum capacity lifts made over the front of the machine can, if swung to the side, tip the machine over.

- The above load capacity chart is representative of a typical chart found in most operator manuals.
- The chart is divided into two sections: One for a lift made straight over the front of the machine, and one for lifts made with the machine swung to the side. Notice how the capacity for lifts made at the same radius decreases as the machine is swung to the side. Maximum capacity lifts made over the front of the machine can, if swung to the side, tip the machine over.
When attaching a chain for lifting on buckets without lifting eyes, the chain should be attached as shown in Fig. A and brought over the back of the bucket as shown in Fig. B. Never make a lift with a chain or sling attached solely to the teeth.

**Fig. A**

**Fig. B**

- **Purpose of Slide:** How a load can be attached to an excavator that doesn’t have designated attachment points.

- For buckets which do not have designated lifting attachment points, a chain can be attached as shown in the above figures. The excavator bucket needs to be rotated outward so that the teeth point downward at all times during the full range of motion of the boom and the stick. The chain is attached to the bucket as shown in figure A. The chain then is placed over the back of the bucket as shown in figure B. Where the chain bends over sharp edges, blocking between the edge and the chain should be used to prevent damage to the chain. Such damage could result in chain failure.
LIFTING WITH THE EXCAVATOR

All slings and lifting hardware need to be load rated and approved for the type of work being done.

- Purpose: To discuss various types of lifting hardware for lifting various objects.