Chapter 18

Scrapers

Topics

To hear audio, click on the box. 

Overview

Scrapers are large earthmovers capable of performing a variety of operations, such as cutting, self-loading, hauling, as well as unloading loose material.

This chapter provides the information you need to successfully execute such operations. It describes the types of scrapers used by the Naval Construction Force (NCF) including a description of major components, controls, and cutting edge attachments. In addition, this chapter explains how to perform all phases of the scraper's work cycle as well as how to increase productivity. Last, it lists safety practices.

Objectives

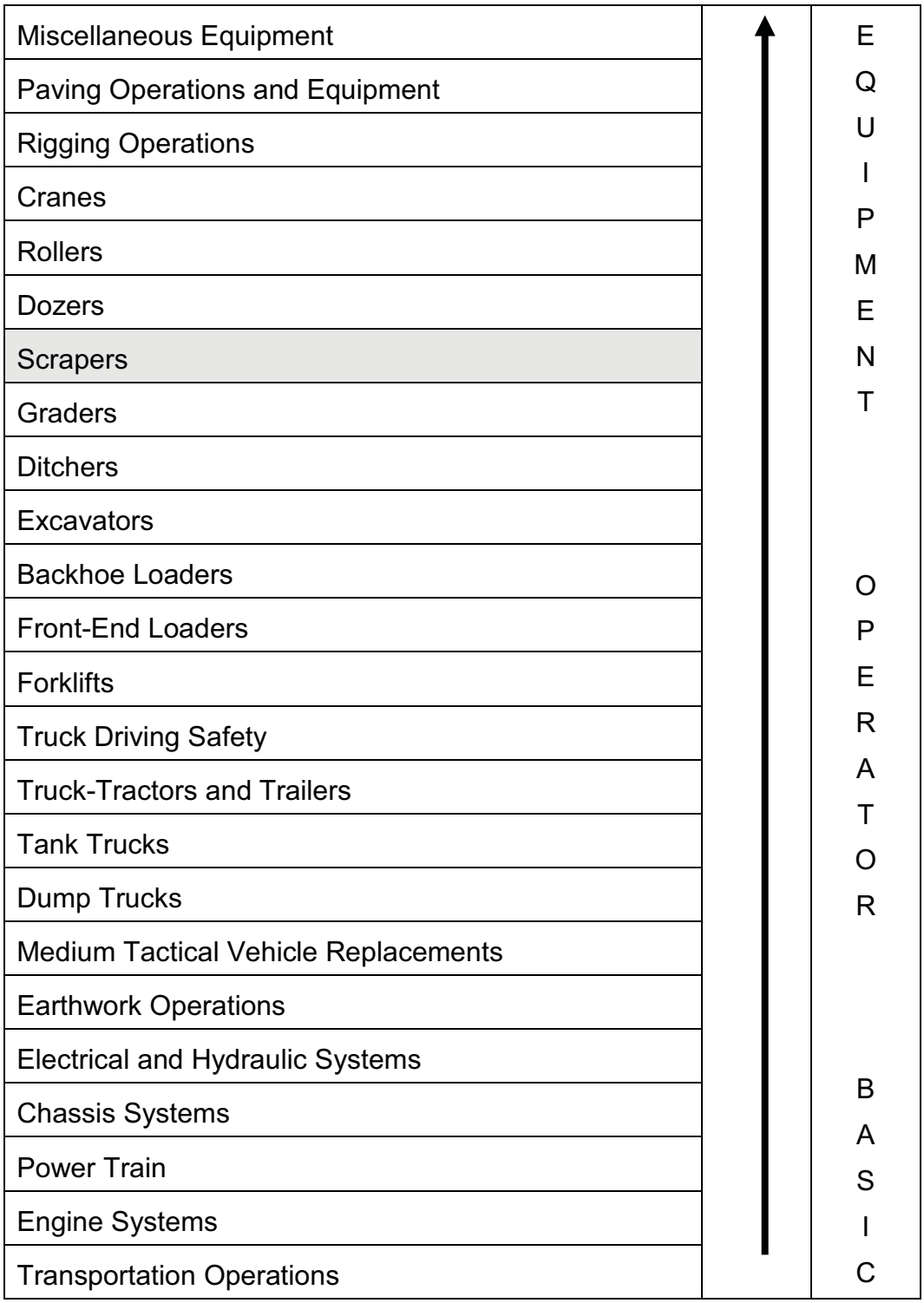
When you have completed this chapter, you will be able to do the following:

1. Understand the use of scrapers.
2. Identify types of scrapers used by NCF.
3. Identify the major components of scrapers.
4. Identify the controls on the scraper.
5. Identify scraper attachments and their use.
6. Understand how to perform scraper operations.
7. Understand scraper safety.

Prerequisites

None

This course map shows all of the chapters in Equipment Operator Basic. The suggested training order begins at the bottom and proceeds up. Skill levels increase as you advance on the course map.



Features of this Manual

This manual has several features which make it easy to use online.

- Figure and table numbers in the text are italicized. The figure or table is either next to or below the text that refers to it.
- The first time a glossary term appears in the text, it is bold and italicized. When your cursor crosses over that word or phrase, a popup box displays with the appropriate definition.
- Audio and video clips are included in the text, with italicized instructions telling you where to click to activate it.
- Review questions that apply to a section are listed under the Test Your Knowledge banner at the end of the section. Select the answer you choose. If the answer is correct, you will be taken to the next section heading. If the answer is incorrect, you will be taken to the area in the chapter where the information is for review. When you have completed your review, select anywhere in that area to return to the review question. Try to answer the question again.
- Review questions are included at the end of this chapter. Select the answer you choose. If the answer is correct, you will be taken to the next question. If the answer is incorrect, you will be taken to the area in the chapter where the information is for review. When you have completed your review, select anywhere in that area to return to the review question. Try to answer the question again.

1.0.0 SCRAPERS

Equipped with a large bowl with a cutting edge attached to the bottom, scrapers can cut, self-load, haul, and spread a great amount of material. They are most efficient when operated in light and medium materials that are nearly free of roots, stumps, and boulders. Heavy or consolidated materials require ripper-equipped dozers to rip open the surface and assist loading operations by pushing the scraper through the cut to achieve maximum loading. A dozer pushing the scraper is referred to as a push cat.

1.1.0 Types of Scrapers Used By Naval Construction Force

The NCF uses three types of scrapers: the single engine, twin engine, and paddle wheel scraper. The sizes of these scrapers determine the depth of the cut as well as the amount of material they can haul.

1.1.1 Single-Engine Scraper

The single-engine scraper, like the one shown in *Figure 18-1*, is essentially a tractor with one engine coupled to a scraper unit. During loading operations, its single-engine does not provide sufficient power or traction to completely load the bowl; therefore, the assistance of a push cat is often required, as shown in *Figure 18-2*.

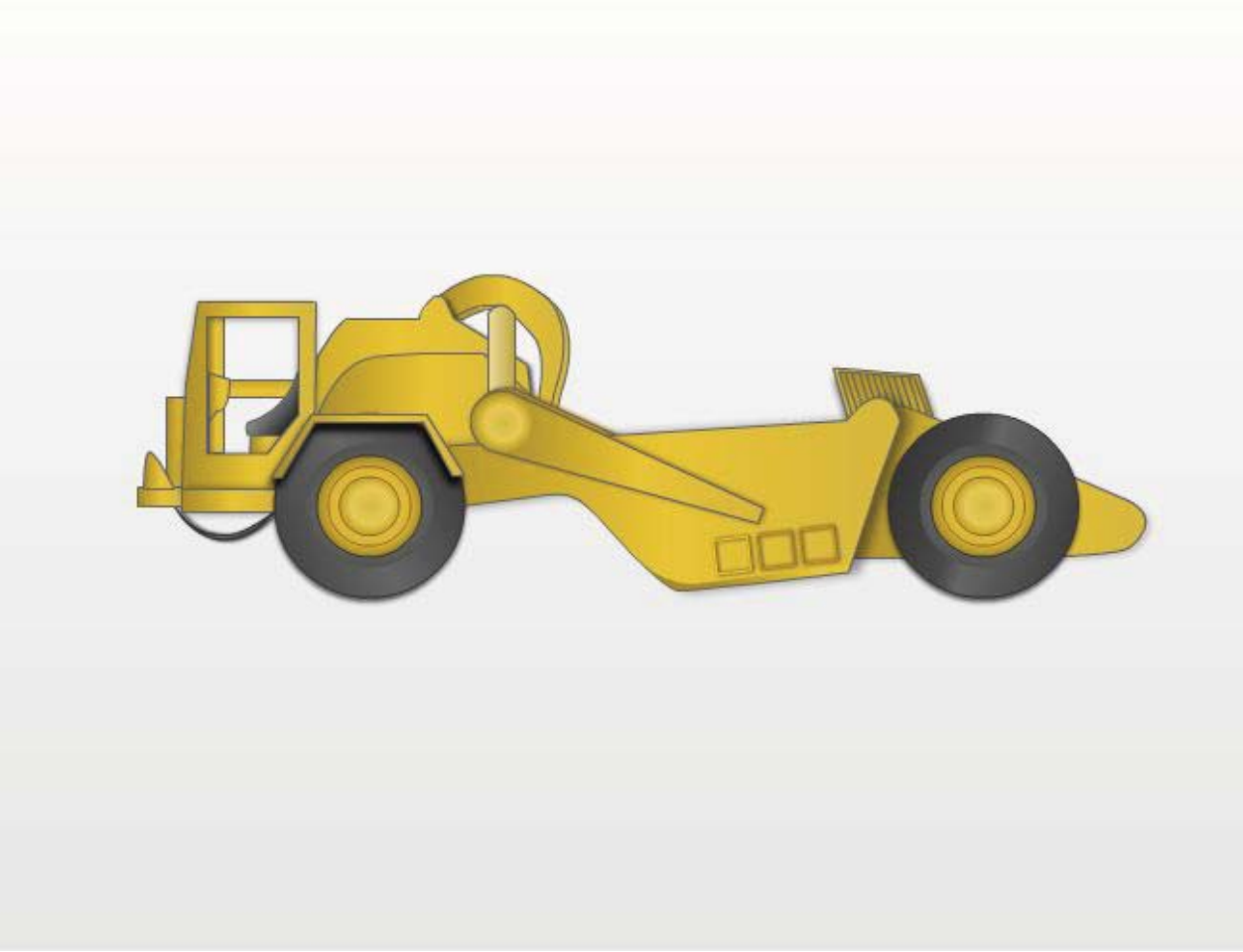


Figure 18-1 – Single-engine scraper.

Figure 18-2 – Push cat pushing scraper.

1.1.2 Twin-Engine Scraper

The twin-engine scraper is also referred to as the push-pull scraper because it has two engines. The engine in the tractor unit pulls the machine, while the other engine at the rear of the scraper unit pushes the machine, as shown in *Figure 18-3*. Under certain loading conditions, two twin-engine scrapers may need to work in tandem. The scrapers are joined together by a rear-mounted hook and a front triangular bail, as shown in *Figure 18-4.*

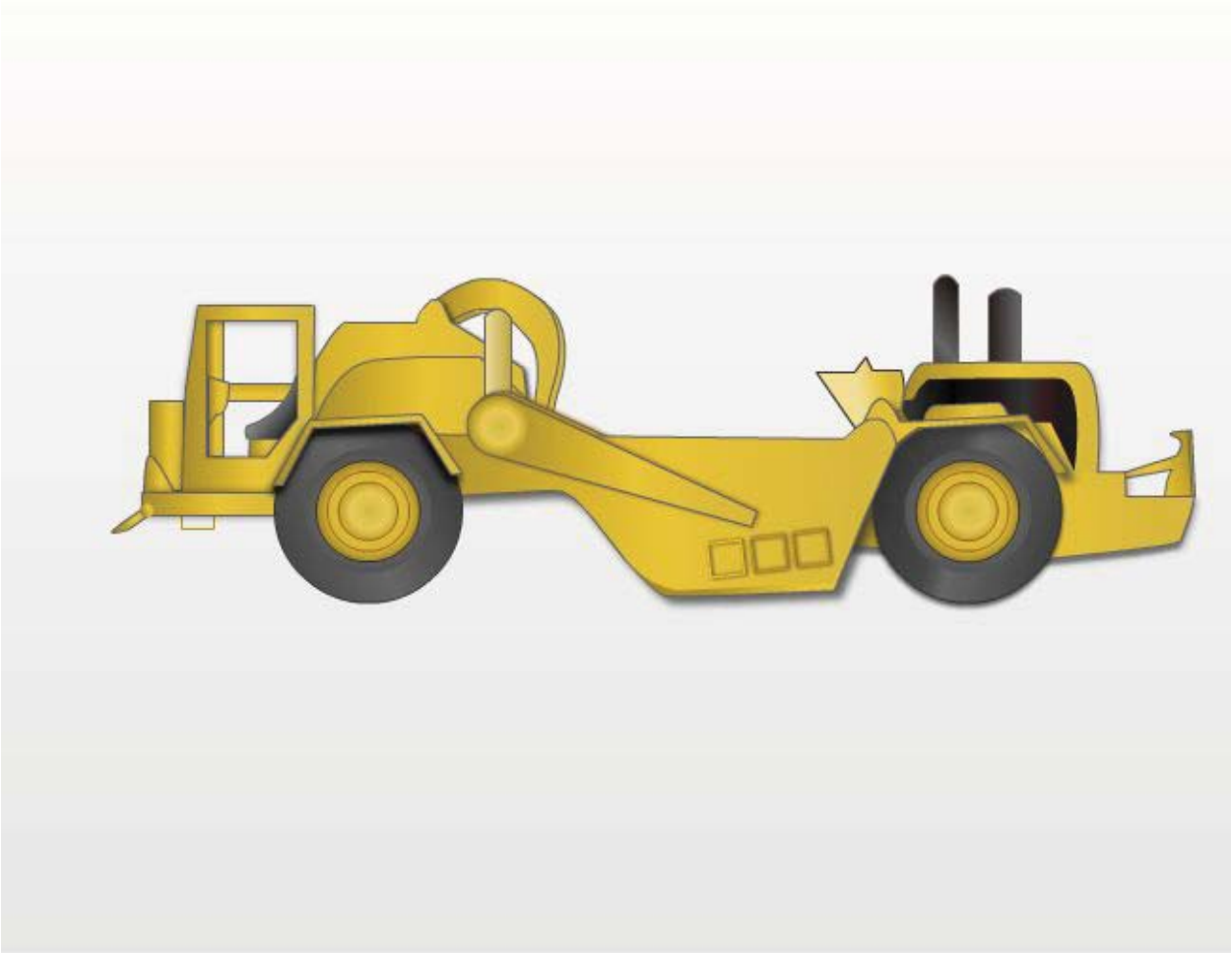


Figure 18-3 – Twin-engine scraper.

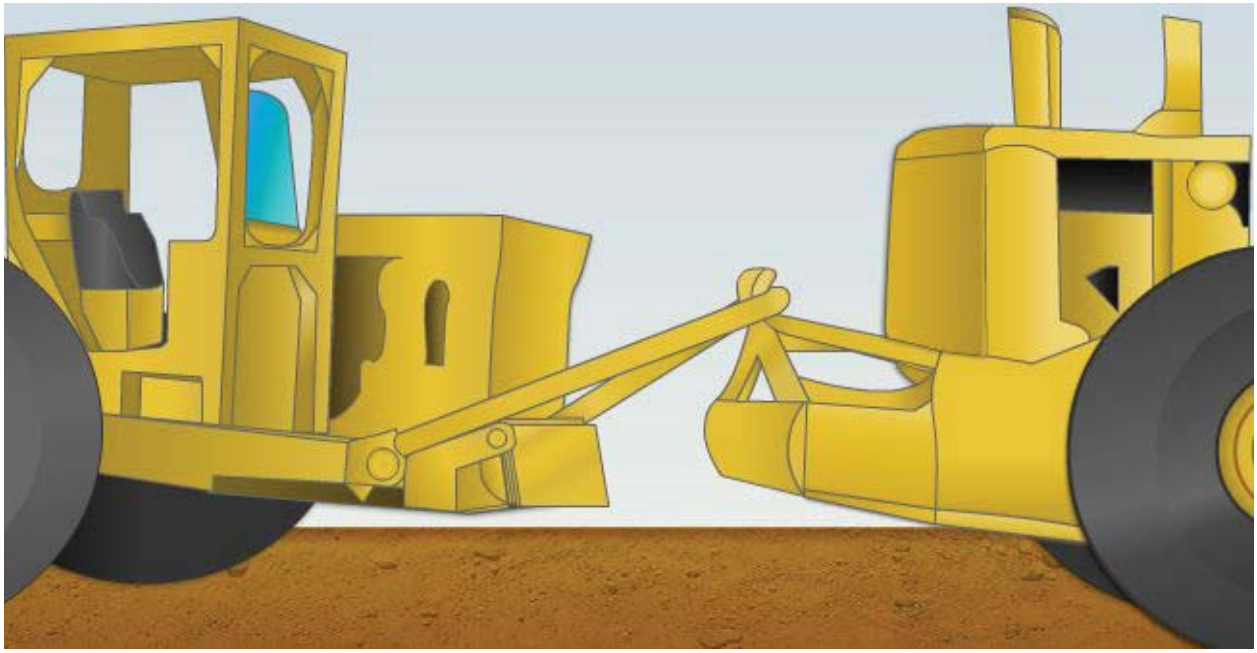


Figure 18-4 – Hook and bail.

1.1.3 Paddle Wheel Scraper

Another type of scraper used in the NCF is the paddle wheel scraper, shown in *Figure 18-5*, also called the elevating scraper. This type of scraper is ideal for small- to medium-size earthmoving jobs, and on most projects does not require a push cat. After the material has been cut by the cutting edge, the material is not forced to the top as on other scrapers; instead, the scraper loads its bowl from the top by means of a paddle wheel elevator. The paddle also aids in breaking up the material, creating a more consistent load.

The bowl can be unloaded by placing the paddle wheel in reverse. This gives the operator more control of the desired depth of fill. For increased productivity, the operator is also able to control the speed of the elevator to match the material condition.

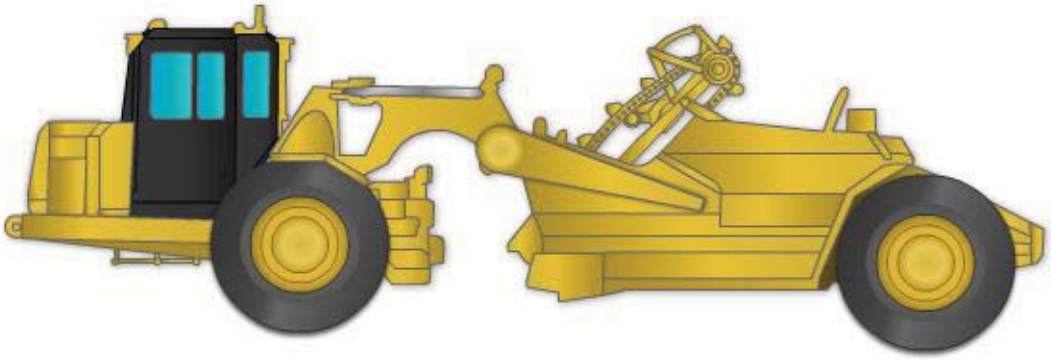


Figure 18-5 – Paddle wheel scraper.

Test your Knowledge (Select the Correct Response)

1. **(True or False)** Scrapers are most efficient when operated in medium to heavy materials that are nearly free of roots, stumps, and boulders.

   A. True
   B. False

2. Which of the following scrapers has a rear-mounted hook and a front bail?

A. Single-engine scraper
B. Twin-engine scraper
C. Paddle wheel scraper
D. Push cat scraper

2.0.0 MAJOR COMPONENTS

Depending on make, model, and configuration, major components on scrapers may vary; therefore, you are responsible for reading the operator's manual for specific information. For a general understanding, the major components of a Caterpillar 621B single-engine scraper are shown in *Figure 18-6.*

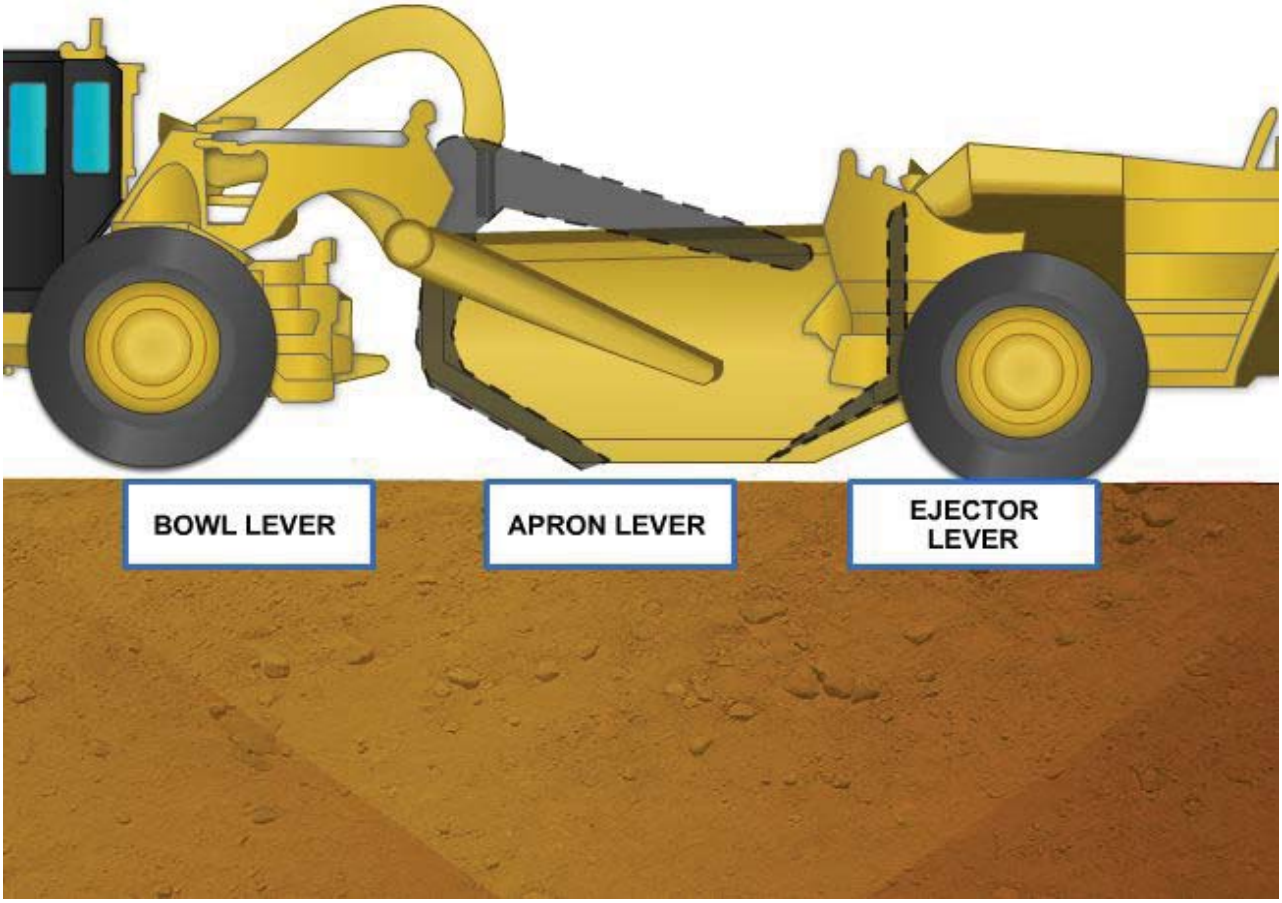


Figure 18-6 – Major components.

2.1.0 Tractor Unit

The tractor unit contains the engine, the drive train and wheels, the hydraulic pumps, and the operator's cab. The tractor is connected to the scraper by a vertical kingpin swivel connection, usually in two parts with upper and lower pins. When steering, this connection permits turns of 85 to 90 degrees to each side of the center line of the scraper. There is also a longitudinal horizontal hinge that permits the two units to move independently from side to side, as shown in *Figure 18-7*.

Figure 18-7 – Articulation.

2.2.0 Gooseneck

The gooseneck couples the tractor and scraper unit. By arching up, it provides space for the tractor wheels to move under it. The gooseneck then widens into a very massive crossbeam becoming a pair of lift arms, also known as bowl stiffeners, which extend back to the ***trunnion*** fastenings on the sides of the scraper bowl.

The gooseneck supports the steering cylinders as well as the cylinders that raise and lower the bowl and apron.

2.3.0 Scraper Unit

The scraper unit has three basic operating parts: the bowl, apron, and ejector.

2.3.1 Bowl

The bowl is a box with rigid sides. Bolted to its bottom is a cutting edge consisting of three blades made of wear-resistant steel. The bottom front sides of the bowl usually have bolted-on wear plates called side cutters. The side cutters normally receive less wear than the cutting edge.

By use of a lever inside the operator's cab, the bowl can be hydraulically lowered or raised. As the scraper travels forward, the bowl is lowered to cut into the material. The cut material is then forced into the bowl. Once the bowl is completely loaded, it is then raised. The material is hauled to a designated location where it is unloaded or spread.

Conveniently, the top of the bowl is open so that spread material can be loaded by crane clam shell, conveyor, or front-end loader.

2.3.2 Apron

The apron forms the forward section and a variable amount of the bottom of the bowl assembly. The apron is also hydraulically raised or lowered by use of a lever inside the operator's cab. When lowered (closed), it rests at the cutting edge to prevent spillage. When raised, it leaves the whole front of the bowl open to accept material.

2.3.3 Ejector

The ejector is the rear wall of the bowl. The most common ejector is hydraulically controlled to move forward horizontally to force the load out of the bowl. It is supported by rollers riding on the floor and on tracks welded to the sides of the bowl.

2.4.0 Push Block

The push block extends past the scraper's rear tires. It is used during loading operations by the push cat while providing extra power.

Test your Knowledge (Select the Correct Response)

3. **(True or False)** The gooseneck supports the cylinders for steering and for operating the bowl and apron.

   A. True
   B. False

4. The bottom front sides of a scraper bowl usually have bolt-on wear plates that are known by what term?

   A. End bits
   B. Wear bits
   C. Side cutters
   D. End cutters

3.0.0 CONTROLS

The bowl, apron, and ejector are controlled by either levers or a joystick. Such controls are located along the cab's right side window. This arrangement allows you to look over your right shoulder to view the bowl while operating it, as shown in *Figure 18-8.*

Figure 18-8 – Operator viewing bowl.

As shown in *Figure 18-9*, the Caterpillar 621B has three levers. Each lever has four positions: completely and slightly right (away from the operator), center, and left (towards the operator). When these levers are released from either the right or left positions, they will return to the center position, whereupon the operation will stop.

Figure 18-9 – Controls.

3.1.0 Bowl Lever

The bowl lever raises and lowers the bowl.

- To quickly drop the bowl, completely move the bowl lever to the right, away from you.
- To slowly lower the bowl, slightly move the lever right.
- To raise the bowl, move the lever left, towards you.

3.2.0 Apron Lever

The apron control lever raises (opens) and lowers (closes) the apron.

- To allow the apron to seek its own level (float), completely move the apron lever to the right, away from you.
- To lower the apron, slightly move the lever right.
- To raise the apron, move the lever left, towards you.

3.3.0 Ejector Lever

The ejector lever moves the ejector forward and back.

- To release the ejector, completely move the ejector lever to the right, away from you.
- To move the ejector back, slightly move the lever right.
- To move the ejector forward, move the lever left, towards you.

NOTE

For maximum operating efficiency, operate the engine at maximum rated speed and the control levers at their extreme operating position.

Figure 18-10 allows you to operate these three levers.

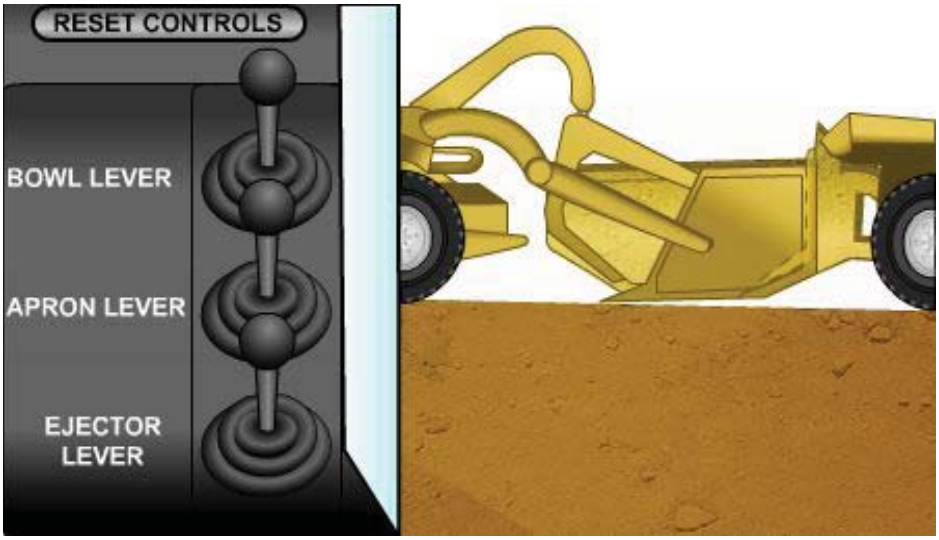


Figure 18-10 – Operating scraper controls.

Test your Knowledge (Select the Correct Response)

5. **(True or False)** On the Caterpillar 621B, the bowl, apron, and ejector are controlled by a joystick.

   A. True
   B. False

6. On the Caterpillar 621B, how would an operator quickly lower the bowl?

   A. Move the bowl lever completely to the right.
   B. Move the bowl lever slightly to the right.
   C. Move the joystick completely to the right.
   D. Move the joystick slightly to the right.

4.0.0 ATTACHMENTS

Unlike other pieces of equipment, there are very few attachments used with or on scrapers; however, there are three commonly used cutting edges that serve various purposes. They are the straight, curved and three-piece cutting edges, shown in *Figure 18-11*. These cutting edges are available in various thicknesses. Thinner edges provide

greater penetration, but have less wear material and impact resistance compared to thicker edges.

4.1.0 Straight Cutting Edge

The straight cutting edge is the most efficient for smooth finish grading.

4.2.0 Curved Cutting Edge

The curved cutting edge penetrates more than the straight edge.

4.3.0 Three-Piece Cutting Edge

The three-piece cutting edge has a center blade positioned ahead of the other two blades for deeper penetration. This center blade is referred to as the stinger.

NOTE

Replace cutting edges that are worn or damaged to prevent wear of the scraper bowl.

Test your Knowledge

7. On a three-piece cutting edge, what term is used to identify the center blade?

   A. Stinger
   B. Point cutter
   C. Scraper
   D. Intermediate bit

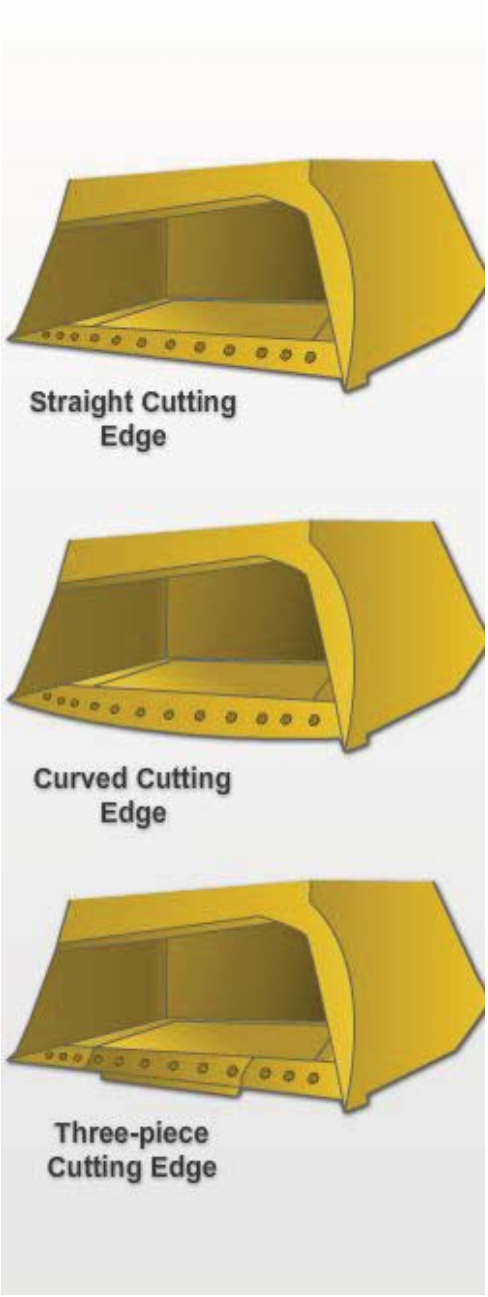


Figure 18-11 – Cutting edges.

5.0.0 OPERATIONS

The greatest engine power is available when the engine is running at top governed speed. The proper transmission gear ratios must also be engaged to obtain maximum engine power output. When the transmission is placed in too high a gear ratio for full engine power, the result is a stall condition in the transmission converter. Stalling the converter prevents the engine from operating at maximum efficiency and results in rapid overheating and premature wear of the converter or transmission.

Downshift the transmission correctly while the scraper is in motion to prevent damage to the power train. Improper downshifting overspeeds the transmission and engine, and usually results in premature wear and unnecessary transmission breakdowns.

When moving the scraper from a full stop, always start with the transmission in low gear, depressing the throttle for the degree of acceleration required. A wide open throttle provides the fastest acceleration under full-load conditions.

When running downgrade, avoid overspeeding the engine by keeping the scraper speed at or below the maximum speed for the transmission range engaged. As a

general rule, downhill scraper speed should not exceed 5 mph more than that attained on level ground in the transmission ratio engaged.

When the selected transmission ratio is too high, slow the scraper with the service brakes until you can properly downshift the transmission to the required range for the grade.

If necessary, you can slow the downhill speed by lowering the scraper bowl until the cutting edge drags enough to slow the scraper to the required speed to permit proper downshifting or stopping.

Do not fan the brakes by repeated depressing and releasing. This practice can reduce air pressure below the point required for proper braking. The air pressure system should indicate 105 to 125 psi on the air pressure gauge for effective braking. When the gauge indicates a pressure drop below 105 psi for a long time, shut down the scraper until the trouble is corrected.

5.1.0 Work Cycle

The scraper's work cycle has four phases of operation: loading, hauling, spreading or unloading, and returning to the cut.

5.1.1 Loading

When loading, enter the cut with the ejector positioned at the rear of the bowl, open the apron enough to allow material to enter the bowl (normally 4 to 8 inches above the leading edge of the bowl), and then lower the bowl to cut a depth of 1 to 1 1/2 inches. The gear that the transmission is engaged in depends on the nature of the material being cut. For light, loose material, a relatively high gear can be used. For heavy, compacted material, a low gear is used; however, to obtain a full load, use a lower gear, even in loose material. As the scraper proceeds through the cut, the material is loosened by the scraper cutting edges and forced into the bowl by the forward motion of the scraper, as shown in *Figure 18-12*.

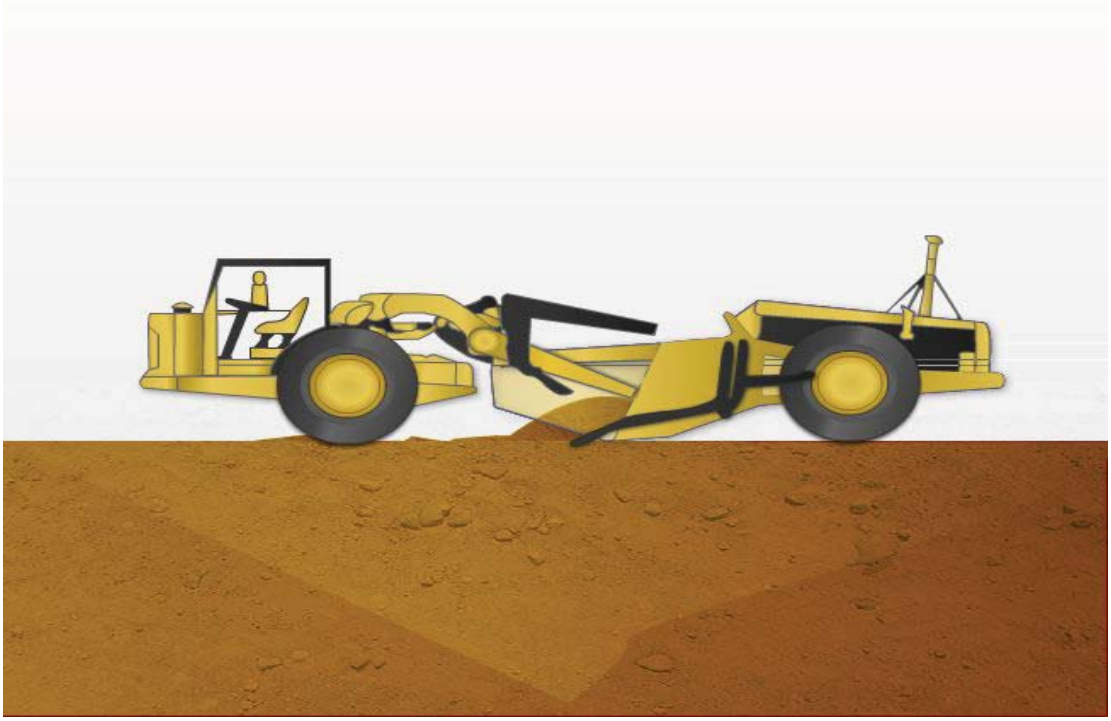


Figure 18-12 – Entering the cut.

NOTE

Avoid spinning the scraper tires during cutting operations. Spinning the tires is nonproductive and causes expensive premature wear to the tires, differential, and transmission.

The material entering the bowl boils back against the ejector and forward against the apron, as shown in *Figure 18-13*. When the bowl is filled to capacity, commonly known as “heaped,” close the apron, and at the same time, raise the bowl 1 or 2 inches above the ground, as shown in *Figure 18-14*. On scrapers equipped with diverter valves in the apron hoist system, the bowl automatically starts rising while the apron control lever is held in the lower position. After the scraper is fully loaded and the bowl is raised, continue to travel out of the cut with the scraper bowl at a height that spreads out the material that piles in front of the cutting edges.

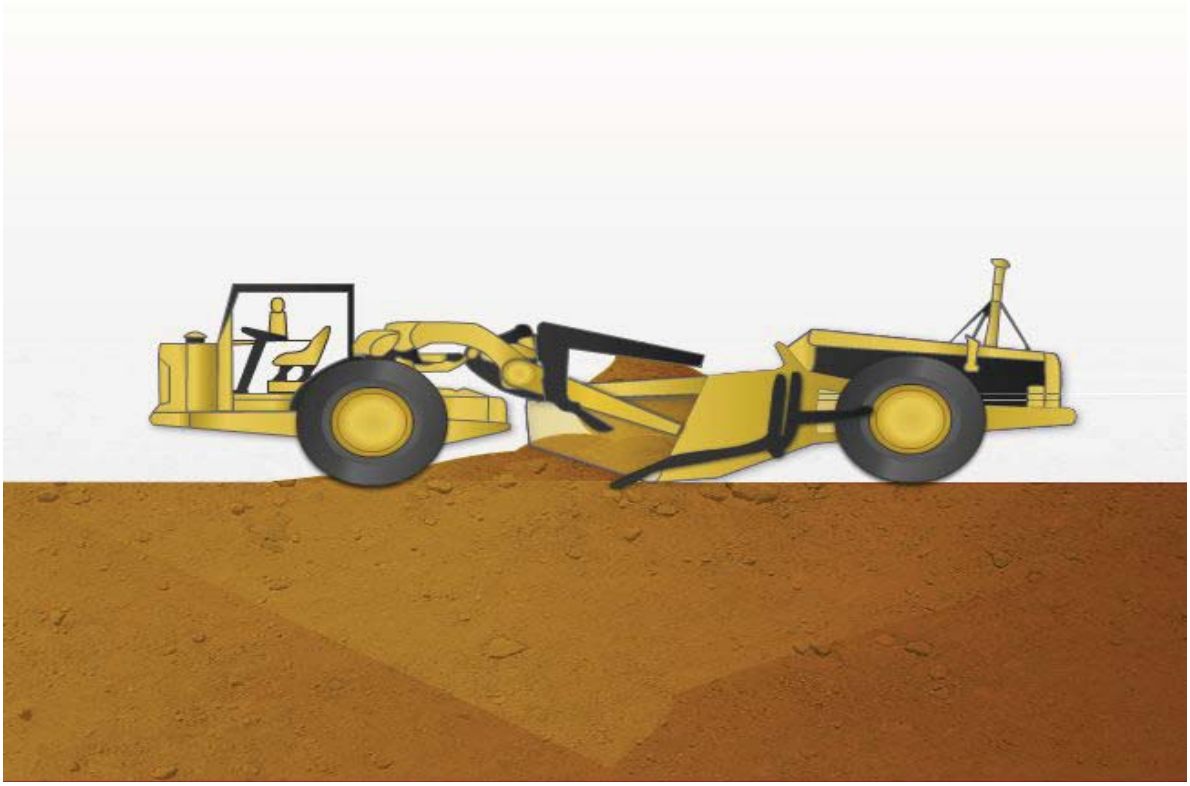


Figure 18-13 – Loading the bowl.

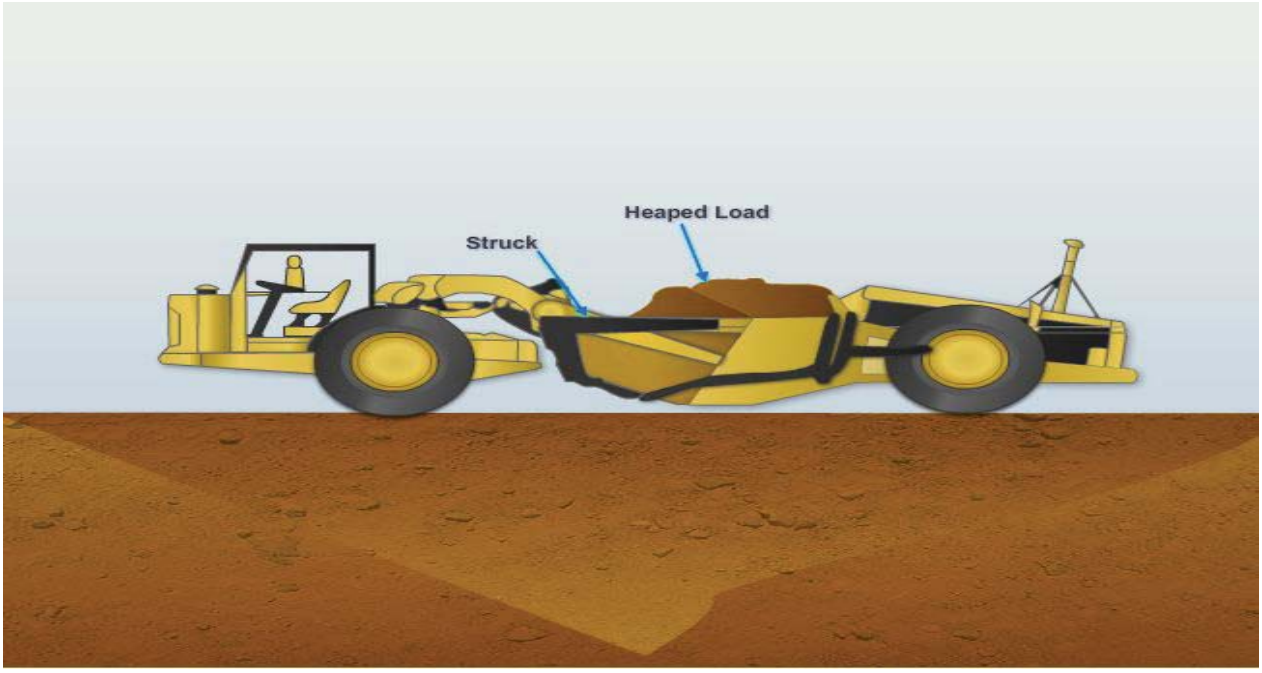


Figure 18-14 – Loaded bowl.

5.1.2 Hauling

After the scraper is fully loaded and has reached the haul road, raise the bowl to travel height and proceed to the fill or dump area in the highest gear range practicable. The bowl travel height should be no higher than needed to clear any obstacles on the haul road. A low bowl height allows better control of the scraper by keeping the center of gravity low and preventing the loss of time needed to lower the bowl as the scraper approaches the fill area. The best bowl height is the height at which the bowl must be when the load is spread.

When hauling down steep grades, lower the bowl until the cutting edge drags to slow the scraper down. When traveling over a slippery haul road, keep the bowl as low as possible to allow for a fast emergency stop by dropping the bowl.

When traveling over haul roads, avoid holes and large obstacles that may damage the scraper tires. When making sharp turns, allow enough clearance for the length and width of the scraper to keep the scraper wheels on the road.

5.1.3 Spreading or Unloading

When approaching the fill area, lower or raise the scraper bowl to the depth of fill desired. Also adjust the speed of the scraper for this depth, such as a high speed for a thin spread or a slower speed for a deep spread.

To start spreading, raise the apron by engaging the apron control lever to allow the material to fall out of the bowl. The size of the apron opening depends mainly upon the depth of the spread and type of material being spread, for example, a thin layer of free-flowing sand needs a fairly small apron opening and a high travel speed, while a thin spread of wet clay will need a larger opening and a slower travel speed.

After the apron opening has been adjusted and the dirt flowing through the opening lessens, engage the ejector lever to finish unloading the scraper bowl. When the scraper is empty, engage the ejector lever to return the ejector to the rear of the bowl and lower the apron.

Unloading techniques are as follows:

- Keep the scraper moving while unloading. Stopping when unloading on soft fill costs production time by needless shifting and the possible miring down of the scraper.
- Always make an even spread, so the next trip will not be rough.
- If possible, when traveling out of a fill, pass back over the area you have just filled to compact it with the large scraper tires.

5.1.4 Returning to the Cut

After unloading the scraper and reaching the haul road, return to the cut as soon as possible. When returning to the cut, carry the scraper bowl high enough to avoid any haul road obstacles, yet low enough for safe handling of the scraper. Carrying the bowl low allows for quick lowering of the bowl to stop the scraper in the event of an emergency. Allow plenty of room for the rear wheel of the scraper to avoid obstacles when making tight turns, and maintain a safe speed for the condition of the haul road.

5.2.0 Using a Push Cat

During loading operations, when a push cat is used to supply extra power to the scraper, it should be positioned about 45 degrees off the lane to be cut. The scraper should start loading before the push cat makes a smooth contact with the rear push block.

CAUTION

The push cat operator should be extremely cautious to avoid hitting the rear scraper tires with the dozer blade.

The push cat operator must be sure to center the reinforced section of the dozer blade on the scraper rear push block. Additionally, the push cat operator must be alert to turns made by the scraper that might cause the push cat to apply unequal pushing force. This could result in the dozer blade contacting the scraper rear tires or causing the scraper to jackknife. The push cat should continue pushing after the scraper has a full load to give the scraper a boost in leaving the cut.

5.3.0 Working Difficult Materials

Special operating techniques are required when you perform scraper operations in difficult materials, such as wet or sticky material, loose sand or gravel, and large objects.

5.3.1 Wet and Sticky Materials

When unloading wet and sticky material, do not try to spread the material too thin. Always keep the bowl high enough to allow the material to flow back under the scraper. Open the apron wide enough to allow an easy flow out of the bowl, Bring the ejector forward with short, snappy movements of the ejector control lever to shake the material loose from it. Allow a little time between each ejector movement to avoid compacting the material between the apron and ejector. In some cases, shifting the ejector between forward and reverse gives the material that has been brought forward a chance to fall out of the apron opening.

NOTE

When the material is spread too thin or the bowl is too low, the material will pack against the scraper cutting edge inside the bowl and will not eject.

5.3.2 Loose Sand and Gravel

Sand is a free-flowing material that tends to float ahead of the scraper cutting edges when being loaded. To obtain a heap load and to avoid being bogged down by the sand, use the technique called pump loading.

To pump load, enter the cut with the apron open about 3 feet and the scraper cutting edges lowered into the sand. Continue through the cut until the engine(s) start(s) to lug down. Then lower the apron into the sand that has piled up in front of the scraper cutting edges, and raise the bowl 2 or 3 inches at a time. Do not completely close the apron or drop the bowl so deep that the engine stalls. This loading technique will ordinarily allow the scraper to get a full load.

When spreading sand, always spread it as thin as possible, and keep the scraper moving in the fill. A thin spread allows better compaction and makes it easier to travel over the fill.

To obtain a full load when loading gravel, you may have to pump load as performed with sand. The apron may be hard to close due to stones getting caught between the apron and cutting edges. A technique used to avoid the stones is to backup a few inches with the cutting edge still in the ground while closing the apron. This should force the stones out and allow the apron to close all the way.

5.3.3 Large Objects

Scrapers are not designed to dig or transport large objects; however, they may be used for this purpose when more suitable equipment is not available.

Approach the object with the apron and scraper bowl fully raised. When the object is too large to clear underneath the tractor, bring the tractor past the object until the drive wheels are a few inches beyond it. Pivot the tractor sharply towards the object to allow the tractor to bypass the object, and bring the cutting edge into position for loading, as shown in *Figure 18-15*.

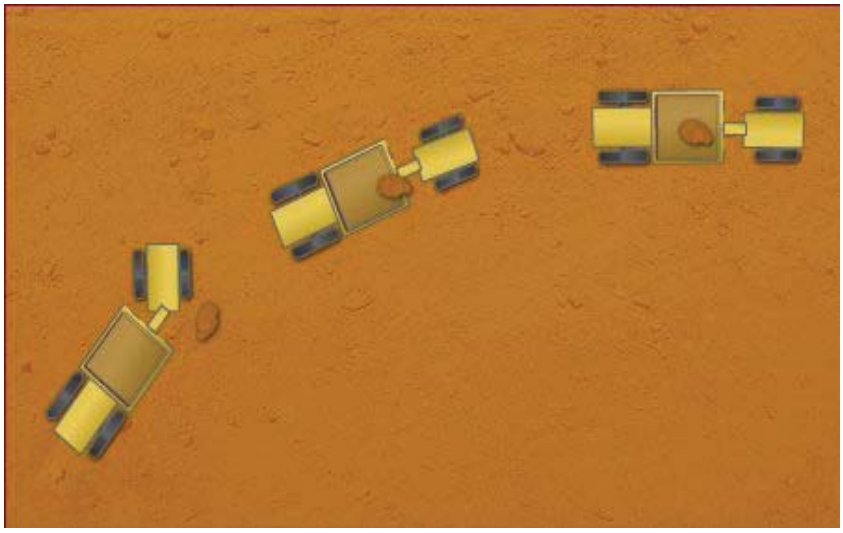


Figure 18-15 – Maneuvering to load a large object.

When the tractor reaches its sharpest angle of the turn, bring the scraper cutting edges within a few inches of the object. Lower the bowl, apply downward pressure, and move forward. When the cutting edge hooks underneath the object, lift the bowl while inching forward. When the object slips off the cutting edge, back up and try again. You may have to approach the object from a different direction to get a grip to load the object.

To shove the object around, keep the ejector in the full forward position. To pick up and carry the object, place the ejector in the normal full back position. To close the apron completely after the object has been loaded, scrape up a little dirt that will push the object back farther into the bowl.

To unload the object, shift the ejector from forward to reverse several times to move the object around so it will fall out. After unloading the object, turn the tractor sharply so the scraper clears the unloaded object.

NOTE

Use extreme care when handling large objects. Oversize objects, such as large rocks, can cause damage by denting, bending, or straining parts. Damage may also be done by accidental collision with large rocks during ordinary digging.

5.4.0 Production Techniques

Scraper production techniques are used to achieve the most amount of work with the scrapers assigned. These techniques are as follows:

5.4.1 Downhill Loading

Downhill loading uses the force of gravity on the scraper to get larger loads in less time. The added force of gravity is 20 pounds per gross ton of weight per 1 percent of downhill grade. The downhill pull adds more material per load, and the added material weight increases the total gravitational pull.

5.4.2 Straddle Loading

Straddle loading gains time on every third trip because the center strip loads with less resistance than a full cut. After the first scraper has made a cut, the second scraper should make a parallel cut while leaving a 4- to 5-foot-wide island between the two cuts, as shown in *Figure 18-16.* The third scraper can straddle this island of material to achieve a fast, less resistant load.

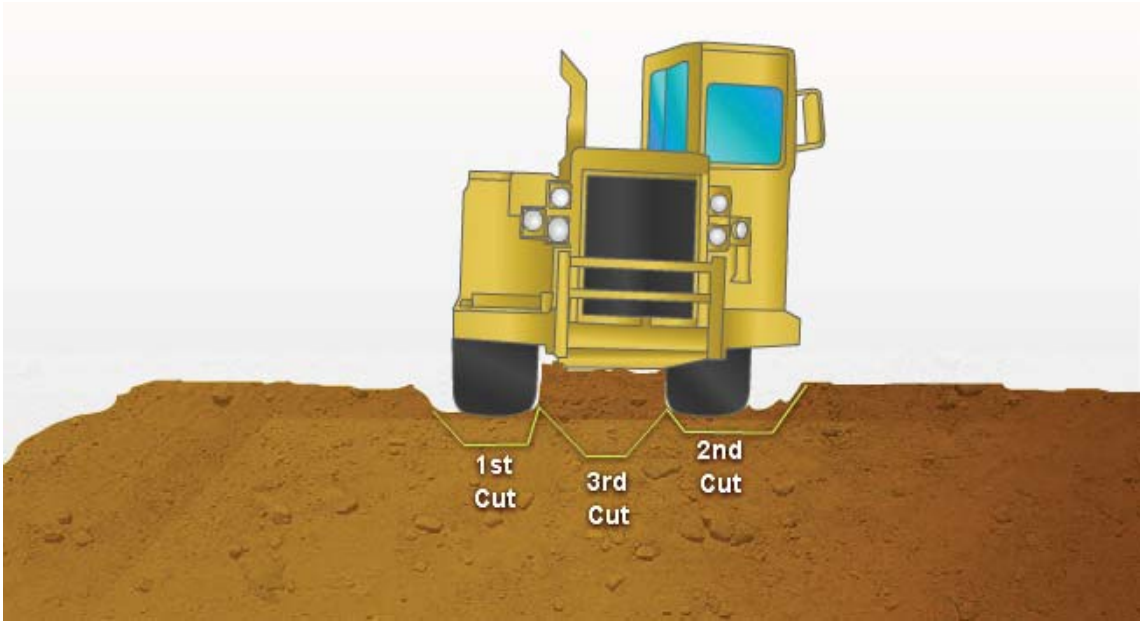


Figure 18-16 – Straddle loading.

5.4.3 Back-Track Loading

Back-track loading, shown in *Figure 18-17,* is used only when the cut is fairly short and loading in both directions is impractical. A great deal of time is spent backtracking and maneuvering the push cat for the next load; therefore, if the cut is wide enough, try other techniques.

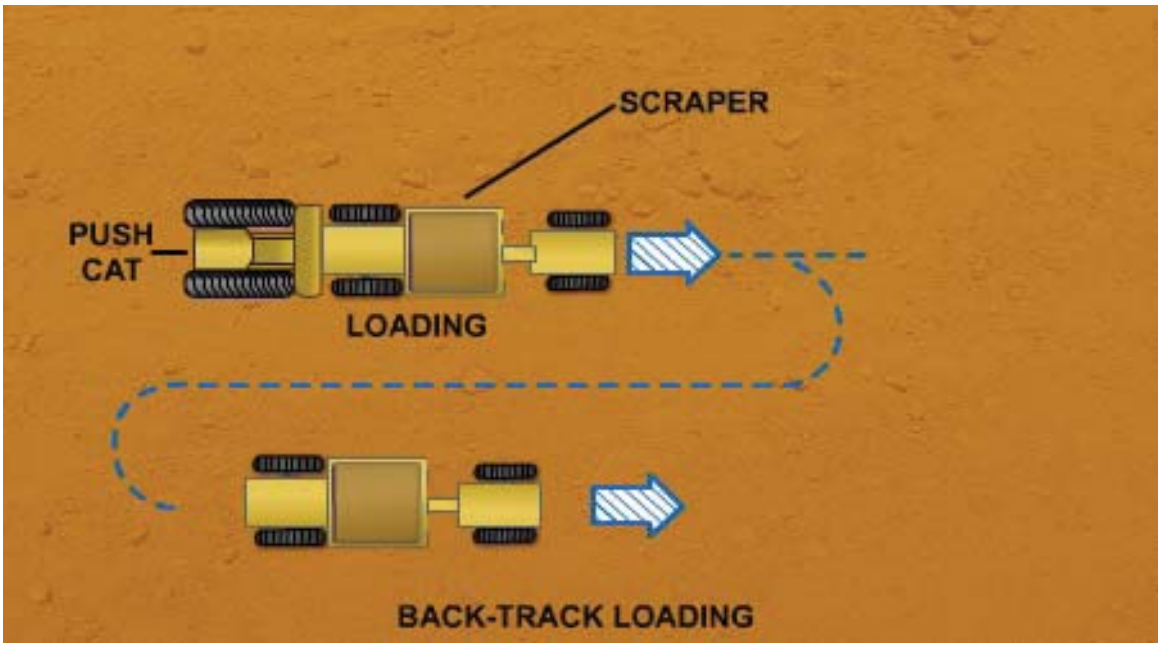


Figure 18-17 – Back-track loading.

5.4.4 Shuttle Loading

Shuttle loading is used for short cuts where it is possible to load in both directions, as shown in *Figure 18-18*. The push cat pushes one scraper in one direction, then turns to push a second scraper in the opposite direction.

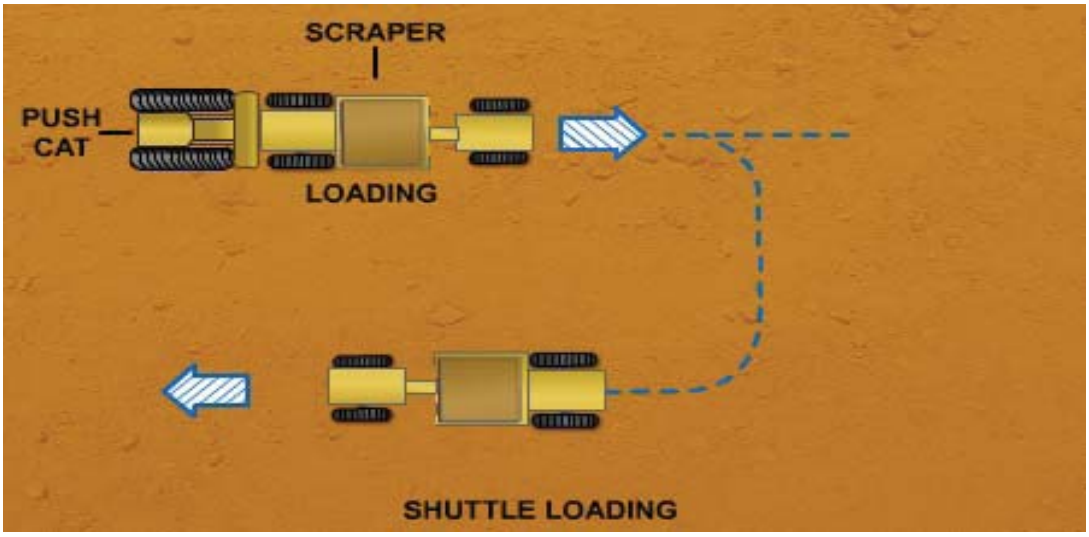


Figure 18-18 – Shuttle loading.

5.4.5 Chain Loading

Chain loading is used when the cut is fairly long, making it possible for the push cat to pickup two or more scraper loads without back tracking, as shown in *Figure 18-19*. The push cat push loads one scraper, then moves in behind another scraper that is moving parallel to the first scraper.

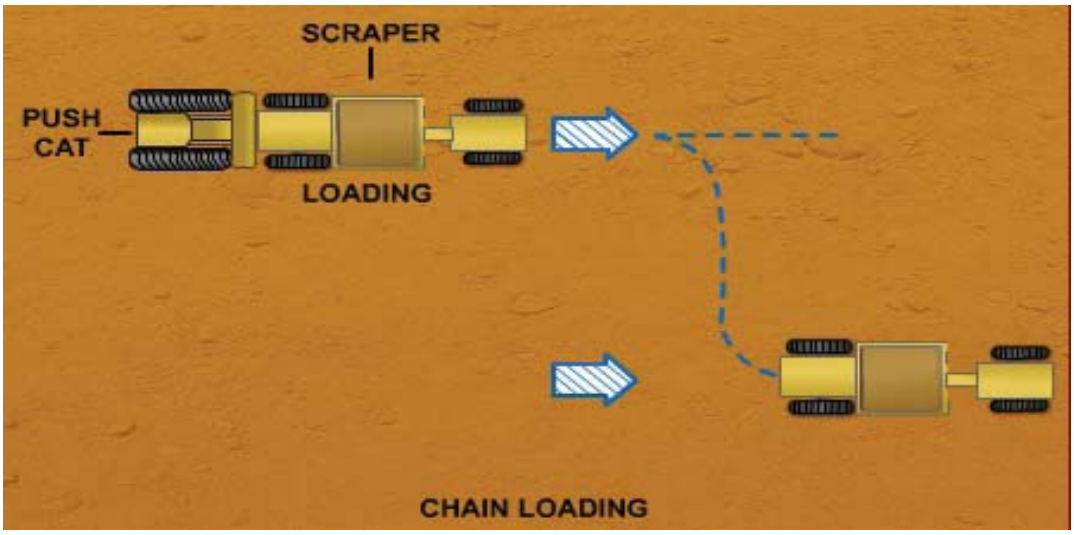


Figure 18-19 – Chain loading.

5.4.6 Optimum Loading

Optimum loading is an operation used when loading time and maximum output are critical. With the assistance of push cats, scrapers should be loaded within 1 minute per 100 feet. You may use more time and distance to obtain more material when the haul is long enough and the added material is great enough to offset hauling fewer loads.

While scrapers are waiting for push cat assistance, spend time cutting without attaining a heaped load. While push cats wait for scrapers, they should be dressing the cut. In some cases, using a dozer to dress the cut full time will increase production. At the end of a workday, take time to shape the cut for good drainage.

NOTE

Maintaining adequate drainage throughout a cut and fill operation reduces compulsory downtime caused by bad weather.

The rule of thumb used for computing the number of push cats required for a scraper operation is to divide the scraper cycle time by the push cat cycle time. When computing cycle time for a scraper, take the total time of loading, hauling, unloading, and return; for instance, a 5-minute scraper cycle time divided by a l-minute push cat cycle time calls for five scrapers per push cat.

5.4.7 Turns

Take turns within the shortest radius possible and at the highest safe speed. If possible, use the sequence shown in *Figure 18-20* to eliminate unnecessary turns when performing cut and spread operations.

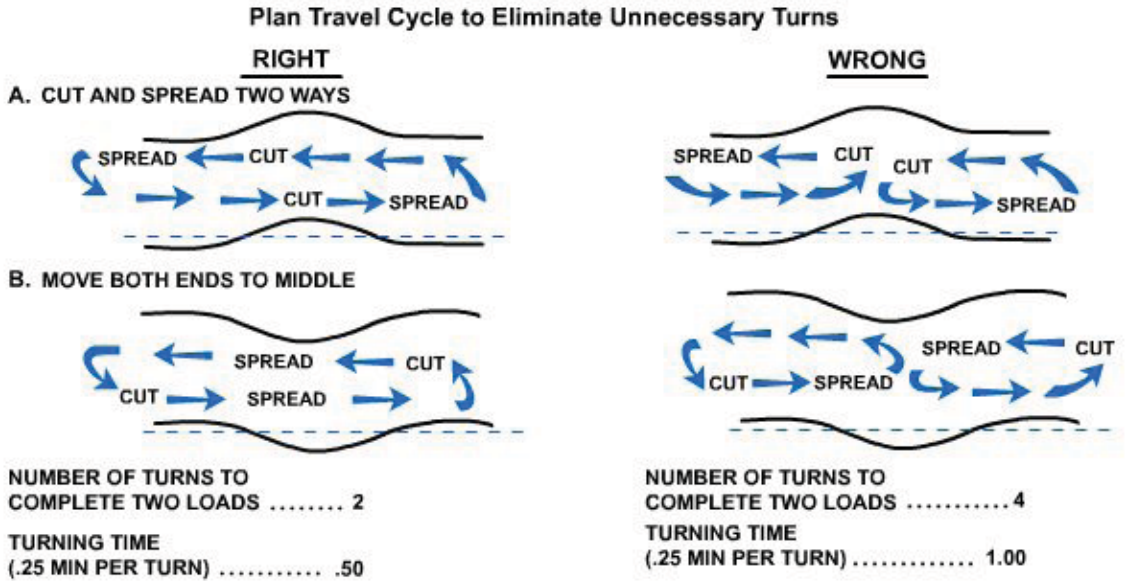


Figure 18-20 – Cut and spread sequence.

5.4.8 Haul Roads

Haul roads should be level and laid out so that time is not wasted maneuvering the scraper. Haul roads that have drastic changes in elevation reduce production. Keep them moist and in good condition. Roads that are moist (not wet) and packed into a hard, smooth surface permit higher traveling speeds, increase safety, and reduce operator fatigue and equipment wear. The moisture also controls the dust entering scraper parts and causing lubrication problems and premature wear. Additionally, controlling the dust allows better visibility.

If the haul road is a dirt road in need of grading, use the scraper's cutting edge to maintain it on returns back to the cut. Do this by opening the apron approximately 12 inches above the cutting edges with the ejector positioned forward within 6 inches of the

cutting edge. Lower the bowl until the cutting edges scrape about 1 to 2 inches of the road surface. By watching the road, you can vary the cutting action to trim small rises and carry the material to fill depressions as the scraper travels the haul road. Perform these grading operations in second or third gear, depending upon road conditions. Grading should be done only when the road surface has ruts and rough or soft spots.

NOTE

Scrapers on the haul road should travel only in the highest gear that is safe for the road.

5.4.9 Scraper Spacing Efficiently

Scrapers should be teamed by their speed whenever possible. The fastest scrapers should be assigned to one section of a job, while the slower ones are assigned to another. If possible, they should use different haul roads.

NOTE

No scraper can travel faster than the scraper ahead of it. Passing only increases the chance of accidents.

Scraper operators can help in traffic control by speeding up to close long gaps and slowing down when coming too close. Efficient spacing supports the optimum use of the push cat. During unloading operations, when lagging far behind the next scraper, spread the load at the beginning of a fill. When traveling too close to the next scraper, spread the load at the far end of the fill.

NOTE

Keep the scraper bowl as close to the ground as possible to lower its center of gravity and to keep it upright.

5.4.10 Spreading

Techniques for scraper spreading operations are as follows:

- Spread the first load at the start of the fill.
- Travel with subsequent loads over the previous fill, provided lifts are small.
- Start each following spread at the end of the previous layer.
- Finish spreading in one full length before starting a new lane, so rollers can begin compaction.
- Route the scrapers to compact the fill. Overlapping the scraper tire tracks aids in the compaction of the entire area and reduces the compaction time necessary with a roller.
- Spread in the highest gear permitted by the condition of the fill area terrain.

NOTE

Slowly discharging loads at low speed slows down production and cycle time.

- Do not waste time on the fill. As soon as the load is spread, get the scraper back on the haul road and return to the cut. Plan your exit from the fill to avoid soft ground and detours around trees and other obstacles.
- As shown in *Figure 18-21*, make the fill high on the outside edge. This prevents the scraper from sliding over the outside edge and helps maintain accurate slopes to desired heights. When the fill is not made in this manner, the scraper

tends to work away from the edge of the fill, making it hard to maintain the correct slope. In inclement weather, build up the center for drainage.

Figure 18-21 – Proper placement to fill material.

Test your Knowledge (Select the Correct Response)

8. A scraper work cycle has a total of how many phases of operation?

   A. One
   B. Two
   C. Three
   D. Four

6.0.0 SAFETY

Safety precautions that apply to scrapers are as follows:

- Never operate a scraper at speeds that are unsafe.
- Always wear seat belts. Uneven terrain can cause a violent tilt of the scraper, causing possible personal injury by throwing you off or against the steering wheel if not secured in the operator's seat.
- Block up the scraper bowl and apron before performing any work on the cutting edges of the scraper.
- Keep the operator's cab clear of debris, grease, oil, and mud, as they can cause the operator to slip or fall.
- Never kick the scraper out of gear when going downhill. The increased speed will make control of the scraper very difficult. Keep the scraper in gear at all times and use the cutting edge to control the speed. When the brakes fail to hold the load, lower and drag the scraper bowl.
- When securing the scraper, ensure the apron is closed and the bowl on the ground.
- Do NOT spread when turning.

- When working on slopes, always turn uphill.
- Do NOT drop the bowl suddenly; ease the cutting edge onto the ground.
- Load and spread when going downgrade, whenever possible.
- When constructing a fill, keep the outside edge high and the center low to prevent the scraper from sliding over the edge.
- When the scraper begins to fall off the fill, steer downhill, drop the bowl, and rapidly accelerate to maximum rpm. Do NOT attempt to turn the scraper back up the slope. Do NOT stop the forward motion of the scraper when there is any danger of the unit tipping over.
- Wear any required personal protective equipment, such as hard hats and steel toe safety shoes.

Test your Knowledge (Select the Correct Response)

9. **(True or False)** It is a safe practice to kick the scraper out of gear when going downhill.

   A. True
   B. False

Summary

Scrapers are large earthmovers designed to cut, self-load, and spread loose materials. This chapter introduced you to three types of scrapers used by the NCF: the single- and twin-engine scraper and the paddle wheel scraper. You were introduced to their major components, which include a tractor and scraper unit consisting of a bowl, apron and ejector. You were also introduced to the scraper's 4-phased work cycle as well as loading techniques that increase productivity by using two scrapers and a push cat. Last, you were introduced to safe practices.

Review Questions (Select the Correct Response)

1. What term is used to describe the type of dozer that pushes a scraper through heavy or consolidated material?

   A. Drive cat
   B. Push cat
   C. Thrust cat
   D. Shove cat

2. In what manner is material loaded in a paddle wheel scraper?

   A. Bottom loaded by a paddle wheel elevator
   B. Top loaded by a paddle wheel elevator
   C. Force loaded from the cutting edges
   D. Bottom loaded by screw augers

3. What component on a scraper permits the tractor and scraper to move independently from side to side?

   A. Vertical kingpin swivel
   B. Horizontal gooseneck
   C. Longitudinal horizontal hinge
   D. Vertical tip hinge

4. Which of the following types of equipment can be used to load a scraper?

   A. Crane clamshell
   B. Conveyor
   C. Front-end loader
   D. All of the above

5. **(True or False)** When closed, the apron rests on the side cutters.

   A. True
   B. False

6. Which of the following scraper components forms the rear wall of the bowl?

   A. Stinger
   B. Apron
   C. Ejector
   D. Paddle wheel

7. What component is supported by rollers riding on the floor and on tracks welded to the sides of the bowl?

   A. Stinger
   B. Apron
   C. Ejector
   D. Bowl stiffeners

8. On the Caterpillar 621B, how would an operator open the apron?

   A. Move the joystick left.
   B. Move the apron lever left.
   C. Move the joystick right.
   D. Move the apron lever right.

9. On the Caterpillar 621B, how would an operator push material out of the bowl?

   A. Move the joystick left.
   B. Move the joystick right.
   C. Move the ejector lever right.
   D. Move the ejector lever left.

10. Which of the following cutting edges penetrates more than the straight cutting edge?

    A. Curved
    B. Three-piece
    C. Stinger
    D. Pointed

11. When you are operating a scraper, what component must you properly engage to obtain maximum engine power output?

    A. Transmission gear ratio
    B. Differential lock
    C. Bogie drive shift lever
    D. Transfer case sprag unit

12. **(True or False)** Improper downshifting over speeds the transmission and engine, usually resulting in premature wear.

    A. True
    B. False

13. Downhill scraper speed should NOT exceed what maximum speed in miles per hour (mph) more than attained on level ground in the transmission ratio engaged?

    A. 20
    B. 15
    C. 10
    D. 5

14. Which of the following operations is NOT part of a scraper cycle time?

    A. Loading
    B. Hauling
    C. Refueling
    D. Unloading

15. To allow material to enter the bowl when loading a scraper, you should ensure the apron is opened by what number of inches above the cutting edge?

    A. Between 1 to 3
    B. Between 4 to 8
    C. Between 9 to 12
    D. Between 13 to 15

16. What term is used to describe a scraper bowl load that is filled to capacity?

    A. Struck
    B. Full
    C. Heaped
    D. Top

17. When traveling over a slippery haul road, you should carry the scraper bowl in what manner?

    A. As high as possible
    B. As low as possible
    C. About halfway between the highest and lowest position
    D. At the height the material is to be discharged

18. When a push cat is waiting for a scraper, it should be positioned at what degree angle off the lane to be cut?

    A. 90°
    B. 75°
    C. 45°
    D. 15°

19. After the apron opening has been adjusted and the dirt flowing through the opening lessens, you should engage which of the following levers to finish unloading the scraper bowl?

    A. Bowl
    B. Apron
    C. Ejector
    D. Power takeoff

20. A push cat operator must ensure that the reinforced section of the dozer blade is centered on what component of the scraper?

    A. Gooseneck
    B. Push block
    C. Spill guard
    D. Bowl stiffener

21. What term is used to describe the technique of obtaining a heap load of sand?

    A. Back-track loading
    B. Shuttle loading
    C. Optimum loading
    D. Pump loading

22. At the start of a pump loading operation, an operator should adjust the opening of the apron to how many feet?

    A. 1
    B. 2
    C. 3
    D. 4

23. **(True or False)** Oversize objects, such as large rocks, can cause damage to a scraper by denting, bending, or straining parts.

    A. True
    B. False

24. Which of the following types of loading techniques uses the force of gravity on the scraper to get larger loads in less time?

    A. High-speed
    B. Downhill
    C. Shuttle
    D. Straddle

25. When you are straddle loading, the island left between the first and second scraper cut should be what width, in feet?

    A. 4 to 5
    B. 10 to 12
    C. 15 to 20
    D. 25 to 30

26. Which of the following types of loading is used when it is possible to load in both directions?

    A. Downhill
    B. Straddle
    C. Back track
    D. Shuttle

27. During optimum loading operations, push-loaded scrapers should be loaded within 1 minute and within a maximum distance of how many feet?

    A. 25
    B. 50
    C. 75
    D. 100

28. **(True or False)** Scrapers on the haul road should travel only in the highest gear that is safe for the road.

    A. True
    B. False

29. In what manner should fills be constructed?

    A. Outside edge low and the center high
    B. Outside edge high and the center low
    C. Outside edge level with center
    D. Outside edge and center at a slope

30. Which of the following actions should you perform if a scraper begins to fall off a fill?

    A. Steer downhill
    B. Drop the bowl
    C. Accelerate rapidly
    D. All of the above

Terms Introduced in this Chapter

Trunnion (Walking beam or bar)	(1) An oscillating bar that allows changes in angle between a unit fastened to its center and another attached to both ends. (2) A heavy horizontal hinge.

Additional Resources and References

This chapter is intended to present thorough resources for task training. The following reference works are suggested for further study. This is optional material for continued education rather than for task training.

Apprentice Construction Equipment Operator, Volume 1 CDC 131, General Subjects and Contingency Responsibilities, Extension Course Institute, Gunter Air Force Base, Montgomery, AL 1984.

Earthmoving Operations, FM 5-434, Headquarters Department of the Army, Washington, DC, 2000.

Equipment Utilization, U.S. Army Subcourse EN5468, U.S. Army Engineer School, Fort Belvoir, VA, 1988.

Heavy Equipment Operations: Level Three, 2nd ed., National Center for Construction Education and Research, Gainesville, FL and Pearson Education, Inc., Upper Saddle River, NJ, 2006.

Nichols, Herbert L., Jr., *Moving the Earth*, 3rd ed., North Castle Books, Inc., Greenwich, CT, 1985.

Technical Manual for Scraper: Earthmoving, Motorized Diesel Engine Driven, Caterpillar 621B, Caterpillar Tractor Company, Peoria, IA, 1984.

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