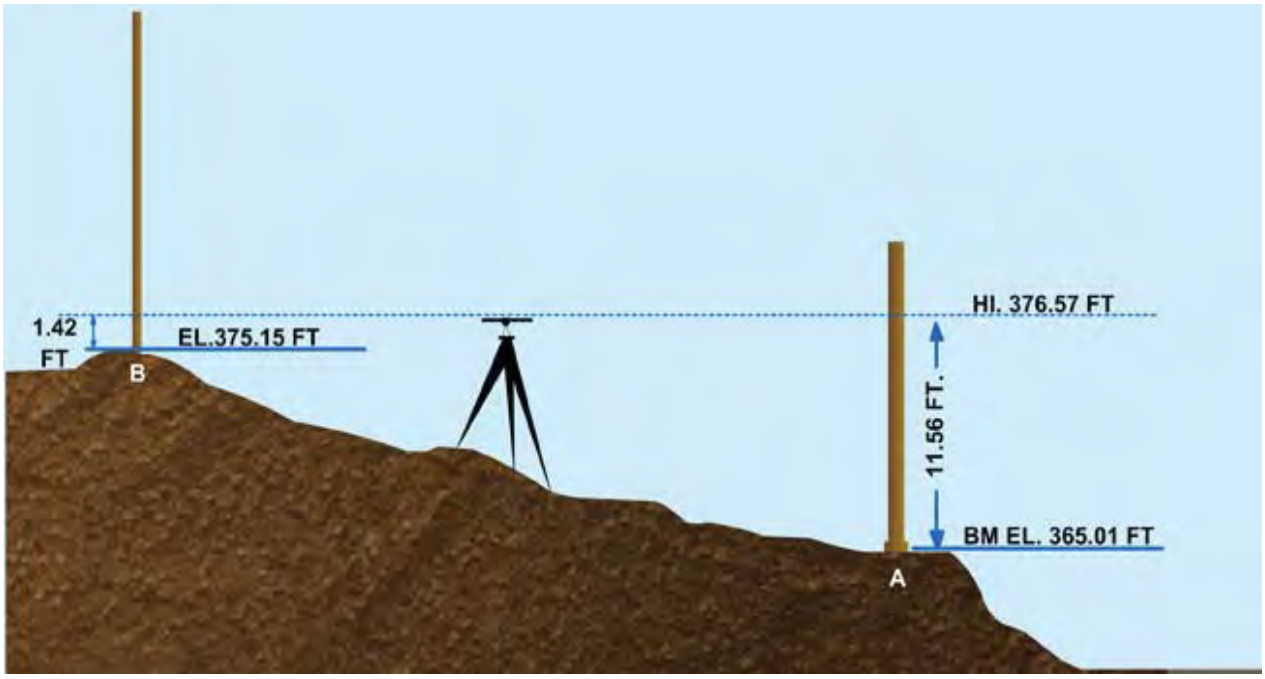

Figure 6-64 – Computing cut-or-fill requirement for a missing grade stake.

Another example of a missing grade stake is shown in *Figure 6-65*. Suppose the stake at station 4 + 50 has been knocked out, and there is no bench mark nearby, but you do have a nearby grade stake at station 4 + 00 and a set of the project drawings. At station 4 + 00, the project drawings call for a subgrade elevation of 240.0 feet. The stake at station 4 + 00 calls for a fill of 7.0 feet; therefore, the existing elevation at station 4 + 00 is 233.0 (7.0 feet below 240.0).

Set up your level and take a backsight direct reading on station 4 + 00 of 4.0 feet. The backsight reading of 4.0 feet plus the existing known elevation of 233.0 feet gives an instrument height of 237.0. Then take a foresight shot on station 4 + 50 and get a direct reading of 4.5 feet. Subtract the foresight reading of 4.5 feet from the instrument height of 237.0 feet, and you get at station 4 + 50, the existing elevation of 232.5 feet.

The project drawings show that the finished subgrade elevation at station 4 + 50 is 239.0 feet. With the existing elevation at 232.5, you must fill at station 4 + 50 a total of 6.5 feet to reach the 239.0 feet required subgrade elevation. Therefore, you need to place a grade stake marked F 6.5 at station 4 + 50.

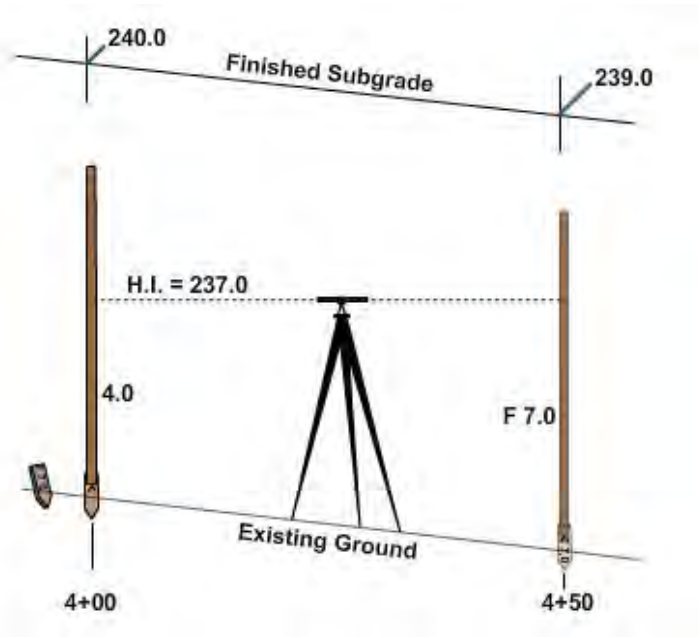

Figure 6-65 – Replacing a missing grade stake.

Turning Point – The two missing grade stake examples were based on elevations of nearby points that could be read from one setup of the level. If differences of elevation or distance are too great or if there are obstructions, you will have to make an intermediate setup and sight on a point called a turning point (T.P.). Any convenient point may be used as a turning point, but the level rod must be set on firm ground or on some firm object so that the elevation of the T.P. will not change while the rodman waits for the levelman to setup at the new position. An example of a level run is shown in *Figure 6-66.*

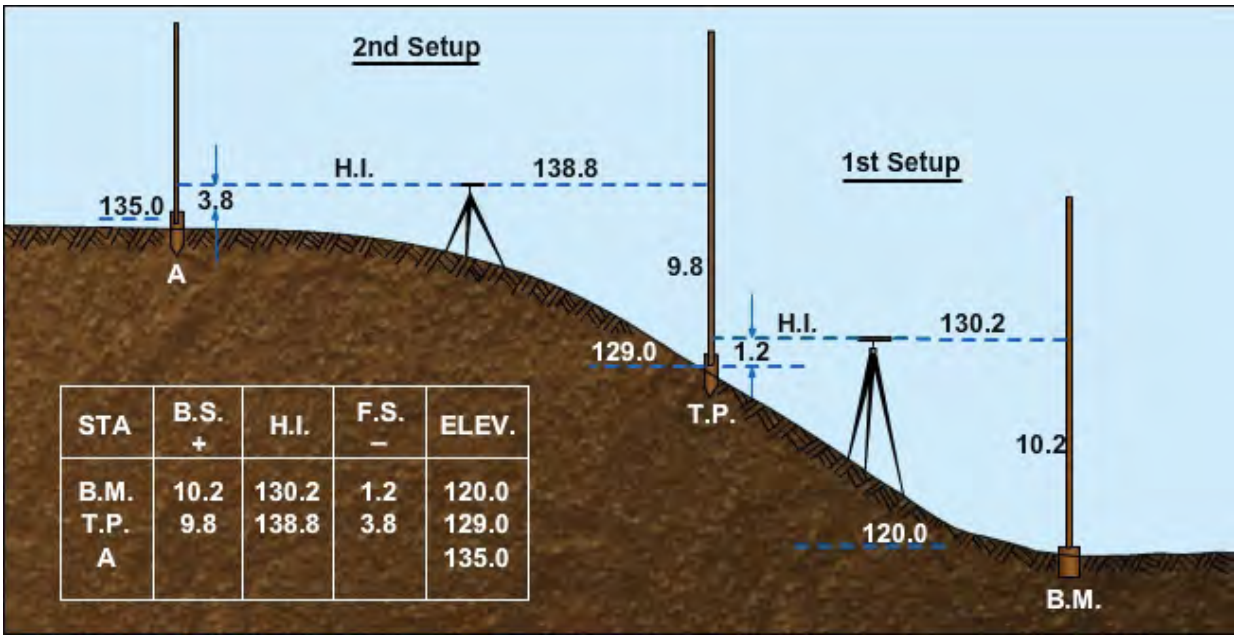

Figure 6-66 – Turning point and level notes.

You have a B.M. at the bottom of a bank and you want to find the elevation at the top of the bank, which is point A. You cannot set up on the top of the bank to take a reading on the level rod held on point A because the level is too short to take a backsight shot on the B.M.

First, record the B.M. elevation of 120.0 feet. Next, set up the level instrument on the bank and take a backsight shot on the B.M. to get a level rod reading of 10.2 feet. Add the backsight shot of 10.2 feet to the B.M. elevation of 120.0 feet to get the first instrument height of 130.2 feet. Then take a foresight shot on the T.P. to get a level rod reading of 1.2 feet. Subtract the 1.2 feet foresight reading from the 130.2 feet instrument height to get a T. P. elevation of 129.0 feet.

Next, move the instrument to the top of the bank. Take a backsight shot on the T.P. to get a level rod reading of 9.8 feet. Add the 9.8 feet backsight reading to the 129.0 feet T.P. elevation to get a second instrument height of 138.8 feet. The last step is to take a foresight shot on point A to get a level rod reading of 3.8 feet. Subtract the 3.8 feet foresight reading from the 138.8 feet second instrument height to get a 135.0 feet point A elevation.

Some level runs may require more than one T. P.; however, no matter how extensive the job, the procedure is always the same: add and subtract successive rod readings from a point of known elevation to the point of unknown elevation.

4.8.0 Measuring Horizontal Distances

Setting or replacing grade stakes requires measuring horizontal distances with either a metallic or nonmetallic woven tape or a steel tape.

4.8.1 Woven Tape

A woven tape (*Figure 6-67*) is made of high-grade cloth (usually linen) fabric. A metallic, woven tape is reinforced with fine bronze or brass wire mesh. A nonmetallic, woven tape does not contain the mesh; however, some nonmetallic, woven tapes are coated with plastic.

Woven tapes are made in 25-, 50-, 75-, 100-, and 150-foot lengths. Some are graduated in feet and inches to the nearest quarter inch. Others are graduated in feet and decimals of a foot to the nearest 0.05 foot. On most decimally graduated woven tapes, only the 0.10-foot graduations are marked with numerals.

Figure 6-67 – Woven tape.

4.8.2 Steel Tape

A steel tape is used for measurements requiring greater precision than is possible with the woven tape. The most commonly used steel tape is 100 feet in length and is graduated in feet, tenths, and hundredths. Some steel tapes are graduated throughout; on others, only the first foot is graduated in subdivisions and the body of the tape is graduated only at every 1-foot mark. A steel tape is sometimes equipped with a reel on which the tape can be wound. The tape can be detached from the reel for more convenient use in taping.

For convenience in carrying from one place to another, a detached tape can be made up into a coil, commonly called “Doing Up” the tape. Do up the tape by placing the 100-foot end (or the 200-foot, 300-foot, etc., end) in your left hand, faceup; then reach back with your right hand, grasp the 95-foot mark, bring it up, and place it faceup on top of the 100-foot mark. Do the same with the 90-foot mark, the 85-foot mark, the 70-foot mark, and so forth, until you have gathered in the entire tape. You will find that the tape now forms a figure eight, as shown in *Figure 6-68*.

The figure eight can be formed into a circular coil, as shown in *Figure 6-69*.

Figure 6-68 – “Doing up” a steel tape.

Figure 6-69 – Forming a circular coil.

4.9.0 Leveling Mistakes

Some common mistakes made in leveling are as follows:

- Inaccurate adjustment of the instrument: The most common instrument error is caused by a level out of adjustment. The instrument must be adjusted so the line of sight is horizontal when the bubble is in the center of level vial.
- Errors in sighting: If the eyepiece of the telescope is not properly focused, the rod reading appears to change.
- Errors due to changes in the position of the instrument: When the instrument is not properly leveled, or if it is set up in an unstable position, errors will result. An unstable instrument setup makes the level bubble tremble slightly, even though it appears to be properly centered. Check the position of the bubble before and after each rod reading to make sure that the bubble has remained in the center of the level vial.
- Faulty handling of the rod: The rod may not be properly plumbed. If the rod is not held plumb, such as if it leans toward or away from the instrument, the result will be an excessive reading.
- Erroneous rod length: Check the length of the extended leveling rod with a steel tape.
- Failure to clamp the rod at the proper place when using an extended leveling rod: This error could result in reading the wrong mark on the rod or reading the wrong cross hairs. Inspect the clamped positions before and after each sight to make sure that the extended rod has not slipped down.

Test your Knowledge (Select the Correct Response)

9. A hand level is NOT used at distances that exceed what number of feet?

   A. 20
   B. 30
   C. 40
   D. 50

10. **(True or False)** When placing a leveling instrument on a tripod, you should torque the instrument down until it binds to the screw threads.

    A. True
    B. False

5.0.0 SOILS

The soil is an important part of a solid foundation. A poor foundation will eventually cause roads, runways, buildings, and other temporary or permanent structures to collapse.

5.1.0 Soil Formation

Soils are formed through the breakdown of a solid rock mass or parent material into smaller particles. You may have seen rocks that have been crumbled up or that were softer than others. This is one step in the breakdown of rock into soil. Rocks wear away when they are in contact with moving water, as in stream beds or rivers. Rocks also break up when they freeze and thaw. When rocks heat up by the sun and then cool quickly, they crack.

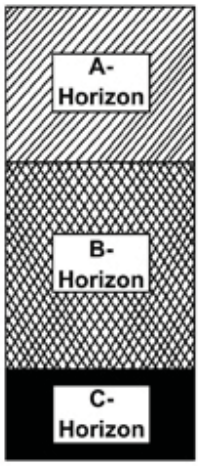

Figure 6-70 – Soil Profile.

5.1.1 Soil Profile

During formation, soils are in a natural profile made up of three distinct layers: A-, B- and C-Horizons (*Figure 6-70*).

A-Horizon – The A-horizon is made up mostly of organic materials. Because these materials are spongy, drain poorly, and do not compact, they are normally removed.

B-Horizon – The B-horizon lies directly beneath the view A-horizon. This layer is lighter in color and made up of sand, gravel, ***silt***, and clay. Seldom is soil in its natural state made up of only sand, gravel, silt, or clay. Most soil is made up of a mixture of the four. How strong and free-draining the soil is depends on the type and amount of each in the mixture. The B-horizon is usually the base for all types of pavement construction.

C-Horizon – The C-horizon is rock in its natural state. It is sometimes called parent material, because this is where B-horizon material comes from. Very seldom are projects built on the C-horizon.

5.1.2 Soil Properties

With experience, you will learn that you can use different properties of soil to your advantage. Soil properties are as follows:

- Expansion
- Contraction
- Plasticity
- Cohesion

Expansion and contraction are undesirable characteristics for a solid foundation and should be monitored closely. Clays and some forms of silt expand and contract with changes in moisture content. Plasticity is the ability of a soil to be molded into shapes. Some clays and silts are also plastic and can be a problem if not controlled properly. Cohesion is the ability of soil to stick together when dry; a good example is clay, which is very cohesive. The more plastic a soil is when wet, the more cohesive it is when dry.

5.1.3 Soil Sizes

Soils are grouped by the size of their particle grains. One method used to distinguish sizes is through the use of sieves (*Figure 6-71*).

A sieve is a screen attached across the end of a cylindrical metal frame. The screen allows particles smaller than its openings to pass through and retains larger particles. Sieves with screen openings of different sizes allow you to sort soil into particle groups, based on size.

Sieve sizes are designated by the screen opening size; for example, a 3-inch sieve has a screen with openings 3 inches square. A No. 4 sieve has four openings per linear inch, thus having 16 openings per square inch.

If a soil sample passes the 3-inch sieve but does not pass the No. 4 sieve, the larger particle size is less than 3 inches and the smallest size is larger than 1/16 inch; therefore the soil is classified as gravel.

Soils that pass the No. 4 sieve but are retained on the No. 200 sieve are classified as sands. Sands are further broken down as coarse sand or fine sands. Coarse sand passes the No. 4 sieve and is retained on the No. 40 sieve. Fine sand passes the No. 40 sieve and is retained on the No. 200 sieve.

Any soil passing the No. 200 sieve is classified as fine-grained.

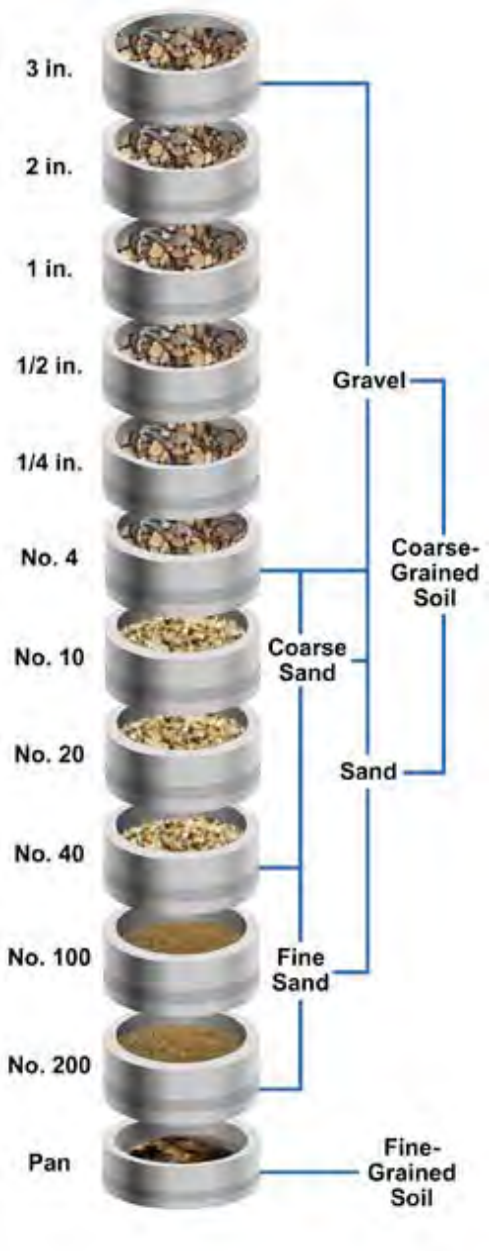

Figure 6-71 – Standard sieve set.

5.1.4 Soil Classification

The soils with which you normally work in earthwork operations are classified as coarse grained, fine grained, and organic.

Coarse-Grained Soils – Coarse-grained soils are composed of sand and gravel and are in the B-horizon. They have 50 percent or less material passing the No. 200 sieve. Their grain shape varies from rounded to angular, and they have good load-bearing qualities and drain freely.

Fine-Grained Soils – Fine-grained soils are composed of silt and clay and are in the B-horizon. They have 50 percent or more material passing the No. 200 sieve. Fine-grained soils have good-load bearing qualities when dry; however, these soils drain poorly, and when wet, have little or no load-bearing strength. Clay especially has this characteristic.

Organic Soils – Organic soils, sometimes referred as ***topsoil*****,** are composed mostly of decayed plant and animal matter and are in the A-horizon. These soils retain moisture, are difficult to compact, and are normally used when landscaping a finished project.

5.1.5 Soil Gradation

Gradation describes the distribution of different size groups within a soil sample. A well-graded soil (*Figure 6-72 A*) is a soil sample that has all sizes of material present from the No. 4 sieve to the No. 200 sieve.

Poorly graded soil may be uniformed-graded (*Figure 6-72 B*) or gap-graded (*Figure 6-72 C*). If a soil is uniformed-graded, most of its particles are about the same size. An example of this is a sieve analysis in which sand size No. 20 is the only size present.

If a soil is gap-graded, at least one particle size is missing. An example of gap-graded soil is one in which a sieve analysis reveals that sand sizes No. 10 and No. 40 are missing. All other sizes are present.

Figure 6-72 – Soil graduation.

5.1.6 Soil Compaction

Compaction is pressing together soil particles to form a consolidated mass with increased stability. Compaction helps the soil resist soaking up moisture from below.

Fills are built up in compacted layers. In earthwork operations, these layers are called lifts. Lifts are from 4 inches to 1 foot in depth, depending upon the compaction necessary, compaction equipment available, and material used for the fill.

The fill material must have the right amount of moisture, referred to as optimum moisture content. To obtain maximum compaction, wet the fill, when necessary, before it is compacted. Compaction may be obtained by using a pneumatic, tandem, or vibratory ***roller***.

5.2.0 Soil Stabilization

There are three purposes for soil stabilization. The first is to improve the strength of the soil. This enhances the existing soil's load bearing capacity. The second purpose is to control dust. This eliminates or alleviates dust generated by the operation of equipment and aircraft during dry weather or in arid climates. The third purpose is to waterproof the soil. This preserves the natural or constructed strength of a soil by preventing the entry of surface water.

There are two methods used to apply soil stabilization materials. The first is the admix method. This is accomplished by combining two different soils together for stabilization. This can be done by:

- In-place mixing: blending of soil and stabilization materials on the jobsite.
- Off-site mixing: using stationary mixing plants.
- ***Windrow*** mixing: mixing the materials using a grader.

The second method is the application of a soil treatment. This is accomplished by placing a soil treatment material, called a binder, directly to the surface of the existing ground by spraying or other means of distribution. Types of binders used in soil stabilization are cement, lime, bituminous products, and calcium chloride. Cement-treated bases are the most commonly used for the purpose of upgrading a poor quality soil. Soil-cement is a mixture of pulverized soil and measured amounts of Portland cement and water, compacted to a high density.

There are three types of soil-cement. The first type is compacted soil-cement that contains sufficient amounts of cement to harden the soil and enough moisture for both compaction and hydration of the cement. The second type is cement modified soil which is an unhardened or semi-hardened mixture of soil and cement. Only enough cement is used to change the physical properties of the soil. The third type is plastic soil-cement. It is a hardened mixture of soil and cement that contains, at the time of placing, enough water to produce a consistency similar to that of plastering mortar. The three basic materials needed when working with soil-cement are soil, Portland cement, and water. The soil can almost be any combination of gravel, sand, silt, or clay.

There are three major control factors when working with soil-cement:

- The proper cement content. A rule of thumb: use one 50-pound bag per square yard.
- Proper moisture content. On a soil sample, a firm cast should be made when squeezed in your hand without squeezing out any water.
- Adequate compaction. The principles of compacting soil-cement are the same for compacting the soils without cement treatment. The soil-cement mixture at optimum moisture content should be compacted to maximum density and finished immediately. Moisture lost by evaporation during compaction, as indicated by the graying of the surface, should be replaced with light applications of water.

Occasionally during compaction, the treated area may yield under the compaction equipment. This may be due to one or more of the following causes:

- The soil-cement mix is much wetter than optimum moisture content.
- The soil may be too wet and unstable.
- The roller may be too heavy for the soil. If the soil-cement mix is too damp, it should be aerated by using the ***scarifier*** on the grader. After it has dried to near optimum moisture content, then it is compacted.

Test your Knowledge (Select the Correct Response)

11. **(True or False)** A poor foundation eventually causes roads, runways, buildings, and other temporary or permanent structures to collapse.

    A. True
    B. False

12. When computing the amount of cement required for a soil stabilization project, you should use what rule of thumb?

    A. One 50-pound bag for every cubic yard
    B. One 50-pound bag for every square yard
    C. One 50-pound bag for every cubic feet
    D. One 50-pound bag for every square feet

6.0.0 TECHNIQUES OF EARTHWORK OPERATIONS

Techniques of earthwork operations consist of knowing the equipment needed and the operations of pioneering, clearing, grubbing, stripping, draining, grading, and excavating. These operations are done primarily with heavy construction equipment, such as ***bulldozers*** and graders. Hand- or powerfelling equipment, explosives, and fire are used when they make the completion of these operations easier.

Large-scale clearing and grubbing operations often produce damaging environmental effects, such as increased soil erosion, reduction of atmospheric oxygen, and destruction of wildlife habitat. Additionally, introduction of particulate matter into streams and riverbeds causes increased siltation and algae growth. Federal regulations may require an environmental impact statement or assessment prior to beginning clearing operations.

To prevent these damaging effects, save as much vegetation such as trees, grass, and other plants, as possible to hold the soil in place. Constructing a shallow ***trench*** or application of plastic barriers or hay bales around the perimeter of a project will help to contain water runoff into streams and rivers, preventing siltation. Scrubs and stumps should be burned only when atmospheric conditions are favorable and the material to be burned is dry. Do not use petroleum based fuels to start fires, as fuels do not burn completely and can seep into the underground water table.

NOTE

A burn permit is required in all burning operations on NCF projects to prevent wild fires and production of smog.

When determining the methods of earthwork operations needed, consider the following factors:

- The acreage to be cleared
- The type and density of vegetation
- The physical features of the land
- The expected weather conditions
- The time available for completion of the job

For best results, use a combination of methods in a sequence of operations. Use the method most suitable and effective for the job.

6.1.0 Equipment

You must know your equipment, its limitations, and its operating characteristics to be an efficient EO on earthmoving jobs. Equipment production must be determined so that the correct amount and type of equipment is selected for a project.

Equipment production rates are available in the *Seabee Planner's and Estimator's Handbook*, NAVFAC P-405. The handbook provides information on estimating construction work elements and material quantities, including equipment and manpower requirements.

Before you begin earthmoving operations, it is often necessary to remove overgrowth, boulders, and other obstructions. You may also have to build a drainage system, so the construction site will drain. These operations are carried out with bulldozers, ***scrapers***, graders, and similar equipment.

The load hauled by a scraper is usually referred to as either heaped or struck (*Figure 6-73*).

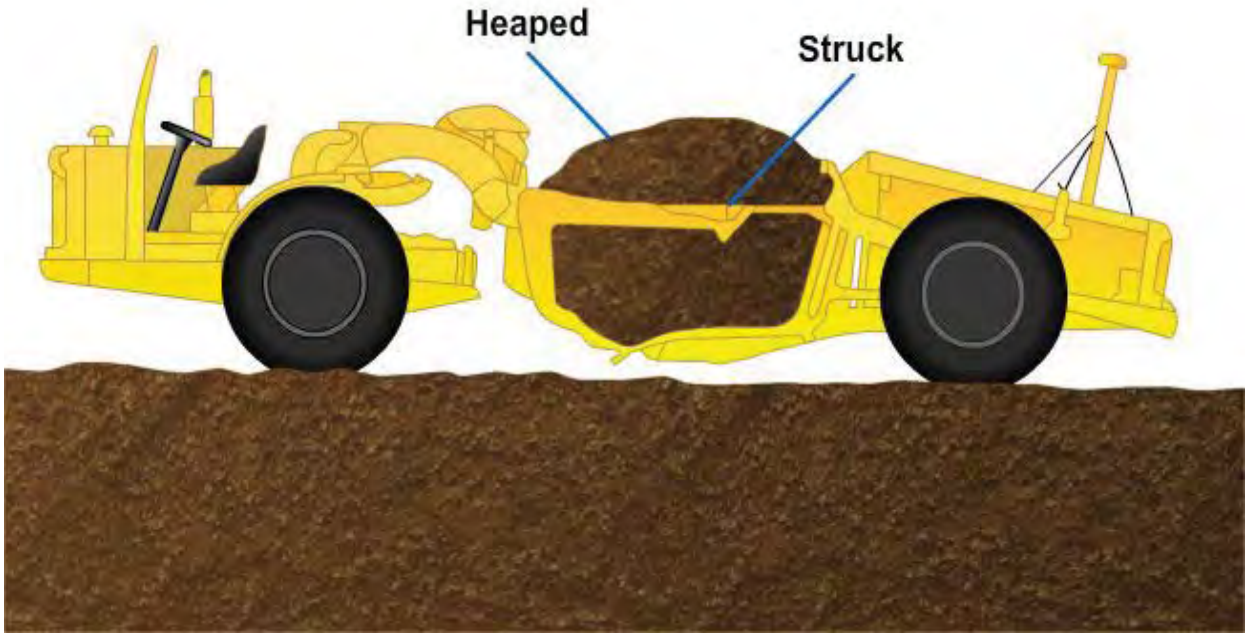

Figure 6-73 – Heaped and struck load.

When moving earth, take a full, heaped load and make it count. In earthmoving operations, travel can be time-consuming. Suppose you are operating a 12-cubic-yard scraper. It will carry about a 15-cubic-yard heaped load. If you carry only a struck (level) load of 12 cubic yards, you lose 3 cubic yards of load each trip. To move 60 cubic yards takes five trips when only 12 cubic yards are hauled each time. Hauling full, heaped loads, you would move the same amount of material in four trips. If your haul is short and units are waiting to go into the cut, you can increase production by taking only a good load (somewhere between struck and heaped) and moving out, rather than spending extra time obtaining a heaped load.

Most construction jobs require both cuts and fills. To increase job efficiency, plan your job so that the material taken from a cut is used in a fill area. This is known as balancing the material**.**

6.2.0 Pioneering

Pioneering refers to the first working over of an area that is overgrown or rough, making it accessible for the equipment needed for the project.

In pioneering, the operations of clearing, stripping, grading, and drainage are all done practically at the same time rather than performed as separate operations. A bulldozer starts out along a predetermined route and leaves a road behind it. This may be a haul road that trucks and equipment will use in later operations.

Suppose you, as a dozer operator, get the job of cutting a road on the side of a mountain to be used for access to a proposed airstrip or to reach a mountain stream to be developed into a water supply system. Where should you start and how should you proceed? The route your mountain road is to follow will be staked out by a survey party. Start your road at the highest point possible and let the force of gravity help the dozer.

In clearing on sidehill cuts, cast brush and trees far enough to the side of the road so that they will not be covered with the earth. It is even better if you can cast them over the edge with an angle blade of the dozer when you cut the road. When cutting the

road, do not watch the grade stake immediately ahead or you will find yourself below grade. Instead, watch the third or fourth stake down.

NOTE

It is better to be above grade and come back and cut down to grade than to be below grade and have to come back and fill.

6.3.0 Clearing

Clearing is a construction operation consisting of cleaning a designated area of trees, timber, brush, other vegetation, and rubbish; removing surface boulders and other material embedded in the ground; and disposing of all material cleared.

Clearing, grubbing, and stripping are different in every climatic zone, because each has different types of forests and vegetation. The nature of a forest can be determined from records of the principal climatic factors, including precipitation, humidity, temperature, sunlight, and the direction of prevailing winds. The types of forests can be generally classified as temperate, rain, monsoon, or dry, according to the climates in which they exist.

Clearing usually consists of pushing uprooted trees, stumps, and brush in both directions from the center of the area to be cleared. Clear so that debris (spoil material) is placed in a designated spot with only one handling. In clearing landing strips, for example, it is generally necessary to dispose of material along each side of the strip outside the construction site. If the site permits burning, the haul distance can be reduced by piling brush, stumps, and trees on the site and burning them. Production in this field must be estimated, rather than calculated.

6.4.0 Grubbing

Grubbing consists of uprooting and removing roots and stumps. In grubbing, stumps that are difficult or impossible to pull out, even with winches, should be burned or blasted. Your supervisor will decide the method. If the stumps are to be removed by blasting, a qualified blaster must be called upon to do the job. If they are to be burned, you may be assigned the task. Green stumps require continuous application of heat before they catch fire. Check with your supervisor about safety measures that should keep the fire from getting out of control if you have to do any stump burning. Remember that it may take as long as 3 or 4 days for a stump to burn out. Keep a check on the burning during this period. If a project has a high priority and time must be saved, stumps will probably be blasted, rather than burned. When stumps have been removed, refill the holes and level the area to prevent the accumulation of water.

6.5.0 Stripping

Stripping consists of removing and disposing of objectionable topsoil and ***sod***. It may either follow or occur simultaneously with clearing and grubbing. Actual earthmoving begins with stripping; surface soil and rocks are removed from the area to be excavated. Deeply embedded rocks and large boulders may have to be blasted before they can be removed.

The material removed by stripping is called spoil. Unless otherwise directed, dump spoil along the area to be excavated within range of the earthmoving equipment. If the spoil will not be put to use, such as turfing or finishing the shoulder of a road or runway, it should be wasted along the edges of the project, as shown in *Figure 6-74*. Take care not to disturb necessary drainage.

Figure 6-74 – Stripping.

Equipment commonly used in stripping consists of a bulldozer, a scraper, and a grader. As mentioned earlier, the dozer is the most often used when removing trees. Dozers can handle all short-haul excavations (up to 300 feet). For long-haul excavations (over 300 feet), use scrapers. A scraper may be used also on fine soils for shallow stripping. A grader is used mainly for shaping and finishing a stripped surface. It is adaptable also for ditching, sidecasting, and sloping banks.

6.6.0 Drainage

Drainage is the construction of facilities needed to allow excess surface and subsurface water to flow from the construction site. Properly designed and constructed drainage systems are one of the most important parts of a construction project. Without proper drainage, rainwater and water running off the surrounding ground could turn the area into a lake. It is also necessary to drain off surface water that would soak down and wet the subgrade.

The elements determining drainage needs for a road or project site are the amount of annual rainfall in the area and the routes or areas that can be used to collect or channel excess surface and subsurface water, such as lakes, ponds, streams, or voids (i.e., gullies).

The type of soil is critical to the design and construction of a road. It is poor judgment to construct a road over or through clay, sand, or other undesirable material if it cannot be properly compacted. It is best to bypass this type of material. If a road surface is to endure continued use for years, it must have firm support from the subgrade. All organic materials, such as living or decayed vegetation, should be removed from the area of the subgrade unless the road is for emergencies or is temporary (e.g., a detour or military road). In designing and building a road, consider the type of drainage, the type of soil, and the amount of clearing or grubbing necessary.

To facilitate drainage, excavate diversion ditches to conduct all surface water into natural channels or outfall ditches. Outfall ditches are constructed to drain low or boggy spots. At the point or the end of the system where the accumulated runoff discharges into the disposal point, the runoff is technically known as discharge. The discharge point

in the system is called the outfall. This preliminary work is done at the same time the area is cleared and grubbed.

The finished drainage system usually consists of ground slopes, ditches, culverts, gutters, storm drains, and underground water drains. Use open channels to intercept or control surface water. Dig these with bulldozers, scrapers, ***backhoes***, or motor graders, depending on circumstances. Culverts drain water across a construction site. Subdrains to drain groundwater are usually excavated with ***ditchers*** or backhoes. The drains used are French drains (perforated or open-joint tile pipes). *Figure 6-75* shows typical covered and French drains.

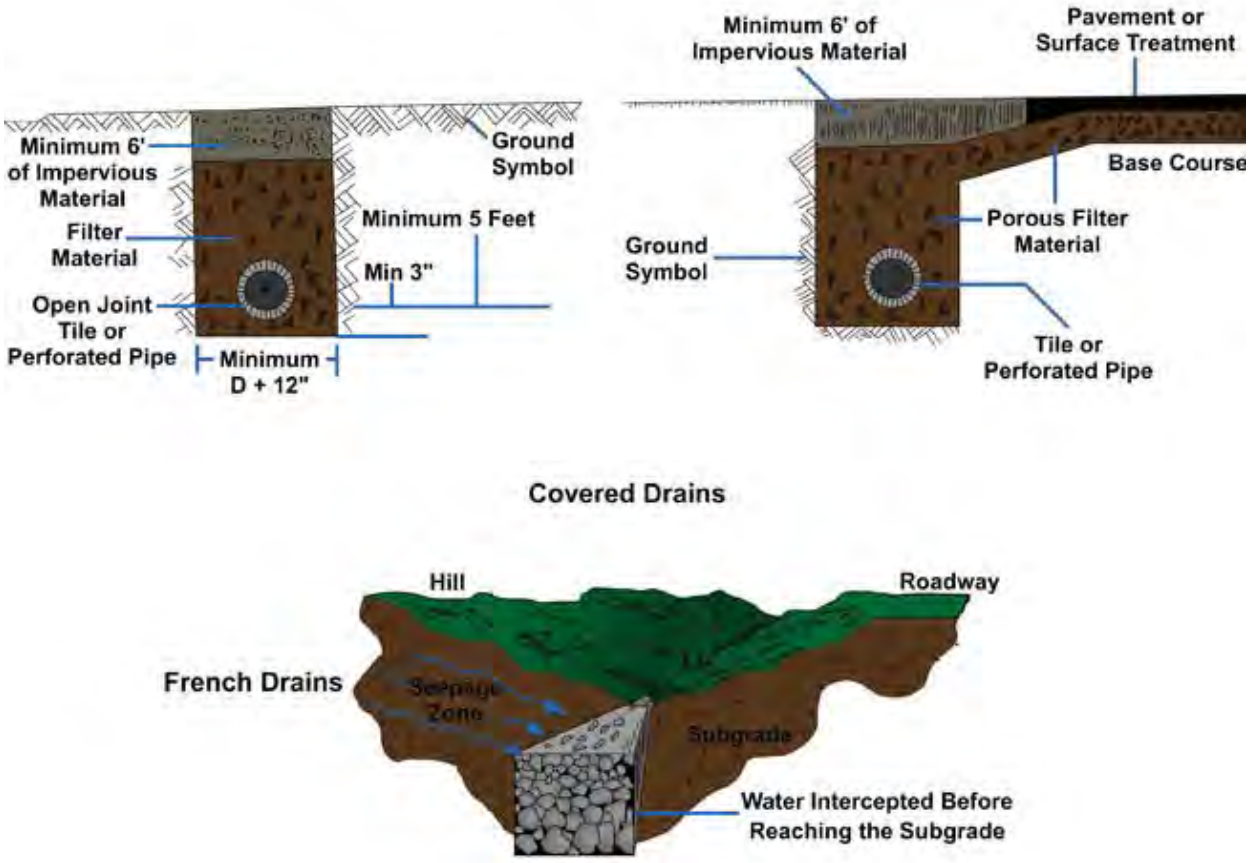

Figure 6-75 – Typical sections of covered and French drains.

Runoff water from rain or melted snow is removed from the area by an adequate transverse slope or crown. This runoff is collected in ditches and drained into the nearest natural drainage channel. Drainage for construction sites can be provided by building the ends of the site sloping towards the middle or sloping from one end to the other. These types of drainage construction are shown on the runways in *Figure 6-76.*

Figure 6-76 – Longitudinal drainage runways.

6.7.0 Grading and Excavating

Grading and excavating are cutting the high spots to grade and filling in the low spots. In cutting down the high spots, enough suitable fill material may be removed to fill in low spots; however, it may be necessary to develop other sources of fill material. If the site is on hard and rocky terrain, loosen and break the soil with a dozer ***ripper***. Before placing fill material in low spots, you must prepare a suitable foundation. You may have to dig up material of a low-bearing capacity before placing the fill.

6.7.1 Base Course

The base course distributes wheel load stresses from the surface pavement to the subgrade. Since stresses in the base course are more concentrated than in the subgrade, the base course must be stronger.

6.7.2 Placement and Compaction

When placing and spreading base course materials on a prepared subgrade, start at the point nearest the source or at the point farthest from the source. Then place the material progressively away from or toward the source, respectively. The advantage of working from the point nearest the source is that hauling equipment can be routed over the spread material, which helps compact the base course and avoids cutting up the subgrade. An advantage of working from the point farthest from the source is that the hauling equipment further compacts the subgrade, reveals any weak spots in the

subgrade, and interferes less with the movement of spreading and compaction equipment.

Base course compaction must produce a uniformly dense layer, conforming in every way to specification requirements. The thickness of the lifts should not exceed that which can be compacted to the required density. The thickness of the lifts is determined by the size of the compaction equipment, such as 6 inches for rollers and 3 inches or less when using tampers.

NOTE

Always maintain optimum moisture during compaction.

Test your Knowledge (Select the Correct Response)

13. Which of the following is NOT a factor when determining the methods of earthwork operations required for a project?

    A. The acreage to be cleared
    B. The availability of water to achieve optimum moisture content
    C. The type and density of vegetation
    D. The expected weather conditions

14. Equipment production rates are obtained from which of the following NAVFAC publications?

    A. P-300
    B. P-306
    C. P-404
    D. P-405

Summary

This was a valuable chapter. In it, you learned how the Seabee Project Package is used to plan and record all phases of a project. You learned the equations to determine the slope ratio of inslopes and backslopes and the square feet area of geometric figures. You learned the uses of centerline, shoulder, and guard stakes. In addition, you learned how to properly operate surveying equipment. You learned about the formation and stabilization of soil by use of binders. You were introduced to pioneering, clearing and grubbing, earthwork techniques commonly performed by Equipment Operators.

Review Questions (Select the Correct Response)

1. **(True or False)** Earthwork operation is referred to as vertical construction?

   A. True
   B. False

2. Step-by-step information on how a project package is developed is outlined in which of the following?

   A. Seabee Crewleader's Handbook
   B. Seabee Planner's and Estimator's Handbook
   C. The Red Book
   D. Operator's Handbook

3. Project drawings do NOT provide _____.

   A. The basis for estimating material
   B. Precise instructions for construction, showing the sizes and locations of various parts
   C. Step-by-step instructions of how construction is to be performed
   D. Means of coordination between the different ratings

4. **(True or False)** A contour line is a symbol that shows an imaginary line that represents a constant elevation on the surface of the earth.

   A. True
   B. False

5. A cubic yard is a cube 3 feet long, 3 feet wide, and how many feet high?

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

6. Which of the following is NOT a condition considered when computing cubic yards of material?

   A. In place
   B. Wet
   C. Loose
   D. Compacted

7. What term is used to describe the section of a ditch that extends from the outside of the shoulder to the bottom of the ditch?

   A. Inslope
   B. Roadbed
   C. Backslope
   D. Travel way

8. **(True or False)** A cross-sectional view of project prints displays the slope limits, the slope ratio, and the horizontal distance between the centerline stakes and the shoulder stakes.

   A. True
   B. False

9. A hub stake with a red or blue top is used for what type of grade work?

   A. Finished
   B. Rough
   C. Profile
   D. Alignment

10. A guard stake provides which of the following services?

   A. Warns the oncoming traffic of construction ahead
   B. Protects construction workers from traffic
   C. Warns the operator that a flag is ahead
   D. Provides a means of locating a reference point

11. Stakes used on construction projects are normally marked in what unit(s) of measurement?

   A. Feet only
   B. Feet and tenths of a foot
   C. Meters only
   D. Meters and centimeters

12. To convert tenths of a foot to inches, you multiply the decimal fraction by what number?

   A. 6
   B. 8
   C. 10
   D. 12

13. What term is used to describe the reference mark on a grade stake that indicates the actual grade desired?

   A. Arrowhead
   B. Sheepsfoot
   C. Crowfoot
   D. All of the above

14. Which of the following station numbers identifies the starting station?

   A. 0 + 00
   B. 1 + 00
   C. 10 + 00
   D. 100 + 00

15. A grade stake station that ends with the number 00 is known by what term?

A. Even
B. Plus
C. Full
D. Midway

16. What type of stake marks the horizontal location of earthwork and gives the direction of the proposed construction?

A. Centerline
B. Line
C. Shoulder
D. Slope

17. What information is written on the front of a centerline stake?

A. Change in elevation
B. Crowfoot
C. Station number
D. Offset information

18. On a road project, a grade stake with the symbol SH should be placed at what location?

A. On a line parallel to the center line
B. Not more than 20 feet from the center line
C. Only on the back side of a fill or cut stake
D. On the back side of the centerline stake

19. A stake marked “OF 65’ CL C-3.5” means that the stake is offset what distance from the centerline stake?

A. 3 feet
B. 3.5 feet
C. 65 feet
D. 68.5 feet

20. When used for alignment, a dumpy level is accurate at distances up to how many feet?

A. 1,000
B. 2,000
C. 3,000
D. 4,000

21. **(True or False)** A compensator on a self-leveling level automatically places the line of sight horizontal.

A. True
B. False

22. Each foot on a Philadelphia rod is subdivided into what fraction of a foot?

A. Tenth
B. Hundredth
C. Thousandth
D. Ten–thousandth

23. The indicators for foot measurements on a Philadelphia rod are what color?

A. White
B. Black
C. Red
D. Brown

24. What person makes the rod reading when a target is used?

A. Levelman
B. Rodman
C. Signalman
D. Targetman

25. What term is used to describe a reference point whose elevation is known and marked?

A. Datum plane
B. Mean sea level
C. Bench mark
D. Backsight

26. To determine the height of the instrument, you add the bench mark elevation to what reading taken from the level rod?

A. Mean sea sight
B. Sidesight
C. Foresight
D. Backsight

27. The height (HI) of the instrument is 136 feet. The foresight (FS) reading is 4.5 feet. What is the elevation at the foresight reading?

A. 91 feet
B. 132.5 feet
C. 140.5 feet
D. 171 feet

28. In setting or replacing grade stakes, horizontal distance is measured with which of the following types of tapes?

A. Metallic woven
B. Nonmetallic woven
C. Steel
D. All of the above

29. Which of the following incremental markings are on a steel surveyor's tape?

A. Feet, tenths of a foot, and hundredths of a foot
B. Feet, tenths of a foot, and yards
C. Yards, feet, and hundredths of a foot
D. Feet and yards only

30. What soil layer is light in color and composed of sand, gravel, silt, and clay?

A. A-horizon
B. B-horizon
C. C-horizon
D. D-horizon

31. Which of the following soils has good load-bearing qualities and drains freely?

A. Organic
B. Fine grained
C. Medium grained
D. Coarse grained

32. Which of the following advantages are reasons soil stabilization is important?

A. Strength improvement
B. Dust control
C. Soil waterproofing
D. All of the above

33. What term is used to describe a construction operation that consists of cleaning a designated area of trees, timber, brush, and rubbish?

A. Clearing
B. Grubbing
C. Stripping
D. Grading

34. What term is used to describe a construction operation that consists of removing and disposing of objectionable topsoil and sod?

A. Clearing
B. Grubbing
C. Stripping
D. Grading

35. What factor(s) must be considered when designing and building a road?

A. Type of drainage
B. Type of soil
C. Amount of clearing and grubbing
D. All of the above

36. **(True or False)** Optimum moisture content must be maintained when compacting lifts of base course materials.

A. True
B. False

Trade Terms Introduced in this Chapter

Culverts	A pipe or small bridge for drainage under a road or structure.
Cut-and-fill	The process of constructing a road whereby the amount of material from cuts roughly matches the amount of fill needed to make nearby embankments, so minimizing the amount of construction labor.
Backhoes	Excavating equipment consisting of a digging bucket on the end of a two-part articulated arm.
Bulldozers	A tractor equipped with a front pusher blade.
Ditchers	A machine used for digging ditches.
Grades	The level at which the ground surface meets the foundation of a building.
Grader	A machine with a centrally located blade that can be angled to cast to either side with an independent hoist control on each side.
Horizontal plane	A transverse plane at right angles to the longitudinal axis of the body.
Orthographic projections	A means of representing a three-dimensional object in two dimensions.
Prismatic	Of, relating to, resembling, or being a prism.
Reference points	Points to which other points, lines, and so forth are referred, usually in terms of distance or direction, or both.
Ripper	An equipment attachment with teeth, used primarily for loosening hard soil and soft rock.
Roller	A compactor type engineering vehicle used to compact soil, gravel, concrete, or asphalt in the construction of roads and foundations.
Scarifier	An equipment attachment that makes shallow cuts into the surface of soil or pavement.
Silt	Fine sand that looks like flour when dry.
Scrapers	A digging, hauling, and grading machine, having a cutting edge, a carrying bowl, a movable front wall (apron), and a dumping or ejecting mechanism.

Sod	The part of the soil beneath it held together by the roots, or a piece of this material.
Topsoil	The topmost layer of soil, usually refers to soil containing humus that is capable of supporting good plant growth.
Windrow	A long, narrow pile of materials.

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.

Leveling Instruments, Linear Programmed Text Series 046/371C, Naval Construction Training Center, Port Hueneme, CA, 1990.

Seabee Crewleader's Handbook: 3rd ed., Seabee Readiness Division of the Naval School, Civil Engineer Corps Officers (CECOS), Port Hueneme, CA, 2003.

Pavements Maintenance Specialist, Volume 2, CDC 55150, General Subjects and Contingency Responsibilities, Extension Course Institute, Gunter Air Force Base, Montgomery, AL, 1991.

Transferrings Elevations, Student Programmed Text Series 046/371D, Naval Construction Training Center, Port Hueneme, CA, 1988.

Seabee Planner's and Estimator's Handbook, NAVFAC P-405, Naval Facilities Engineering Command, Alexandria, VA, 1996.

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Chapter 7

Medium Tactical Vehicle Replacements

Topics

To hear audio, click on the box. 

Overview

Since replacing the aging 5-ton truck, the 7-ton Medium Tactical Vehicle Replacement (MTVR) has become the Seabee's new workhorse. There are several variants of MTVRs, for a wide spectrum of tasks including hauling, dumping, towing and winching. Theses heavy-duty vehicles are primary operated by trained Equipment Operators.

This chapter describes to the types of MTVRs used by the Naval Construction Force (NCF). It includes descriptions of major components, capabilities, and features that make MTVRs extraordinary military vehicles.

Objectives

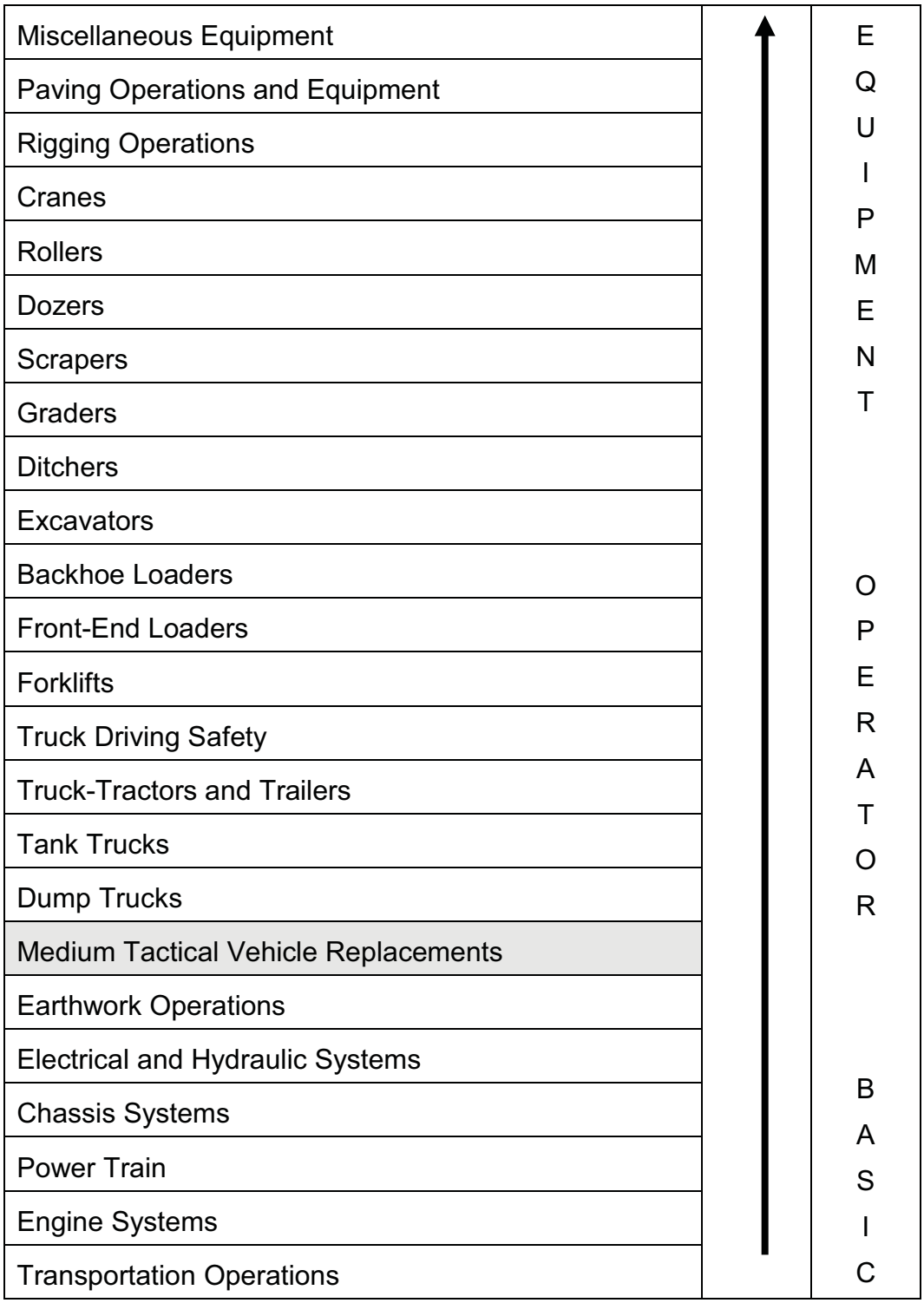
When you have completed this chapter, you will be able to do the following:

1. Identify the types of MTVRs used by NCF.
2. Identify the major components of MTVRs.
3. Understand the principles of the Central Tire Inflation System (CTIS) on MTVRs.
4. Understand the principles of the Anti-Lock Brake System (ABS) on MTVRs.
5. Understand the principles of the Automatic Traction Control (ATC) on MTVRs.
6. Identify the controls and instruments on MTVRs.
7. Identify the types of collateral equipment on MTVRs.

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 MEDIUM TACTICAL VEHICLE REPLACEMENTS

Medium Tactical Vehicle Replacements (MTVRs) are purpose-designed military vehicles manufactured by Oshkosh Truck Corporation (*Figure 7-1*). These 7-ton, 6x6 vehicles were designed for use on all types of roads, highways, and cross-country terrains.

Figure 7-1 – MTVR.

On roads and highways, MTVRs are capable of traveling a maximum speed of 65 mph; however, operators must adhere to the speed limits set by the NCF. Additionally, MTVRs are capable of climbing 60 percent grades and ***traversing*** 30 percent side slopes at 15 mph and 40 percent side slopes at up to 5 mph. They are capable of ***fording*** water as deep as 60 inches, as shown in *Figure 7-2.*

Figure 7-2 – MTVR fording.

MTVRs are also capable of operating in extreme conditions and temperatures from -25°F to 125°F. With the use of arctic kits, consisting of an extra battery and an engine heater, MTVRs are capable of operating in -50°F.

All MTVRs can be fitted with armor protection kits (APKs), as shown in *Figure 7-3*. Made of a hard steel and metal composite, these kits provide complete 360-degree protection as well as overhead and underbed protection for the operator's cab.

Figure 7-3 – MTVR with armor.

For transportation by aircraft, MTVRs were designed with hinged, one-piece windshields, roofs, side walls, door frames, and rear walls. This design makes it possible to reduce MTVR's vehicle height from 140 inches to 98 inches (*Figure 7-4*). This can be performed within 30 minutes by two individuals. In addition, these vehicles are equipped with tiedown points located so that the vehicle can be restrained during air, highway, rail, and sea transportation.

Figure 7-4 – MTVR vehicle height reduced.

1.1.0 Types of Medium Tactical Vehicle Replacements Used By Naval Construction Force

To perform operations such as hauling containers, dumping payloads, pulling trailers, and towing other vehicles, the NCF uses four types of MTVRs: cargo truck MK27 and 28, dump truck MK30, truck-tractor MK31 and wrecker MK36.

1.1.1 Cargo Truck MK27 and MK28

Equipped with an extended cargo bed 20 feet long, the MK27 and MK28 *(Figure 7-5)* were designed for hauling.

Figure 7-5 – MK28.

Without armor, they can haul up to 15 tons on ***primary*** and ***secondary roads*** or 7.1 tons on all terrains. With armor, the MK27 and MK28 can haul 12 tons on primary and secondary roads or 6 tons on all terrains.

The MK27 and MK28 can also haul International Organization for Standardization (ISO) containers (*Figure 7-6*). Their extended cargo beds, with locks, are long enough to haul one 20-foot ISO container or two 10-foot ISO containers. These containers may contain cargo such as construction material and tool kits.

Figure 7-6 – ISO container.

By installing a cargo cover, operators can protect cargo from the weather and hide it from view. The cargo cover is stowed in a stowage box mounted on the left side of the vehicle, as shown in *Figure 7-7*. Its bows are stowed on front of the cargo bed headboard, as shown in *Figure 7-8*.

Figure 7-7 – Stowage location of cargo cover.

Figure 7-8 – Stowage location of bows.

The main difference between the MK27 and MK28 is that the MK28 is equipped with a ***self recovery winch*** (*Figure 7-9*) used to pull the MK28 or another vehicle from mired conditions. The self recovery winch is mounted onto the rear of the vehicle, on the right side and has the pulling capacity of 20,000 pounds.

Figure 7-9 – MK28 self recovery winch.

NOTE

MTVRs equipped with self recovery winches have a greater ***vehicle curb weight (VCW)*** and ***gross vehicle weight rating (GVWR).***

The even numbered MTVRs, such as the MK28 and MK30 are equipped with self recovery winches.

1.1.2 Dump Truck MK30

Equipped with a dump body made of high-strength steel, the MK30, shown in *Figure 7-10*, was designed to haul and dump material. On paved surfaces, it can haul a ***struck*** payload of 21,060 pounds (10.5 tons) or a ***heaped*** payload 28,000 pounds (14 tons). On cross-country terrains, it can haul a struck or heaped payload of 14,200 pounds (7.1 tons).

Figure 7-10 – Dump truck MK30.

The dump body's adjustable tailgate allows for dumping and spreading of payloads. The MK30 is used to haul and dump loose materials such as concrete, earth, tree stumps, and large boulders.

Like the MK28, the MK30 is equipped with a cargo cover and bows. It is also equipped with a cargo tarp made of nylon mesh that is rolled out over the payload. This tarp prevents driving hazards by limiting dirt spills on turns and curves.

The MK30 also is equipped with a self recovery winch; however, unlike the MK28, the MK30's self recovery winch is mounted behind the cab on the right hand side.

1.1.3 Truck-Tractor MK31

Equipped with a fifth wheel assembly and a coupling device, the truck-tractor MK31 was designed to pull semi-trailers. On highways, it can pull semi-trailers weighing 94,000 pounds, on cross-country terrains, semi-trailers weighing 67,000 pounds. These trailers are often loaded with Civil Engineering Support Equipment (CESE) and construction supplies. *Figure 7-11* shows an MK31 pulling a hydraulic detachable gooseneck trailer loaded with a bulldozer.

Figure 7-11 – Truck-Tractor MK31.

Unlike the other MTVRs, the MK31 is equipped with a hydraulic system that uses hydraulic cylinders on axles No. 2 and No. 3 to level the MK31. The hydraulic system has two modes, automatic and manual. In both modes, the hydraulic system will adjust the level of the MK31 when it is not moving, when its engine is running, and when it is out of level; however, the automatic mode is recommended for level surfaces such as roads and highways while the manual mode is recommended for cross-country terrains.

NOTE

Before operating the MK31, be sure to select the automatic or manual mode to ensure that the vehicle is level prior to operation.

1.1.4 Wrecker MK36

Equipped with a crane, the wrecker MK36, shown in *Figure 7-12*, was designed to lift and tow. It can lift 22,000 pounds to 9 feet or 3,960 pounds to 31 feet.

Figure 7-12 – Wrecker MK36.

The MK36 is equipped with a self recovery winch. Unlike other MTVR self recovery winches, the winch on the MK36 has a pulling capacity of 25,000 pounds. Additionally, it is mounted on the front bumper. Because it is equipped with a crane and a self recovery winch, the MK36 is the biggest and heaviest of all MTVRs.

Test your Knowledge (Select the Correct Response)

1. MTVRs are capable of climbing _____ percent grades.

   A. 70
   B. 65
   C. 60
   D. 55

2. **(True or False)** The vehicle height of a MTVR can be reduced to 96 inches.

   A. True
   B. False

3. **(True or False)** On the MK31, the automatic mode is recommended for level surfaces such as roads and highways.

   A. True
   B. False

2.0.0 MAJOR COMPONENTS

Besides the specific components used for hauling, dumping, and lifting, all MTVRs have the same major components as shown in *Figure 7-13.*

Figure 7-13 – Major components.

2.1.0 Engine Compartment

The engine compartment protects a Caterpillar C-12 engine that supplies power to move the vehicle and operate equipment and accessories.

2.2.0 Operator’s Cab

The all-aluminum operator’s cab provides seating for 3 people. It also protects the controls, gauges, and indicators, located on the instrument panel, from the weather.

2.3.0 Tires and Wheel Assemblies

MTVRs are equipped with six tires. A tire's wheel assembly consists of two 20 x 10 inch steel discs. Together, a tire and its wheel assembly weigh 500 pounds.

WARNING

Do not attempt to lift or catch a tire/wheel assembly without the aid of an assistant and a suitable lifting device. Failure to comply may result in injury or death to personnel.

2.4.0 Axles No. 2 and No. 3

Axles No. 2 and No. 3 transmit power to the hubs to turn the wheels.

2.5.0 Fuel Tank

The fuel tank can store a total of 80 gallons of diesel fuel; 76 are usable gallons to operate the vehicle. MTVRs have a ***cruising range*** of 300 miles.

2.6.0 Battery Box

The battery box stores up to four batteries for operating in normal and arctic temperatures. It has rubber latches for securing a cover that protects the batteries from the weather.

2.7.0 Air Cleaner

The air cleaner filters out dust and debris, preventing such foreign particles from entering the air induction system and damaging the engine.

2.8.0 Muffler and Exhaust Piping

The muffler and exhaust piping directs exhaust fumes from the engine away from the operator's cab

2.9.0 Machine Gun Mount

The machine gun mount is a kit and will not be installed on all MTVRs.

2.10.0 Towing Eyes

When the MTVR is towing another vehicle, the towing eyes serve as attachment points for safety chains and towing shackles.

2.11.0 Gladhands

Gladhands are coupling devices used for connecting the service and emergency air lines from the MTVR to a towed vehicle or trailer. The blue gladhand is for connecting the service air line, the red one is for connecting the emergency air line.

2.12.0 Pintle Hook

The pintle hook is a fixed unit that has swivel capability. It is used to connect the MTVR to a towed vehicle or trailer.

2.13.0 Tiedown Eyes

For transporting an MTVR, the tiedown eyes are used as attachment points for securing the MTVR to a trailer or railcar.

2.14.0 Front and Rear Intervehicular Electrical Connector

The front and rear intervehicular electrical connector connects the MTVR to the electrical system of a towed vehicle.

Test your Knowledge (Select the Correct Response)

4. **(True or False)** A tire and its wheel assembly weigh 300 pounds.

    A. True
    B. False

5. What are gladhands used for?

    A. Preventing foreign particles form entering the air induction system
    B. Connecting the service and emergency air lines from the MTVR to a towed vehicle or trailer
    C. Connecting the MTVR to a towed vehicle or trailer
    D. Securing the MTVR to a trailer and railcar

3.0.0 CENTRAL TIRE INFLATION SYSTEM

One feature that makes MTVRs extraordinary vehicles is their Central Tire Inflation Systems (CTIS). The CTIS was designed to maximize traction, mobility, and ride quality. During operation, the operator selects the appropriate terrain and load setting to correspond to the terrain condition and weight of the load being transported; the CTIS adjusts the tire pressure accordingly and continues to check the pressure at intervals.

Located on the left side of the steering wheel, the CTIS controller (*Figure 7-14*), has four terrain settings and three load settings.

The four terrain settings are highway (HWY), cross-country (CC), mud/sand/snow (MSS) and emergency (EMER). *Table 7-1* describes the terrain conditions under which to use the settings.

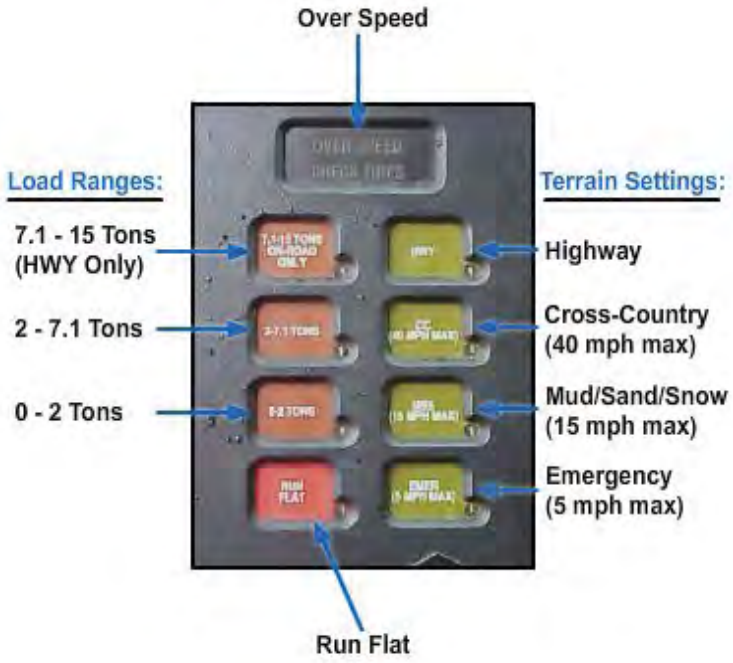


Figure 7-14 – MK28 CTIS.

Table 7-1 – CTIS settings and terrain conditions.

CTIS SETTINGS	TERRAIN CONDITIONS
Highway	For operation on improved paved surfaces
Cross-Country	For operation on non-paved secondary roads and hard packed trails
Mud/Sand/Snow	For operation on soft-surface trails and other unimproved surfaces
Emergency	For selection of extremely low tire pressure to help free a mired vehicle or to traverse a short distance over a terrain known to require very low tire pressure

The load settings on the MK28 and MK30 are different. On the MK28, the cargo load settings are as follows: 0-2 tons, 2-7.1 tons, and 7.1-15 tons. On the MK30, the dump load settings are as follows: 0-2 tons, 2-6.1 tons, and 6.1-14 tons. As shown in *Table 7-2*, the terrain and load settings affect the tire inflation pressure of both the front and rear tires.

Table 7-2 – Tire pressure.

	MK30	MK28		TERRAIN			
				HWY	CC	MSS	EMER
Empty Condition	0-2 tons	0-2 Tons	Front Rear	43 PSI 35 PSI	28 PSI 22 PSI	15 PSI 12 PSI	12 PSI 10 PSI
Partial Load	2-6.1 tons	2-7.1 Tons	Front Rear	42 PSI 55 PSI	27 PSI 34 PSI	14 PSI 19 PSI	11 PSI 14 PSI
Full Load	6.1-14 tons	7.1-15 Tons	Front Rear	42 PSI 96 PSI	27 PSI 70 PSI		
				MAXIMUM SPEED	40 MPH	15 MPH	5 MPH
NOTE: All tire pressures are ± 3 PSI.							

CAUTION

The load setting, on the CTIS controller, must be changed as required, immediately upon adding or removing payload from the MTVR. Failure to comply may result in damage to equipment.

3.1.0 Run Flat Feature

Pushing the run flat button on the CTIS controller (*Figure 7-14*) reduces the intervals between tire pressure checks and adjustments, allowing more frequent checks and adjustments.

The operator engages the run flat button during a mission when the MTVR has sustained minor tire damage or as a preventive measure when the MTVR is traveling in conditions where tire damage is likely.

3.2.0 Overspeed Protection Feature

The CTIS includes an automatic feature called Overspeed Protection. It is designed to prevent tire damage. If the operator exceeds maximum allowable speed for a specific terrain setting, the CTIS will monitor the overspeed situation for a predetermined time (15 to 90 seconds, depending on terrain setting). If vehicle speed does not decrease to an allowable speed during this predetermined time, an alarm will sound and the over speed indicator (*Figure 7-14*) will blink. Once the alarm sounds, the operator has 30 seconds to adjust the vehicle speed or upshift to a new CTIS terrain setting. If the operator does not adjust the vehicle speed or terrain setting, the CTIS will automatically shift the terrain setting to the next setting appropriate for the speed of the vehicle.

3.3.0 Limp Home Mode

The limp home mode is unique to MTVRs. It is performed after a tire has sustained major damage and the CTIS Run Flat feature cannot maintain its pressure. Limp home procedures vary depending on which axle has the flat tire. The procedures involve exchanging the flat tire with a tire from an immediate axle.

The limp home mode is intended to minimize ground pressure on the flat tire by compressing wheel end suspension. It is not intended to lift the tire completely off the ground. The tire will still be in contact with the ground while the MTVR returns to the yard for repairs.

In limp home mode, the operator must use caution to not exceed speeds listed in *Table 7-3*.

Table 7-3 – Maximum speed during limp home.

TERRAIN	SPEED NOT TO EXCEED
Cross-Country/Trails	5 mph
Secondary Roads	10 mph
Highway	15 mph

The equipment needed to perform the limp home mode is a hydraulic jack, jack plate, chock, limp home strut and a ramp used for the vehicle tires. These items are issued with all MTVRS.

Test your Knowledge (Select the Correct Response)

6. **(True or False)** The CTIS was designed to maximize traction, mobility, and speed.

   A. True
   B. False

7. On the CTIS controller, when should the cross-country setting be used?

   A. On improved paved surfaces
   B. On non-paved secondary roads and hard packed trails
   C. On soft-surface trails and other unimproved surfaces
   D. To free a mired vehicle

4.0.0 ANTI-LOCK BRAKE SYSTEM

The brake system on the MTVR incorporates an anti-lock brake system (ABS). ABS-controlled braking ensures optimum vehicle stability while minimizing stopping distance.

When the operator applies the service brakes, the ABS monitors all six vehicle wheels for wheel lock condition. If wheel lock occurs, the ABS makes a new assessment of the condition and adjusts the air pressure to the service brakes to eliminate wheel lock. The ABS, in effect, pulses the brakes to eliminate wheel lock. Once the ABS detects that the

wheel lock condition has been eliminated, it will stop adjusting the air pressure to the service brakes.

Test your Knowledge (Select the Correct Response)

8. **(True or False)** The ABS adjusts the pressure to the emergency brakes to eliminate wheel lock.

    A. True
    B. False

5.0.0 AUTOMATIC TRACTION CONTROL SYSTEM

The MTVR incorporates an automatic traction control (ATC) system. The ATC system helps improve traction on slippery or unstable driving surfaces by reducing drive wheel slippage.

The ATC system constantly monitors the wheels for a wheel slip condition. If a wheel slip condition occurs, the ATC system activates and throttles back the engine to help reduce wheel slip. If the vehicle is traveling at a speed of less than 25 mph, the ATC system will also pulse the service brake system to aid in reducing wheel slip. Once the ATC system detects that the wheel slip condition is no longer present, it will return the engine and service brake system to normal operating condition.

Test your Knowledge (Select the Correct Response)

9. What is the function of the ATC system?

    A. Adjust the pressure to the emergency brakes to eliminate wheel lock
    B. Improve traction by reducing drive wheel lock
    C. Prevent tire damage by monitoring overspeed
    D. Optimize vehicle stability while minimizing stopping distance

6.0.0 CONTROLS and INSTRUMENTS

Inside the operator's cab, MTVRs look very similar. With the exception of the specific controls and instruments used to direct hauling, dumping, and lifting, all MTVRs have the same foot, hand, and steering column controls, as well as instrument panel controls and indicators.

6.1.0 Cab Mounted Foot Controls

The cab mounted foot controls include a service brake pedal, throttle, and steering wheel lock, as shown in *Figure 7-15*.

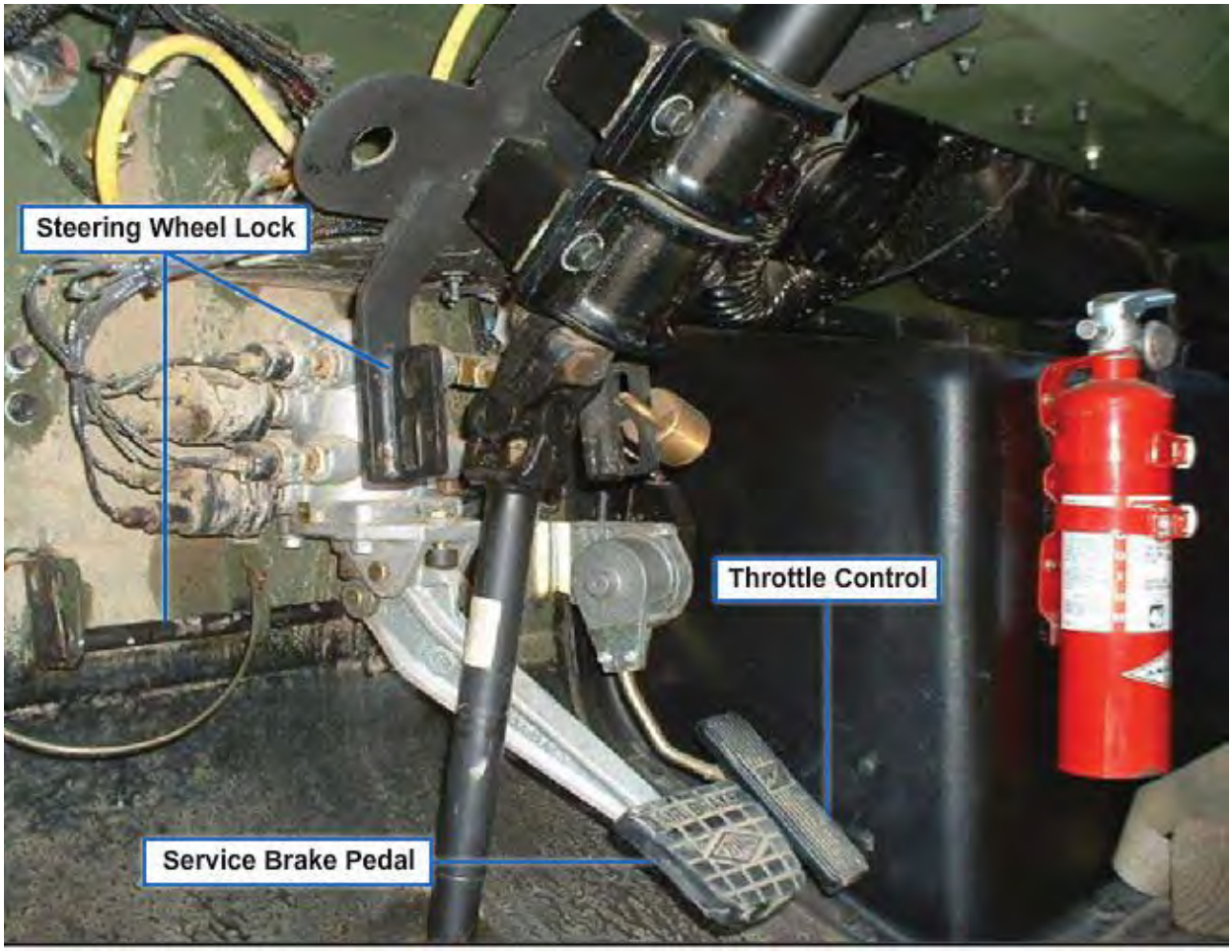


Figure 7-15 – Cab mounted foot controls.

6.1.1 Service Brake Pedal

The service brake pedal is used to apply the service brakes, stopping or slowing the speed of the MTVR.

6.1.2 Throttle Control

The throttle control is used to control engine speed.

6.1.3 Steering Wheel Lock

The steering wheel lock allows the operator to lock the steering wheel.

6.2.0 Cab Mounted Hand Controls

The cab mounted hand controls include a door window glass crank, inside and outside handles, and battery disconnect switch, as shown in *Figure 7-16*.

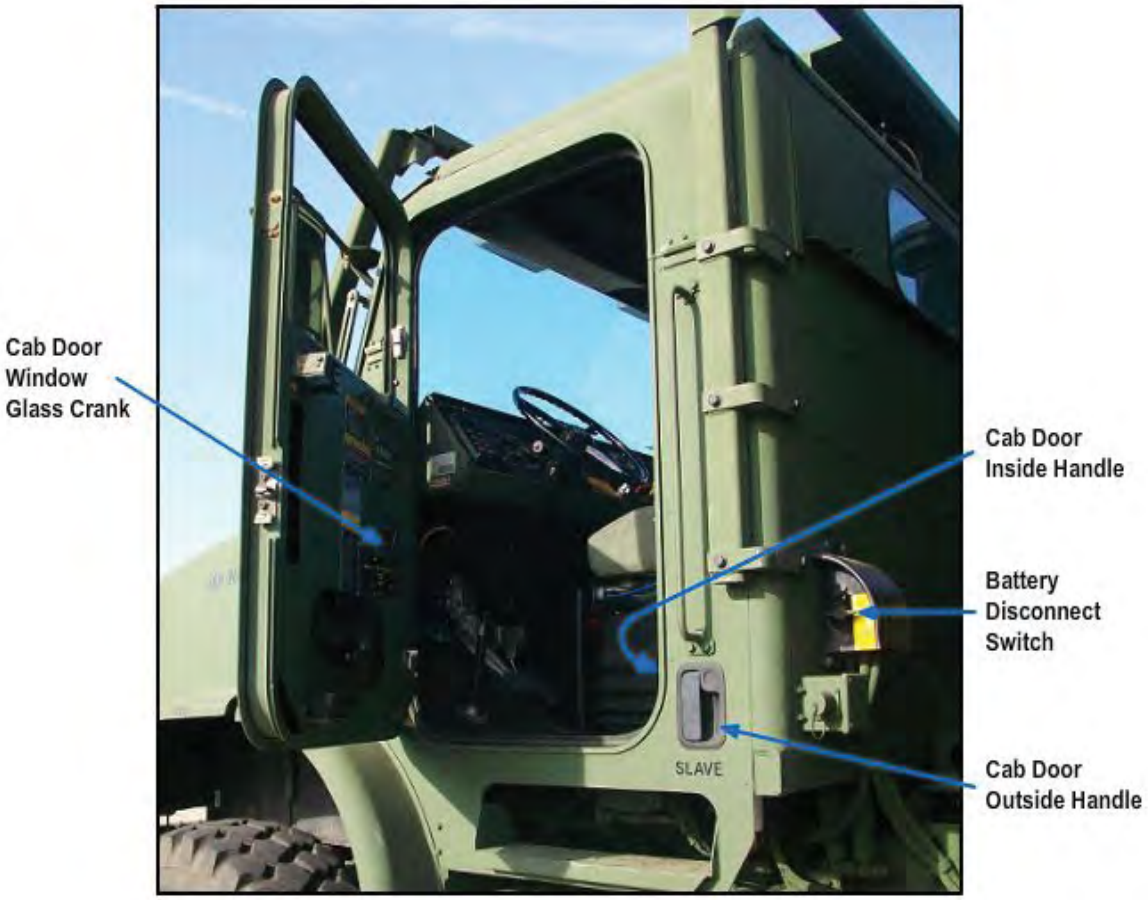


Figure 7-16 – Cab mounted hand controls.

6.2.1 Cab Door Window Glass Crank

When rotated clockwise or counter clockwise, the cab door window glass crank opens and closes the window.

6.2.2 Cab Door Inside Handle

The cab door inside handle is used to open the cab door from inside the MTVR.

6.2.3 Cab Door Outside Handle

The cab door outside handle is used to open the cab door from outside the MTVR.

6.2.4 Battery Disconnect Switch

The battery disconnect switch turns the vehicle battery power on and off.

6.3.0 Steering Column Mounted Controls

The steering column mounted controls include an emergency flasher control, steering wheel, horn, turning signal lever, and dimmer switch, as shown *Figure 7-17.*

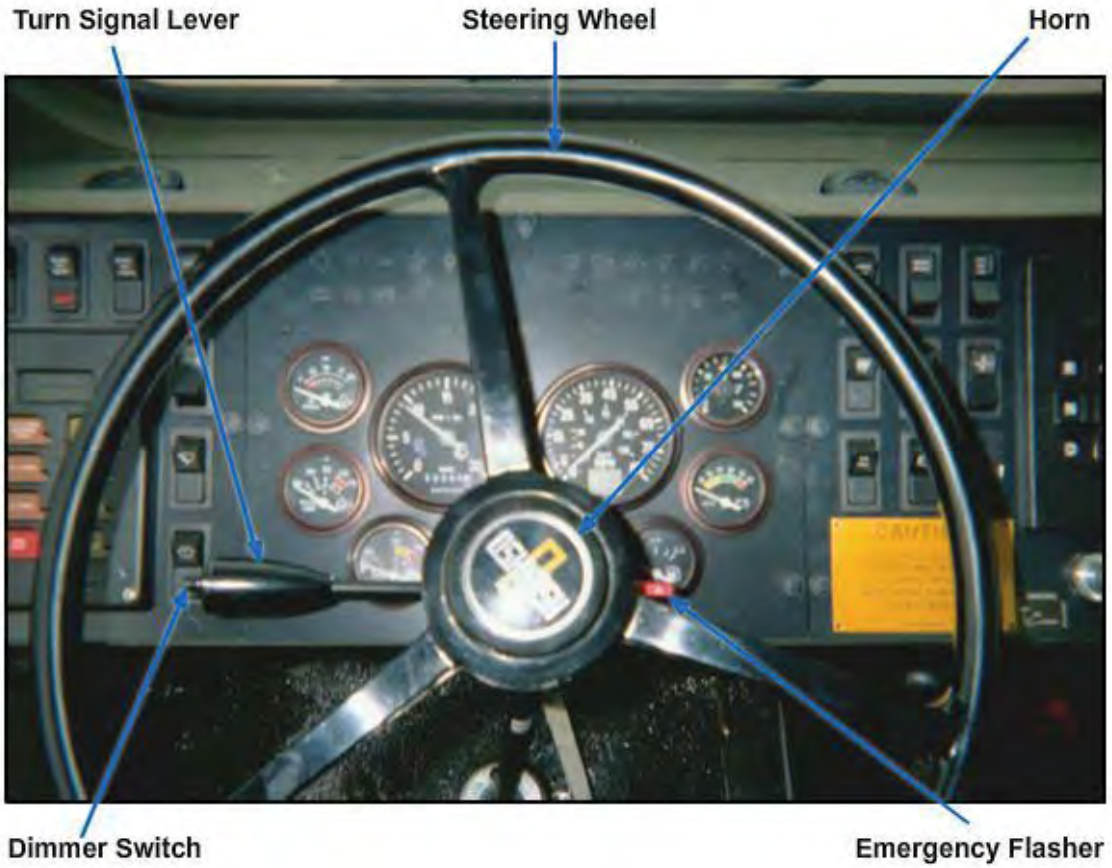


Figure 7-17 – Steering column mounted controls.

6.3.1 Emergency Flasher Control

The emergency flasher control is used to turn on and off the hazard warning flashers.

6.3.2 Steering Wheel

The steering wheel is used to control the direction of the MTVR.

6.3.3 Horn

The horn is used alert others who are in close distance of the MTVR.

6.3.4 Turn Signal Level

By pushing up or pulling down the turn signal lever the operator signals a right or left turn.

6.3.5 Dimmer Switch

The dimmer switch rises and lowers the headlight beams.

6.4.0 Instrument Panel Controls and Indicators

Controls and indicators such as gauges and lights are located on the MTVR's instrument panel, as shown in *Figure 7-18.*

Figure 7-18 – MK28 instrument panel.

6.4.1 Headlights/Clearance/Marker Lights

The headlights, clearance lights and marker lights are turned on and off by a 3-way rocker switch. When this switch is in the center position, the clearance, marker, and parking lights are turned on. In the up position, the headlights are added. In the down position, the headlights, clearance lights and marker lights are turned off.

6.4.2 Blackout Select

The blackout select is operated by a 2-way rocker switch. This switch allows an operator to select between normal or blackout mode. To select normal mode, press the smaller bottom switch up and hold, while pressing the main switch down. To select blackout mode, instead of pressing the main switch down, press it up.

NOTE

In blackout mode, the backup alarm will not operate.

6.4.3 Blackout Light

The blackout lights are turned on and off by a 3-way rocker switch. When this switch is in the center position, the blackout lights are turned on. In the up position, the blackout headlights are added. In the down position, both the blackout lights and headlights are turned off.

6.4.4 Panel Dimmer

The panel dimmer is operated and controlled by a 3-way position switch. When the switch is in the down position, the instrument panel lights are turned off. In the center position, the illumination of instrument panel is reduced. In the up position, the illumination is increased.

6.4.5 Windshield Wiper

The windshield wipers are controlled and operated by a 3-way position switch. When this switch is the down position, the windshield wipes are turned off. In the center position, the speed of windshield wipers is reduced. In the up position, the speed is increased.

6.4.6 Windshield Washer

The windshield washer is operated by a 1-way momentary switch. Press this switch to apply windshield washer fluid.

6.4.7 CTIS OFF Switch

The CTIS off switch is used to partially disable the CTIS when the MTVR is operating in temperature below 0°F. Normally, this switch is in the down (off) position.

6.4.8 Over Speed/Check Tire Light

When the over speed illuminates (amber), it is alerting the operator that the vehicle speed has exceeded the maximum allowable speed as determined by the CTIS. An audible alarm will come on with this indicator.

Additionally, when the check tire indicator is lit, it is alerting the operator that substantial damage may have occurred to one or more tires.

6.4.9 Engine Oil Pressure Gauge

The engine oil pressure gauge indicates engine oil pressure

6.4.10 Water Temperature Gauge

The water temperature gauge indicates engine coolant temperature.

6.4.11 Transmission Oil Temperature Gauge

The transmission oil temperature gauge indicates transmission oil temperature.

6.4.12 Fuel Gauge

The fuel gauge indicates the amount of fuel in the fuel tank.

6.4.13 Volt Gauge

The volt gauge indicates the state of charge of batteries and voltage level in a 24-volt system.

6.4.14 Tachometer/Hourmeter

The tachometer/hourmeter indicates engine operating speed (rmp x 100) and total operating time (hours).

6.4.15 Speedometer

The speedometer indicates vehicle traveling speed.

6.4.16 Odometer/Trip Odometer

The odometer indicates total miles the vehicle has traveled.

Trip odometer indicates miles the vehicle has traveled since last time the trip odometer reset button was pushed.

The odometer display will black out when the cab average air temperature drops below approximately -4°F. The odometer will continue to record information.

6.4.17 Trip Odometer Reset Button

The trip odometer reset button resets the trip odometer to 0.

6.4.18 Left Turn Indicator

The left turn indicator flashes (green) when the left turn signal is on.

6.4.19 Automatic Traction Control Light

The ATC light illuminates steadily when the engine is started. The light remains illuminated until the operator engages the service brake pedal for the first time.

During operation, when the CTIS controller is set to HWY, the ATC light will remain off, unless the ATC system detects a wheel slip condition and activates. During activation, the light will flash rapidly until the wheel slip condition is no longer present.

If the ATC light illuminates steadily, during operation set to HWY, the ATC is malfunctioning.

NOTE

If the ATC light indicates a malfunction, the ATC and possibly the ABS may be disabled. If the ATC and/or ABS are disabled, the emergency and service brake systems remain functional.

The ATC light illuminates steadily when the CTIS controller is set to CC, MSS, or EMER. This indicates that the ATC is disabled. This indication is normal and does not indicate a malfunction in the ATC.

6.4.20 Anti-Lock Brake System Light

When the engine is started, the ABS light illuminates steadily for a 2-second bulb check. After that bulb check, if no ABS malfunctions are present, the light turns off. If the ABS is malfunctioning, the light will illuminate steadily.

NOTE

If the ABS light indicates a malfunction, the ABS and possibly the ATC system may be disabled. If the ABS and/or ATC are disabled, the emergency and service brake systems remain functional.

The ABS light flashes slowly when the CTIS controller is set to CC, MSS, or EMER. This indicates that the ABS is disabled. This indication is normal and does not indicate a malfunction in the ABS.

6.4.21 Water Temperature Light

The water temperature light turns (red) when the coolant temperature reaches 235°F. An audible buzzer also sounds. The cooling system fan turns on when coolant temperature reaches 205°F.

6.4.22 High Transmission Temperature Light

The high transmission temperature light turns on (red) when transmission fluid temperature is approximately 300°F. An audible alarm will also sound.

6.4.23 Check Transmission Light

The check transmission light illuminates (yellow) when transmission fluid temperature reaches 250°F.

6.4.24 Engine Warning Indicator Light

The engine warning indicator light illuminates (red) to alert the operator of engine problem detected by the electrical control module.

6.4.25 Parking Brake Indicator Light

The parking brake indicator light illuminates (red) when the parking brake is activated.

6.4.26 Oil PSI Warning Light

The oil PSI warning light illuminates (red) when the engine oil pressure is below 5 psi.

6.4.27 Low Air 1 Warning Light

The low air 1 warning light illuminates (red) when the front air system pressure drops to between 64 and 76 psi. An audible alarm will also sound.

6.4.28 Low Air 2 Warning Light

The low air 2 warning light illuminates (red) when the rear air system pressure drops to between 64 and 76 psi. An audible alarm will also sound.

6.4.29 Right Turn Indicator

The right turn indicator flashes (green) when the right turn signal is on.

6.4.30 Check Engine Light

The check engine light illuminates (yellow) when the coolant temperature reaches 217°F or when the oil pressure is low (dependent on engine rpm).

6.4.31 Low Fuel Light

The low fuel light illuminates (yellow) when the fuel in the tank is low.

6.4.32 Fan Off Warning Light

The fan off warning light illuminate when the engine fan lockout circuit is activated during fording operations.

6.4.33 High Idle Light

The high idle light illuminates when the engine is in high idle mode.

6.4.34 Winch Indicator Light

On a MTVR equipped a winch, the winch indicator light illuminates (red) when the power take-off (PTO) is activated for winch and dump bed operation.

6.4.35 High Beam Indicator

The high beam indicator illuminates blue when the vehicles lights are on high beam.

6.4.36 Driveline Lock Lights

The driveline lock lights indicate three-step locking sequences.

The first icon (left) indicates the transfer case and interaxle locks are engaged.

The second icon (center) indicates the transfer case, interaxle, and rear intra-axle locks are engaged.

The third icon (right) indicates the transfer case and interaxle as well as front and rear intra-axle locks are engaged (full locked condition).

6.4.37 High idle

High idle is controlled by a 2-postion switch. When this switch is in the up position, the engine idle speed raises to 1500 rpm.

6.4.38 Engine Brake

The engine brake/retarder is turned on and off by a 2-position switch. When this switch is in the up position, the engine brake/retarder is turned on.

6.4.39 High/Med/Low

The range for the engine brake/retarder is controlled by a 3-positon switch.

6.4.40 Winch On/Off

On MTVRs equipped with winches, the winch is turned on and off by a 2-position switch. When this switch is in the up position, the power to the PTO is activated for winch and dump bed operation.

6.4.41 Winch In/Out

On MTVRs equipped with winches, the winch cable is controlled by a 2-way momentary switch. When this switch is in the up position, the cable is pulled in. In the down position, the cable is fed out. The operator must hold the switch in at the desired position to affect winch operation.

6.4.42 Driveline Lock

The driveline lock is a 2-way momentary switch that allows an operator to manually override the CTIS by sequentially engine locks for transfer case and all axles.

6.4.43 Fan Ford

The fan can be turned on and off by a 2-position switch. The fan off light will illuminate when the switch is turned on.

6.4.44 ABS Diagnostic

A diagnostic can be performed on the ABS by pressing the ABS diagnostic, which is a 2-way momentary switch. During the diagnostic, the ABS light will illuminate as well.

6.4.45 Selection Display Indicator

The selector display indicator displays the transmission setting that the operator has selected. This indicator will display R for reverse, N for neutral, and D for drive.

6.4.46 Mode Button

On MTVRs equipped with winches, the PTO is activated by the MODE button. When the mode button is selected, its red light illuminates.

6.4.47 R (Reverse) Button

The R (reverse) button is used for backing the vehicle.

6.4.48 N (Neutral) Button

The N (neutral) button is used when starting the engine or if the vehicle is left unattended while the engine is running.

6.4.49 D (Drive) Button

The D (drive) Button is used for all normal driving conditions. The transmission will upshift and downshift automatically.

6.4.50 ^ (Increase) Button

When in drive, the ^ (increase) button allows the operator to increase the gear range used by the transmission. Gear 7 is the highest available setting and is also the default setting when the D button is first pushed upon starting.

6.4.51 V (Decrease) Button

When in drive, the V (decrease) button allows the operator to decrease the gear range used by the transmission.

6.4.52 Fan Control

The fan control operates the speed of the fan (Low/Med/High). The lowest setting turns the fan off.

6.4.53 Cab Air Directional Control Lever

The cab air direction control lever controls the direction of the air. By pushing the lever to the left the air is directed to the defroster louver. By pushing the lever to the right the air is directed to the floor.

6.4.54 Vent Control Lever

The vent control lever re-circulates air throughout the cab. It controls the amount of outside air entering the cab though fresh air vent. The farther left the lever is the less outside air enters the cab.

6.4.55 Heater Control Lever

The heater control lever controls the temperature level or amount of heat entering the cab.

6.4.56 Air Pressure Gauge

The red needle on the air pressure gauge indicates rear brake air pressure. The green needle indicates front brake air pressure.

6.4.57 Defroster Louver

The defroster louver directs air against the windshield for defrosting. It can be opened, closed, and rotated to control the direction and flow of the air.

6.4.58 Air Conditioning Switch

The air conditioning switch turns the A/C on and off. To enable the A/C, the fan ford switch must be in normal operating mode, and the fan off warning light must not be illuminated.

6.4.59 Trailer Air Supply Control

When pushed, the trailer air supply control will supply air to the trailer air system. Pull the control to shut off the trailer air.

6.4.60 Air Filter Restriction Indicator

The air filter restriction indicator shows the condition of the air filter. Push the button to rest.

6.4.61 Parking Brake Control

When pushed, the parking brake control releases the vehicle brakes. Pull the control to apply vehicle and trailer brakes.

6.4.62 Ignition Switch

The ignition switch is a 3-position rotary switch used to turn the engine on and off.

6.4.63 12-VDC Auxiliary

The VDC AUX is a receptacle used for powering 12-vdc auxiliary equipment.

6.4.64 Circuit Breaker Block

The circuit breaker block contains the circuit breakers that help to protect the vehicle's electrical circuits from overload.

6.4.65 Message Information Center

The message information center (MIC) shows current system operating readings and fault codes.

Test your Knowledge (Select the Correct Response)

10. Which of the following lights will illuminate when the vehicle speed has exceeded the maximum allowable speed as determined by the CTIS?

    A. Over speed
    B. Check tire
    C. Check engine
    D. Check transmission

11. **(True or False)** If the ATC light illuminates steadily during operation set to HWY, the ATC is malfunctioning.

    A. True
    B. False

12. The oil PSI warning light illuminates (red) when the engine oil pressure is below _____ psi.

    A. 15
    B. 10
    C. 5
    D. 2

13. What button allows the operator to increase the gear range used by the transmission?

    A. D
    B. ^
    C. High idle
    D. Low air 1

7.0.0 COLLATERAL EQUIPMENT

All MTVRs are issued with collateral equipment called Component of End Items (COEI) and Basic Issue Items (BII). The specific type of items and quantity may vary amongst the MTVRs.

COEI are part of the MTVR, but they are to be removed and separately packaged for transportation or shipment. Examples of COEI include cargo cover, bows, and air intake stake. These items must be with the MTVR whenever it is issued and transferred between property accounts.

BII are essential items, required for operating the MTVR and performing emergency repairs. Examples of BII include limp home strut, tire inflator/gauge, and fire extinguisher. Although packaged and shipped separately, BII must be with the MTVR during operation and when it is transferred between property accounts.

The MTVR's technical manual, TM 10629-10, includes illustrations to help operators find and identify these items. In addition, national stock numbers are provided to be used for requisitioning purposes. The technical manual also provides lists that identify the stowage location of these items. These items may be stowed in a box, under the crew seat, or on the vehicle.

Test your Knowledge (Select the Correct Response)

14. Which of the following is NOT an example of a Component of End Item?

    A. Bows
    B. Air intake stack
    C. Cargo cover
    D. Fire extinguisher

15. **(True or False)** The only time the BII must be with the MTVR is when it is being transferred between property accounts.

    A. True
    B. False

8.0.0 VEHICLE RECOVERY OPERATIONS

The following section discusses basic procedures and guidelines for self-recovery of vehicles, recovery with wreckers, and recovery.

WARNING

Remember, recovery is a major operation; therefore always refer to the operator's manual for instructions. Situation and equipment will determine the proper procedure. A haphazard approach to a recovery problem or the use of a trial-and-error method can be a costly mistake. Such a mistake can "deadline" the disabled vehicle longer than necessary, cost valuable time, damage equipment, and injure personnel.

8.1.0 Wreckers

Recovery, using wrecker trucks, should be performed by trained recovery personnel of Alpha Company or the transportation division. An understanding of the ability of the vehicle to winch, lift, and tow is very important. For in-depth information, refer to the operator's manual that relates to the operation of specific equipment and their specific abilities.

8.1.1 Mired Truck

The recovery of a mired truck using a wrecker truck is not always an easy task because it involves the resistance of the load, the approach to the load, and the distance between the wrecker and the mired vehicle. Use a direct pull if the resistance created by the mired vehicle is less than the winch capacity of the wrecker.

⚠ CAUTION ⚠

Do not hook the winch cable around the bumper on a vehicle. Wrapping the tow cable around the bumper of a mired vehicle will result in a bent bumper.

An example of a simple winching operation is shown in *Figure 7-19*. Some winching operations are more difficult. The mired truck may have a resistance greater than the winch capacity of the wrecker. Also, the wrecker may not be able to align itself with the truck due to terrain. If so, use a 2:1 mechanical advantage and a change of direction pull, as shown in *Figure 7-20*

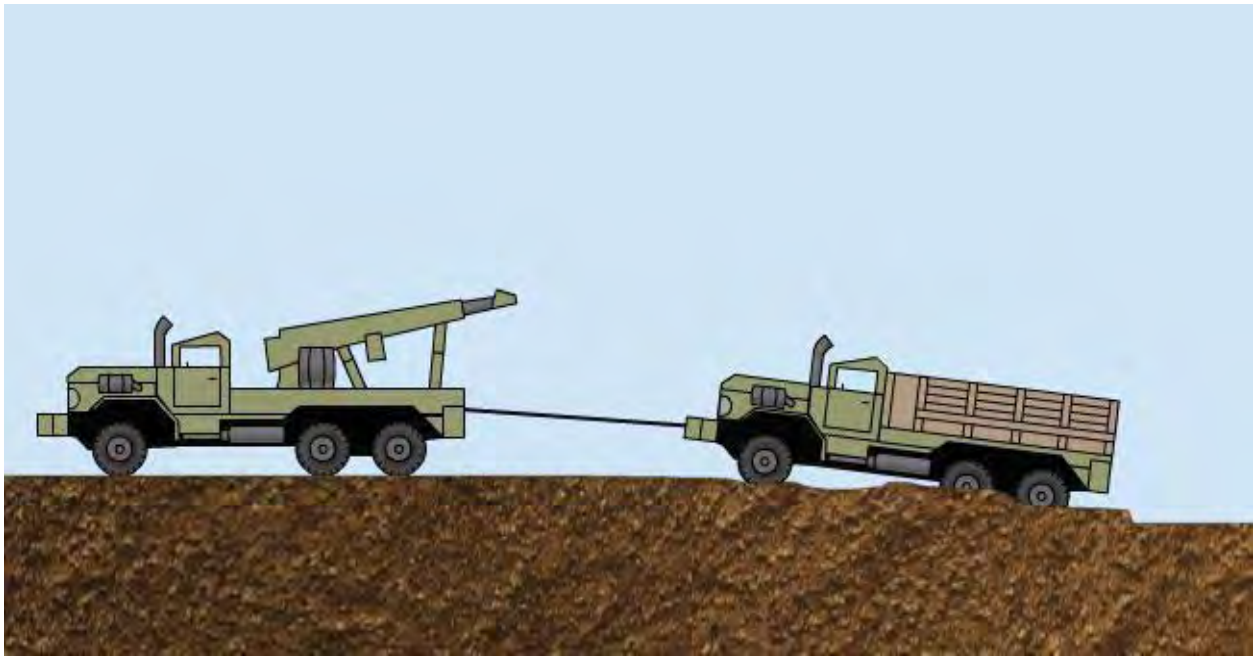


Figure 7-19 – Simple winch operations.

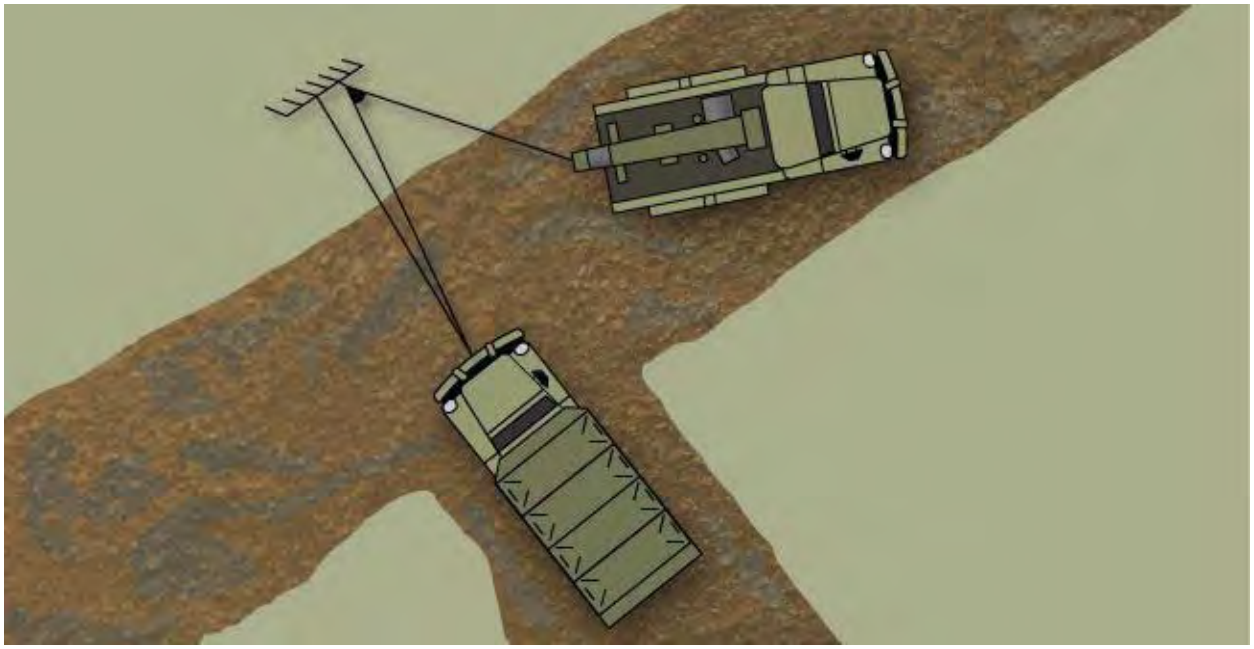


Figure 7-20 – Mechanical advantage and change of direction (winching).

8.1.2 Nosed Truck

The recovery of a nosed truck using a wrecker truck may require only a towing operation. Some situations may require all three of the capabilities (winching, lifting, and towing) of the trucks to complete the recovery.

Figure 7-21 shows a mechanically disabled 2 1/2-ton truck nosed off a narrow road in such a way that the wrecker cannot be positioned directly behind the vehicle. You may notice that the winch cable is not running in a direct straight line with the winch. On a normal winch, this angle causes the wire rope to wind off the side (flange) of the winch drum; however, the wrecker winch has a level winding device that offsets the difference. Other vehicles with winches do not have this device.

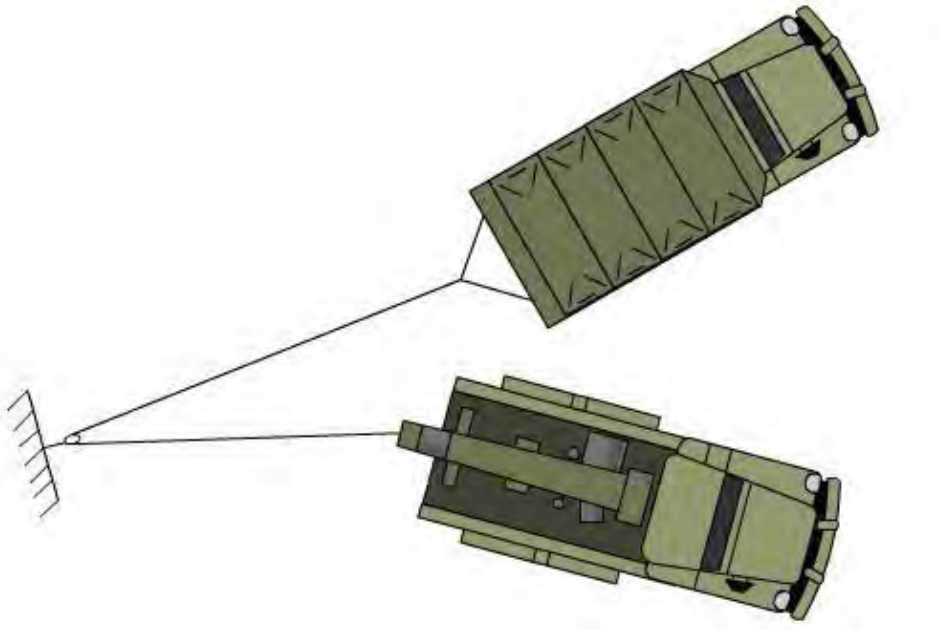


Figure 7-21 – Winching by change direction.

8.1.3 Overturned Truck

To upright an overturned truck with a wrecker truck, you should use a sling method of attachment, because a pulling force applied to only one point of the frame can result in a bent frame. A sling lifting attachment is made up of either two utility chains or two 1-inch fiber ropes. The sling ends are attached to the front and rear lifting devices on the high side of the overturned truck. Then the winch cable is attached to the center of the sling. A holding force is required to prevent the overturned vehicle from crashing onto its wheels. The holding force could be another vehicle, the wrecker boom, or a rope block and tackle with manpower.

The attachment for the holding force is a holding sling attached to the same points on the overturned truck as the pulling sling. The holding sling is then attached to the holding force with wire rope, rope, or chain, making sure the holding force is attached to the center of the sling. If a holding vehicle is not available, use the wrecker boom to hold the load, as shown in *Figure 7-22*.

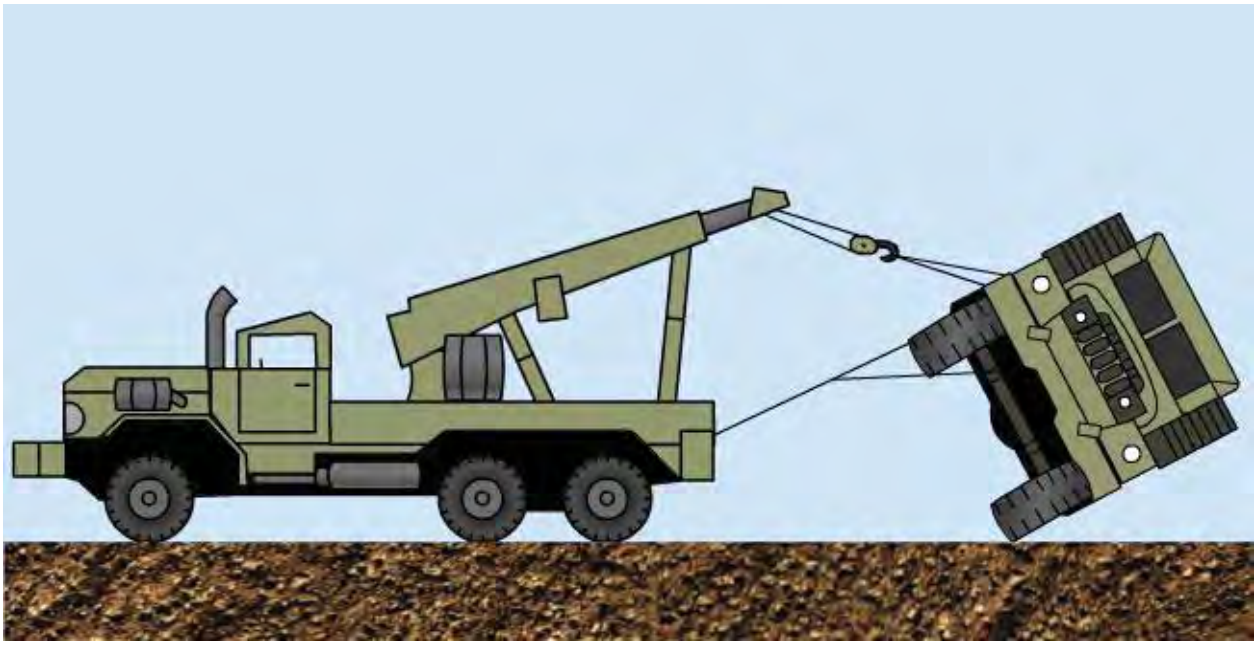


Figure 7-22 – Righting an overturned truck.

Apply power gradually to the winch until the overturned truck is past the vertical position. Then lower the truck on its wheels with the hoist winch, rather than booming out with the crane.

NOTE

Maximum use of the boom jacks and outriggers should be employed when this method is used.

8.1.4 Towing

A wrecker truck is capable of towing vehicles in several ways. The proper procedures and safety guidelines for towing are important factors in preventing damage to vehicles and injury to personnel. The basic procedures and guidelines for highway towing and cross-country towing are as follows:

Highway Tow – Attach the tow bar to the lifting shackle eyes of the disabled vehicle and the wrecker truck tow pintle. All wheels of the towed vehicle should be on the ground. With the tow bar, a driver is not required in the towed vehicle (*Figure 7-23*).

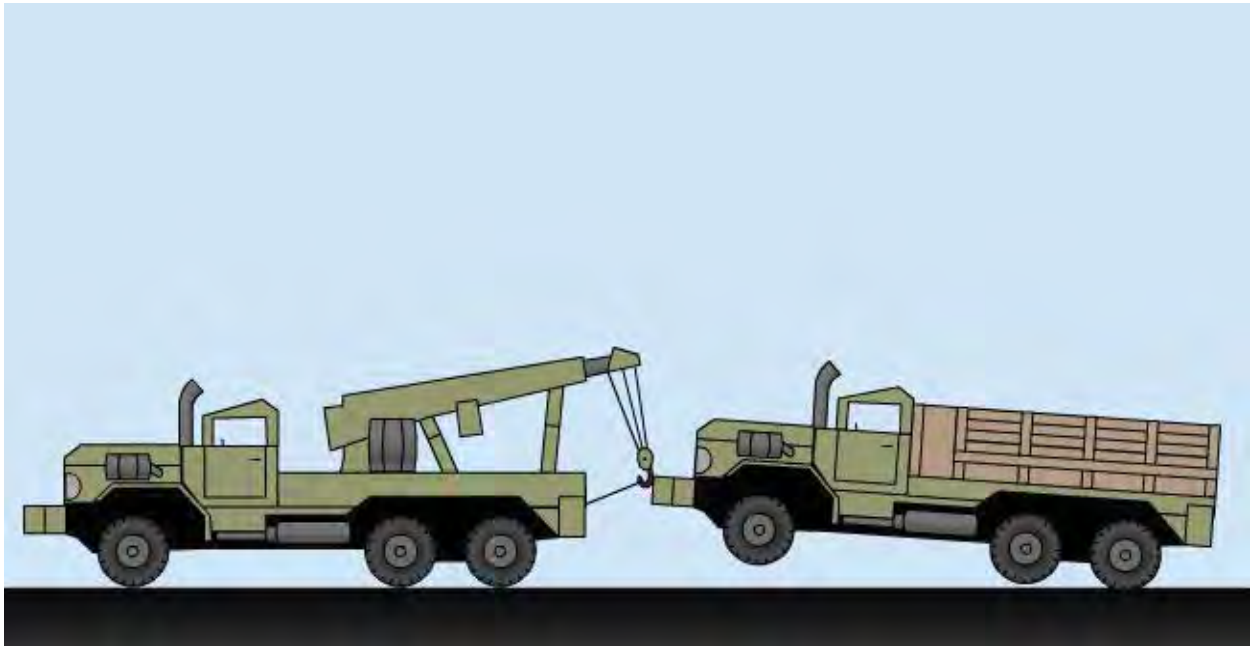


Figure 7-23 – Highway tow.

Cross-Country Tow – Over rough terrain, across-country tow controls the towed vehicle well. The procedure for rigging for the cross-country tow is as follows:

Step 1. Attach a chain lifting sling or the hoisting bar between the front lifting shackles of the truck

Step 2. Attach a tow chain from the wrecker tow pintle to the lifting shackles of the disabled truck

Step 3. Place the hoist hook block in the lifting sling approximately 12 inches off the ground

Step 4. Extend the boom to remove the slack from the tow chain, and keep the towed vehicle from ramming into the rear of the wrecker truck

Step 5. Support the boom with the shipper braces to prevent impact loads on the crane mechanisms, as shown in *Figure 7-24*.

If the front end of the vehicle is damaged, use cross-country towing even though the disabled vehicle is being towed on the highway. Use the tow bar instead of a tow chain.

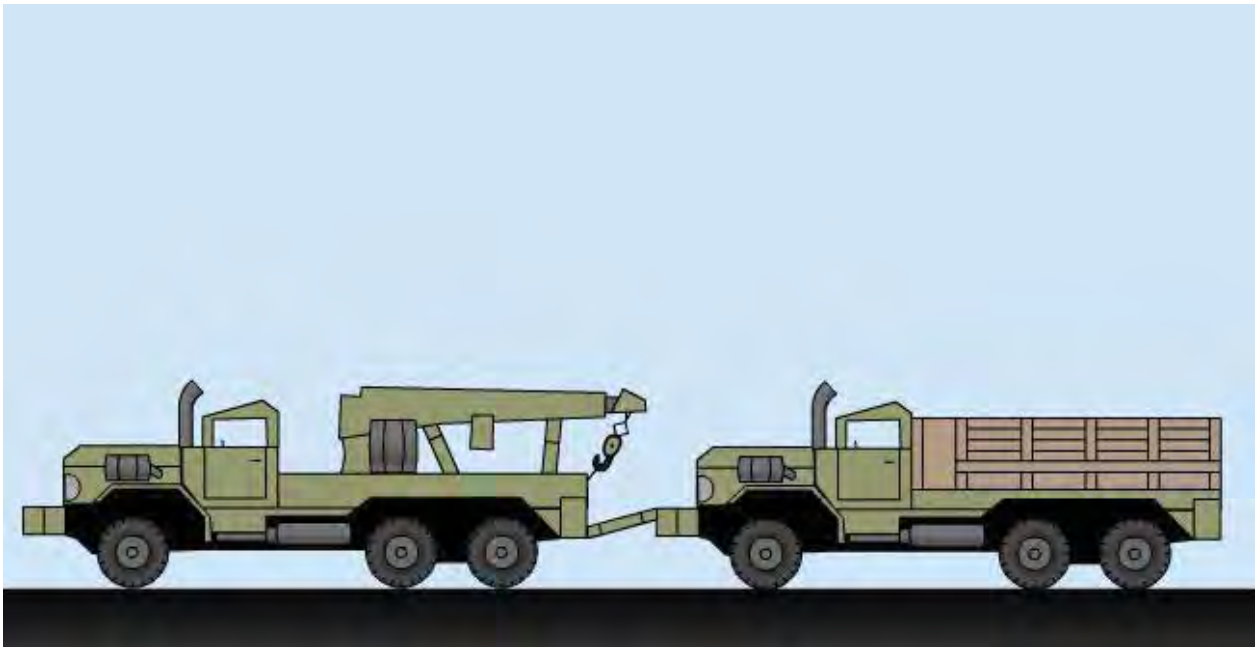


Figure 7-24 – Cross-country tow.

8.2.0 Self- and Like Vehicle Recovery

A winch-equipped mired vehicle can perform self-recovery. Attach the snatch block to a suitable anchor and the free end of the cable to a chain sling connected to both of the front lifting shackles of the mired vehicle. A fixed block provides a mechanical advantage on a self-winching operation, even though the sheave of the block is performing as a first-class lever (*Figure 7-25*).

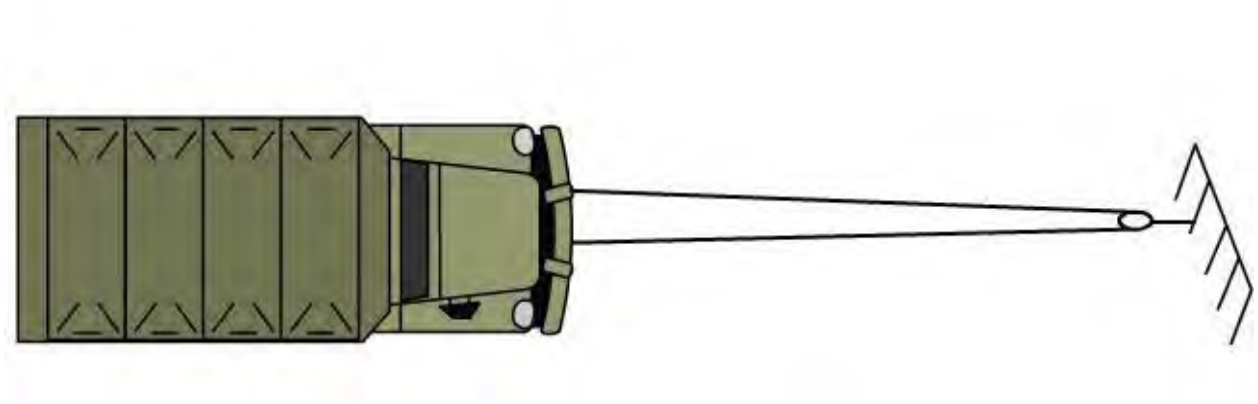


Figure 7-25 – Self-winching.

Use a similar wheeled vehicle as the source of effort to perform recovery by towing and winching. For vehicles not equipped with lifting shackles, attach a tow chain to the main structural members. Before towing or recovering a disabled vehicle, check the vehicle operator's manual to ensure that all physical and safety features are considered. This must be done to prevent additional damage to the disabled vehicle.

To recover a mired truck by towing with a similar vehicle, use a tow chain or a wire rope sling between the towing vehicle and the mired vehicle. Attach it to one lifting shackle of the mired vehicle and through the tow pintle on the towing vehicle.

Apply power slowly to prevent shock to the towing device and lifting shackles. If one towing vehicle cannot attain sufficient towing effort to overcome the resistance, use another towing vehicle in tandem with the first, as shown in (*Figure 7-26*).

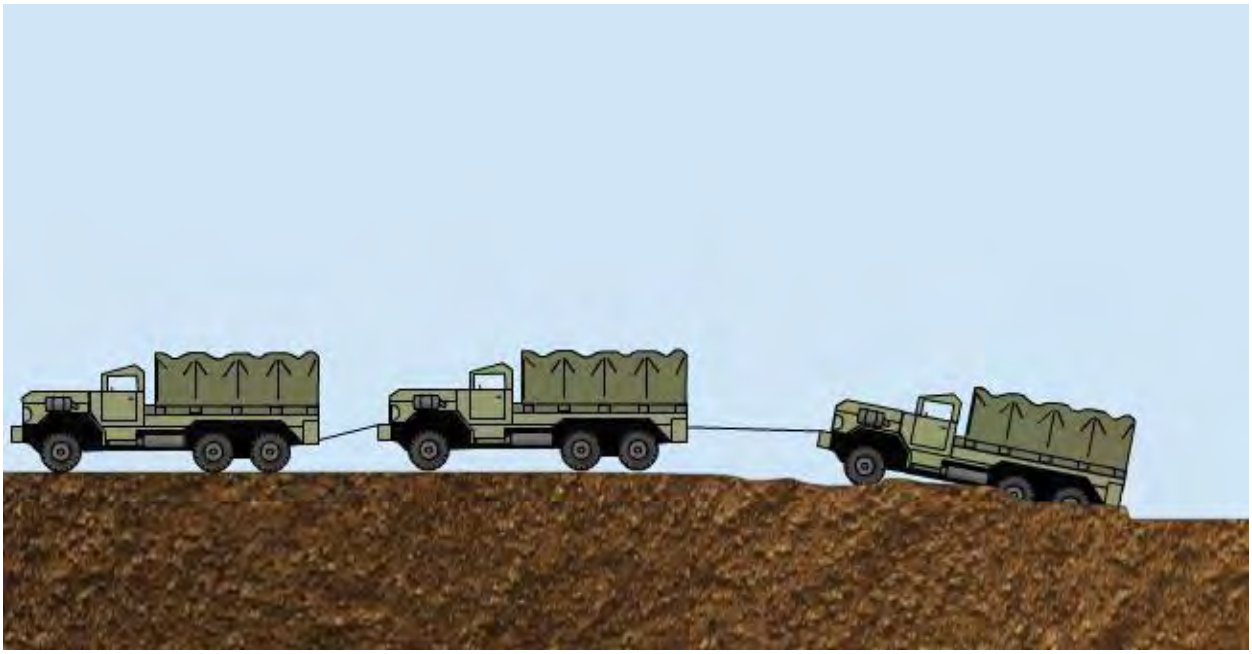


Figure 7-26 – Like-vehicle recovery.

To winch a mired truck, use a truck with a winch of equal or greater capacity to perform the recovery. Often, the winching or recovery vehicle must be anchored by more than its own weight. Place wheel blocks, chocks, or natural material in front of the front wheels of the recovery vehicle (*Figure 7-27*).

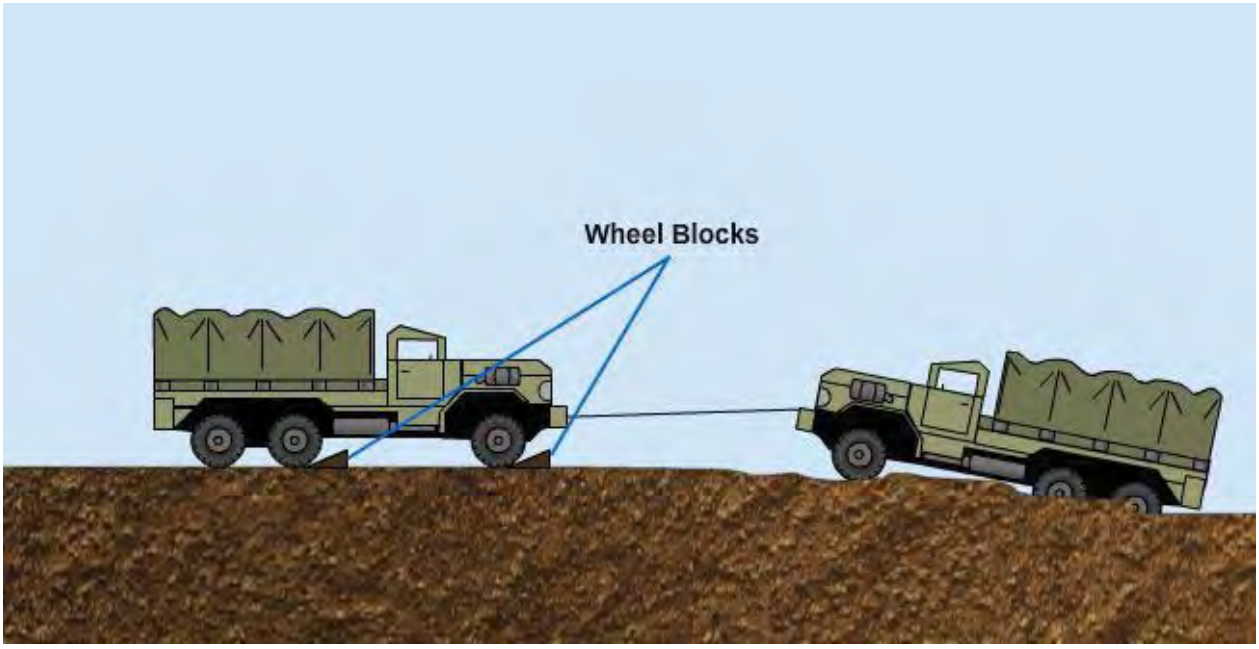


Figure 7-27 – Winching with a like-vehicle.

Test your Knowledge (Select the Correct Response)

16. Which of the following problems can occur if you use a trail-and-error method during vehicle recovery operation?

    A. The loss of valuable time
    B. Damaged equipment
    C. Injured personnel
    D. All the above

17. Which of the following is a function that a wrecker CANNOT provide during a vehicle recovery operation?

    A. Winch
    B. Push
    C. Tow
    D. Lift

Summary

Equipment Operators must be highly trained and qualified to operate MTVRs. This chapter introduced you to four types of MTVRs. Additionally, you were introduced to their hauling, dumping, pulling, and towing capabilities. You learned about their major components and systems including CTIS, ABS, and ATC. You also learned how the controls on the instrument panel are used as well as what the lights and gauges indicate. Lastly, you learned about collateral equipment and vehicle recovery operations.

Review Questions (Select the Correct Response)

1. MTVRs are capable of traveling a maximum speed of _____ mph.

   A. 75
   B. 70
   C. 65
   D. 60

2. MTVRs are capable of fording water _____ inches deep.

   A. 75
   B. 70
   C. 65
   D. 60

3. **(True or False)** The MK28 is equipped with a cargo bed 30 feet long.

   A. True
   B. False

4. Without armor, the MK28 is capable of hauling _____ tons on all terrains.

   A. 15.1
   B. 11.1
   C. 7.1
   D. 3.1

5. **(True or False)** The MK27 is equipped with a self recovery winch.

   A. True
   B. False

6. The MK30 is capable of hauling a heaped payload _____ pounds on paved surfaces.

   A. 48,000
   B. 38,000
   C. 28,000
   D. 18,000

7. On the MK30, where is the self recovery winch mounted?

   A. Behind the cab on the right hand side
   B. Behind the cab on the left hand side
   C. At the rear of the vehicle, on the right hand side
   D. On the front bumper

8. **(True or False)** The MK31 is used to pull semi-trailers.

   A. True
   B. False

9. The MK36 is capable of lifting _____ pounds to 9 feet.

   A. 44,000
   B. 33,000
   C. 22,000
   D. 11,000

10. MTVRs have a cruising range of _____ miles.

   A. 500
   B. 400
   C. 300
   D. 200

11. **(True or False)** The MK30's dump load settings are as follows: 0-2 tons, 2-7.1 tons, and 7.1-15 tons.

   A. True
   B. False

12. What is the maximum speed for the cross-country terrain setting?

   A. 30 mph
   B. 40 mph
   C. 15 mph
   D. 5 mph

13. **(True or False)** Once the Overspeed Protection alarm sounds, the operator has one minute to adjust the vehicle speed or upshift to a new CTIS terrain setting before the CTIS automatically upshifts the terrain setting.

   A. True
   B. False

14. At what speed will the ATC system pulse the service brake system to reduce wheel slip.

   A. less than 35 mph
   B. more than 35 mph
   C. less than 25 mph
   D. more than 25 mph

15. The odometer display will black out when the cab average air temperature drops below approximately _____.

    A. -8°F
    B. -6°F
    C. -4°F
    D. -2°F

16. **(True or False)** When the engine is started, the ABS light illuminate steadily for a 2-second bulb check.

    A. True
    B. False

17. **(True or False)** The ABS light flashes slowly when the CTIS controller is set to CC, MSS, or EMER.

    A. True
    B. False

18. When the coolant temperature reaches _____, the cooling system fan turns on.

    A. 235°F
    B. 225°F
    C. 215°F
    D. 205°F

19. The check transmission light turns on when the transmission fluid temperature reaches _____.

    A. 260°F
    B. 250°F
    C. 240°F
    D. 230°F

20. **(True or False)** The red needle on the air pressure gauge indicates front brake air pressure.

    A. True
    B. False

21. **(True or False)** The low air 1 warning light illuminates when the rear air system pressure drops to between 64 and 76 psi.

    A. True
    B. False

22. What does the center driveline lock icon indicate?

A. The transfer case is engaged.
B. The transfer case and interaxle locks are engaged.
C. The transfer case, interaxle, and rear intra-axle locks are engaged.
D. The transfer case and interaxle as well as front and rear intra-axle locks are engaged.

23. On the transmission, what is the highest available gear on the increase button?

A. 8
B. 7
C. 6
D. 5

24. **(True or False)** COEI are essential items, required for operating the MTVR and performing emergency repairs.

A. True
B. False

25. **(True or False)** COEI and BII may be stowed in a box under the crew seat or on the vehicle.

A. True
B. False

26. **(True or False)** Wrapping a tow cable around a bumper of a mired vehicle will result in a bent bumper.

A. True
B. False

27. Which of the following components allows a wrecker to winch a disabled vehicle under conditions where the wrecker cannot be positioned directly behind the vehicle?

A. Level winding device
B. Drum flange
C. Tagline winder
D. Floating sheave

28. What can result if you attach a winch cable to only one point on the frame of an overturned truck?

A. Winch cable can snap
B. Rigging gear can bend
C. Frame of truck can bend
D. Propeller shaft can bend

29. **(True or False)** When towing a vehicle with a tow bar, an operator is required in the vehicle being towed.

A. True
B. False

Trade Terms Introduced in this Chapter

Cruising range	The maximum distance that a vehicle can travel away from and back to its point of origin without refueling.
Fording	The act of crossing water.
Gross vehicle weight rating (GVWR)	The maximum gross vehicle weight specified by the manufacture for a single vehicle, including load.
Heaped	The volume of material the dump bed will hold when the material is heaped.
Primary roads	Improved, paved roads.
Secondary roads	Non-paved or hard packed trails.
Self recovery winch	A drum that can be rotated so as to exert a strong pull winding in a line.
Struck	The volume of material the dump bed will hold when the material is up to the very rim.
Traversing	The act of crossing.
Vehicle curb weight (VCW)	The total weight of the empty truck with the fuel tank, cooling system and crankcases filled. Additionally, it also includes the weight of tools, spares tire, and all other equipment specified as standard. However, this weight does not include the weight of payload and operator.

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.

MTVR Medium Tactical Vehicle Replacement, Oshkosh Corporation, Oshkosh, WI, 2008.

Ross, Daniel Charles. (Double Issue 2004). MTVR: Medium Tactical Vehicle Replacement. *Seabee Magazine*, 4-15.

U.S. Marine Corps Technical Manual: System Operation Manual with Components List for Truck, XLWB Cargo, 7-Ton, w/o Winch, MK27, Truck, XLWB Cargo w/ Winch MK28, and Truck, Dump, 7-Ton w/ Winch, MK30, TM 10629-10C, Marine Corps Systems Command, VA, 2006.

U.S. Marine Corps Supplemental Manual: System Operation Manual with Components List for Truck, Tractor, 7-Tons w/o Winch, MK31, TM 7610-LL-L27-3050, Marine Corps Systems Command, VA, 2006.

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Chapter 8

Dump Trucks

Topics

To hear audio, click on the box. 

Overview

Dump trucks are widely used in construction work. The Naval Construction Force (NCF) uses commercial and Medium Tactical Vehicle Replacement (MTVR) dump trucks to perform operations such as hauling, dumping and spreading of loose material. As an Equipment Operator, you will be expected to safely perform these operations.

This chapter describes the types of dump trucks used by NCF including descriptions of major components and controls. In addition, this chapter explains how to perform dump truck operations. Lastly, it lists safety practices.

Objectives

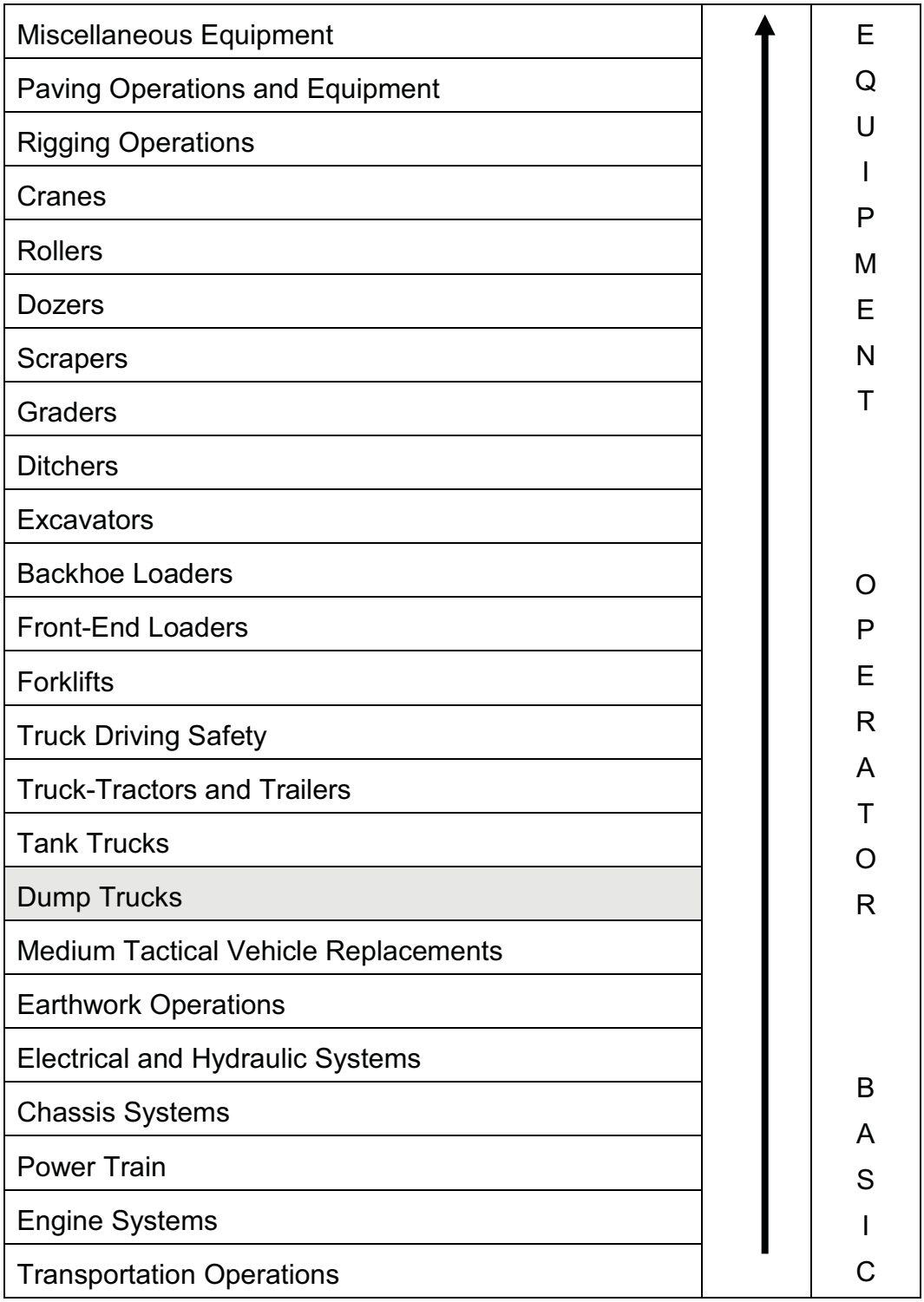
When you have completed this chapter, you will be able to do the following:

1. Understand the use of dump trucks.
2. Identify the types of dump trucks used by NFC.
3. Identify the major components of dump trucks.
4. Identify the controls on the dump truck.
5. Understand how to perform dump truck operations.
6. Understand dump truck 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 DUMP TRUCKS

A typical dump truck, as shown in *Figure 8-1*, is equipped with a dump body hinged to the rear of a sub-frame that is mounted directly onto a heavy-duty chassis. The dump body, operated by a hydraulic hoist assembly, can be raised and tilted back to unload loose material.

Dump bodies range in structural strength and size to support different operations. The load hauled by the dump body is referred to as either ***heaped*** or ***struck***.

Figure 8-1 – Typical dump truck.

1.1.0 Types of Dump Trucks Used By Naval Construction Force

The NCF uses commercial and Medium Tactical Vehicle Replacement (MTVR) dump trucks to support construction, quarry, and disaster repair operations. That support includes hauling, dumping, and spreading sand, quarry rock, asphalt, and tree stumps. Such materials are commonly loaded into the dump body by front-end loaders and excavators, as shown in *Figure 8-2*.

Although the NCF has various types of hauling equipment, dump trucks have many distinct advantages. They can haul more and further than other types of hauling equipment, and haul ***off-road*** and ***over-the-road***.

Figure 8-2 – Excavator loading a dump truck.

1.1.1 Commercial Dump Trucks

Most commercial dump trucks used by the NCF are 6x6 vehicles with the capacity to haul a payload of 15 tons (*Figure 8-3*). They are categorized as rigid dump trucks because they have a ridge frame structure, i.e., their cabs and dump bodies are on one continuous frame and operate together. Because of their rigid frames, operating these trucks in tight areas can be difficult. Additionally, when operating these trucks over rough terrain, operators must use caution because their rigid frame permits one or more of tires to lift off the ground. Commercial dump trucks have tailgates that facilitate bottom dumping and spreading of loose materials.

Figure 8-3 – Commercial dump truck.

1.1.2 Medium Tactical Vehicle Replacement Dump Truck MK30

The MTVR dump truck, MK30, is a 7-ton, 6x6 vehicle, designed for use on all types of roads, highways and cross-country terrains (*Figure 8-4*). On paved surfaces, it has the capacity to haul a struck payload of 21,060 pounds (10.5 tons) or a heaped payload of 28,000 pounds (14 tons). On cross-country terrains, it can haul a struck or heaped payload of 14,200 pounds (7.1 tons). It is also capable of fording water as deep as 60 inches.

Figure 8-4 – MK30.

The MTVR dump body's adjustable tailgate facilitates top and bottom dumping as well as spreading loose material.

The MK30 is equipped with a cargo cover and bows to protect uncontained cargo from the weather and hidden from view. It is also equipped with a cargo tarp made of nylon mesh that is rolled out, over the payload. This tarp prevents driving hazards by limiting dirt spills on turns and curves.

The MK30 also is equipped with a self recovery winch, which is mounted behind the cab on the right side.

Test your Knowledge (Select the Correct Response)

1. **(True or False)** Commercial dump trucks have tailgates that facilitate top and bottom dumping.

   A. True
   B. False

2. **(True or False)** Compared to most commercial dump trucks, the MK30 has a greater hauling capacity.

   A. True
   B. False

2.0.0 MAJOR COMPONENTS

Figure 8-5 shows the major components of the MK30. While the components and controls on dump trucks will vary with manufacture and model, they are quite similar; however, before beginning operation, read and understand the operator's manual for the specific type of dump truck.

Figure 8-5 – MK30 major components.

2.1.0 Dump Body

On the MK30, the dump body has a capacity of 6.5 cubic meters yards by volume and 21,000 pounds by gross weight. It is constructed of high-strength steel.

2.2.0 Dump Tarp

The dump tarp is deployed over the load using a torsion spring and swing arms. It is stored in a rolled-up configuration, controlled by a hand crank.

2.3.0 Tailgate

The tailgate is made of high-strength steel. It has chain slotted brackets on the rear corner pillars to adjust the tailgate opening for bottom dumping and spreading operations. During top dumping operations, the tailgate wings are swung toward the rear of the vehicle to support the tailgate and direct the load. To release the tailgate, the MK30 has a switch inside the cab; whereas commercial dump trucks have hand levers at the front left corner of the body (*Figure 8-6*).

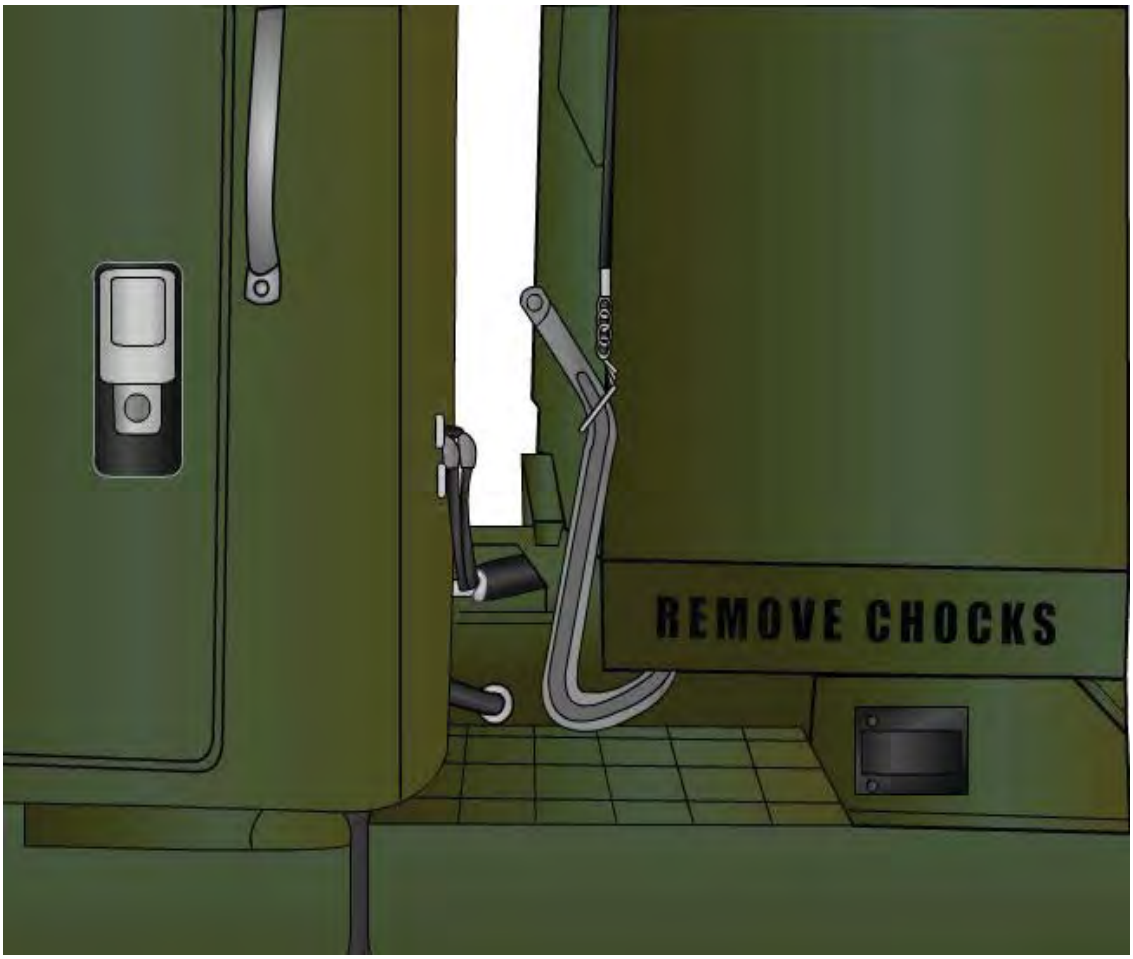


Figure 8-6 – Commercial dump truck tailgate hand lever.

2.4.0 Cab Shield

The cab shield is attached to the front of the dump body and extends the full width of the cab. It protects the operator from falling material during loading.

On the MK30, the cab shield extends 3 feet from the front end of the dump body and is capable of supporting an evenly distributed load of at least 1,500 pounds. The cab shield, if removable and may be stored in the dump body in order to meet transportability requirements.

2.5.0 Dump Body Hoist

On the MK30, the dump body hoist consists of single and double-acting hydraulic cylinders. The bore at the base of the cylinder is 5 inches. The stroke is approximately 29 inches.

2.6.0 Dump Tarp Swing Arms

A torsion spring drives the swing arms to deploy the tarp. A crank handle drives the swing arms to stow the tarp.

2.7.0 Access Cover and Pin

The access cover and pin provide access to the rear hardlifts. Hardlifts are the lifting eyes between the rear-tandem axles, which are used for load-on/load off (LOLO) loading.

2.8.0 Body Props

The MK30 has two body props located on each side of the vehicle. During inspection and maintenance, both body props must be supporting the empty dump body.

Test your Knowledge (Select the Correct Response)

3. On most commercial dump trucks, how is the tailgate released?

   A. By hand lever
   B. By a switch
   C. By an air released lock
   D. By swinging the tailgate wings

4. On the MK30, the cab shield is capable of supporting an evenly distributed load of at least _____ pounds.

   A. 2,000
   B. 1,500
   C. 1,000
   D. 500

3.0.0 CONTROLS

With the exception of the dump load settings on the Central Tire Inflation System (CTIS) and dump body controls, the MK30's instrument panel (*Figure 8-7*) and cab are similar to those of other types of MTVRs.

Figure 8-7 – MK30 instrument panel.

3.1.0 Dump Loading Settings

As shown in *Figure 8-7*, the dump load settings on the CTIS controller are as follows: 0-2 tons, 2-6.1 tons, and 6.1-14 tons.

Table 8-1 shows how the terrain and load settings affect the tire inflation pressure on both the front and rear tires.

Table 8-1 – Tire pressure.

	MK30		TERRAIN			
			HWY	CC	MSS	EMER
Empty Condition	0-2 tons	Front Rear	43 PSI 35 PSI	28 PSI 22 PSI	15 PSI 12 PSI	12 PSI 10 PSI
Partial Load	2-6.1 tons	Front Rear	42 PSI 55 PSI	27 PSI 34 PSI	14 PSI 19 PSI	11 PSI 14 PSI
Full Load	6.1-14 tons	Front Rear	42 PSI 96 PSI	27 PSI 70 PSI		
			MAXIMUM SPEED	40 MPH	15 MPH	5 MPH
NOTE: All tire pressures are ± 3 PSI.						

CAUTION

Change the dump load setting, on the CTIS controller as required immediately upon adding or removing payload from the MK30. Failure to do so may result in damage to the equipment.

3.2.0 Dump Body Controls

Before using the dump body controls on the MK30, push the mode button and turn on the winch on/off switch to activate the ***power takeoff (PTO).***

The PTO plays an important role in dumping operations. It controls the hydraulics for operating the dump body hoist.

NOTE

There is a variety of ways to engage the PTO on dump trucks the NCF uses; therefore, consult the operator's manual for specific instructions on how to engage the PTO and hoist assembly.

3.2.1 Control Console Button

Push in on the control console button to release the dump body lever.

3.2.2 Dump Body Lever

Pull up and back on the dump body lever (*Figure 8-8*) to raise the dump body. Push forward and down to lower the dump body. The dump body lever is center spring loaded and will always return to the center position when released. *Figure 8-9* shows the operation of the dump body lever.

Figure 8-8 – Dump body controls.

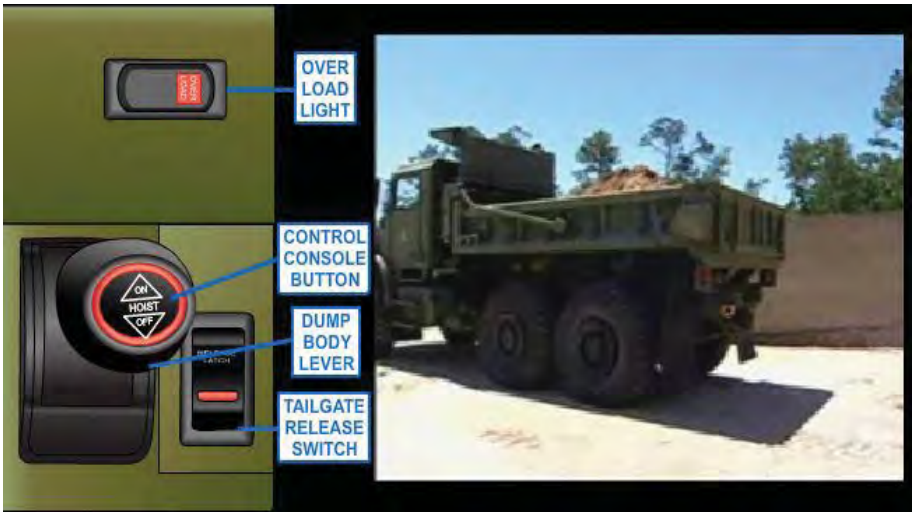


Figure 8-9 – Dump body lever in operation.

3.2.3 Tailgate Release Switch

Toggle the tailgate release switch forward to unlock the tailgate. Toggle the switch backward to lock the tailgate.

3.2.4 Tarp Crank Handle

Use the tarp crank handle to roll up the tarp into the stowed position. It is stowed under the dump controls between the operator and passenger seats.

3.2.5 Tarp Brake Lever

Use the tarp brake lever, shown earlier in *Figure 8-5*, to fully deploy the tarp over the load.

3.2.6 Travel Lock

Located on the left side of the MK30, the travel lock locks the hydraulic system to prevent operation during load handling, rail transportation, and troop transportation. It is equipped with hooks that secure the front end of the dump body.

Test your Knowledge (Select the Correct Response)

5. **(True or False)** On the MK30, the CTIS dump load settings are as follows: 0-2 tons, 2-6.1 tons, and 6.1-14 tons.

   A. True
   B. False

6. On the MK30, how would an operator raise the dump body?

   A. Push forward and down on the dump body
   B. Pull up and back on the dump body lever
   C. Push in the on button
   D. Toggle the dump body switch

4.0.0 OPERATIONS

As an operator, you are responsible for reading and understanding the operator's manual. Before operating a dump truck, you must know the type and load capacity for which the assigned dump truck is designed; for example, you do not want to haul quarry rocks in a dump body designed to haul and heat asphalt. The quarry rock can damage the dump body and render it useless for asphalt operations. The operator's manuals are located in the Technical Library.

In addition, before dump truck operation, ensure that the truck is in good, safe operating condition, the frame is sound, the dump body is firmly attached, and the tailgate opens easily and locks securely.

4.1.0 Loading

Before loading the dump truck, be sure to set the vehicle park brake, otherwise the truck may roll or shift causing injury to personnel or damage to equipment.

Before loading large quarry rocks, line the dump body with a load of sand or wooden planking. The material will act as a cushion and help protect the dump body from damage.

Before loading asphalt, coat the inside of the dump body with diesel fuel. The fuel prevents the asphalt from sticking to the dump body. To control any rapid heat loss, cover the hot-mix with a tarpaulin tied down securely to prevent flapping in the wind.

Whenever possible, load dump trucks from the operator's side, as shown in *Figure 8-10*. As the truck is loaded, the operator stays either in the cab or away from the truck and loader. Additionally, whenever possible, position the truck so that you can drive away without backing up. Backing up a loaded dump truck is dangerous and difficult.

Figure 8-10 – Loading from operator's side.

When loading material, never exceed the recommended load capacity of the dump truck. Additionally, make sure that the load is delivered from the lowest possible height and distributed evenly down the center of the dump body. An uneven load can cause damage and make the dump truck unstable; for example, a load to the front of the dump body puts more strain on the hydraulic hoist and can cause the truck to tipover backwards. A load to one side of the dump body can damage the hinge pins or dump body or bend the chassis. This can also cause the dump truck to tipover to one side. A load piled against a hinged tailgate can damage the tailgate and cause the front wheels of the dump truck to rise off the ground.

During the loading process, avoid compacting loose material. Compacted material can become stuck at the top, bottom, or to one side of the body, causing damage and the vehicle to tip over. For these same reasons, avoid leaving loose material in the body overnight, especially in freezing temperatures.

4.2.0 Hauling

Some states and countries require that all loose materials hauled in dump trucks must be covered to prevent spillage on roadways and breaking of vehicle windshields. Know the rules and regulations for the area in which you are operating.

Operators must adjust vehicle speed when taking a curve. Two things can happen when hauling a full load and taking a curve at a high speed. The tires can lose their traction and continue straight ahead, causing you to skid off the road. Or the tires may keep their traction, causing the vehicle to roll over. To avoid these possibilities, reduce speed before entering the curve and gently accelerate when coming out of the curve. Remember, it is dangerous to brake in a curve. It can cause the wheels to lock, resulting in a skid.

In addition, avoid sudden stops, turns, or accelerations. They may cause the load to shift.

4.3.0 Backing

Backing a loaded dump truck is a dangerous maneuver. Backing into other vehicles, objects, power lines, or people is considered negligence on the part of the operator. To avoid backing mishaps, always use the common practices of the NCF. These practices are as follows:

- Blow the horn at least twice before reversing the vehicle. This alerts personnel in the surrounding area that a vehicle is preparing to backup.
- Exit the vehicle and survey the area for items you cannot see from the cab of the truck or equipment before backing into an unfamiliar area. Check for the following: low power lines, fire hydrants, warning poles, guy wires, parked vehicles, and other obstacles.
- Use a backup guide (signal person) as shown in *Figure 8-11*. The backup guide signals you from the rear of your vehicle as you perform your backing operations. Survey the area and communicate with the backup guide so you both have an understanding of the backing operation.
- Make reverse turns toward your left. This provides maximum visibility.

Figure 8-11 – Backup guide.

4.4.0 Dumping

Before dumping operations, rear mud flaps must be in the lowered position.

During dumping operations, the operator must stay in the cab and wear a seatbelt.

When the dump body is raised, the center of gravity for the truck changes to a higher position, placing the truck at a risk of tipping over. This risk increases when dumping takes place on a slide slope, as shown in *Figure 8-12*; therefore, dump operations must be limited to side slopes no greater than 7 percent (4 degrees). On uphill inclines, the front of the truck should face downwards.

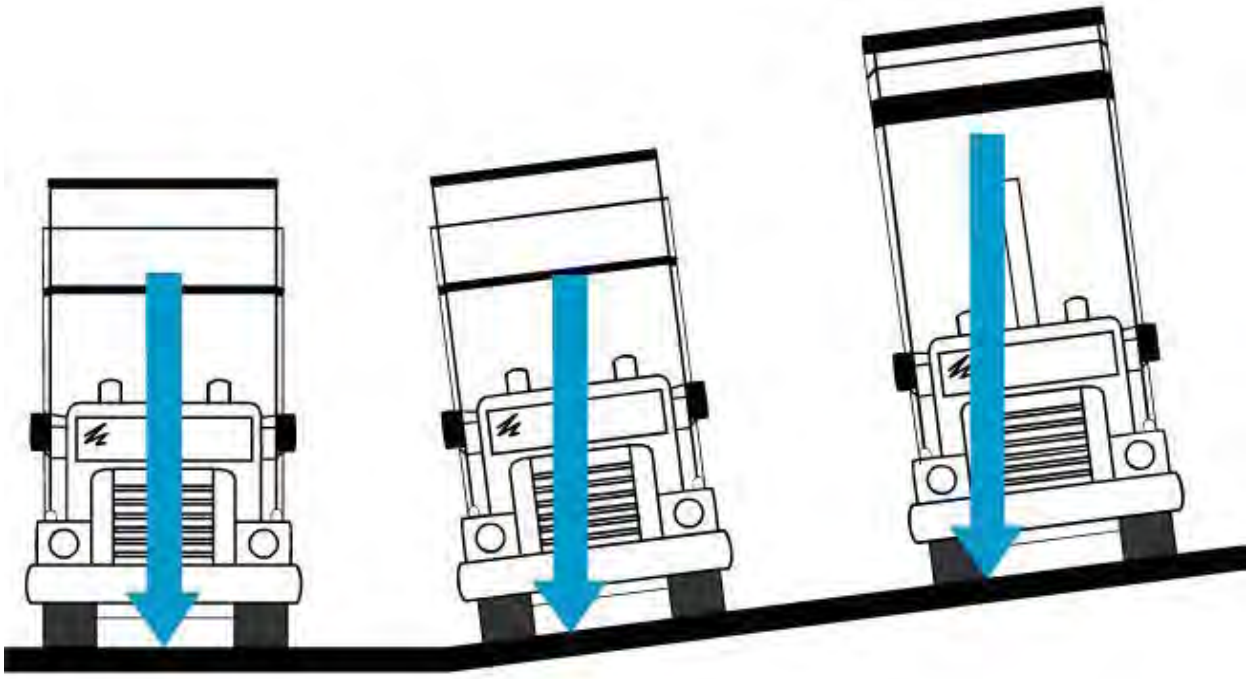


Figure 8-12 – Stability.

Trucks should not dump when they are parked side by side with another vehicle. When a dump truck tips over, the operator in the adjoining vehicle is often the one injured.

When dumping material raise the dump body only enough to allow the payload to slide out of the body. If the load does not slide out easily, lower the body and have someone dislodge the load with a long-handled shovel, taking care not to stand in the immediate dumping area. Once the entire load has been dumped, ensure all personnel are clear of the dump body before lowering it.

Two methods can be utilized for dumping operations, top dumping and bottom dumping.

4.4.1 Top Dumping

The MK30 can perform top dumping. Top dumping, as shown in *Figure 8-13,* is used for dumping large bulky payloads, such as boulders and tree trunks. It consists of unlocking the tailgate, swinging the tailgate wings to the rear of the vehicle and lowering the tailgate onto the tailgate wings. The payload is discharged over the tailgate and is directed by the tailgate wings.

Not all dump trucks have tailgate wings. On those that do not, you must lower the tailgate and support it with chains.

Figure 8-13 – Top dumping.

4.4.2 Bottom Dumping

Both the MK30 and the 15-ton commercial truck can perform bottom dumping. Bottom dumping, as shown in *Figure 8-14,* is used for dumping free flowing payload, such as gravel, sand, or dirt. It consists of rigging the tailgate to swing open at the bottom. In the case of the MK30, the tailgate is unlocked by the tailgate release switch. The payload is discharged through the opening between the bottom of the tailgate and outer edge of the truck body.

Figure 8-14 – Bottom dumping.

During bottom dumping, if the payload piles up and blocks the tailgate, place the truck in low gear and move it forward until there is more space to dump the remainder of the load.

4.4.3 Spreading

When you perform bottom dumping, loose material can be spread in forward or reverse direction, depending on terrain, as shown earlier in *Figure 8-14*. But before spreading operations, make sure that the entire length the dump truck must travel is reasonably level.

Control the amount of spread by securing chains from the tailgate to the dump body and adjusting their lengths. To spread material over a large area, shift the dump truck into low gear and drive slowly while dumping.

4.4.4 Dumping off of an Edge

Before dumping off the edge of a fill, as shown in *Figure 8-15*, check the stability of the ground. If the dump truck has all-wheel drive, like the MK30, or if the fill is shallow, a close approach may be possible. But if the fill is soft or slippery, keep the rear wheels six feet or more away from the edge.

Figure 8-15 – Dumping off an edge.

Remember, when you are backing up, the rear tires should be at the same distance from the edge, rather than at an angle. Have the backup guide continue checking the stability of the ground. Always be prepared to stop quickly, in case the backup guide notices that one tire sinking deeper than the others. In this case, it may not be possible to dump off the edge.

Dump trucks can exert considerable pressure on the banks of ditches and shoulders of lanes that run along fields. If the soil is weakened from freezing, thawing, or prolonged wet weather, and the dump truck is driven on the shoulder or too close to the ditch, the weight may be enough to collapse the soil, resulting in a tip over. This is usually referred to as a shear line hazard. *Figure 8-16* identifies the shear line of a six foot ditch bank.

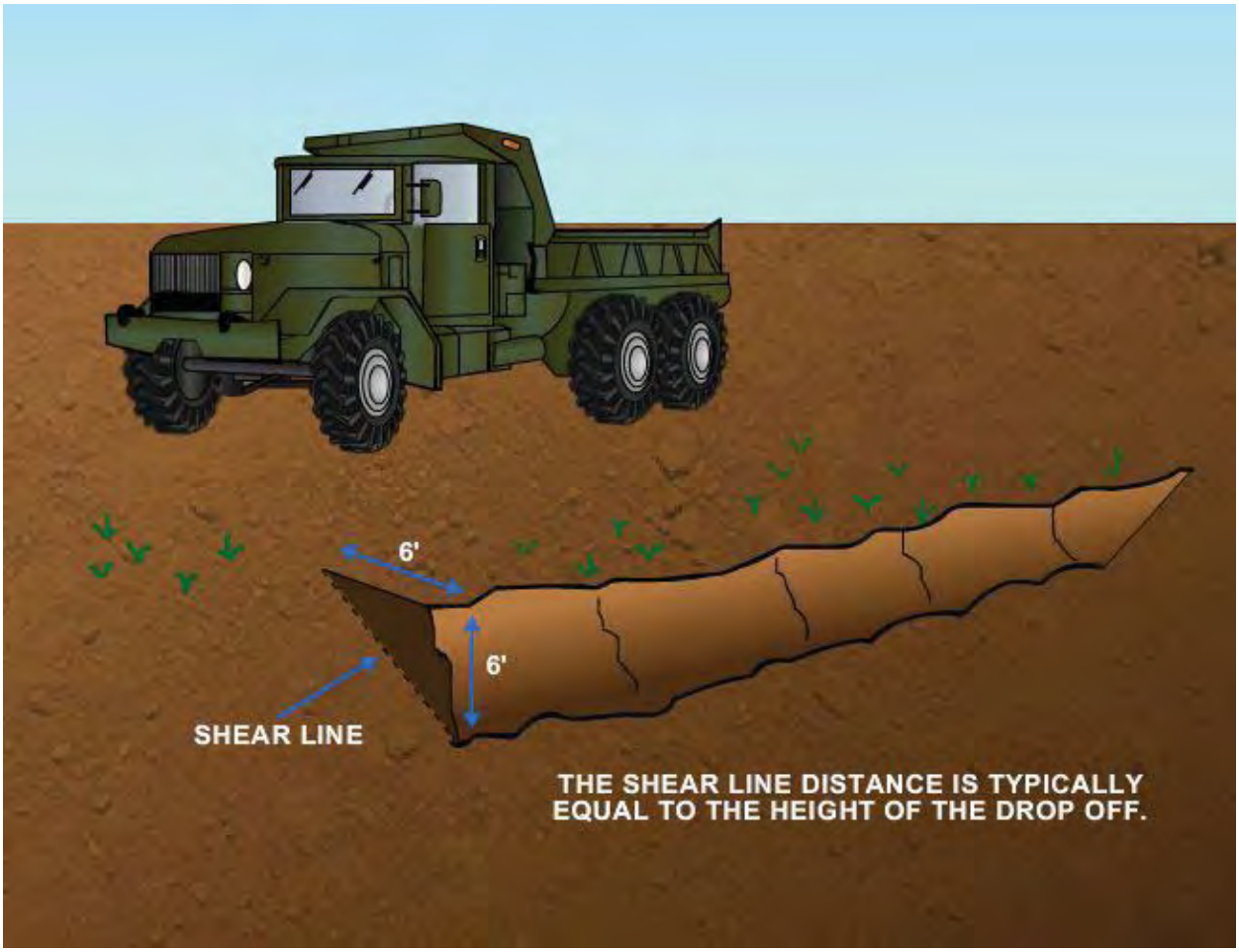


Figure 8-16 – Shear line hazard.

Test your Knowledge (Select the Correct Response)

7. An operator would perform top dumping to unload _____.

   A. a cement barricade
   B. sand
   C. gravel
   D. free flowing payload

8. Dumping operations are limited to side slopes no greater than _____ percent.

   A. 8
   B. 7
   C. 6
   D. 5

5.0.0 SAFETY

The following additional safety practices apply to dump truck operation:

- Dump operations should be done with a ground guide.
- When performing dumping operation, be careful to avoid overhead obstructions, such as power lines and trees.
- Before leaving a dump location, ensure that the dump body is completely lowered.
- When backing, use a guide to avoid backing accidents.
- Once the tailgate has been unlocked, do NOT stand behind a truck with a loaded dump body.
- Do NOT walk or stand under a raised dump body.

Test your Knowledge (Select the Correct Response)

9. **(True or False)** Before leaving a dump location, an operator must ensure that the dump body is complete lowered.

   A. True
   B. False

Summary

In this chapter, you were introduced to the two types of dump trucks used by the NCF, the 15-ton commercial dump truck and MK30. You learned about their capabilities, components and controls. Additionally, you were introduced to operations such as top and bottom dumping and spreading. Finally and importantly, you were introduced to dump truck safety.

Review Questions (Select the Correct Response)

1. **(True or False)** The NCF uses dump trucks to haul and dump materials, such as sand, quarry rocks, asphalt, and tree stumps.

   A. True
   B. False

2. **(True or False)** The commercial trucks used by the NCF have articulated frames.

   A. True
   B. False

3. On cross-country terrains, the MK30 can haul a struck and heaped payload of _____.

   A. 8.1 tons
   B. 7.1 tons
   C. 6.1 tons
   D. 5.1 tons

4. On the MK30, the tailgate wings serve what purpose?

   A. Direct the load being dumped during top dumping operations
   B. Direct the load being dumped during bottom dumping operations
   C. Protect the operator from falling material
   D. Deploy the tarp

5. What is the maximum speed for the emergency terrain setting?

   A. 10 mph
   B. 7mph
   C. 5 mph
   D. 3 mph

6. **(True or False)** Immediately after adding or removing payload from the MK30, the dump load setting must be changed.

   A. True
   B. False

7. On the MK30, how is the PTO activated?

   A. Push the control console button and turn the winch on/off switch on
   B. Push the mode button and turn the winch on/off switch on
   C. Push the mode button and turn the CTIS on
   D. Push the 7.1 tonsmode button and the control console button

8. On the MK30, how would an operator lower the dump body?

   A. Push forward and down on the dump body
   B. Pull up and back on the dump body lever
   C. Push in the on button
   D. Toggle the dump body switch

9. **(True or False)** On the MK30, toggle the tailgate release switch forward to lock the tailgate.

   A. True
   B. False

10. Who is responsible for reading and understanding the operator's manual.

   A. The Mechanic
   B. The Yard Boss
   C. The Dispatcher
   D. The Operator

11. Whenever possible, dump trucks should be loaded from _____.

   A. behind
   B. the passenger's side
   C. the operator's side
   D. the side closer to the stockpile

12. **(True or False)** When loading material, the operator must be sure not to exceed the recommended load capacity of the dump truck.

   A. True
   B. False

13. When taking a curve with a loaded dump truck, what actions should an operator take?

   A. Reduce speed before entering the curve and gently accelerate when coming out of the curve
   B. Reduce speed before entering the curve and accelerate hard when coming out of the curve
   C. Reduce speed before entering the curve; in the middle of the curve if the speed is still too high, press down on the brake pedal.
   D. Reduce speed before entering the curve and gently brake when coming out of the curve

14. If a load does NOT slide out easily, what actions should be taken?

    A. Have someone jump into the dump body to dislodge it
    B. Lower the body and have someone dislodge it with a long-handled shovel
    C. Repeatedly raise and lower the dump body to shift the load
    D. Leave it overnight so that the material can dislodge on its own

15. What dump truck operation consists of rigging the tailgate to swing open at bottom?

    A. Top dumping
    B. Bottom dumping
    C. Hauling
    D. Loading

16. **(True or False)** On dump trucks without tailgate wings, chains are used to supports the tailgate during top dumping operations.

    A. True
    B. False

17. When dumping at a fill that is soft and slippery, keep the rear wheels _____ feet or more away from the edge.

    A. 10
    B. 8
    C. 6
    D. 4

18. When backing up to an edge of a fill, the tires should be _____.

    A. at an angle
    B. at the same distance from the edge
    C. as close to the edge as possible
    D. sunken into the ground

19. Which of the following does NOT weaken soil?

    A. Freezing
    B. Plant life
    C. Thawing
    D. Prolonged wet weather

20. **(True or False)** Once the tailgate has been unlocked, do NOT stand behind a truck with a loaded dump body.

    A. True
    B. False

Terms Introduced in this Chapter

Heaped	The volume of material the dump body will hold when the material is heaped.
Off-road	Hauling that is done within a job site and not over public highways.
Over-the-road	Hauling that is done over public highways.
Power takeoff (PTO)	A mechanic link to an engine or transmission to which a cable, belt or propeller shaft may be connected to power another device.
Struck	The volume of material the dump body will hold when the material is up to the very rim.

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 55131, General Subjects and Contingency Responsibilities, Extension Course Institute, Gunter Air Force Base, Montgomery, AL, 1984.

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

Manual for the Wheeled Vehicle Driver, Army Field Manual, FM 21-305, Air Force Regulation AFR 77-2, Headquarters, Department of the Army and Air Force, Washington, DC, 1984.

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

Operator's Maintenance Manual, TM 5-2330-378-14 & P, Headquarters, Department of the Army, Washington, DC, 1988.

U.S. Marine Corps Technical Manual: System Operation Manual with Components List for Truck, Dump, 7-Ton w/ Winch, MK30, TM 10629-10C, Marine Corps Systems Command, VA, 2006.

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Chapter 9

Tank Trucks

Topics

To hear audio, click on the box. 

Overview

By providing fuel and water, tank trucks play a critical role in assisting heavy equipment at the construction site.

This chapter provides information needed to operate such vehicles. It describes the types of tank trucks used by Naval Construction Force (NCF) and includes description of major components, and controls. In addition, this chapter explains how to safely perform fuel and water operations.

Objectives

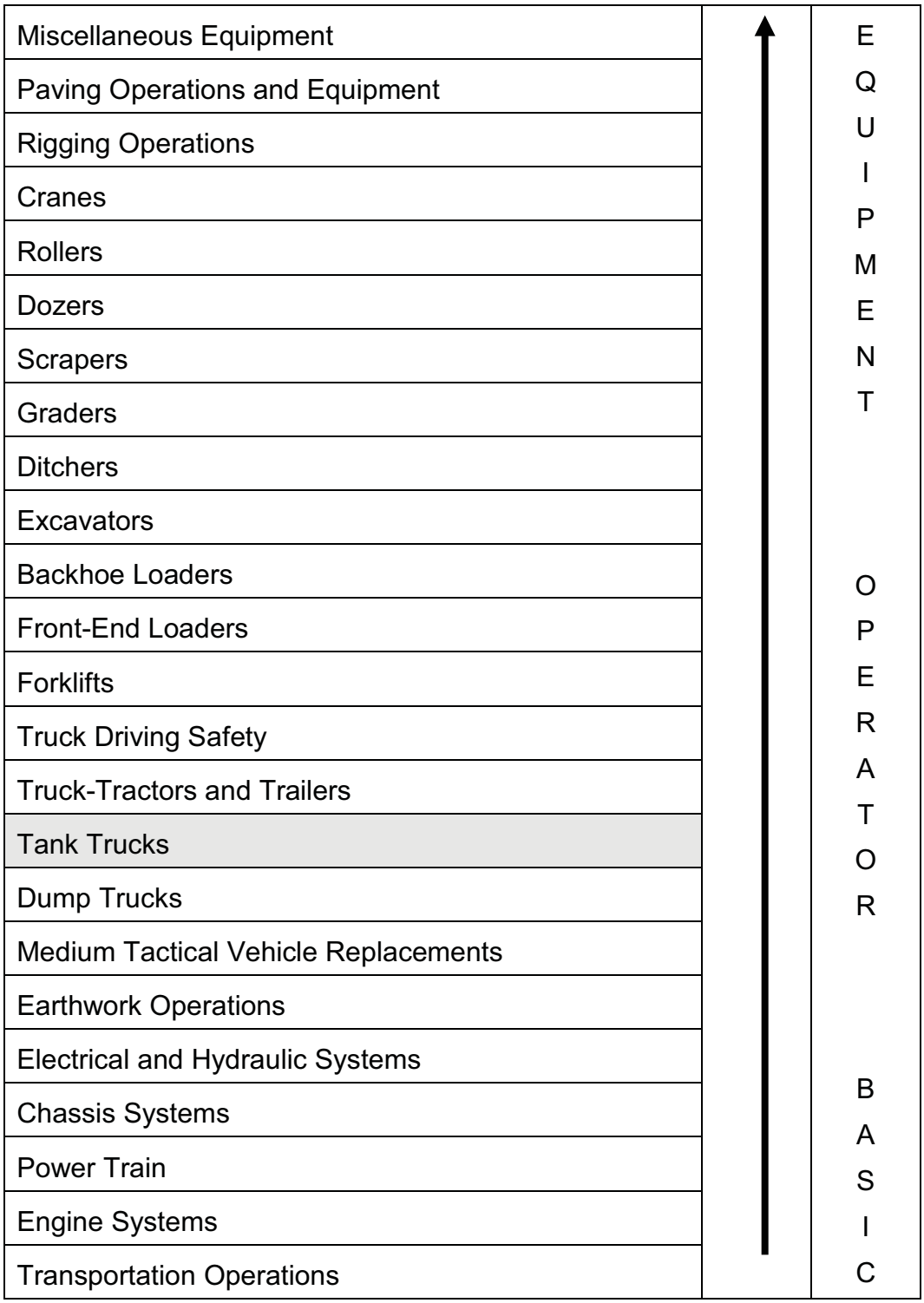
When you have completed this chapter, you will be able to do the following:

1. Understand the use of tank trucks.
2. Identify the types of tank trucks used by NCF.
3. Identify the major component of tank trucks.
4. Identify the controls on tank trucks.
5. Understand how to perform tank truck operations.

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 TANK TRUCKS

Tank trucks are motor vehicles mounted with cylindrical tanks capable of transporting and dispensing liquefied loads such as fuel and water. In the NCF, such tanks are mounted horizontally onto the chassis of commercial trucks or Medium Tactical Vehicle Replacements (MTVRs) cargo trucks MK28s.

Although they are recognizable by they welded tanks, the tank trucks used by the NCF have distinguishing characteristics such as purpose, size, and volume capacity. Before operating a tank truck, you are responsible for reading the operator's manual for specific information.

Test your Knowledge (Select the Correct Response)

1. **(True or False)** Tank trucks are capable of transporting and dispensing liquefied loads.

   A. True
   B. False

2.0.0 FUEL TRUCK

The purpose of the fuel tank truck, or simply fuel truck, is to provide a mobile fuel source to refuel equipment. Out at construction sites, crawler-mounted Civil Engineering Support Equipment (CESE) rely heavily on fuel trucks for refueling because of their limited mobility.

2.1.0 Major Component

As shown in *Figure 9-1*, a fuel truck's major component is its fuel tank. The tank's volume capacity varies depending on size, make, and manufacturer. The MTVR fuel truck shown in *Figure 9-1* is capable of carrying 2000 gallons of fuel.

Figure 9-1 – Major components of a fuel truck.

Figure 9-2 shows the inside of the pumping compartment on an MTVR fuel truck. Inside is a pump driven by a hydraulic motor connected to the vehicle's hydraulic pumping system. At a rate of 100 gallons per minutes (gpm), this pump enables the fuel tank to dispense pressurized, metered fuel through a hose reel and trigger type nozzle. Instead of using the onboard pumping system, the fuel tank can utilize gravity to dispense metered or unmetered fuel through one of two 2.5-inch drains.

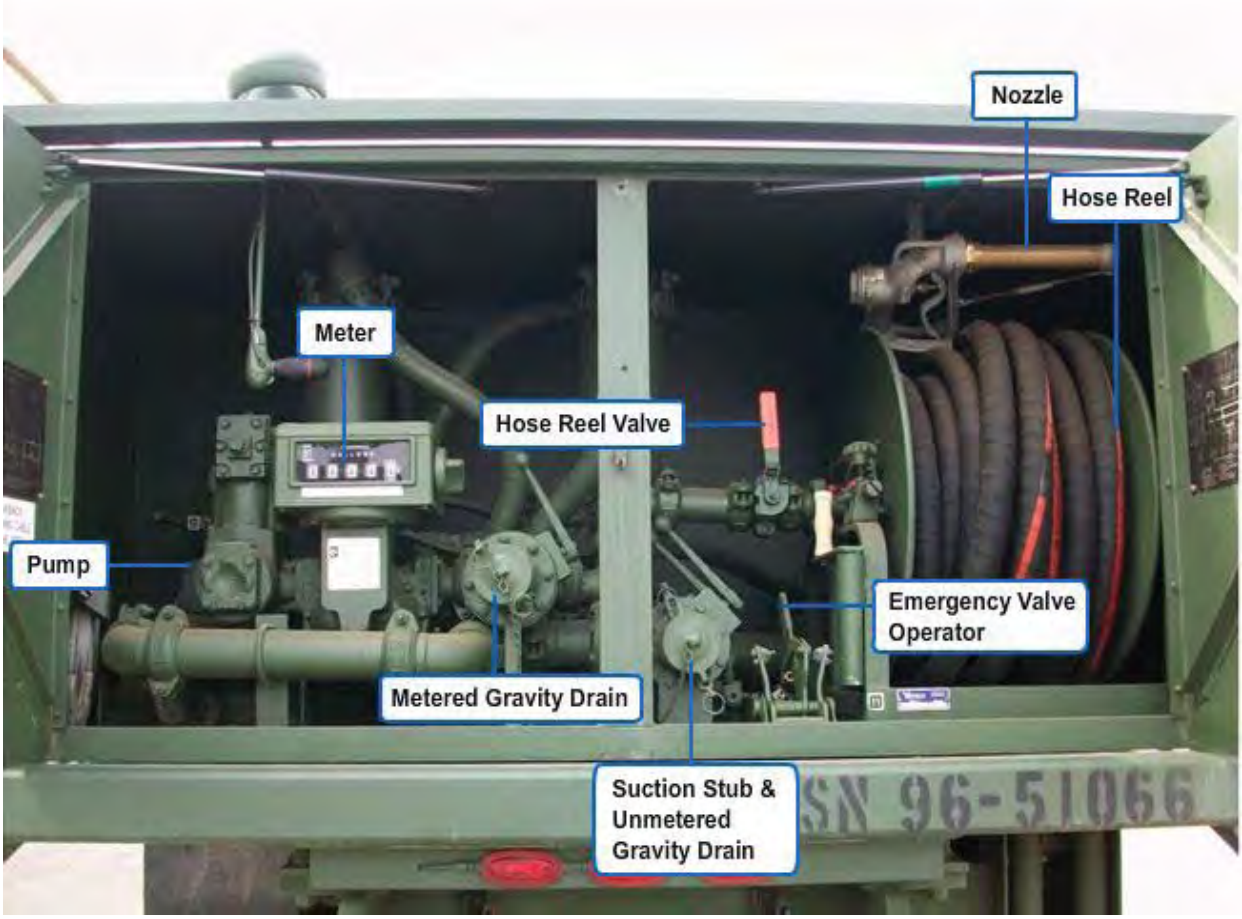


Figure 9-2 – Inside of pumping compartment.

This same pump enables the fuel tank to self load, through a suction stub, at any rate up to 100 gpm. The fuel tank can also be loaded by a pressurized fuel source such as a fuel dispensing facility. In such a case, fuel may be received by use of a manhole located on top of the fuel tank. Receiving fuel in this matter is commonly referred to as top loading. Fuel may also be received by use of an adapter located on the bottom right side of the tank. This is referred to as bottom loading. The tank is equipped with a vapor recovery piping system. The purpose of such a system is to prevent fuel vapors from escaping into the atmosphere. Doing so reduces physically harmful, potentially explosive fumes and pollution. The system can only be used at filling stands equipped with vapor recovery equipment.

To prevent spillage as a result of overloading, the fuel tank is equipped with an automatic shutoff system consisting of a jet level sensor installed in the top of the tank near the manhole. When fuel contacts the jet level sensor, flow into the tank stops.

2.2.0 Controls

On the MTVR fuel truck, fuel dispensing and self loading operations are controlled by the winch in/out switch and transmission mode button (*Figure 9-3*). The Power Takeoff (PTO) hydraulic control, located on the left side of the vehicle, engages the pump.

An emergency valve in the pumping compartment opens and in case of an emergency closes the main valve to the tank. Other controls for closing the main valve were shown earlier in *Figure 9-1*.

They include four emergency shut off handles, located on the right side rear of the tank, near the operator's door, on top of the tank, and on the left side of the pumping compartment.

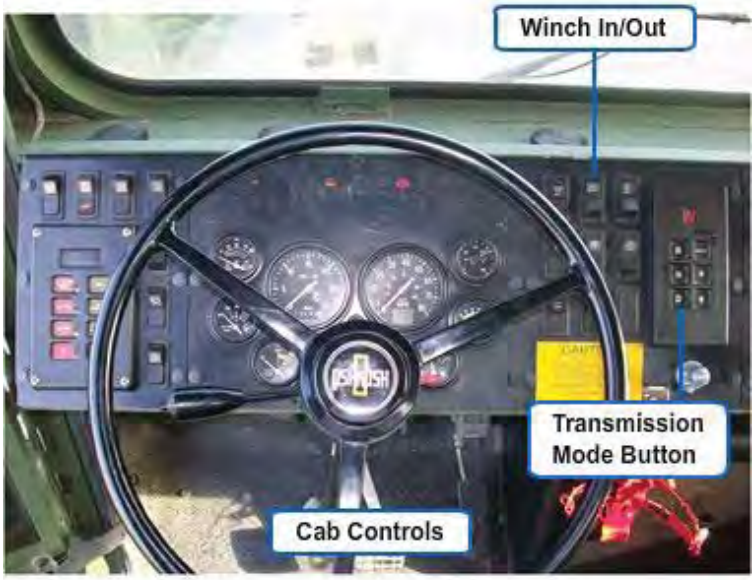


Figure 9-3 – Fuel truck controls.

2.3.0 Fuel Truck Operator

NMCB fuel operations are managed by the transportation chief or supervisor. Because poorly managed fuel operations can result in needless downtime of equipment and delays in production, responsibilities are normally delegated to an operator who is mature, independent, and reliable.

The fuel truck operator must possess the knowledge, skill, and abilities to accomplish the following:

- Use the Equipment Status Board to determine the location of all CESE.
- Know the fuel requirements and function of equipment used on construction sites.
- Avoid fueling equipment with the wrong fuel or filling hydraulic systems or cooling systems with the fuel.
- Prevent contamination of fuel by the use of proper equipment and by careful and proper operating procedures.
- Maintain accurate records in a log documenting amounts of fuel issued by equipment USN number.
- Ensure fuel availability for contingency readiness, daily transportation, and construction operations.

- Maintain a fire extinguisher on the tank truck as set forth by COMFIRSTNCDINST 11200.2. The fire extinguisher should be inspected in accordance with National Fire Protection Association (NFPA) 10: Standard for Portable Fire Extinguisher. It should also have an Underwriters Laboratory (UL) rating no less that 20 B:C and filled with a dry chemical that provides the smothering effect necessary to extinguish a Class B fire involving gasoline or diesel fuel. As shown earlier in *Figure 9-1*, the MTVR fuel truck has a fire extinguisher located on both sides of the pumping compartment. In addition to the fire extinguishers mounted on the fuel truck, all refueling stations have extinguishers per COMFIRSTNCDINST 11200.2.

  To use an extinguisher, squeeze its handle while aiming the nozzle at the base of the flames. Remember to keep a safe distance from the fire and spray in the same direction as the wind.

- Be alert to avoid environmental pollution. Fuel spillage can be disastrous.
- Daily communicate with the yard boss, dispatcher, and the transportation supervisor.
- Be a qualified professional operator of the fuel truck.

2.4.0 Warning Signs

Fuel trucks must be marked with the word “FLAMMABLE” with six-inch black letters and the words “NO SMOKING WITHIN 50 FEET” in three-inch black letters and numerals on both sides and the rear of the tank. This marking should be on two lines and placed so that the latter wording appears directly below the word “FLAMMABLE” as per COMFIRSTNCDINST 11200.2. If the tank is too small to accommodate this size, use the largest size that will fit.

Additionally, as outlined in COMFIRSTNCDINST 11200.2, the type of liquid must also be displayed. An 8 inch by 36 inch bracket with backing is bolted to each side of the tank. A removable plate painted black with six-inch yellow letters to designate the liquid is inserted in the bracket. One side of the plate is marked, “DIESEL” and the other side "MOGAS" for mobile gasoline.

Title 49 of the Code of Federal Regulations (49 CFR) classifies hazardous materials into 9 classes based on the degree of risk associated with the material. Some classes have subdivisions to better define the type of hazard. Gasoline and diesel fuel are classified as Class 3 Flammable Liquids because they both have a flash point of 141°F or lower. Flash point is the minimum temperature at which a liquid gives off vapor in sufficient concentration to form an ignitable mixture with air. The flash point of gasoline is -49°F. This means that all temperatures above minus 49 degrees can produce vapor which can ignite gasoline. The flash point of Diesel #2 is 125 degrees Fahrenheit while the flash point of JP8 (a fuel commonly used in contingency operations) is 100 degrees Fahrenheit.

Regulations require vehicles transporting hazardous materials to have U.S. Department of Transportation (DOT) placards on all sides of the vehicle to warn others of the hazardous cargo. As shown earlier in *Figure 9-1*, US DOT placards display the hazard class and are 10 ¾ inches square in a diamond shape turned upright on a point.

2.5.0 Safety

The following additional safety practices apply to fuel truck operation:

- Drive defensively and make allowances for other drivers.
- Make a proper lane change only after signaling to other drivers.
- Avoid excessive speeds at all times. The fuel truck is top-heavy when fully loaded with fuel, and unstable when partially filled with fuel. The operator must be alert when traveling over rough terrain, on gravel, and on curves. Be alert for passing or approaching traffic.
- Drive downgrade in the same gear that would be used to drive upgrade.
- If you are stopping due to and emergency and/or breakdown attempt to remove the vehicle completely off the road. Use reflective triangles to make others aware of your situation. Never use flares as a signal device for a fuel truck.
- Come to a complete stop prior to crossing railroad tracks and proceed only after it is clear to do so.
- If a leak should occur while transporting fuel, move the vehicle off the road, turn off the engine, cordon the area, and obtain hazardous material emergency support as necessary.
- Never smoke on or around tank trucks used for hauling flammable liquids. Additionally, do NOT carry cigarettes or matches around such vehicles.
- Examine tires regularly for proper air pressure and to ensure no damage has occurred which may cause an accident.
- When parking a fuel truck in ensure proper spill contamination is applied.
- Per 49 CRF Hazard Materials Regulations, when transporting flammable liquid, the maximum driving time within a work period is 10 hours for operators of tank trucks with a capacity greater than 500 gallons.
- Never fill a fuel tank to more than 95% of its capacity as it is against federal law and does not allow for heat expansion.
- Fuel vapors are heavier than air and tend to collect at floor level where they are susceptible to ignition therefore increasing the importance of preventing leaks and spills beyond already significant environmental perspectives.

Test your Knowledge (Select the Correct Response)

2. **(True or False)** The fire extinguisher on a fuel truck should have an UL rating of at least 5 B:C or more.

   A. True
   B. False

3.0.0 WATER TRUCK

Another type of tank truck used in the NCF is the water truck. This vehicle has multiple uses to include pressurized water spraying for soil stabilization/compaction and dust control operations. The water truck may also be used to provide water to showering units and act as auxiliary fire fighting equipment.

3.1.0 Major Components

As shown in *Figure 9-4*, a water trucks major components include a 2,000 gallon water tank, front and rear spray nozzles and a rear spray bar.

Figure 9-4 – Major components of a water truck.

The MTVR water truck can perform multiple operations. For high-volume water spray operations, it uses a centrifugal pump to draw water from the water tank and send it through the nozzles bars. Water can be sprayed from the front and rear corner nozzles simultaneously, with each nozzle controlled independently using switches in the operator's cab. For lower-volume operations, such as dust suppression, water can be pumped to the rear spray bar. For fire suppression, a 1 ½ inch hose can be connected to an outlet stub inside the pump enclosure and used as a hand held hose (*Figure 9-5*).

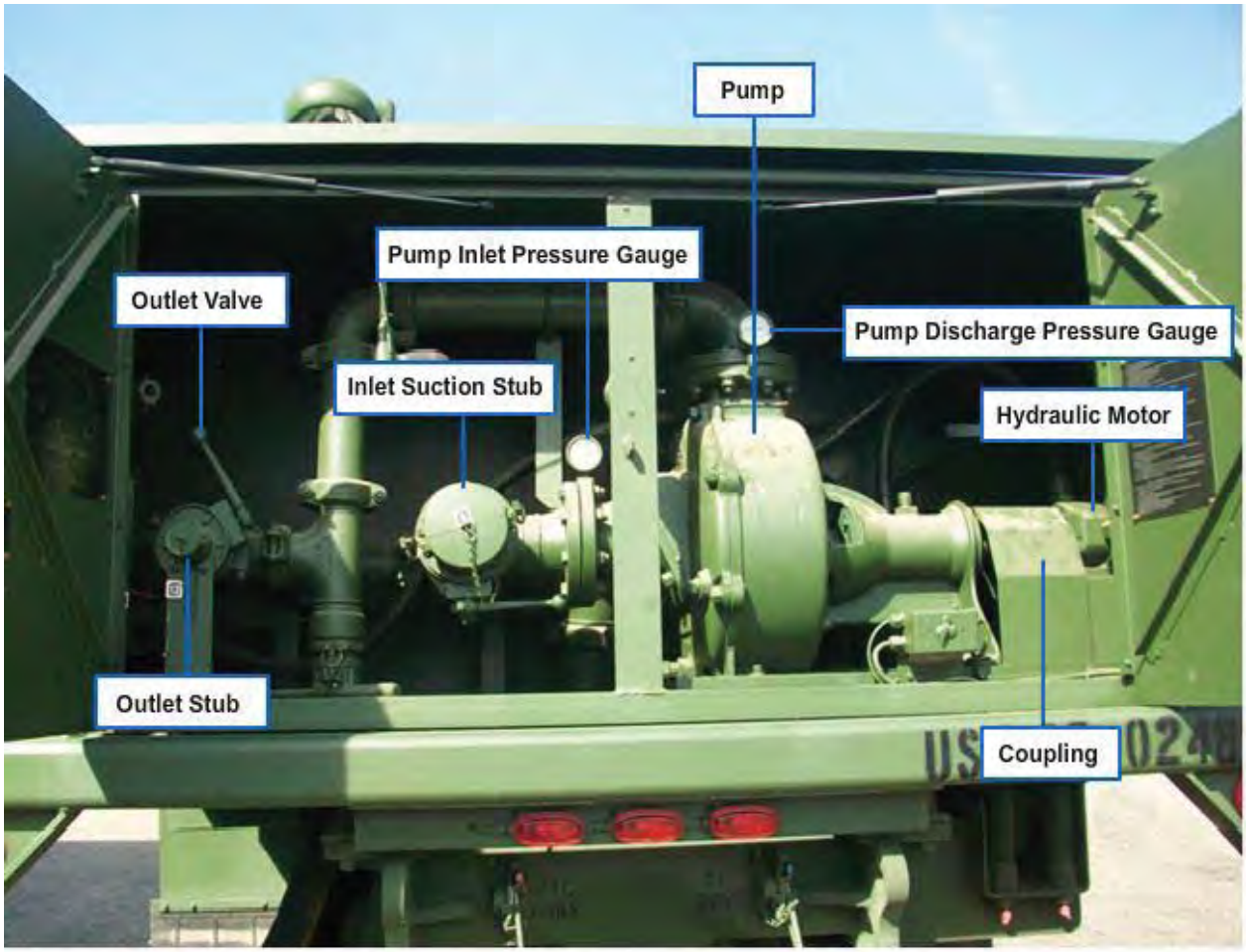


Figure 9-5 – Inside the pump enclosure.

The water tank may be filled through a manhole opening on top of the tank. Filling the tank in this matter is referred to as gravity fill. The pump may be used to draw water from another source such as a pond or lake through a suction hose connected to an inlet suction stub.

3.2.0 Controls

For many of its operations, the MTVR water truck uses a centrifugal pump driven by a hydraulic motor. The pump and motor are connected via a chain coupling. Hydraulic lines from the vehicle are connected to the hydraulic motor through a 0-10 VDC controller. Responding to an electrical signal from the pump speed control mounted a control pedestal in the operator's cab (*Figure 9-6*), the controller adjusts the hydraulic pressure applied to the hydraulic motor and controls the speed of the pump and the rate of water flow.

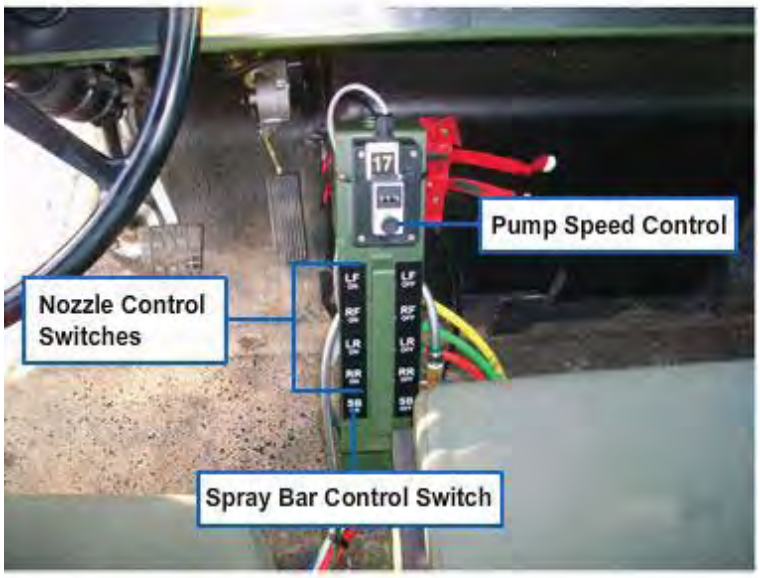


Figure 9-6 – Water truck controls.

Control of water supplied to the nozzles and rear spray bar is accomplished by means of pneumatic lines connected to the control pedestal. The vehicle supplies air pressure for the controls. Each nozzle is equipped with pneumatically operated valves. Another pneumatic valve controls water flow to the rear spray bar. The operator uses two-position switches on the control pedestal to open or close each valve.

Test your Knowledge (Select the Correct Response)

3. **(True of False)** The pump can be used to draw water from ponds and lakes.

   A. True
   B. False

4.0.0 OPERATIONS

Because of the possibility leaking, rolling over, and liquid surge, the operation of tank trucks require additional inspections and special skills.

4.1.0 Inspecting Tank Trucks

On all tank trucks, the most important item to check for is leaks. Check under and around the vehicle for signs of any leaking. In general check the following:

- The tank's body for dents or leaks.
- The intake, discharge, and cut-off valves. Make sure the valves are in the closed position except when loading or unloading.
- The pipes, connections, and hose for leaks, especially around joints.
- The manhole covers and vents. Make sure the covers have gaskets and they close correctly. Keep the vents clear so they work correctly.

- The special purpose equipment. If you vehicle has any of the following equipment make sure it works:
  - Vapor recovery
  - Grounding and bonding cables
  - Emergency shut-off systems
  - Built-in fire extinguisher and/or system

4.2.0 High Center of Gravity

As shown in *Figure 9-7*, compared to other vehicles, tank trucks have a high center of gravity because they carry their loads half off the road. This makes them top-heavy and easy to roll over. Tests have shown that tank trucks can roll over even at cautionary speeds posted for curves; therefore, when driving a tank truck take curves well below posted speeds.

Figure 9-7 –Center of gravity.

4.3.0 Liquid Surge

Liquid surge results from movement of the liquid in partially filled tanks. For example, when the truck comes to a stop, the liquid will surge back and forth. When the wave hits the end of the tank, it tends to push the truck in the direction the wave is moving. The danger of liquid surge is particularly great on slippery surfaces such as ice. On ice, the wave of liquid can push a stopped truck into an intersection.

To prevent the back and forth movement of the liquid, some tanks have walls with holes called baffles. These baffles assist in controlling the abrupt flow of liquid. Another liquid movement control technique is to divide the tank into several smaller tanks with solid steel dividers called bulkheads.

Test your Knowledge (Select the Correct Response)

4. **(True or False)** Tank trucks have a low center of gravity.

   A. True
   B. False

Summary

This chapter introduced you to two types of tank trucks commonly used by the NCF: the MTVR fuel truck and water truck. Both vehicles are equipped with large, welded tanks designed to transport and dispense liquefied loads. Because fuel is a classified as a hazardous material, fuel truck operators must display maturity and adhere to all safety practices introduced in this chapter. Additionally, all tank truck operators must be cautious of leaks, rolling over, and liquid surge.

Review Questions (Select the Correct Response)

1. A fuel or water tank may be mounted to which of the following MTVR?

   A. MK31
   B. MK30
   C. MK28
   D. MK27

2. How many gallons of fuel can the MTVR fuel truck carry?

   A. 3,500
   B. 3,000
   C. 2,500
   D. 2,000

3. **(True or False)** On the MTVR fuel truck, a hydraulic motor drives the pump?

   A. True
   B. False

4. **(True or False)** The MTVR fuel truck can dispense pressurized, unmetered fuel.

   A. True
   B. False

5. Receiving fuel by use of an adapter located on the right side of the fuel tank is called _____.

   A. right side refueling
   B. bottom refueling
   C. right side loading
   D. bottom loading

6. **(True or False)** The vapor recovery pipe system can be used at any filling stand.

   A. True
   B. False

7. What is the function of the automatic shutoff system?

   A. Prevent fumes from escaping
   B. Prevent spillage
   C. Reduce pollution
   D. Reduce noxious

8. **(True or False)** On the MTVR fuel truck, fuel dispensing and self loading operations are controlled by the winch on/off switch.

   A. True
   B. False

9. How many emergency shut off handles does the MTVR fuel truck have?

   A. 6
   B. 5
   C. 4
   D. 3

10. **(True or False)** Poorly managed fuel operations can result in needless downtime of equipment and delays in production.

    A. True
    B. False

11. Which of the following Navy publication outlines the required markings on fuel trucks?

    A. NAVFAC P-307
    B. Navy Driver
    C. Operator's Handbook
    D. COMFIRSTNCDINST 11200.2

12. **(True or False)** Gasoline and diesel are classified as Combustible Liquids.

    A. True
    B. False

13. The flash point of gasoline is _____.

    A. 49°F
    B. 48°F
    C. -48°F
    D. -49°F

14. **(True or False)** It is a safe practice to NOT carry cigarettes or matches around such vehicles.

    A. True
    B. False

15. To prevent spills due to fuel expansion, never fill a fuel tank more than _____ percent of its capacity.

    A. 98
    B. 95
    C. 89
    D. 85

16. How is the water truck NOT used?

    A. soil stabilization
    B. soil compaction
    C. provide water to showering units
    D. provide drinking water to troops

17. **(True or False)** The MTVR water truck has a front spray bar.

    A. True
    B. False

18. Filling the water tank through a manhole opening located on top of the tank is called what?

    A. Gravity load
    B. Gravity fill
    C. Top load
    D. Top fill

19. **(True or False)** The MTVR water tank may be filled using an adapter located on the bottom right-side of the tank.

    A. True
    B. False

20. On the MTVR water truck, what cab control is used to adjust the hydraulic pressure applied to the hydraulic motor?

    A. Motor speed control
    B. Pump speed control
    C. Winch in/out switch
    D. Power takeoff (PTO) hydraulic control

21. **(True or False)** On the MTVR water truck, the front and rear nozzles are controlled individually.

    A. True
    B. False

22. **(True or False)** When inspecting for leaks, the joints around pipes, connections, and hoses should be checked.

    A. True
    B. False

23. **(True or False)** When driving a tank truck, take curves at posted speeds.

    A. True
    B. False

24. **(True or False)** Liquid surge results from movement of the liquid in completely filled tanks.

A. True
B. False

25. What prevents liquid surge by controlling the flow of the liquid?

A. Bulkhead
B. Steel dividers
C. Baffles
D. Anti-liquid surge walls

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.

Adams, A., (2006). *Trucking: Tractor-Trailer Driver Handbook/Workbook*, 3rd ed. New York: Thomson Delmar Learning.

California Commercial Driver Handbook, State Department of California, Department of Motor Vehicles, 2007.

Naval Construction Force (NCF) Equipment Management Instruction, COMFIRSTNCDINST 11200.2, Department of Navy, First Naval Construction Division, 2006.

Technical Manual: Tank Body, Fuel Servicing 2000 Gallon. MTVR Mountable, Isometric, Inc., 2008.

Technical Manual: Water Distributor Body Front and Rear Spray, MTVR Mountable, Isometric, Inc., 2008.

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Chapter 10

Truck-Tractors and Trailers

Topics

To hear audio, click on the box. 

Overview

During a deployment, tractor-trailer operations cover thousand of miles. The Naval Construction Force (NCF) uses tractor-trailers to haul equipment, construction supplies and materials. These vehicles support construction operations and disaster recovery operations.

This chapter describes the types of truck-tractors and trailers used by the NCF, including descriptions of major components and controls. In addition, this chapter explains how to safely perform tractor-trailer operations and how to load and secure cargo and equipment.

Objectives

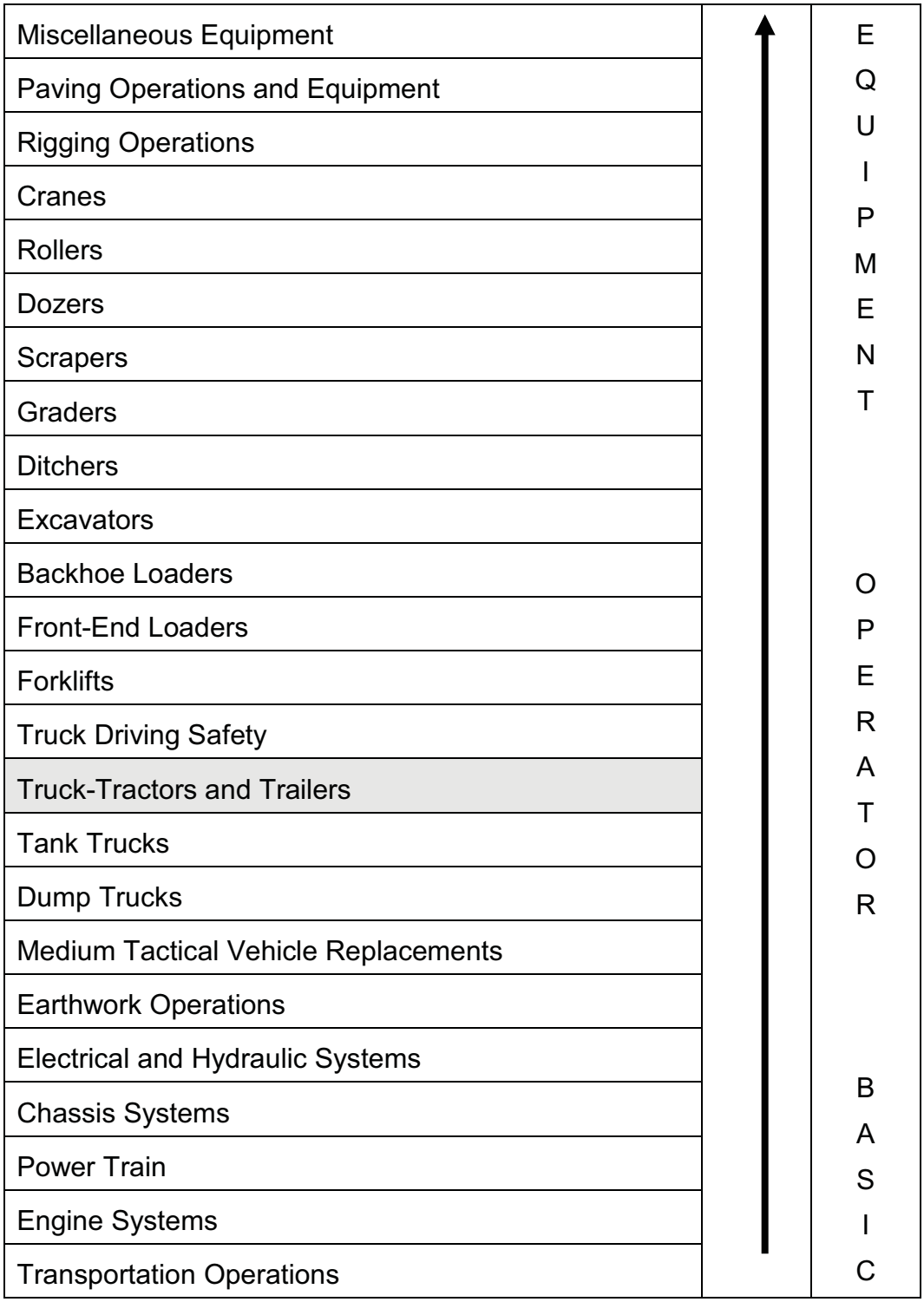
When you have completed this chapter, you will be able to do the following:

1. Understand the use of truck-tractors and trailers.
2. Identify the types of truck-tractors and trailers used by NCF.
3. Identify the major components of truck-tractor.
4. Identify the controls on truck-tractors.
5. Identify the major components of trailers.
6. Understand how to perform tractor-trailer operations.
7. Understand how to perform loading operations.
8. Understand how to perform securing operations.

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 TRUCK-TRACTORS

Truck-tractors (*Figure 10-1*), also simply called tractors, are used to pull semi-trailers. They are built to support only part of semi-trailer's weight. The truck-tractor and trailer are separate units, coupled together by a fifth wheel assembly.

Figure 10-1 – Truck-tractor.

Most truck-tractors have three axles, two of which are rear driving axles that provide extra traction in slippery or extreme conditions. Truck-tractors may have a gasoline- or diesel-powered engine, be equipped with an automatic or manual transmission, and have varying pulling capacity. In some cases, dual wheels are mounted at the end of the driving axles. *Figure 10-2* identifies the wheels on a truck-tractor.

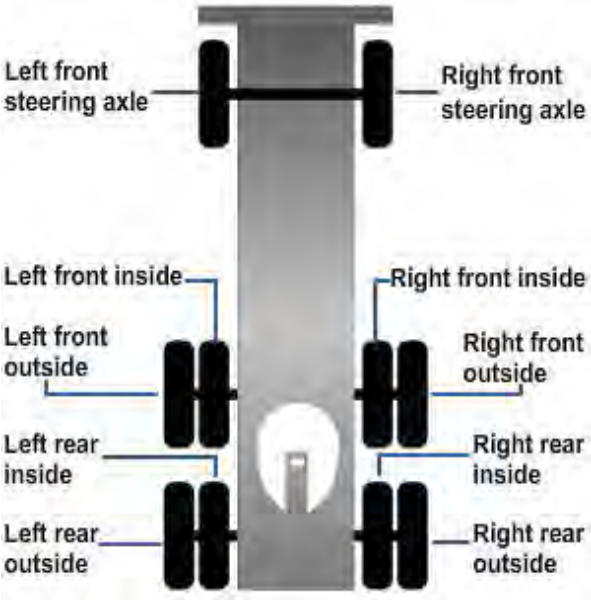


Figure 10-2 – Truck-tractor wheel identification.

1.1.0 Types of Truck-Tractors Used By Naval Construction Force

The NCF uses commercial and Medium Tactical Vehicle Replacement (MTVR) truck-tractors.

1.1.1 Commercial Truck-Tractor

The NCF uses a variety of commercial truck-tractors, like the one shown in *Figure 10-3*. One commonly used commercial truck-tractor is manufactured by Navistar International Transportation Corporation. It is a 6x6 vehicle with a diesel powered engine and a manual transmission.

Figure 10-3 – Commercial truck-tractor.

Because of the variety of commercial truck-tractors, you must study the operator's manual before operating a certain model of truck-tractor. The operator manuals are located in the Technical Library.

Operator's errors, such as grinding gears while shifting, clutch slipping, rapid engagement during shifting, improper downshifting, and so forth, often cause premature failure of drive-line components, resulting in needless downtime and delays in production.

1.1.2 Medium Tactical Vehicle Replacement MK31

The MTVR truck-tractor, MK31, is a 7-ton, 6x6 vehicle (*Figure 10-4*). It has an automatic transmission designed for use on all types of roads, highways, and cross-country terrains. On highways, it can pull semi-trailers weighing 94,000 pounds, on cross-country terrains, semi-trailers weighing 67,000 pounds.

Figure 10-4 – MK31.

There are differences between the MK31 and commercial truck-tractors. For example, unlike many commercial truck-tractors, the MK31 does not have dual wheels. It also has a hydraulic suspension that uses hydraulic cylinders on axles No. 2 and No.3 to level the MK31. The hydraulic system has two modes, automatic and manual. In both modes, the hydraulic system will adjust the level of the MK31 when it is not moving, when its engine is running, and when it is out of level. The automatic mode is recommended for level surfaces such as roads and highways. The manual mode is recommended for cross-country terrains. Before driving the MK31, be sure to select the automatic or manual mode to ensure that the vehicle is level prior to operation.

The hydraulic system is also used to lower and raise the rear suspension during limp home procedures; therefore, there is no need for a hydraulic jack when exchanging the flat tire with a tire from an immediate axle.

Test your Knowledge (Select the Correct Response)

1. **(True or False)** Truck-tractors are used pull semi-trailers.

   A. True
   B. False

2. **(True or False)** The MK31 has dual wheels.

   A. True
   B. False

2.0.0 MAJOR COMPONENTS of TRUCK-TRACTORS

Figure 10-5 shows the major components of the MK31. While components and controls on truck-tractors will vary with manufacturers and model, they are quite similar. Even so, before operation, read and understand the operator's manual for the specific type of truck-tractor.

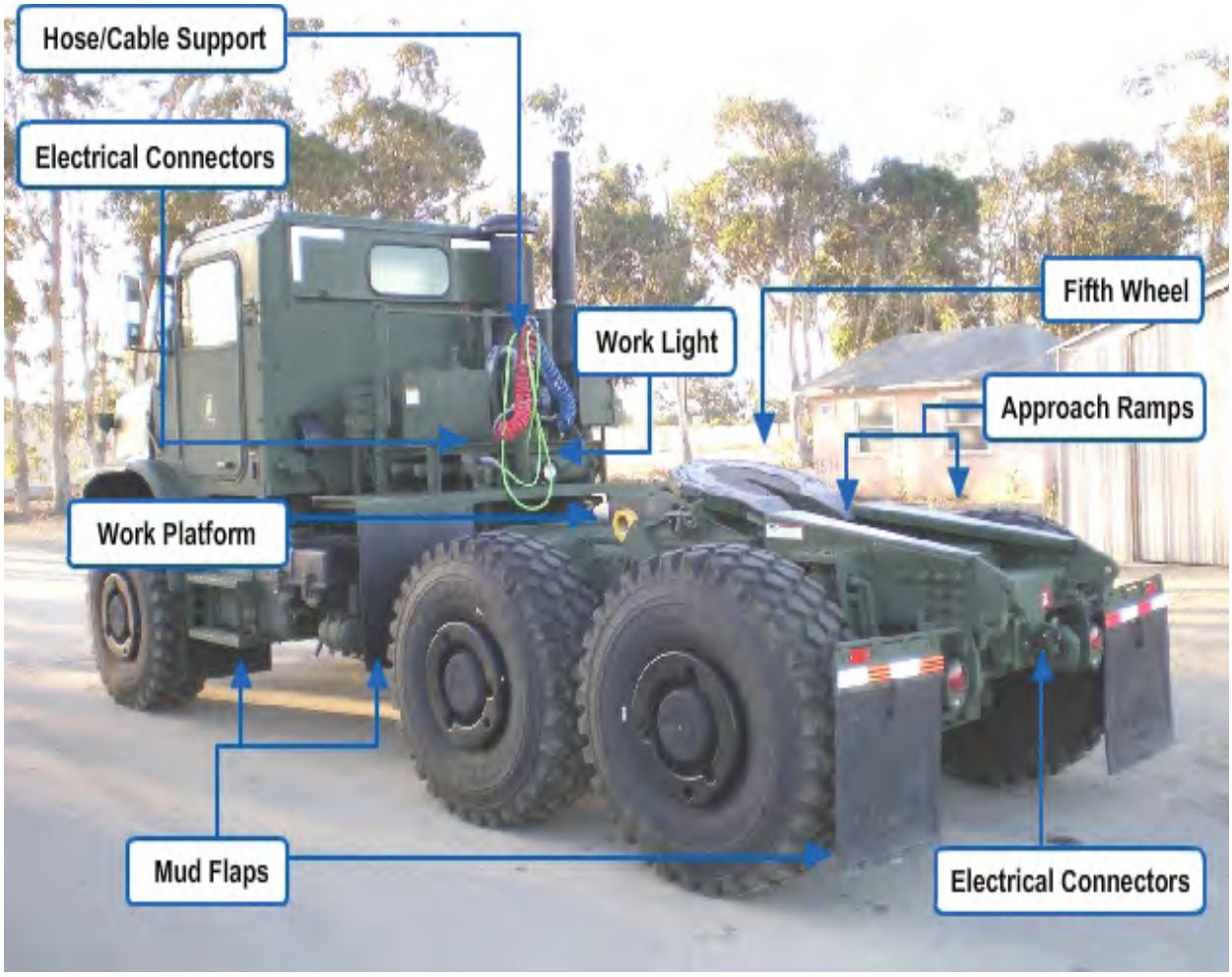


Figure 10-5 – MK31 major components.

2.1.0 Air Lines

The air lines allow the MK31 to supply air to the semi-trailer. The blue air line provides air to the service brakes, and the red air line provides air to the emergency brakes. On some equipment, metal tags are attached to the air lines with the words "service" and "emergency" stamped on them. At ends of the air lines are gladhands.

2.2.0 Gladhands

Gladhands, also known as hose couplers, are coupling devices used to connect the service and emergency air lines from the truck-tractor to the trailer. The gladhands have rubber seals known as grommets that prevent the air from escaping (*Figure 10-6*).

Cleaning the gladhands and rubber grommets before you connect the air lines is important. When connecting the gladhands, press the two seals together with the gladhands at a 90-degree angle to each other. A turn of the gladhands attached to the hose joins and locks the couplers.

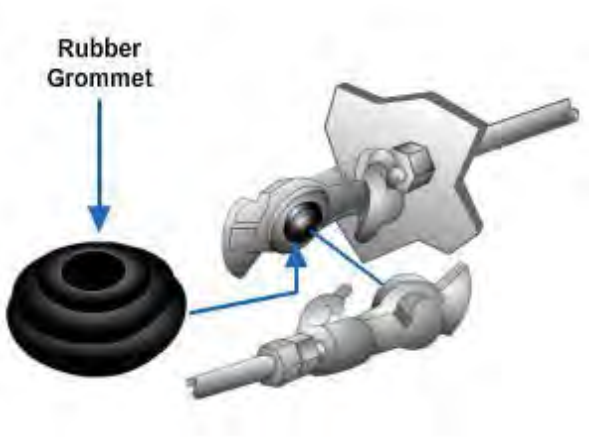


Figure 10-6 – Gladhands.

Always ensure that the proper gladhands and air lines are coupled. If the air lines are crossed, supply air is sent to the service line instead of to charge the trailer air tanks; therefore, air is not available to release the trailer spring brakes (parking brakes). If the spring brakes do not release when you push the trailer air supply control knob, check the air line connections.

⚠ CAUTION ⚠

Older trailers do not have spring brakes. If the air supply in the trailer air tanks has leaked out, emergency brakes will not exist, and the trailer wheels will turn freely. If you cross the air lines, the trailer will roll; however, there will be no trailer brakes.

2.3.0 Hose/Cable Support

The hose/cable support retains the air lines and dummy gladhands, also called dead ends. When the air lines are not connected to a semi-trailer, they are coupled to the dummy gladhands, which prevent water and dirt from entering the gladhands and air lines. This is very important because keeping the air system clean is critical.

2.4.0 Electrical Connectors

The MK31 has two sets of electrical connectors, 12-volt, 24-volt, and 24-volt anti-lock brake system (ABS). By means of intervehicle cables, these connectors supply power and ABS connection from the truck-tractor to the semi-trailer. One set of electrical connectors is located in back of the cab. The other set is located at the rear of truck-tractor.

2.5.0 Work Platform

The work platform, also known as the catwalk, holds accessory items and provides the operator access to electrical connectors and air lines.

2.6.0 Fifth Wheel

The fifth wheel, also referred to as lower fifth wheel, is mounted over the rear axle of the truck-tractor. It has locking jaws in its center where the semi-trailer's kingpin fits. The fifth wheel on the MK31 has a primary and a secondary lock release handle. Pulling the secondary lock release handle unlocks the locking jaws and allows them to be opened by pulling the primary handle. The fifth wheel assembly couples the truck-tractor and semi-trailer. It serves as a pivot points between the units and supports the weight of the front of the semi-trailer.

2.7.0 Approach Ramps

The approach ramps are used to raise the front end of the semi-trailer and guide the kingpin into the fifth wheel.

2.8.0 Mud Flaps

The rear detachable mud flaps and permanently mounted forward mud flaps prevent wheel splashing and stone throwing. They also reduce the amount of mud from the inner axles thrown into mirrors and the back of the cab.

2.9.0 Work Light

The work light, located outside and behind the operator's cab, provides light for coupling and uncoupling operations.

Test your Knowledge (Select the Correct Response)

3. **(True or False)** The blue air line provides air is to the services brakes.

    A. True
    B. False

4. What is the purpose of the dummy gladhands?

    A. Supply air to the service and emergency brakes
    B. Prevent water and dirt from entering the gladhands and air lines
    C. Provide power and ABS connection
    D. Provide the operator access to electrical connectors and air lines

3.0.0 CONTROLS on TRUCK-TRACTORS

Figure 10-7 shows the MK31's instrument panel. Its instrument panel is similar to that of other MTVRs with the exception of the controls and indicators associated with the hydraulic system and semi-trailer.

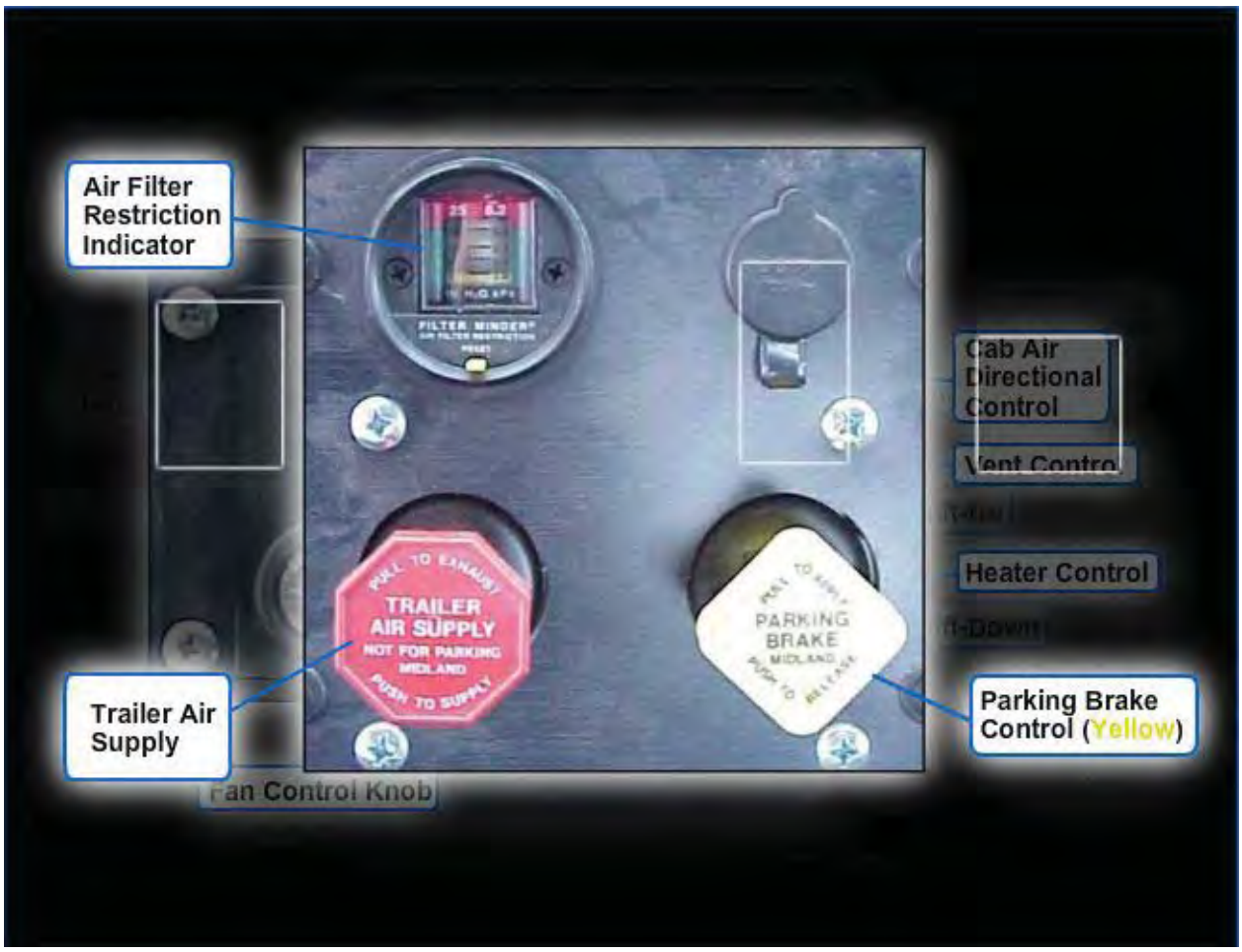


Figure 10-7 – MK31 instrument panel.

3.1.0 Driveline Lock Button

The driveline lock button locks the differentials.

3.2.0 Drive Unlock Button

The driveline lock button unlocks the differentials.

3.3.0 Suspension Not Level

The suspension not level warning light illuminates when the MK31 is not level.

3.4.0 Suspension Error

The suspension error warning light illuminates when an operator attempts input at speeds over 2 mph or when a suspension malfunction exists.

3.5.0 Work Light On

The work light on indicator illuminates when the work light is on.

3.6.0 Manual Suspension Light

The manual suspension light illuminates when the manual hydraulic suspension mode is selected.

3.7.0 Automatic Suspension Light

The automatic suspension light illuminates when the operator selects automatic hydraulic suspension mode.

3.8.0 Semi-Trailer Handbrake

The semi-trailer handbrake is used to apply and release the semi-trailer's service brakes. Do not use it during normal operation because of the danger of making the trailer skid; instead use the service brakes via the brake pedal to reduce speed or stop. Apply brake pressure gradually and smoothly, keeping in mind that stopping distance will increase when you are towing a semitrailer. The brake pedal sends air to all the brakes on the vehicle, including the trailer. There is much less danger of causing a skid or jackknife when you use only the brake pedal. The semi-trailer handbrake can be used for coupling and uncoupling the semi-trailer without spring brake.

3.9.0 Trailer Anti-Lock Brake System Indicator

Under normal conditions, the trailer ABS indicator light illuminates steadily for a 2-second bulb check whenever the ignition switch is turn on and an ABS equipped trailer is connected. After that bulb check, if no trailer ABS malfunctions are present, the light turns off. If the ABS is malfunctioning, the light will illuminate steadily.

3.10.0 Limp Home Indicator Light

The limp home indicator light illuminates when the limp home left/right function is engaged.

3.11.0 Limp Home Left/Right Switch

The limp home left/right switch is used for limp home mode. If the flat tire is on the driver's side, push this switch down. If it is on the passenger's side, push the switch up. In the center position the switch is disengaged.

3.12.0 Work Light On/Off

The work light is controlled by a 2-position switch. In the up position the work light is turned on. In the down position it is turned off.

3.13.0 Suspension Diagnostic Switch

The suspension diagnostic switch is used to put the suspension system in diagnostic mode. Push the diagnostic switch up to enable the suspension diagnostic mode.

3.14.0 Suspension Auto/Manual

The suspension auto/manual is a 2-position switch. This switch allows the operator to select manual or automatic suspension mode. Push the switch up for automatic or down for manual mode. The switch is momentary and will automatically return to center position.

3.15.0 Suspension Up/Down

The suspension up/down is a 3-positon switch. It allows suspension adjustment when the trailer is in manual suspension mode. Push the switch up to adjust suspension up. Push it down to adjust suspension down. The switch is momentary and will automatically return to center position.

3.16.0 Trailer Air Supply

The tractor protection valve keeps air in the tractor should the trailer break away or develop a bad air leak. The valve is controlled by the trailer air supply control knob in the tractor's cab. The control knob allows the opening and shutting of the tractor protection valve. The tractor protection valve closes automatically when the air pressure drops to a predetermined range. When the tractor protection valve is closed, it stops any air from escaping the tractor. It also shuts off the air from the trailer emergency line, causing the trailer emergency brakes to engage.

3.17.0 Parking Brake Control

On the MK31, a diamond shaped, yellow push-pull control knob is used to engage or disengage the parking brakes to both the truck-tractor and semi-trailer. Pulling the knob out engages the brakes; pushing the knob in releases (disengage) the brakes.

3.18.0 Brake Pedal

When using air brakes, push the brake pedal down and control the pressure so the vehicle comes to a smooth, safe stop.

3.19.0 Steering Wheel

When steering, hold the steering wheel firmly with both hands on opposite sides of the wheel. If you do not have a firm hold and hit a pothole or a curb, the steering wheel could pull away from your hands.

Test your Knowledge (Select the Correct Response)

5. **(True or False)** The semi-trailer handbrake is used during normal operation.

   A. True
   B. False

6. How does the trailer ABS indictor light indicate a malfunction?

   A. Illuminates steadily
   B. Turns off
   C. Flashes
   D. Illuminates steadily for 2-seconds

4.0.0 TRAILERS

Trailers are built to haul cargo and equipment. Some are designed with one or more axles and two or more wheels. There are two categories of trailers, full trailers and semi-trailers. Full trailers are designed with front axles, no part of the trailer's weight rests on the pulling vehicle (*Figure 10-8*). Semi-trailers, commonly used by the NCF, are designed without front axles, part of the trailer's weight rests on the fifth wheel of the truck-tractor (*Figure 10-9*).

Figure 10-8 – Full trailer.

Figure 10-9 – Semi-trailer.

4.1.0 Types of Trailers Used By Naval Construction Force

To support missions, the NCF uses a variety of trailers, such as van, stake, low-bed, and hydraulic detachable gooseneck trailers. Before using any trailer, know all safety precautions and check the manufacturer's recommendations for loading requirements and weight restrictions. This is important because the operator is responsible for the safe loading, securing, and operation of the tractor-trailer.

4.1.1 Van Trailer

A van trailer (*Figure 10-10*) is fully enclosed with a permanent top and sides to keep the inside of the trailer dry. At the rear is a large door which may swing open or roll up. Some van trailers have another door on the side. In the NCF, some van trailers have been modified to carry different types of cargo.

You may have to operate a refrigerated van trailer. The construction of a refrigerated trailer is similar to that of van trailer, except that the refrigerated trailer has a self-contained refrigeration unit built onto it.

Figure 10-10 – Van trailer.

4.1.2 Stake Trailer

The stake trailer (*Figure 10-11*) is often referred to as a flatbed or highboy. It is designed for cargo that cannot fit through the doors of a van trailer. This type of trailer has removable side stakes.

Figure 10-11 – Stake trailer.

NOTE

Side stakes are collateral equipage for the stake trailer. The operator is responsible for any removed, broken, or lost side stakes. When the side stakes are removed for storage, ensure they are tagged with the USN number of the trailer. Report damaged, lost, or stolen stakes, immediately through your chain of command.

4.1.3 Low-Bed Trailer

The low-bed trailer (*Figure 10-12*) is often referred to as a lowboy. It is used for hauling heavy equipment and material that is overheight and overweight for stake trailers. Low-bed trailers are heavily constructed to handle loads of 35 tons or more.

Figure 10-12 – Low-bed trailer.

4.1.4 Hydraulic Detachable Gooseneck Trailer

The hydraulic detachable gooseneck (HDG) trailer is often referred to as a drop neck (*Figure 10-13*). It is designed so that the gooseneck can be removed, leaving the front of the frame resting on the ground ready for loading. It allows the operator to hydraulically slide the kingpin to change axle weights, attach and detach the gooseneck without getting back into the operator's cab, and slide the fifth wheel hydraulically.

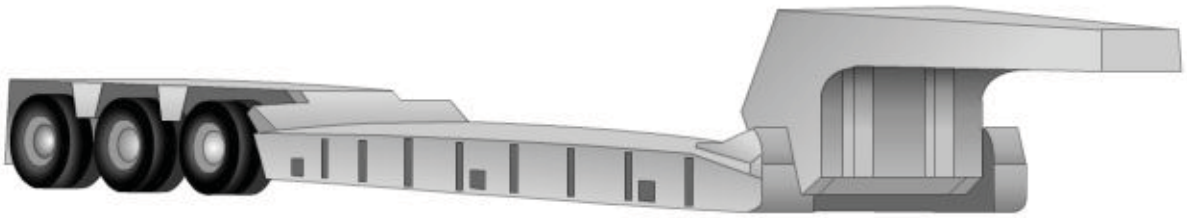


Figure 10-13 – Hydraulic detachable gooseneck trailer.

Test your Knowledge (Select the Correct Response)

7. Which of the following trailers is fully enclosed?

   A. Van
   B. Stake
   C. Low-bed
   D. Hydraulic detachable gooseneck

8. Which of the following trailers was designed for cargo that cannot fit through the doors of a van trailer?

   A. Low-boy
   B. Low-bed
   C. Hydraulic detachable gooseneck
   D. Stake

5.0.0 MAJOR COMPONENTS of TRAILERS

Most trailers have similar major components, including a kingpin, landing gears electrical connectors, gladhands, air lines, air storage tanks, and drain valves.

5.1.0 Kingpin

The kingpin, also referred to as upper fifth wheel fits into the locking jaw of the lower fifth wheel (*Figure 10-14*). The upper and lower fifth wheels form a flexible coupling that permits both rotational and vertical movement between the truck-tractor and semi-trailer. The kingpin consists of three parts: base, shank, and head.

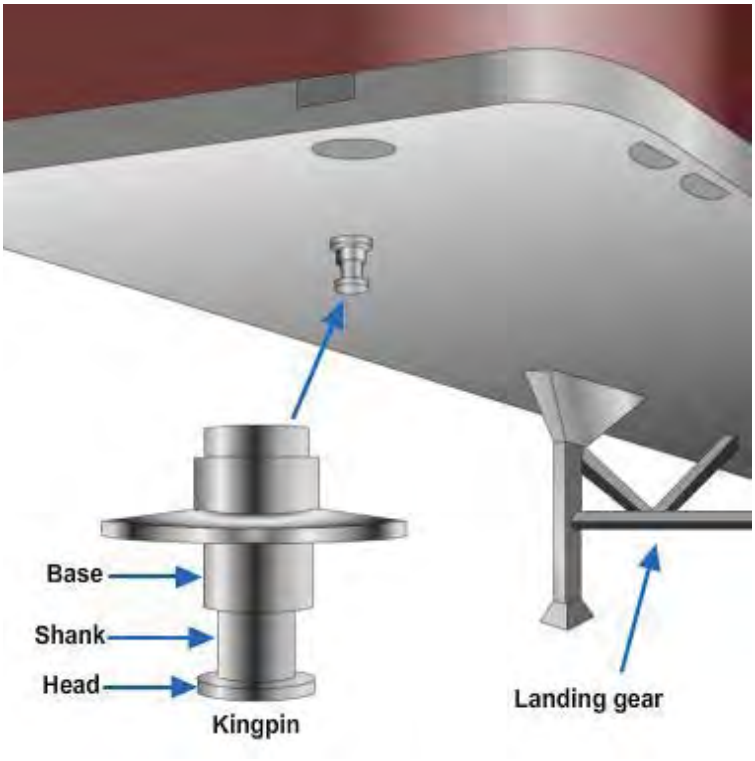


Figure 10-14 – Kingpin.

5.2.0 Landing Gear

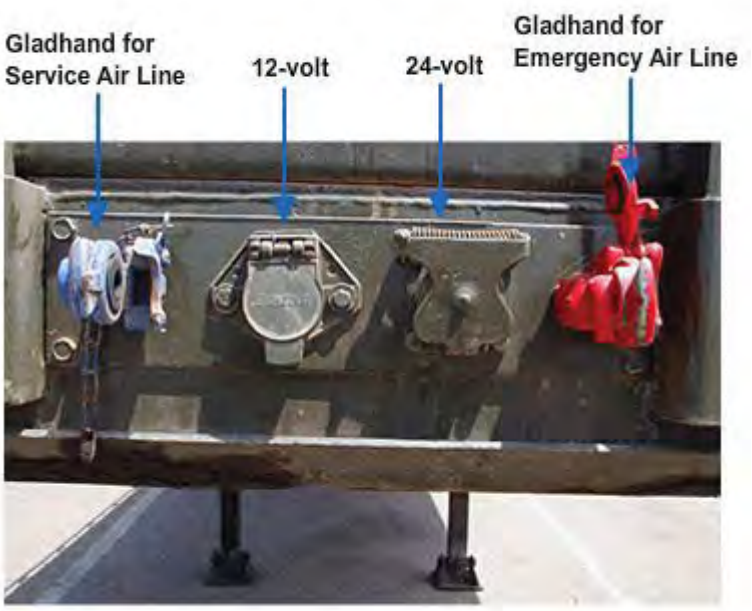
When the semi-trailer is not connected to the truck-tractor, the front end of the trailer is supported by a retractable two-legged landing gear, as shown in *Figure 10-15*. The landing gear may be equipped with either wheels or pads consisting of flat pieces of heavy metal.

Figure 10-15 – Landing gear.

5.3.0 Electrical Connectors

Truck-tractors supply power to semi-trailers by means of electrical connectors. The power is used for the clearance, side makers, and brake lights. These electrical connectors are located on the front of the trailer.

Most semi-trailers used by the NCF have two electrical connectors adaptable for either a 12- or 24-volt electrical system, as shown in *Figure 10-16*. If the trailer is equipped with an ABS, it can have a third electrical connector.



10-16 – Electrical system.

5.4.0 Gladhands

Like truck-tractors, semi-trailers have gladhands. To ensure that the proper air line is coupled to the correct gladhand, gladhands have blue and red coverings or are painted blue and red, as shown earlier in *Figure 10-16*.

5.5.0 Emergency Air Line

The emergency air line has two purposes. First, it supplies air to the semi-trailer air tanks. Second, the emergency line controls the emergency brakes on the truck-tractor. Loss of air pressure in the emergency line causes the trailer emergency brakes to activate. The pressure loss could be caused by a trailer breaking loose and tearing apart the emergency air hose or be the result of a hose, metal tubing, or other part breaking and causing an air leak. Loss of pressure in the emergency line also causes the truck-tractor protection valve to close, causing the trailer air supply knob to pop out.

5.6.0 Service Air Line

The service air line carries air that is controlled by the brake pedal or the semi-trailer handbrake. Depending on how hard the brake pedal is pressed, the pressure in the service line will similarly change. The service air line is connected to relay valve(s) on the trailer to apply more or less pressure to the trailer brakes. As pressure increases in the service air line, the relay valve opens and sends air pressure from the trailer air tanks to the trailer brake chambers, thus applying the trailer brakes.

5.7.0 Air Storage Tanks

Semi-trailers have air storage tanks (reservoirs) to hold compressed air, as shown in *Figure 10-17.* The number and size of air tanks varies among trailers. The tanks hold enough air to allow the brakes to be used several times.

Compressed air usually has some water and some compressor oil in it, which is bad for the air brake system. For example, the water can freeze in cold weather and cause brake failure. The water and oil tend to collect in the bottom of the air tanks; therefore each air tank is equipped with a drain valve. *Figure 10-18* shows manual drain valves. Such valves are operated by pulling a cable. Part of post-operational procedures is to drain all air tanks at the end of each day.

Figure 10-17 – Air storage tanks.

Figure 10-18 – Manual drain valves.

Test your Knowledge (Select the Correct Response)

9. The kingpin is also referred to as the _____.

    A. upper fifth wheel
    B. lower fifth wheel
    C. shank
    D. base

10. **(True or False)** The upper and lower fifth wheels form a ridged coupling that prevents both rotational and vertical movement between the truck-tractor and semi-trailer.

    A. True
    B. False

11. What is the function of the emergency air line?

    A. Send air to the relay valve only
    B. Supplies air to the trailers air tanks only
    C. Sends air to the relay valve and controls the emergency brakes on truck-tractors
    D. Supplies air to the semi-trailer air tanks and controls the emergency brakes on truck-tractors

12. What is the name of the line that carries air to the trailer and is controlled by the brake pedal or semi-trailer handbrake?

    A. Service air line
    B. Emergency air line
    C. Electrical line
    D. Drive line

6.0.0 TRACTOR-TRAILER OPERATIONS

The following section provides instructions for performing tractor-trailer operations with automatic, manual, and auxiliary transmissions. In addition, this section provides instructions for performing operations such as coupling and uncoupling, turning, and backing.

6.1.0 Automatic Transmission

Some tractors in the NCF are equipped with automatic transmissions. A low range can be selected to have a greater engine braking power when going down grades. The lower ranges prevent the transmission from shifting up beyond the selected gears. Shifting an automatic transmission incorrectly can cause serious damage to the transmission; therefore, operators must study the operator’s manual for techniques of shifting automatic transmission.

6.2.0 Manual Transmission

When driving a tractor-trailer, you must not roll backward when you start, because you may hit a vehicle behind you. Partly engage the clutch before taking your right foot off the brake. If on an incline, engage the parking brake to hold the tractor, and then release the parking brake only when you have applied enough engine rpm to keep from rolling backward. Another technique is to engage the engine hand throttle to increase the engine rpm while your right foot is on the brake and your left foot is partly engaging the clutch. As the clutch engages, release the foot brake and disengage the engine hand throttle.

Accelerate smoothly and gradually so the tractor does not jerk. Rough acceleration causes unnecessary premature mechanical damage to the drive train and the coupling. When traction is poor as in rain or snow, speed up gradually. Using too much power may cause the drive wheels to spin. If the drive wheels lose traction, do not apply the brakes; just take your foot off the accelerator pedal.

6.2.1 Shifting Gears

Correct shifting of gears is important. Not only must you have full control of your tractor-trailer, but “grinding to find them” (a term used when a driver forces the gears to engage), clutch slipping, rapid engagement during shifting, improper downshifting, and so forth, causes premature failure of drive-line components.

Most tractor-trailers with manual transmissions require double clutching to change gears. The procedures for double clutching were covered in the Power Train chapter. Remember, shifting gears using double clutching requires practice. If you remain too long in neutral, you may have difficulty putting the transmission into the next gear. If this happens, do not try to force it. Instead, return to neutral, release the clutch, increase engine speed to match the road speed, and try to shift into the correct gear.

You can use two factors to tell when to shift the transmission. One is the engine rpm. The operator’s manual tells you the operating rpm range for the tractor. Using the tachometer, shift up when the engine reaches the top of the range. The second factor is the road speed (mph). Through experience you will learn what speeds each gear is good for. Then by using the speedometer or engine sound, you will know when to shift.

6.3.0 Multi-Speed Rear Axles and Auxiliary Transmission

Multi-speed rear axles and auxiliary transmissions are used on many tractors to provide extra gears. These gears are shifted by a selector knob or switch on the gearshift lever of the main transmission. Many different transmission shifting patterns are used; therefore, it is important to study the operator’s manual before operating a tractor with an unfamiliar transmission shifting pattern.

6.4.0 Coupling and Uncoupling

Coupling and uncoupling correctly is basic to the safe operation of a tractor-trailer. Incorrect coupling and uncoupling can be dangerous and cause unnecessary equipment damage and downtime. Before coupling and uncoupling operations, refer to both the tractor’s and trailer’s operator’s manuals.

6.4.1 Coupling Procedures

The basic steps for coupling a tractor-trailer are as follows:

Step 1. Inspect Fifth Wheel

- Check for damaged and missing parts.
- Ensure the mounting to the tractor is secure and there are no cracks in the frame.
- Ensure the fifth wheel plate is greased. Failure to keep the fifth wheel plate lubricated could cause steering problems because of friction between the tractor and the trailer.
- Ensure the fifth wheel is in proper position for coupling by completing the following checks:
  - Ensure the fifth wheel is tilted down towards the rear of the tractor.
  - Ensure the locking jaws are open.
  - If equipped with a sliding fifth wheel assembly, ensure it is locked in position.
  - Ensure the trailer kingpin is not bent or broken.

Step 2. Inspect Area

- Ensure the area around the truck-tractor and trailer is clear of obstacles.
- Ensure that the cargo will not move when the trailer is coupled to the tractor.
- If the trailer is equipped with spring brakes, ensure that these brakes are applied before coupling begins.

Step 3. Position Tractor

- Position the tractor directly in front of the trailer.

CAUTION

Backing under the trailer at an angle could push the trailer sideways and damage the landing gear *Figure 10-19.*

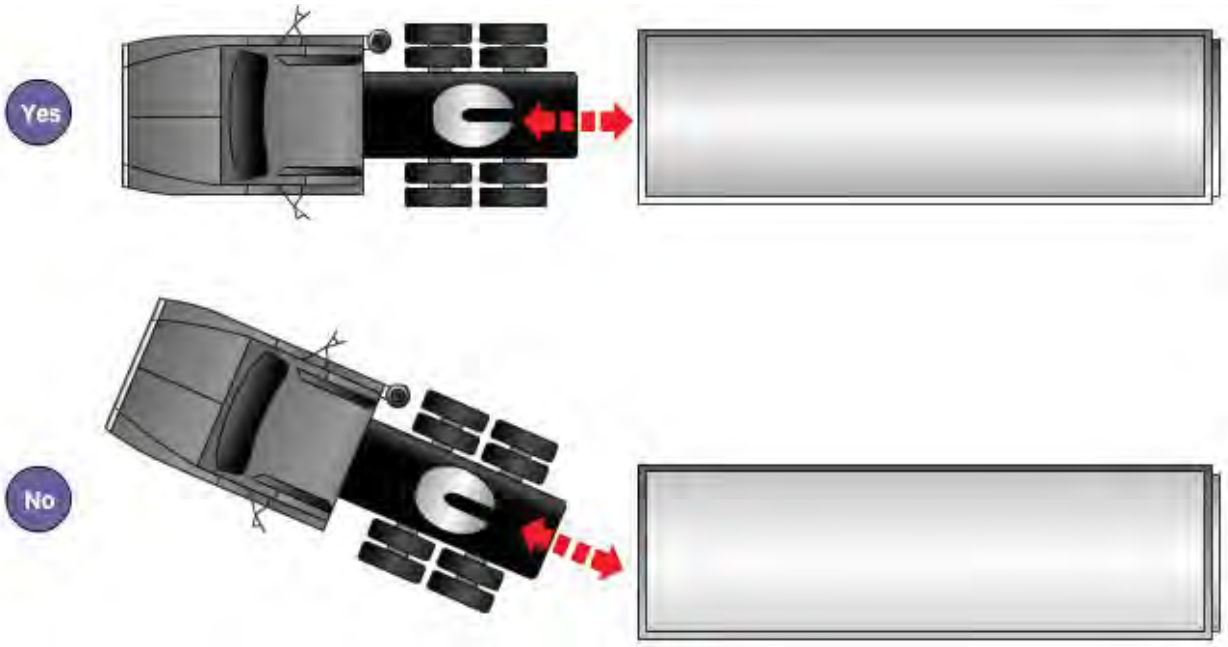


Figure 10-19 – Tractor position.

- Check the position of the tractor by using both outside mirrors and by looking down both sides of the trailer.

Step 4. Back Slowly

- Back slowly until the fifth wheel just touches the trailer.

Step 5. Secure Tractor

- Apply the parking brake.
- Place the manual transmission in neutral; if the transmission is automatic, place it in park.

Step 6. Check the Height of Trailer

- Ensure that the kingpin and fifth wheel are aligned.
- The trailer should be low enough to allow it to be raised slightly by the tractor when the tractor is backed under it. Raise or lower the trailer as needed.

⚠ CAUTION ⚠

If the trailer is too low, the tractor may strike it and cause unnecessary damage to both the rear of the tractor and the nose of the trailer. If the trailer is too high, it may not couple correctly. *Figure 10-20* shows the correct height for coupling a trailer.

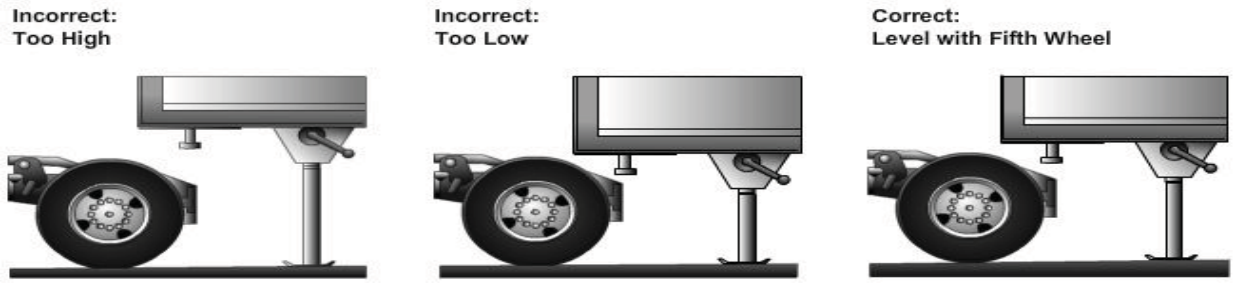


Figure 10-20 – Correct trailer height.

Step 7. Connect the Air and Electrical Lines

- Inspect rubber grommets in the gladhands for wear and tear.
- Connect the tractor emergency air line to the trailer emergency gladhands.
- Connect the tractor service air line to the trailer service gladhands.
- Ensure air lines are safely supported so they cannot be crushed or caught while the tractor is backing under the trailer.
- Plug the electrical cord into the trailer and fasten the safety catch.
- Ensure air and electrical lines do not contact any moving parts of the vehicle.

Step 8. Supply Air to the Trailer

- From the cab, push in the “air supply” known to supply air to the trailer brake.
- Listen for escaping air. If you hear a leak, or if the air pressure gauge registers excessive air loss, report it immediately to maintenance.

Step 9. Release the Tractor’s Parking Brake and Pull Out on the Trailer Brake

- Put the truck into gear.
- Release the truck-tractor’s parking brake.
- Apply the trailer brake.

Step 10. Back Under the Trailer

- Use the lowest reverse gear.
- Back the tractor under the trailer until the kingpin is locked into the fifth wheel.
- Pull the tractor gently forward while the trailer brakes are still engaged ensuring the trailer kingpin is locked into the locking jaws of the fifth wheel.

Step 11. Inspect Coupling

- Place the transmission in neutral, if manual; in park, if automatic.
- Engage parking brakes.
- Disengage the trailer hand valve.

NOTE

Depending on your location, you may want shut off the engine and take the key with you to prevent someone from moving the truck while you are under it.

- Inspect the area around the fifth wheel. Make sure there is no gap between the upper and lower fifth wheel. If there is a gap, something is wrong. The kingpin may be on top of the closed locking jaws; if so, the trailer can come loose easily.
- Go under the trailer and look into the back of the fifth wheel. Ensure the fifth wheel locking jaws have closed around the shank of the kingpin.
- Check that the locking lever pin is in the “lock” position.
- Ensure the safety catch is in position over the locking lever pin (if so equipped).

Step 12. Raise Landing Gear

- Use the low gear (if so equipped) to begin raising the landing gear. Once free of weight, switch to the high gear range.
- Raise the landing gear all the way up. Driving with the landing gear part way up is not a good practice because it may catch on railroad tracks or other obstacles.
- Secure the crank handle safely after the landing gear is raised.
- Check the rear of the tractor frame and the landing gear for enough clearance to make turns.
- Ensure there is enough clearance between the top of the tractor tires and the nose of the trailer.

Figure 10-21 is an illustration of a coupled truck and trailer..

Figure 10-21 – Coupling.

6.4.2 Uncoupling Procedures

The basic steps for uncoupling a tractor-trailer are as follows:

Step 1. Position the Vehicle

- Ensure the parking area surface can support the weight of the trailer.
- Ensure the tractor is lined up with the trailer, if at all possible, because pulling out at an angle can bend and damage the landing gear.

Step 2. Ease Pressure on Locking Jaws

- Shut off trailer air supply or engage the trailer hand valve to lock the trailer brakes.
- Ease pressure on the locking jaws by backing up gently. (This procedure helps you release the fifth wheel locking lever.)
- Apply the parking brakes while the tractor is backing; this holds the tractor in place with the pressure of the kingpin off the locking jaws.

Step 3. Lower the Landing Gear

- If the trailer is empty, lower the landing gear until it makes firm contact with the ground.
- If the trailer is loaded, after the landing gear makes firm contact with the ground, turn the crank in low gear a few extra turns; this lifts some weight off the tractor suspension.

NOTE

Do not lower the landing gear so low that it lifts the trailer off the fifth wheel because doing this makes the trailer harder to couple and uncouple.

Step 4. Disconnect and Store the Air Lines and Electrical Cable

- Disconnect the air lines and electrical cable.
- Place the air lines gladhands on the dummy couplers behind the cab.
- Hang the electrical cable with the plug down to prevent moisture from entering it.

Step 5. Release the Fifth Wheel Latch

- Raise the release handle lock pin and pull to the open position.

WARNING

Keep legs and feet clear of the rear of the tractor wheels to avoid injury should the tractor move.

Step 6. Lower the Air Suspension

- If the tractor has air suspension, lower the air bags to prevent the end of the vehicle from popping up when later pulling clear.

Step 7. Pull Tractor Partially Clear of Trailer

- Pull tractor forward until the fifth wheel comes out from under the trailer.
- Stop with the tractor frame underneath the trailer. This prevents the trailer from falling to the ground if the landing gear should collapse or sink.

Step 8. Secure Tractor

- Put on the tractor parking brakes.

Step 9. Inspect the Trailer Supports

- Ensure the ground is supporting the trailer.
- Ensure the landing gear is not damaged.

Step 10. Pull the Tractor Clear of Trailer

- Release the parking brakes.
- Check the surrounding area and drive the tractor clear of the trailer.

Step 11. Re-Inflate the Air Suspension System

- Re-inflate the air bags after pulling the tractor away from the trailer.

Figure 10-22 is an illustration of an uncoupled truck from trailer.

Figure 10-22 – Uncoupling.

6.5.0 Turning

When making turns with the tractor-trailer, you must allow for the overall length of the unit. Remember: the tractor-trailer is hinged in the middle, and the trailer has a tendency to off-track. Off-tracking, as shown in *Figure 10-23*, occurs during turning when the tractor-trailer and the rear wheels of the trailer do not follow the same path as the front wheels of the tractor. The rear wheels cut corners by following a shorter path. Two factors determine the extent of off-tracking. One factor is the distance between the kingpin and the rear trailer wheels; the greater distance, the more off-tracking. The other factor is the amount of sideway drag of the rear tires. The number of tires increases the sideway dragging of the rear tires; the more sideway dragging, the more off-tracking.

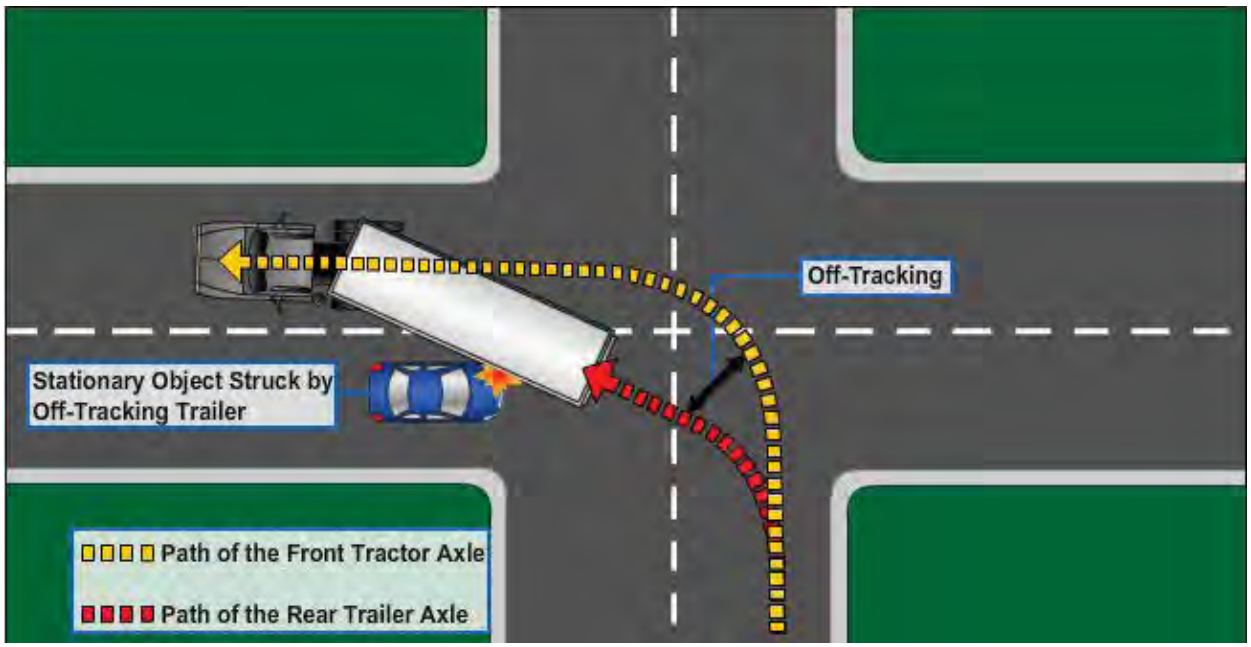


Figure 10-23 – Off-tracking.

CAUTION

Engage turn signals on well in advance of starting a turn is extremely important. This action warns other drivers that a turn is coming and allows them to drive safely.

6.5.1 Right Turns

When performing a right-hand turn, turn slowly to give yourself and others time to avoid problems. If you cannot make the right turn without swinging into another lane, turn wide as you complete the turn, as shown in *Figure 10-24*. This type of right turn is referred to as a buttonhook. Keep the rear of the tractor-trailer close to the curb to stop any drivers from passing on the right. If you must cross into the oncoming traffic lane when making your turn, watch for vehicles coming towards you. Give them room to go by or stop; however, do not back up for them, because you may have a vehicle directly behind you.

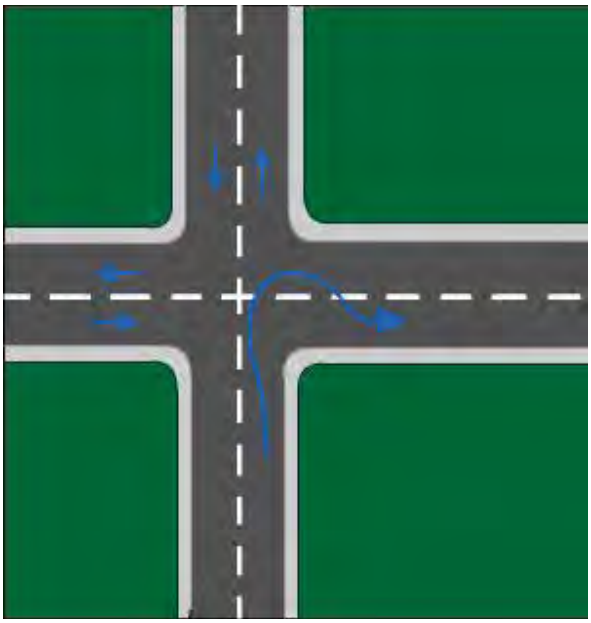


Figure 10-24 – Right turn.

6.5.2 Left Turn

When performing a left-hand turn, reach the center of the intersection before starting the turn. If you turn too soon, the left side of your vehicle may hit another vehicle because of off-tracking.

If there are two turning lanes, always take the right-hand turn lane, as shown in *Figure 10-25*. Do not start in the inside lane because you may have to swing right to make the left turn. You may not see vehicles on the right and cause a collision.

Figure 10-25 – Left turn from right-hand lane.

6.6.0 Taking Highway Curves

Before taking a left or right highway curve, position the tractor-trailer carefully in the following manner.

6.6.1 Left Curve

On a left highway curve, as shown in *Figure 10-26 A*, position the tractor close to the right edge of the lane. Doing so prevents the trailer from running over the center line.

6.6.2 Right Curve

On a right highway curve, as shown in *Figure 10-26 B*, position the front of the tractor-trailer towards the center of the lane. Doing so prevents the rear of the trailer from running off the highway.

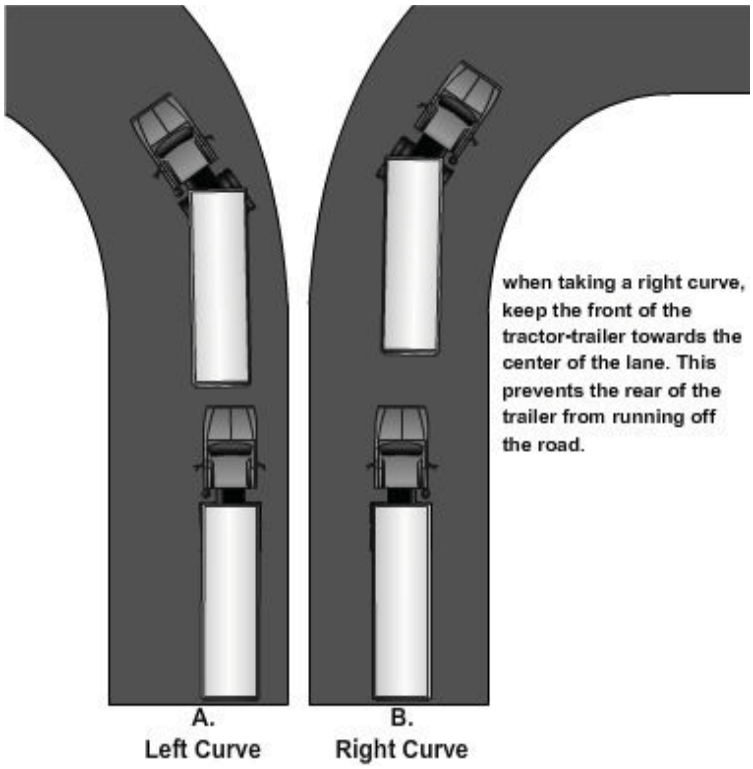


Figure 10-26 – Left and right highway curves.

6.7.0 Backing

When backing, the rear tires on the semi-trailer will always move in a direction opposite from that of the front wheels on the tractor, as shown in *Figure 10-27*. When the tractor's front wheels are turned right, the rear of semi-trailer will go left. When the tractor's front wheels are turned left, the rear of the semi-trailer will go right.

After the trailer is headed in the desired direction, turn the steering wheel slowly to the left. This puts the tractor in the same line of travel as the trailer and prevents the tractor and trailer from jackknifing.

Figure 10-27 – Tractor-trailer backing.

Backing the tractor-trailer to the left is known as sight-side backing because the operator has a better view of the area into which he or she is backing, as shown in *Figure 10-28*. This is the recommended method for backing.

Backing the tractor-trailer to the right is known as blind-side backing because the operator cannot see the rear of the trailer or the area into which he or she is backing, as shown in *Figure 10-28.*

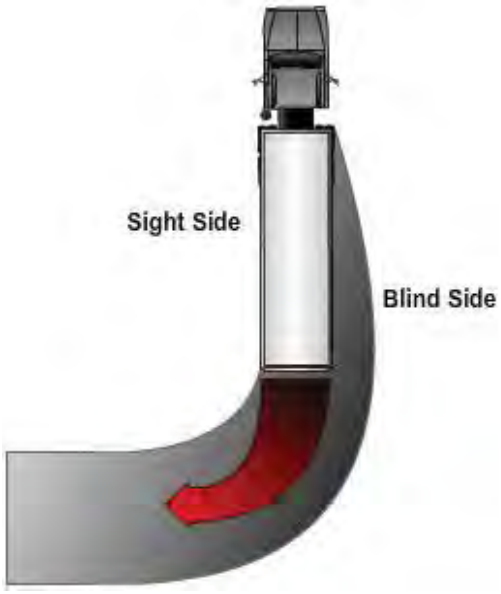


Figure 10-28 – Sight-side and blind-side.

Observe the following precautions when backing a semi-trailer.

- Adjust side mirrors for best visibility.
- Use a ground guide when backing a tractor-semitrailer. The ground guide must be visible at all times to provide backing instructions.
- Back up slowly and pay close attention to the location and signals of the ground guide.

There are four basic backing maneuvers that you should be able to perform safely and effectively: straight-line backing, alley-dock backing, straight-line parking, and parallel parking.

6.7.1 Straight-Line Backing

Straight line backing is the easiest backing maneuver to perform. The key to straight-line backing is recognizing in what direction, left or right, the trailer is drifting towards and making needed adjustment. When you realize that the trailer is drifting, turn the top of the steering wheel slightly towards the drift but remember not to oversteer or overcorrect. After the trailer has responded to the adjustment, turn the steering wheel in the opposition direction to remove the initial adjustment.

6.7.2 Alley-Dock Backing

Alley-dock backing is a maneuver used for backing up to a freight dock or backing up between two parked vehicles.

The steps for alley-dock backing are as follows:

Step 1. Pull the tractor-trailer forward in a straight line. When the front of the trailer is in line with the left side of the parking space, turn to the right.

Step 2. Slowly continue to move forward. When the tractor is at the straight away from the parking space, turn to the left.

Step 3. Keep moving forward until the trailer is near a 45-degree angle. When the tractor is at the slight angle to the left of the trailer and you can see the parking space from the driver's window, straighten the front tires and stop.

Step 4. Set the parking brakes and exist the cab. The tractor-trailer should be a foot in front of the left side of the parking space. Ensure that the front tires are straight. Return to the cab and start backing. Straighten out the tractor-trailers as you enter the space and watch the direction of the trailer. Correct drift as needed.

Figure 10-29 demonstrates alley-dock backing.

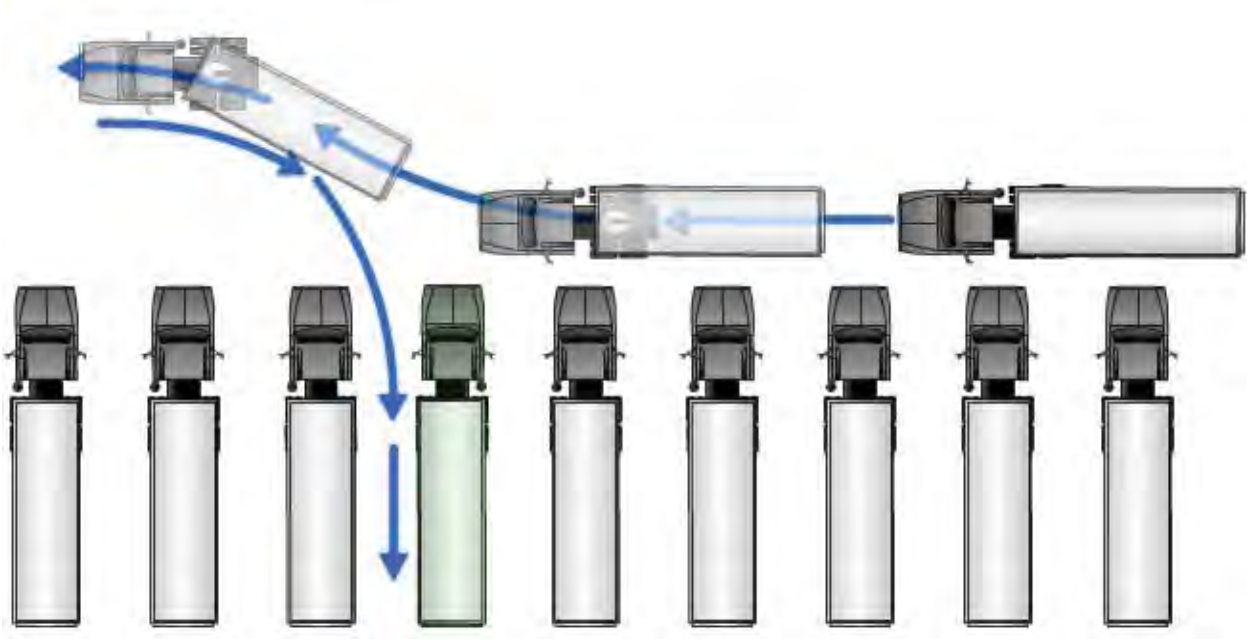


Figure 10-29 – Alley-dock backing.

6.7.3 Straight-Line Parking

The steps for straight line parking are as follows:

Step 1. Pull the tractor-trailer forward in a straight line near the parking space. You should be about 5 feet out from the parked vehicles.

Step 2. Stop when your line of sight is in the middle of the parking space. Look out your right window for a reference point that is within a line of sight and even with the middle of the parking space.

Step 3. Continue moving forward. When the front of the trailer is in line with the left side of the parking space, turn to the right. Keep turning to the right until the tractor is headed toward the 2 o'clock position.

Step 4. Straighten the front tires and pull forward until the tractor-trailer is in front of the parking space. Set the parking brakes and exit the cab. Ensure that the trailer is directly behind the tractor. The tractor-trailer should be directly in front of the parking space. Return to the cab and start backing.

Figure 10-30 demonstrates straight-line parking.

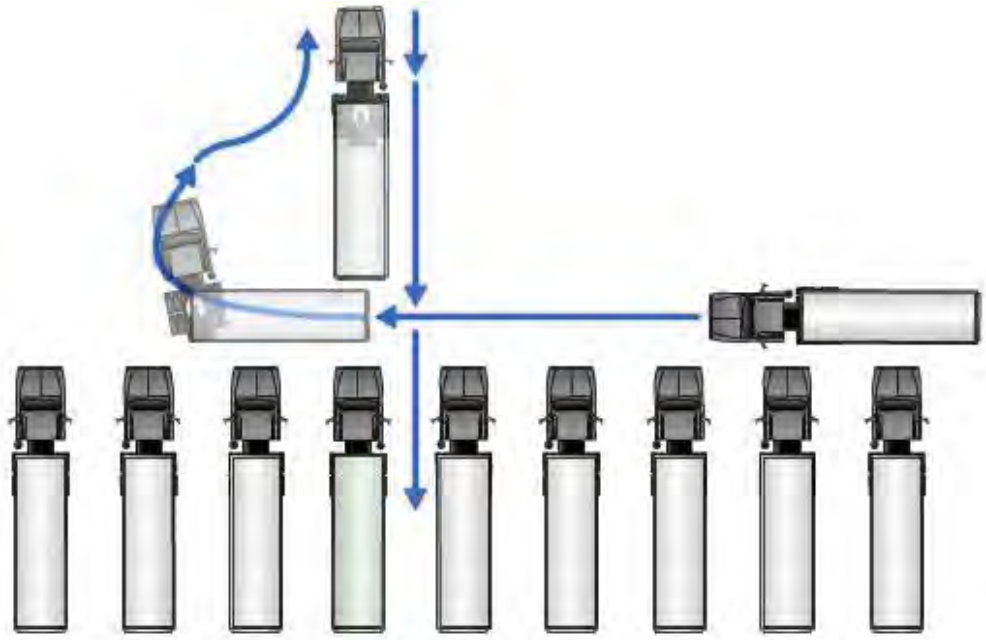


Figure 10-30 – Straight-line parking.

6.7.4 Parallel Parking

Parallel parking is a maneuver used when an operator has to bring the tractor-trailer alongside a curb, between two vehicles. The steps for parallel parking are as follows:

Step 1. Ensure that the tractor-trailer can fit into the parking space.

Step 2. Begin with the tractor-trailer 2 to 3 feet from the other parked vehicles. Pull forward in a straight line near the parking space. Stop when the rear axle of the trailer is about 8 feet in front of the parking space.

Step 3. Set the brake and get out of the cab. Ensure that the tractor-trailer is in a straight line and is 2 to 3 feet away from parked vehicles. In addition, ensure that the rear axle of the tractor-trailer is 8 feet in front of the parking space.

Step 4. Get back into the cab and begin backing with the steering wheel turned to the left. The angle of the left side of the tractor is about 12 to 15 degrees away from the front of the trailer.

Step 5. Turn hard to the right and continue backing until the tractor-trailer is in a straight line. Continue backing until the front of the trailer is even with the front of the parking space.

Step 6. Turn right and continue backing up until the trailer is parallel inside the parking space. The tractor should be at an 85- to 90-degree angle to the left. Leave the tractor in this position for an easy exit.

Figure 10-31 demonstrates parallel parking.

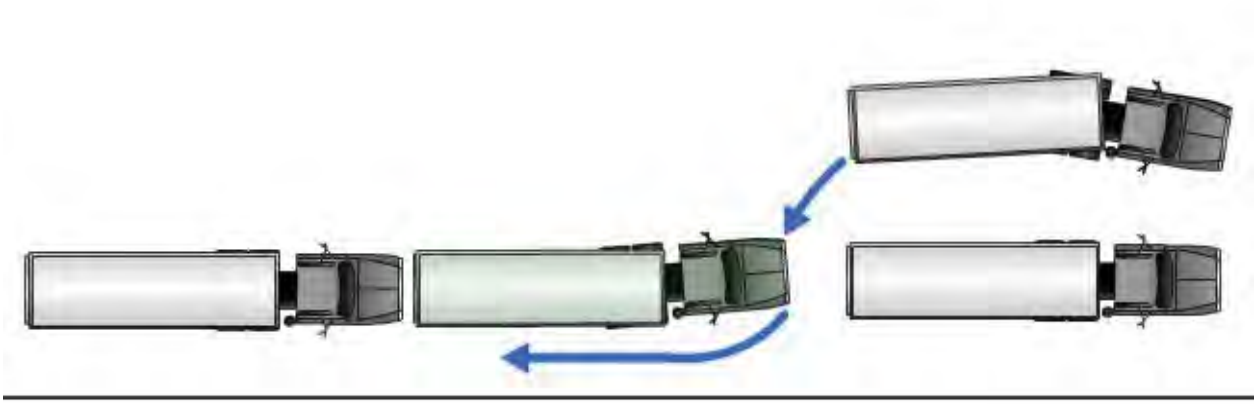


Figure 10-31 – Parallel parking.

Test your Knowledge (Select the Correct Response)

13. On tractor-trailers equipped with an automatic transmission, what transmission range provides greater braking power when going down grades?

    A. High
    B. Medium
    C. Low
    D. Neutral

14. What is the first step of coupling?

    A. Inspect the fifth wheel
    B. Inspect the area
    C. Position the tractor
    D. Connect air lines

15. What is it called when the rear wheels of the trailers do not follow the same path as the front wheels of the tractor?

    A. Off-turning
    B. Off-tracking
    C. Sideway drag
    D. Side-tracking

7.0.0 SAFETY

This section describes emergency stops and how to prevent skids, pull over to the side of road in case of an emergency and maintain a safe following distance.

7.1.0 Emergency Stops

Controlled and stab braking are two methods of performing an emergency stop in a truck-tractor without ABS.

7.1.1 Controlled Braking

Controlled braking is also called “squeeze” braking. Controlled braking is applying the brakes as hard as possible without locking the wheels. Do not turn the steering wheel while doing this. If steering is required or the wheels begin to slide, release the brakes. Brake again as soon as the tires gain traction.

7.1.2 Stab Braking

The stab braking method requires applying the brakes as hard as possible and releasing them when the wheels lock up. As soon as the wheels start to roll, apply the brakes fully again. It can take up to 1 second for the wheels to start rolling after releasing the brakes. Stay off the brakes long enough to get the wheels rolling again; otherwise, the vehicle may not stay in a straight line.

7.2.0 Downhill Braking

The correct method for going down long grades is to use a low gear and travel at a slow speed that allows a fairly light, steady use of the brakes to prevent the vehicle from speeding up. When you go slow and apply light pressure, the brakes cool down and work properly.

CAUTION

When you are going down a hill, overuse of the brakes can overheat them, causing them to wear down. This can cause you to press down harder on the pedal to gain the required braking power. Prolonged action like this can cause the brakes to fade until they stop working.

NOTE

Some tractors are equipped with a retarder that helps slow the vehicle, reducing the need for braking. One common retarder is known as the “jake brake.” Retarders reduce brake wear and provide another means to slow down. Retarders are controlled by the operator and are either exhaust, engine, hydraulic, or electric.

7.3.0 Preventing Skids

In order to prevent skids, an operator must know how skids are caused. There are four types of skids. They include trailer jackknife, tractor jackknife, front-wheel skid, and all-wheel skid.

7.3.1 Trailer Jackknife

A trailer jackknife is caused by excessive braking or sharp cornering (*Figure 10-32*). As a result, the trailer's wheels lock up and begin to slide. This is more likely to happen when the trailer is empty or lightly loaded.

To prevent this type of skid avoid the following:

- Excessive braking
- Excessive cornering

Figure 10-32 – Trailer jackknife.

7.3.2 Tractor Jackknife

A tractor jackknife, also known as a drive-wheel skid, is caused by wheel lockup, overacceleration, and trailer override (*Figure 10-33*). As a result, the tractor's rear wheels lose traction. This causes the rear of the tractor to swing out and the tractor to pull the trailer outwards. Then the trailer pushes the tractor outward.

To prevent this type of skid avoid the following:

- Overbraking
- Overaccelerating
- Sudden turns
- Improper loading

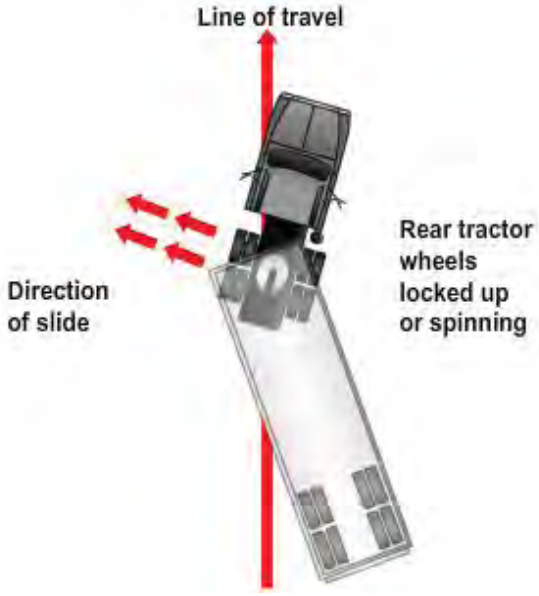


Figure 10-33 – Tractor jackknife.

7.3.3 Front-Wheel Skid

A front-wheel skid is caused by many factors, such as excessive speed, too big a load on the fifth wheel, a dry fifth wheel, and hydroplaning (*Figure 10-34*). As a result, the tractor's front wheels lose traction. This causes the tractor-trailer to move sideways; without front wheel traction, the operator cannot steer.

To prevent this type of skid:

- Use good braking techniques
- Reduce speed on slippery surfaces
- Load cargo correctly
- Ensure there is an adequate amount of grease on the fifth wheel

Figure 10-34 – Front-wheel skid.

7.3.4 All-Wheel Skid

An all-wheel skid is caused by excessive speed and overbraking on slippery surfaces (*Figure 10-35*). As a result, all the wheels on the tractor-trailer lose traction. This causes the vehicle to slide and continue in a straight line; without traction the operator loses control.

To prevent this type skid:

- Allow plenty of stopping distance
- Reduce speed on slippery surfaces
- Avoid overbraking

Figure 10-35 – All-wheel skid.

7.4.0 Pulling Off Road

When pulled off the road in a tractor-trailer, turn on the four-way emergency flashers. Do not trust taillights to provide a warning because drivers have crashed into the rear of parked vehicles they thought were moving. If you must stop on a road or on a shoulder, place reflective triangles within as soon as possible. Place the reflective triangles at the following locations:

- On a two-lane or undivided highway, place reflective triangles on the traffic side of the vehicle within 10 feet of the front or rear corners. This marks the location of the vehicle. Additionally, place reflective triangles about 100 feet behind and ahead of the tractor-trailer on the shoulder or in the lane in which you are stopped, as shown in *Figure 10-36*.
- If you are stopped beyond a hill, curve, or other obstruction that prevents other drivers from seeing the tractor-trailer within 500 feet, place reflective devices, as shown in *Figure 10-37*.
- If you are stopped on or by a one-way or divided highway, place reflective triangles 10 feet, 100 feet and 200 feet toward the approaching traffic, as shown in *Figure 10-38*.

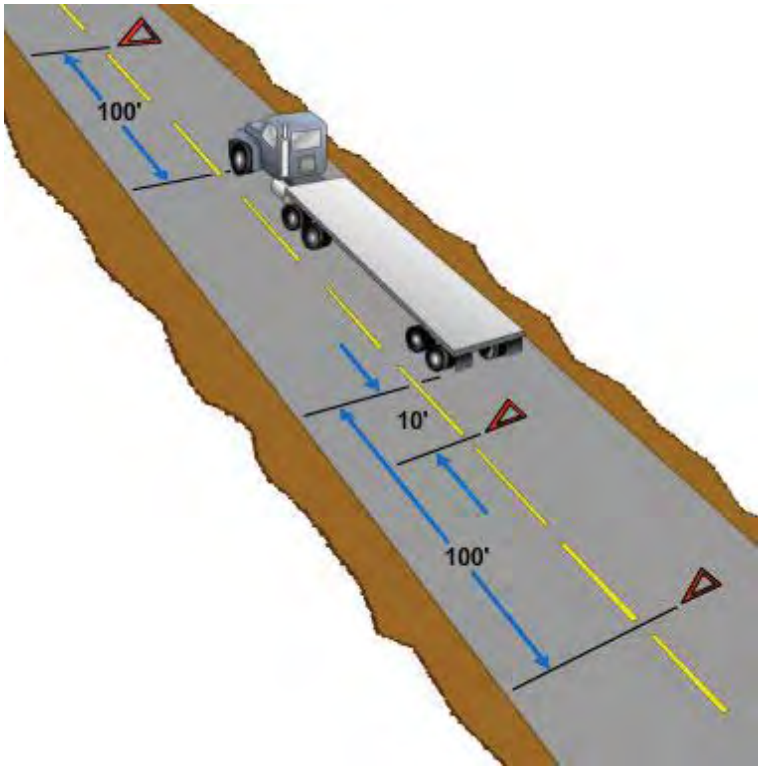


Figure 10-36 – Reflective triangle placement: two lane or undivided highway.

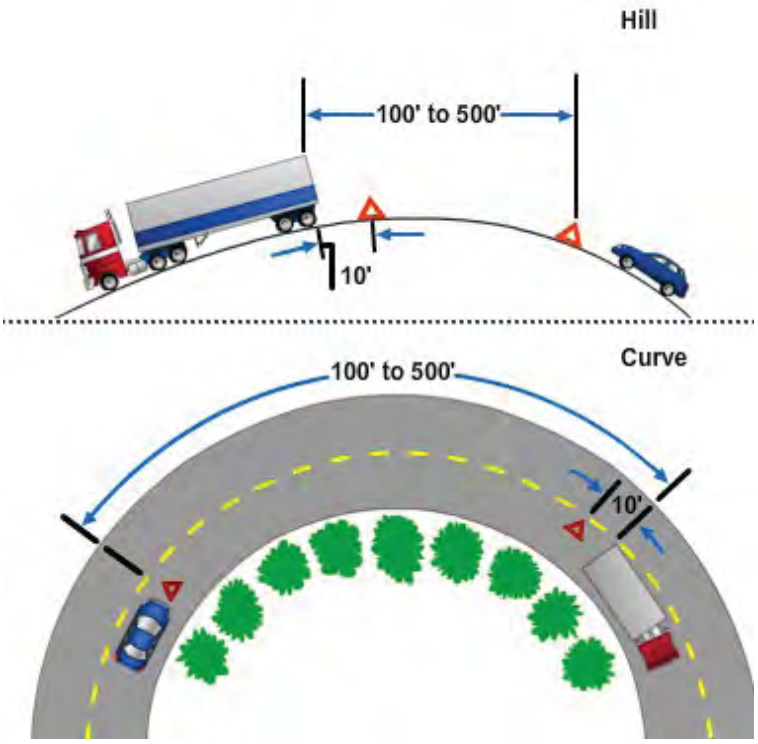


Figure 10-37 – Reflective triangle placement: obstructed view.

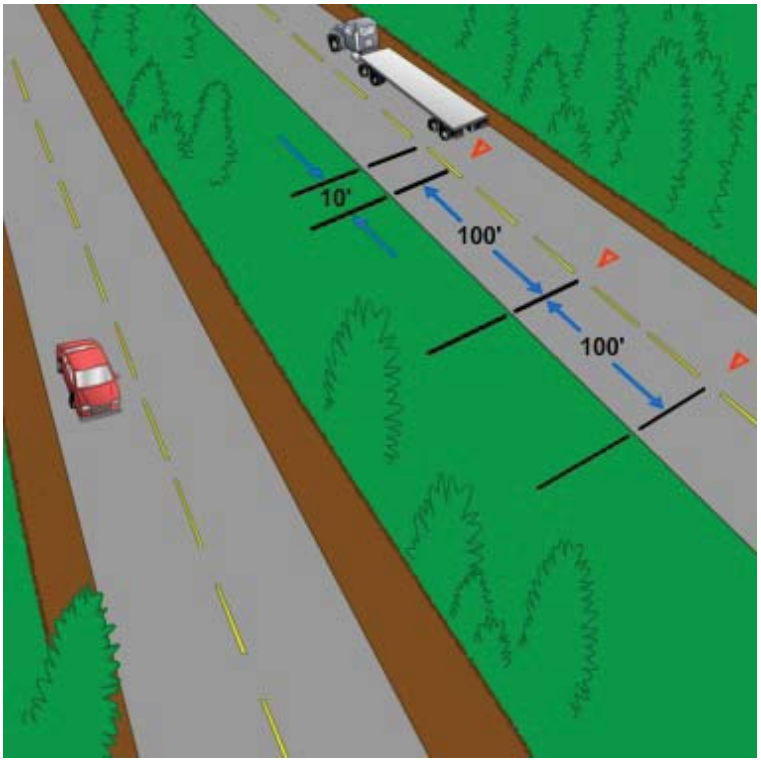


Figure 10-38 – Reflective triangle placement: one way or divided highway.

7.5.0 Maintaining Safe Distance

When driving a tractor-trailer, maintain a safe following distance to avoid rear-end collisions. A rule of thumb for measuring how much to maintain from the vehicle in front of you is at least 1 second for each 10 feet of vehicle length at speeds below 40 mph. At greater speeds, you must add 1 second for safety; for example, if you are operating a 40-foot vehicle, you should allow at least 4 seconds between you and the vehicle ahead. In a 60-foot tractor-trailer, you need 6 seconds. For over 40 mph, you need 5 seconds for a 40-foot vehicle and 7 seconds for a 60-foot tractor and trailer.

To measure distances, wait until the vehicle ahead passes a shadow on the road, a pavement marking, or some clear landmark. Then count off the seconds as “one thousand-and-one, one thousand-and-two” and so forth, until your vehicle reaches the same spot. Compare your count with the rule of 1 second for every 10 feet of length. If you are operating a 40-foot truck and only counted up to 2 seconds, you are too close.

Test your Knowledge (Select the Correct Response)

16. What term is used to describe applying the brakes as hard as possible without locking the wheels?

    A. Severe braking
    B. Controlled braking
    C. Panic braking
    D. Stab braking

17. What type of skid results in the tractor’s rear wheel losing traction?

    A. Trailer jackknife
    B. Tractor jackknife
    C. Front-wheel skid
    D. All-wheel skid

18. On a two-lane or undivided highway, reflective triangles should be placed about _____ feet behind and ahead of the tractor-trailer on the shoulder or in the lane in which it is stopped.

    A. 500
    B. 300
    C. 100
    D. 50

19. What is the rule of thumb for following distance when operating a tractor-trailer under 40 mph?

    A. 1 second for each 10 feet of vehicle length
    B. 5 seconds for each 25 feet of vehicle length
    C. 10 seconds for each 35 feet of vehicle length
    D. 15 seconds for each 40 feet of vehicle length

8.0.0 LOADING OPERATIONS

As an operator, you must have an understanding of the basic procedures and safety rules for transporting construction supplies and equipment. Improper loading can be dangerous, causing damage and affecting the steering of the tractor-trailer. Regardless of who loaded and secured the load, the operator is responsible for inspecting the load, recognizing overloads and poorly balanced weight, and ensuring that the load is properly tied, strapped, or chained down, and covered (if required).

NOTE

Tying down a load take less time than reporting the reason a load fell off a trailer.

8.1.0 Vehicle Weight Definitions

The operator is responsible for knowing how much weight is loaded on the tractor-trailer and knowing the total weight of both the unit and cargo. The terms used for vehicle weight are as follows:

8.1.1 Payload Allowance or Payload

Payload allowance or payload is the maximum weight of material that can be transported.

8.1.2 Gross Vehicle Weight

Gross vehicle weight (GVW) is the total weight of a single vehicle plus its load.

8.1.3 Gross Combination Weight

Gross combination weight (GCW) is the total weight of a powered unit including the trailer(s) and cargo.

8.1.4 Gross Vehicle Weight Rating

Gross vehicle weight rating (GVWR) is the maximum GVW specified by the manufacturer for a single vehicle, including the load.

8.1.5 Gross Combination Weight Rating

Gross combination weight rating (GCWR) is the maximum GCW specified by the manufacturer for a specific combination of vehicles, including the load.

8.1.6 Curb Weight

Curb weight is the total weight of the empty truck with the fuel tank, cooling system, and crankcase filled. It also includes the weight of tools, spare tire, and all other equipment specified as standard. However, it does not include the weight of the payload and operator.

8.1.7 Axle Weight

Axle weight is the weight transmitted to the ground by one axle or one set of axles.

8.1.8 Tire Load

Tire Load is the maximum safe weight a tire can carry at a specified pressure. This rating is stated on the side of each tire.

8.1.9 Suspension Systems

Suspension systems have a manufacturer's weight capacity rating.

8.1.10 Coupling Device Capacity

Coupling device capacity is rated for the maximum weight the device can pull and/or carry.

8.2.0 Operating Conditions

The maximum payload of a truck is determined by subtracting the curb weight and weight of the operator (175 pounds) from the manufacturer's gross vehicle weight rating. The maximum gross vehicle weight rating for a specified operating condition applies only when the tires and equipment on the truck meet the manufacturer's recommendations for the specified operating condition; whether that condition is ideal, moderate, or severe.

8.2.1 Ideal Condition

An ideal condition is when a truck is operated over improved, level roads, such as asphalt or concrete, at constant, relatively moderate speeds with no adverse weather or road conditions. Under these conditions, recommended payload equals 100 percent of maximum permissible payload.

8.2.2 Moderate Condition

A moderate condition is when a truck is operated at high speeds over improved highways, such as asphalt or concrete, with or without long or steep grades. Moderate conditions also include operating at moderate speeds over semi-improved roads with gravel or equivalent surfacing, in gently rolling country with few steep grades and no adverse weather or road conditions. Under these conditions, recommended payload equals 80 percent of maximum permissible payload.

8.2.3 Severe Condition

A severe condition is when the vehicle is operated off the highway on rough or hilly terrain or over unimproved or pioneer access roads with deep ruts, holes, or steep grades. Severe conditions also include operating where traffic has created deep holes or ruts in heavy snow covering normally good city streets or highways. Under these conditions, the recommended payload equals 64 percent of the maximum permissible payload.

8.3.0 Weight Distribution

Distribution of cargo has a definite bearing on the life of the tires, axles, frame, and other parts of the vehicle. The fact that a truck or trailer is not loaded beyond its gross vehicle weight capacity does not mean that the individual tires and axles may not be overloaded by faulty distribution of the cargo. Additionally, states have maximums for GVW, GCW, and axle weights. Axle weights prevent the overloading of bridges and roadways. Some examples of proper and improper placement of the load are shown in *Figure 10-39*.

WRONG

This will bend the frame, overload front tires, make steering harder.

RIGHT

Place heavy part of load near rear axis for proper tire loading and to keep frame from bending.

WRONG

This will bend the frame, overload front tires, make steering harder.

RIGHT

Set a concentrated load just ahead of the rear axis with the longest side on the floor, if possible.

WRONG

RIGHT

Use the right vehicle for the job.

WRONG

This overloads trailer rear wheels. Brakes won't brake properly, rubber scuffs away. Distribute the load over the full trailer floor.

WRONG

This overloads one spring and set of tires. Brakes lock on the light side, cause skids.

RIGHT

Nothing overloaded. Frame won't twist and loosen cross-member rivets.

WRONG

This overloads and shortens tire life, bends the truck rear axle housing. Applying the trailer brakes may lock the wheels, cause flat spots and skidding.

RIGHT

WRONG

If you are not careful, this will happen.

Figure 10-39 – Correct placement of payload.

To load a truck or tractor-trailer properly, you must determine the center of the payload. In a truck, the position of the center of the payload is the center of the body or the point midway between the rear of the driver's cab and the tailgate. In a tractor-trailer unit, the position of the center of the payload is roughly the center of the trailer body because the front wheels of the tractor seldom carry any of the payload. When you are loading, ensure that the maximum capacity of the vehicle is not exceeded over any one axle and, if possible, that loads are distributed so there is less-than-maximum axle loading. Examples of approximate distribution of total weight are shown in *Figure 10-38*.

Be sure to distribute the payload weight over the body properly so the percentage of weight carried by the front axle and that carried by the rear axle equals the ratio for which the vehicle was designed, as shown in *Figure 10-40*.

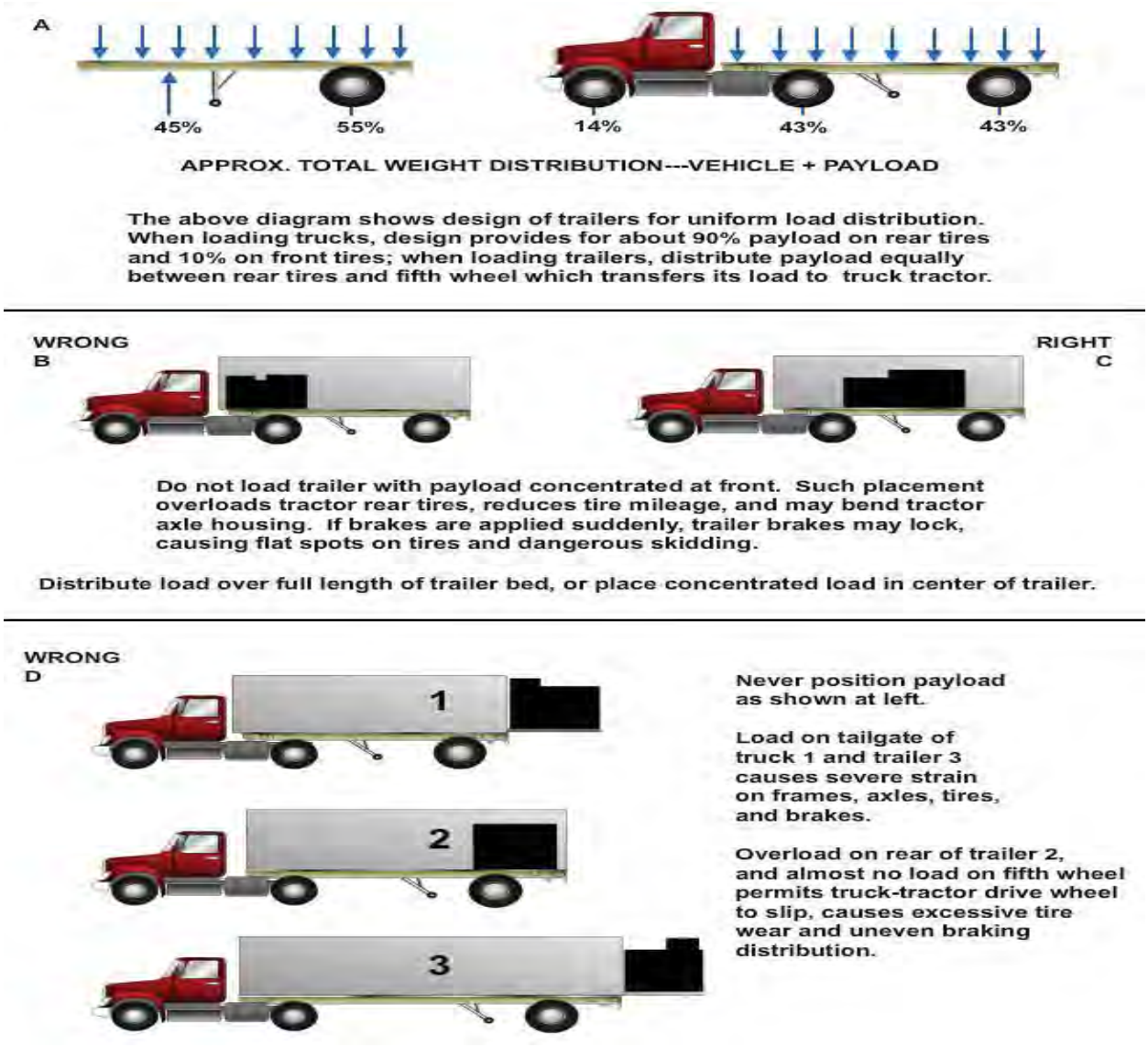


Figure 10-40 – Distribution of weight.

8.4.0 Loading Procedures

The following section describes loading procedures for cargo, equipment, and oversized and overweight loads. In addition, it describes the procedures for loading onto different types of trailers.

8.4.1 Loading Cargo

The tractor-trailer can be adapted to transport various types of materials, such as fragile, bulky, compact, dense, rough, and high center-of-gravity items. To accommodate a variety of items, you must plan the load, properly prepare the tractor-trailer, and secure the load to the vehicle. Securing the load by restraining it with proper lines, cargo straps, chains, or fastening it with tie-downs or binders should keep it from shifting or falling off the vehicle. Should a load fall from a vehicle, it could foul underpasses, culverts, or bridge abutments, and create a hazard to pedestrians. Use cardboard, paper, cloth, or other filler to protect fragile items from damage by chafing (rubbing together).

When loading steel, lumber, or anything that must be unloaded with a forklift or crane, place 4 by 4 timbers or pallets under the load. This helps forks or cables get in and out from under the load.

8.4.2 Loading Equipment

Loading equipment onto a trailer is dangerous. In most cases the equipment will be just as wide as the trailer plus little room for error. Always use a guide to ensure that the equipment is on the trailer straight and that you do not run it off the trailer. Regardless of what type of equipment you are loading or what type of trailer you are using, some general rules apply. The rules are as follows:

1. Have the equipment in line with the trailer and the transmission placed in low gear. Increase the throttle of the tractor just high enough to have power to pull itself onto the trailer.
2. Watch and follow your guide.
3. Do not steer sharply.
4. Do not stop except for an emergency.
5. For crawler machines only, move slowly at the top of any ramp or a jarring fall can result when the machine is past the balance point.
6. Center the equipment on the trailer to load the truck-tractor and trailer axles evenly.

8.4.3 Oversize and Overweight Loads

Oversize and overweight loads require special permits. Driving is usually limited to certain times of the day and requires special equipment, such as “wide load” signs, flashing lights, flags, police escort or pilot vehicles bearing warning signs, and/or flashing lights.

NOTE

Each state or country sets its own weight, height, and width limitations. Always know the weight, height, and width of the load you are pulling and the regulations for the state(s) or countries in which you are to operate.

8.4.4 Loading Low-Bed Trailer

When loading a low-bed trailer with a self-propelled machine, you must use a ramp, blocks, bank or pile of dirt, or a ditch.

Portable ramps are heavy and hard to handle and require as many as four people to lift, carry, and set up. In most equipment yards, a permanent ramp, like the one shown in *Figure 10-41,* is constructed of timber or concrete to support the loading and unloading of equipment.

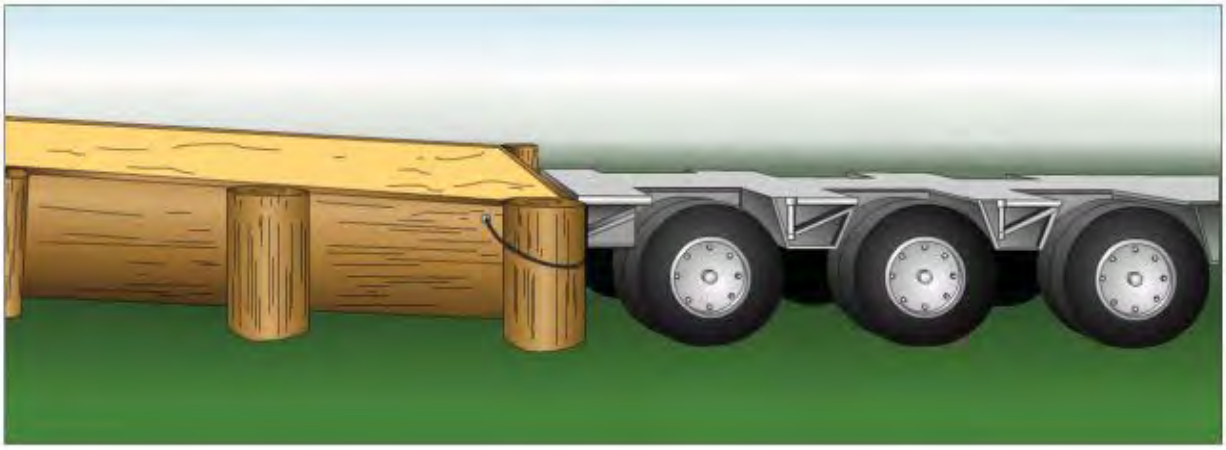


Figure 10-41 – Permanent loading ramp.

Blocks can be used to load crawler equipment. Use blocks if you have nothing else; however, be cautious because the machine will be at a greater angle than desired when the balance point is met (*Figure 10-42*).

WARNING

Blocks are not recommended for wheel equipment.

When a trailer can be backed against a bank or into a ditch, you may load or unload without the use of ramps.

When you have to load a machine and you do not have ramps, blocks, or ditches, you may have to push up a pile of dirt from which to load. Do not dig a hole in finish grade or any place you would have to smooth out. But if you do push up a pile of dirt for a ramp, ensure the ramp angle is not too steep (3 feet out for every 1 foot up). Ensure the ramp is wider than the trailer and somewhat compacted to support the ground-bearing pressure of the equipment.

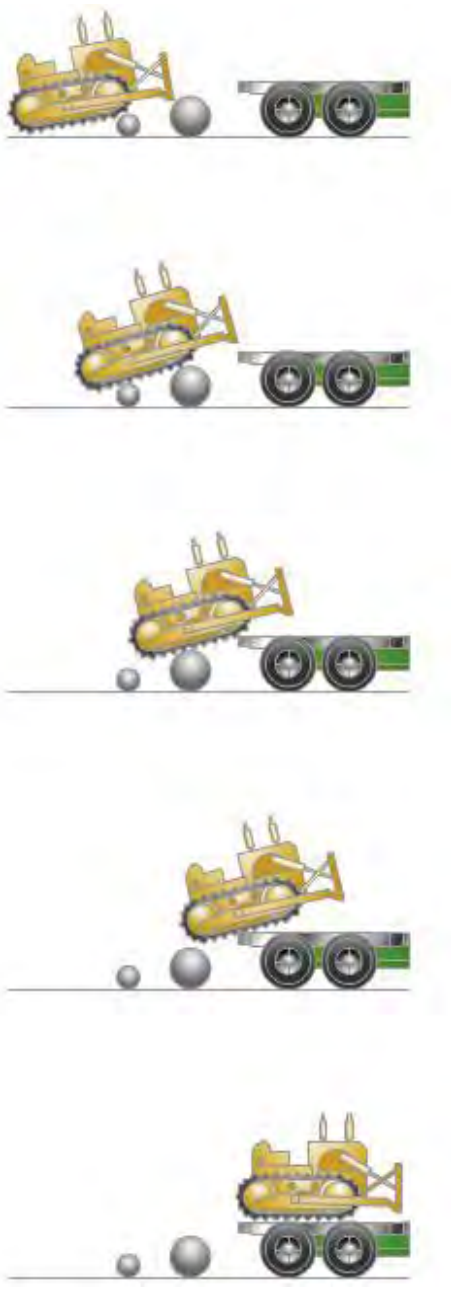


Figure 10-42 – Loading crawler equipment using blocks.

8.4.5 Loading Detachable Gooseneck Trailer

Detachable gooseneck trailers are designed so when the gooseneck is detached you can load a machine from the front without any ramps or tilting of the deck at the balance point.

The gooseneck and frame are held together in alignment by removable pins or safety locks. When you remove or release the pins or safety locks and disconnect the brake and electrical lines, a hydraulic jack in the gooseneck or a line from a winch mounted on the tractor lowers the two units to the ground. The gooseneck is then detached from the frame and carried or dragged a short distance by the tractor.

Flip the ramps over to rest on the ground, and drive the equipment is up onto the trailer. Back the gooseneck into place and attach, lift, and lock it. Reconnect the brake and electrical lines, and fold the ramps onto the deck of the trailer.

You can also load from the rear, in most cases, like a regular low-bed trailer. Before you operate this type of trailer, read and understand the operator's manual. These trailers have low ground clearance, so take extreme care when crossing any high point in the roadway, such as railroad tracks, speed bumps, and dips.

8.4.6 Loading Stake Trailer

Stake trailers are easy to load and unload with forklifts from the side when the side stakes are removed. Any load that extends over the width or length of the flatbed must be visually marked with a flag during the day and lights at night.

Test your Knowledge (Select the Correct Response)

20. Who is responsible for inspecting a load before transportation?

    A. The person who did the loaded
    B. The person who did the securing
    C. The Operator
    D. The Yard Boss

21. What is the definition of gross vehicle weight (GVW)?

    A. The total weight of a powered unit including the trailer(s) and cargo.
    B. The maximum weight of material that can be transported.
    C. The total weight of a single vehicle plus its load.
    D. The weight transmitted to the ground by one axle or one set of axles.

22. **(True or False)** Axle weights prevent the overloading of bridges and roadways.

    A. True
    B. False

9.0.0 SECURING OPERATIONS

Regardless of what type of truck you are operating, material you are hauling, or how far you are hauling it, your load must be secure from falling or shifting. When a load shifts, the weight of the load has moved also. This could cause axle overload and mechanical failure.

9.1.0 Securing Methods

Certain conditions can cause cargo being transported to shift; however, almost all cargo movement can be controlled using the blocking or bracing method.

9.1.1 Blocking Method

The blocking method, shown in *Figure 10-43*, is used in front, in back, and/or on the sides of a piece of cargo to keep it from sliding. Blocking should be shaped to fit snugly against the cargo secured to the deck of the trailer to prevent the cargo from moving.

Figure 10-43 – Blocking method.

9.1.2 Bracing Method

The bracing method, shown in *Figure 10-44*, is used to prevent movement of the cargo in the trailer. Bracing is placed from the upper part of the cargo to the floor and/or walls of the cargo compartment.

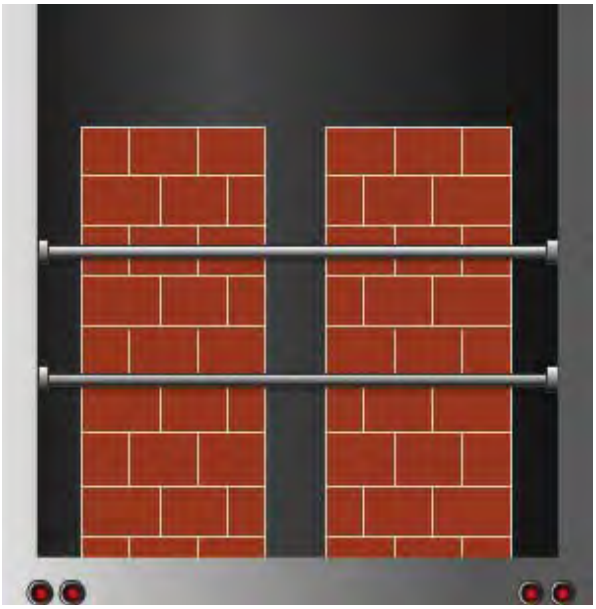


Figure 10-44 – Bracing method.

9.2.0 Restraints

Be sure to secure loads enough to prevent movement in any direction, which means movement forward, aft, vertically, or horizontally. To prevent such movements, use restraints such as web straps, chains, or binders. Tiedown assemblies also assist in restraining loads.

9.2.1 Web Straps

Web straps, like the one shown in *Figure 10-45*, are easy to use to secure boxes and pallets for transportation. Their rated capacity varies, so before using a web strap, know its capacity. In addition, before each use, inspect straps for burns, tears, punctures, cuts, caustic damage, oil or grease contamination, and fraying or broken stitches. Also, inspect their metal parts for improper operation, corrosion, cracks, or distortion. If any of these conditions exist, replace the strap. Do not use them for any mode of transportation if they have been damaged.

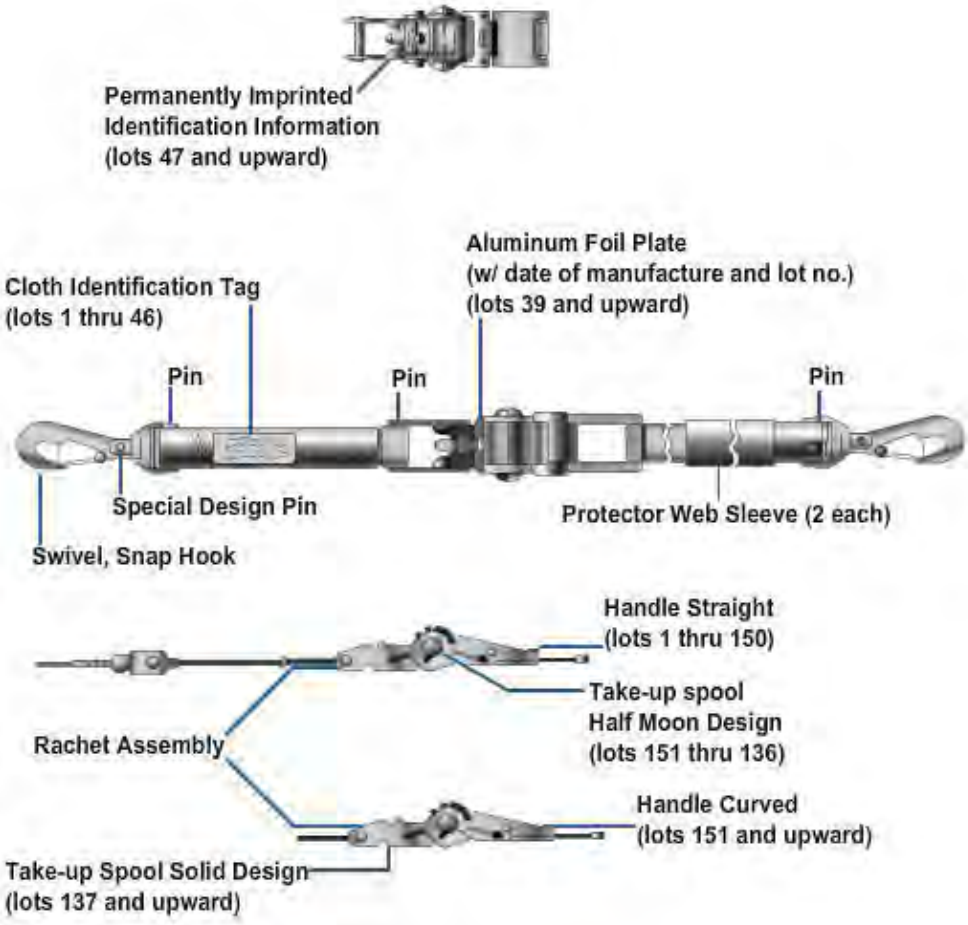


Figure 10-45 – Web strap.

When using web straps to secure loads on pallets, you may need to place padding between the load and the hooks to prevent the hooks from damaging the load. *Figure 10-46*, shows typical loads secured to the cargo bed of the vehicle with web straps. *Figure 10-47* shows how to use web straps to secure a load to a pallet.

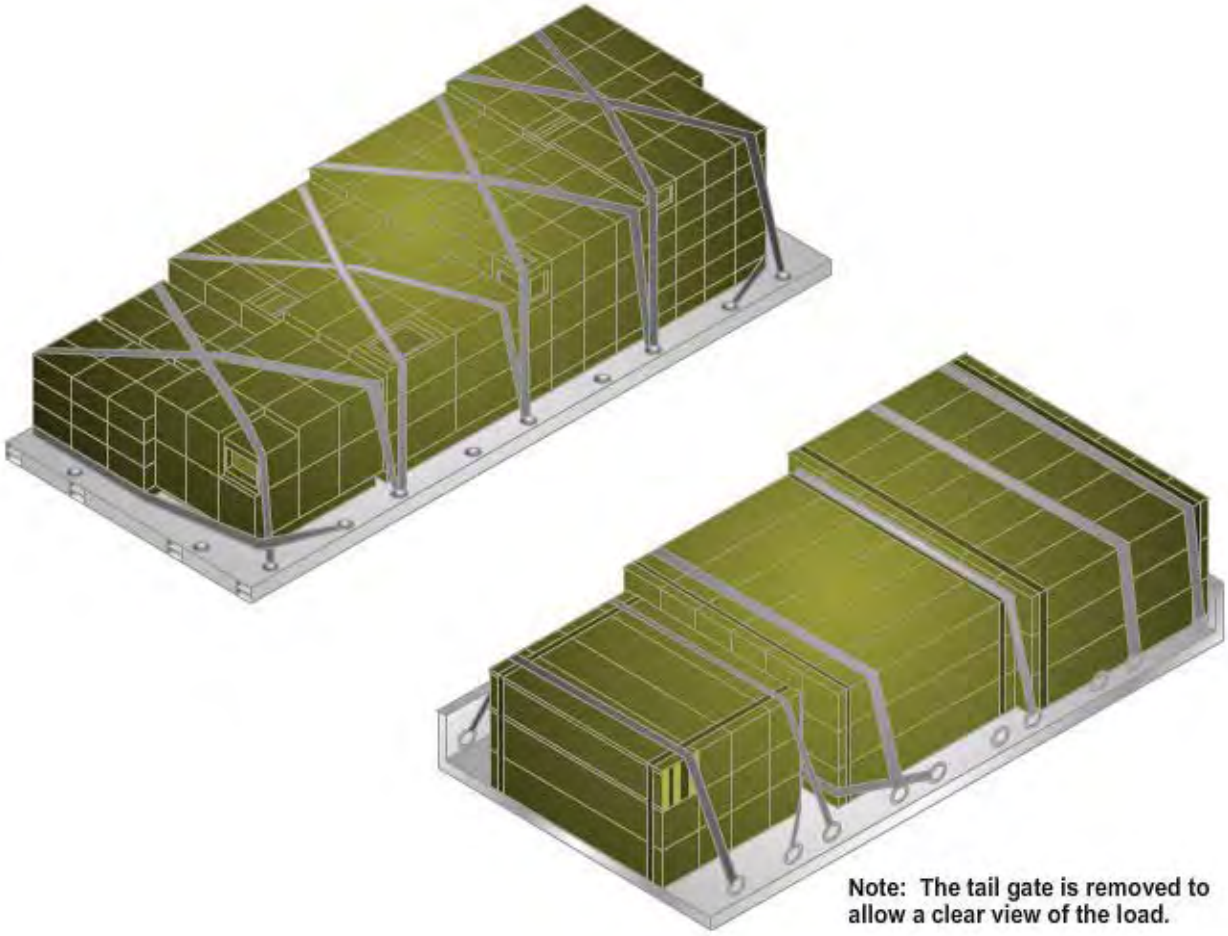


Figure 10-46 – Typical loads secured with web straps.

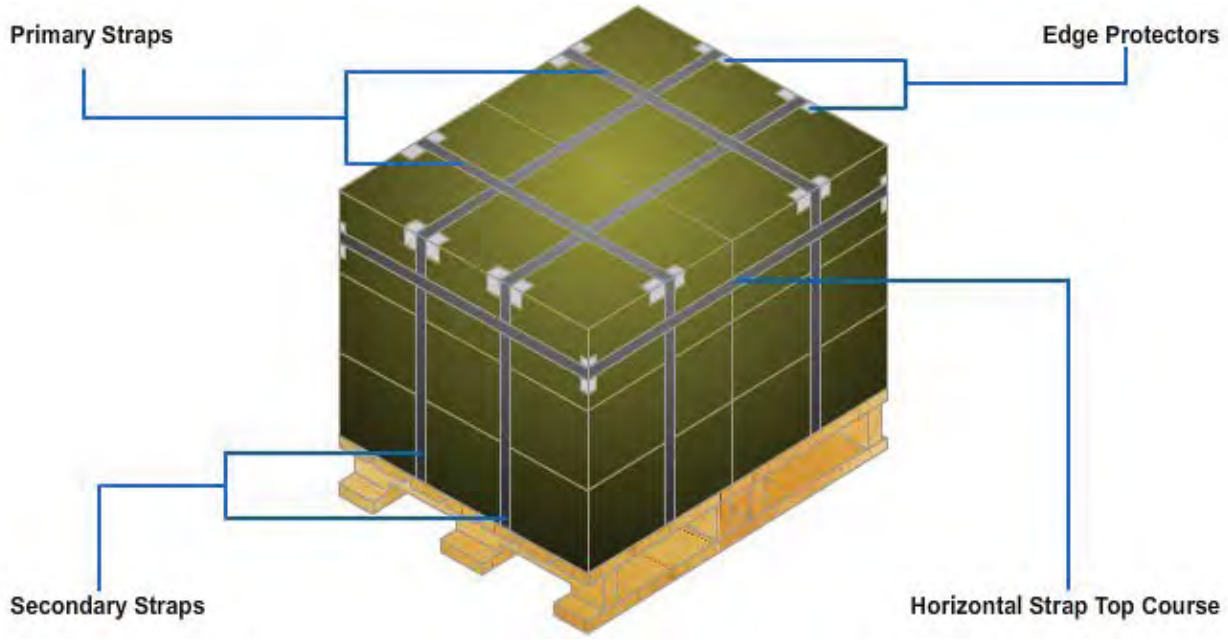


Figure 10-47 – Palletized load using web straps.

9.2.2 Chains

The size chains the NCF normally uses are 3/8 and 1/2 inch. They are made of the class A type of alloy steel. Know the safe working load of any chain before you use it.

Chains used for restraints should have grab hooks on both ends. Attach the hook into the chain as close as possible to the tie-downs on the trailer and on the equipment (*Figure 10-48*). This prevents the chain from getting slack once the binder is attached and closed.

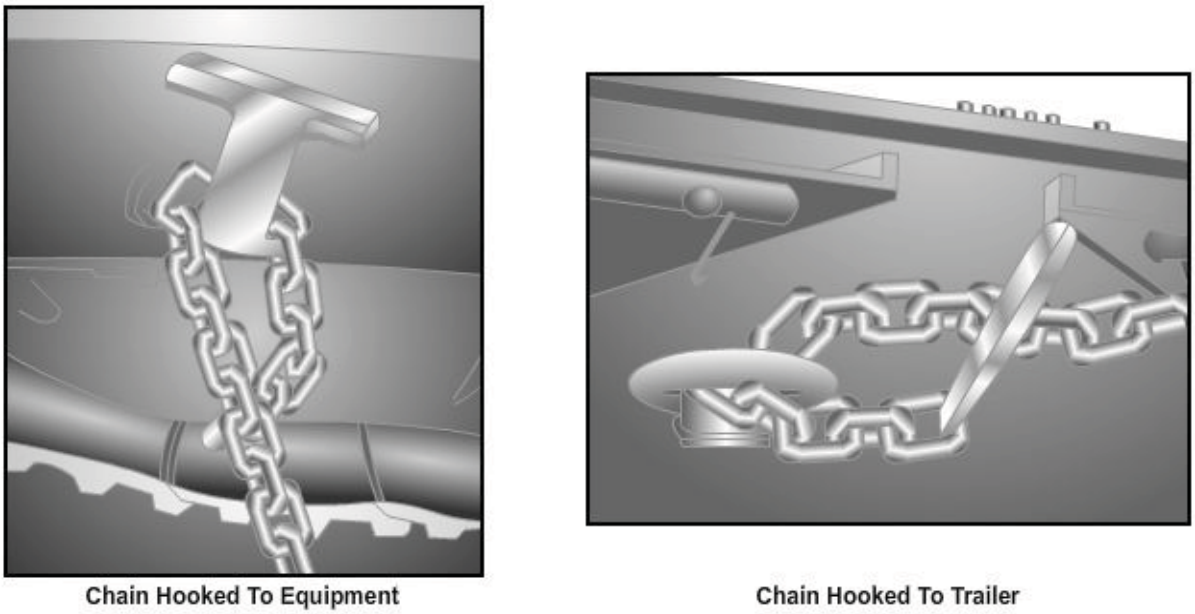


Figure 10-48 – Chains properly hooked on equipment and trailer tiedown eyes.

CAUTION

Do not put chains around any hydraulic, fuel, or break lines because they will be crushed when the binders are closed.

9.2.3 Binders

Binders, like those shown in *Figure 10-49*, are chain-tightening devices made of steel with swivels, chain hooks, and a lever. Hook one of the binder hooks on the chain near the trailer deck and the other higher up the chain near the load (*Figure 10-50*). Tighten the chain by pulling the lever down, as shown in *Figure 10-51*. A 3-inch-diameter 3-foot-length pipe, commonly known as a cheater bar, is normally used on the lever to provide more leverage when closing the binder.

Figure 10-49 – Types of binders.

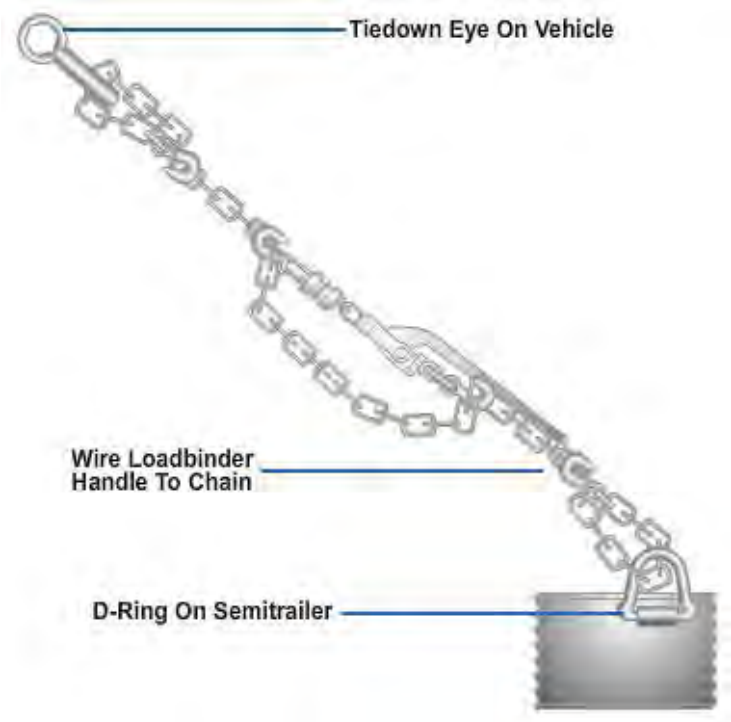


Figure 10-50 – Chain tiedown with binders.

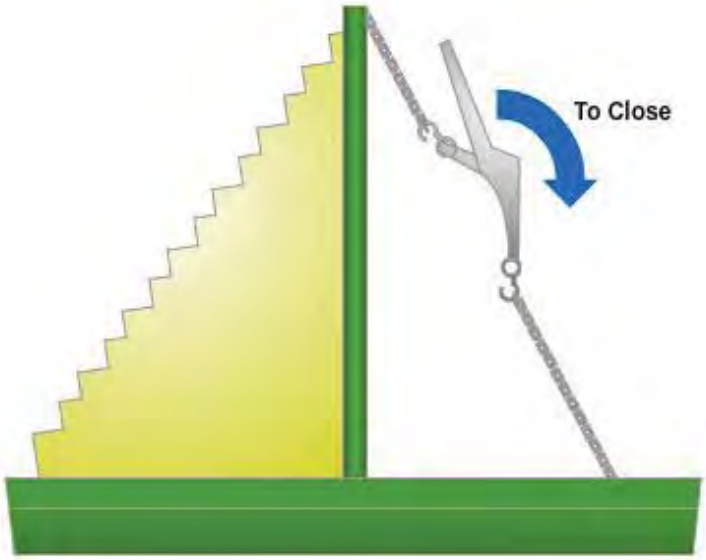


Figure 10-51 – Using binder.

WARNING

When you are closing and opening the lever, do not put your head or arm in line with the lever. If you lose your grip, the lever will open and hit you. Always maintain personnel clear from the path of the binder.

9.3.0 Tiedown Assemblies

When securing loads, place the tiedowns in a symmetrical pattern, as shown in *Figure 10-52*. A tiedown assembly must have a safe working load (SWL) of 1 1/2 times the weight of the load to be restrained. For example, to restrain a crawler tractor weighing 55,000 pounds, you need a tie-down assembly for 82,500 pounds (55,000 x 1.5 = 82,500). This means you need eight 1/2-inch chains with an SWL of 11,000 pounds each and eight binders with 1/2-inch hooks.

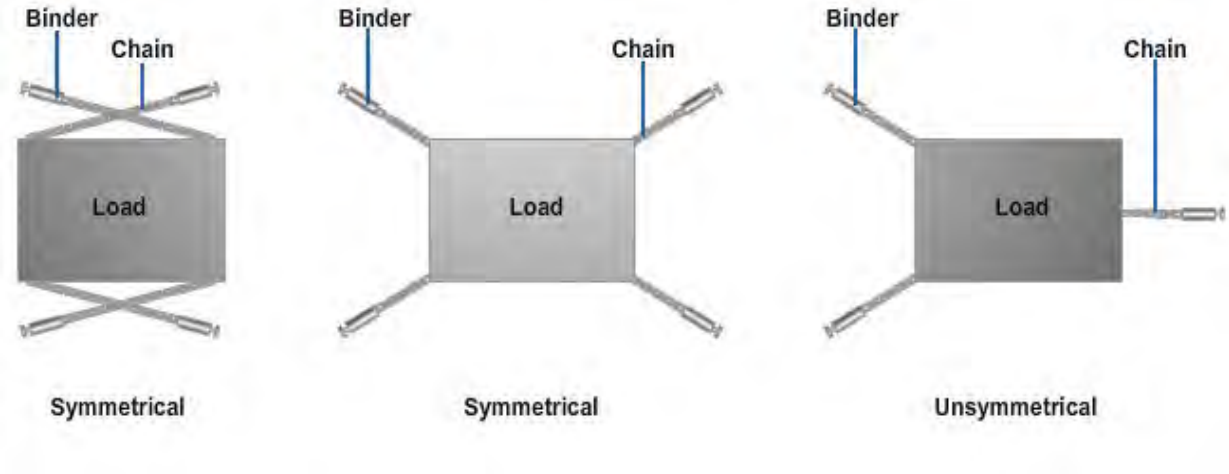


Figure 10-52 – Symmetrical tiedown assembly.

On flatbed and lowboy trailers without sides, cargo must be secured to the trailer using tiedown eyes to keep it from shifting and falling off. *Figure 10-53* shows the locations of tiedown eyes on a trailer. On closed van trailers, tiedowns can also prevent cargo shifting that may affect the handling of the vehicle. Tiedowns must be of the proper type and strength. The combined strength of all tiedowns must be strong enough to lift 1 1/2 times the weight of the piece of cargo tied down.

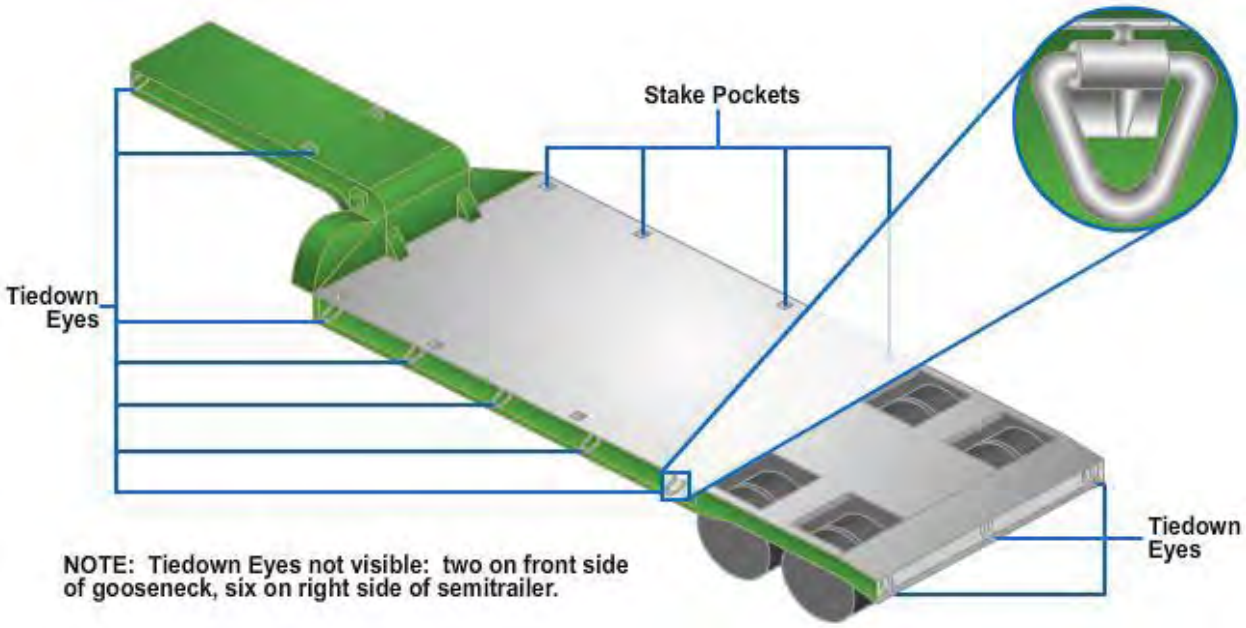


Figure 10-53 – Tiedown eye locations.

You should usually run chains in a same side pattern. Cross chains when:

- There is interference with a same side pattern, as shown in *Figure 10-54.*
- Two chains use the same tiedown fitting on the trailer. In this case, one chain may be same-side and the other may be crossed, as shown in *Figure 10-55.*
- When the same-side pattern results in a chain length that is too short for the appropriate load binder, as shown in *Figure 10-56.*
- Same-side may not provide adequate lateral restraint, if the tiedown has no lateral angle, in the end view, the two tiedowns would appear nearly parallel to each other and/or vertical if they have no lateral angle. In this case, a cross pattern should be used to secure the payload vehicle, as shown in *Figure 10-57*.

Figure 10-54 – Inference with a same side pattern.

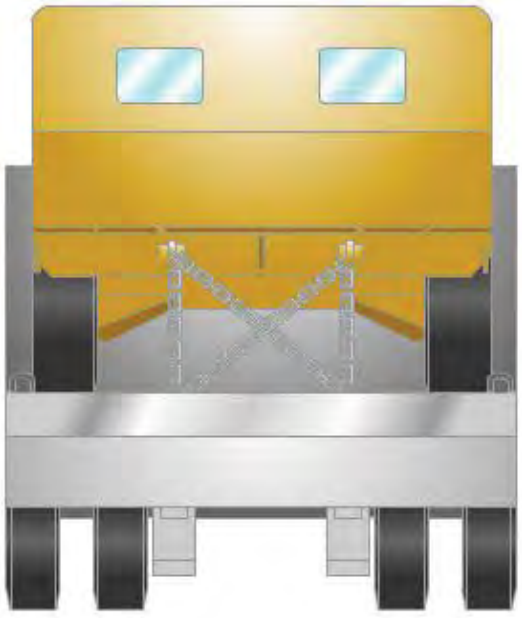


Figure 10-55 – Two chains using the same tiedown fitting.

Figure 10-56 – Crossed chains for inadequate chain length with the same side pattern.

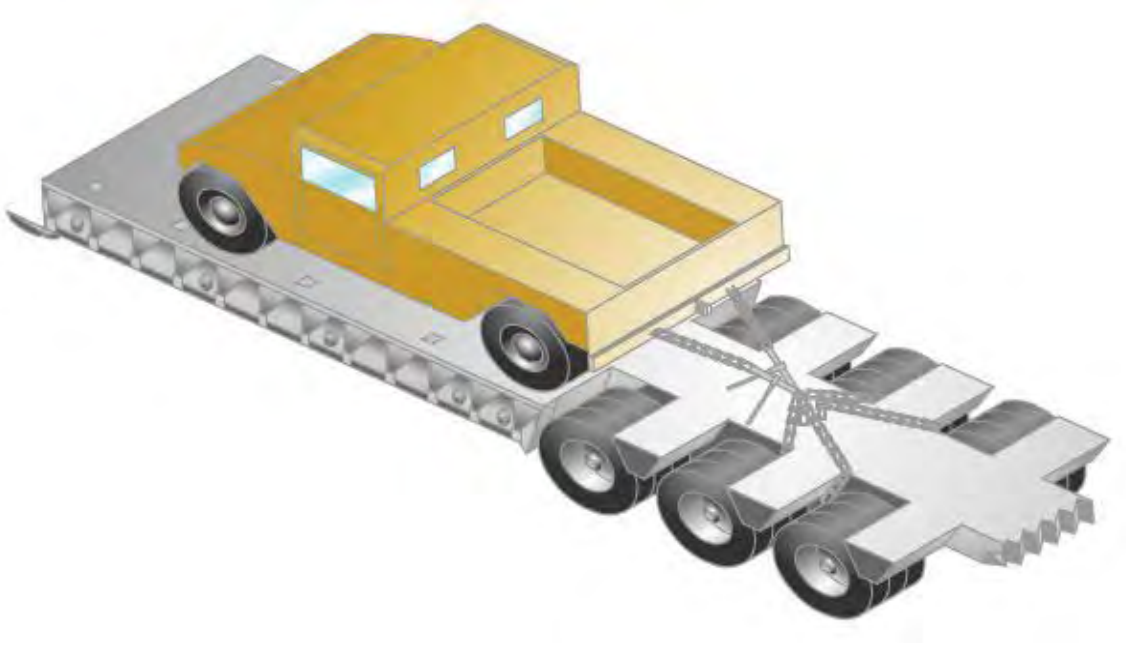


Figure 10-57 – Tiedown with no lateral angle.

9.3.1 Tiedown Equipment

Assume the equipment has been loaded as described earlier in this chapter. Place your tiedown assemblies to the correct tiedown on the equipment. Be sure you do not put a chain around any hydraulic, fuel, or brake lines, because they will be crushed when you close the binders. Ensure you secured all movement symmetrically, as shown earlier in *Figure 10-52*, so that the equipment cannot move forward, aft, vertically, or horizontally.

CAUTION

When transporting equipment equipped with turbochargers, seal off the exhaust stacks to prevent alterations of the turbocharger turbine due to wind velocity. Failure to do so can result in damage to the turbine bearings due to the lack of lubrication.

9.4.0 Inspecting Load

Because cargo loads have a tendency to shift, a common rule of thumb is to inspect the cargo and securing devices before departing and within 25 miles after beginning a trip. Always check the cargo and securing devices as often as necessary during a trip to keep the load secured. Inspect the cargo and securing devices after you have driven for 3 hours or 150 miles and after every break taken during the trip.

Test your Knowledge (Select the Correct Response)

23. **(True or False)** The blocking method is used in front, in back, and/or on the side of a piece of cargo to keep it from sliding.

    A. True
    B. False

24. **(True or False)** For securing equipment, chains can be placed around hydraulic, fuel and brake lines.

    A. True
    B. False

Summary

This chapter introduced you the MK31 and commercial truck-tractors. Additionally, you were introduced to the types of trailers, such as van, stake, low-bed and hydraulic detachable gooseneck trailers, that are used in conjunction with truck-tractors. You were introduced to their major components and controls. Lastly, you were introduced to tractor-trailer operations such as coupling and uncoupling, loading and securing.

Review Questions (Select the Correct Response)

1. A difference between the MK31 and commercial truck-tractors is that the MK31 has a _____.

   A. fifth wheel assembly
   B. hydraulic system
   C. dual system
   D. all-terrain system

2. **(True or False)** The hydraulic system's automatic mode is recommended for level surfaces, such as roads and highways.

   A. True
   B. False

3. **(True or False)** During limp home procedures, the hydraulic system is used instead of a hydraulic jack to raise and lower the front suspension.

   A. True
   B. False

4. What is the purpose of rubber grommets?

   A. Allow air to enter the air line
   B. Prevent air from escaping the air line
   C. Couple the air lines
   D. Prevent water and dirt from getting into the air lines.

5. **(True or False)** Before connecting air lines, the gladhands and grommets should be clean.

   A. True
   B. False

6. **(True or False)** The primary lock release handle unlocks the locking jaws.

   A. True
   B. False

7. The suspension error warning light illuminates when input is attempted at speeds over _____ mph.

   A. 10
   B. 8
   C. 5
   D. 2

8. **(True or False)** There is a less danger of causing a skid or jackknife when only the brake pedal is used.

   A. True
   B. False

9. How would an operator engage the parking brakes?

   A. Pulling out the parking brake control
   B. Pushing in the parking brake control
   C. Put the semi-trailer handbrake in the on position.
   D. Putting the semi-trailer handbrake in the off position.

10. **(True or False)** Full trailers are designed with front axles; part of the trailer's weight rests on the fifth wheel of the pulling vehicle.

    A. True
    B. False

11. Which of the following trailers is very similar to a refrigerated trailer?

    A. Van
    B. Stake
    C. Low-bed
    D. Hydraulic detachable gooseneck

12. Who is responsible for removed, broken, or lost side stakes?

    A. The Yard Boss
    B. The Dispatcher
    C. The Operator
    D. The Collateral Custodian

13. Which of the following trailers is used for hauling heavy equipment and material that is overheight and overweight for stake trailers?

    A. Van
    B. Highboy
    C. Low-bed
    D. Stake-bed

14. Which of the following trailers is allows the operator to slide the kingpin to change axle weights?

    A. Van
    B. Highboy
    C. Low-bed
    D. Hydraulic detachable gooseneck

15. NCF assigned trailers normally have two electrical connections for what electrical voltages?

    A. 6 and 12
    B. 12 and 24
    C. ABS and 12
    D. ABS and 24

16. **(True or False)** Part of post-operational procedure is to drain all air tanks at the end of each day.

    A. True
    B. False

17. **(True or False)** During coupling, the fifth wheel is tilted down towards the front of the tractor.

    A. True
    B. False

18. **(True or False)** Backing under the trailer at an angle could push the trailer sideways and damage the landing gear.

    A. True
    B. False

19. **(True or False)** During coupling, there should be a gap between the upper and lower fifth wheel.

    A. True
    B. False

20. When making a left turn, if there are two turning lanes, an operator should always take the _____.

    A. right-hand turn lane
    B. left-hand turn lane
    C. least crowded lane
    D. safest and available lane

21. **(True or False)** On a right highway curve, position the tractor toward the outer edge of the lane.

    A. True
    B. False

22. **(True or False)** During backing, when the truck-tractor front wheels are turned right, rear of trailer will go right.

    A. True
    B. False

23. **(True or False)** Backing the trailer to the left is known as blind-side backing.

A. True
B. False

24. **(True or False)** The key to straight-line backing is recognizing in what direction the trailer is drifting towards and making needed adjustment.

A. True
B. False

25. What maneuver is used for backing up to a freight dock or backing up between two parked vehicles?

A. Blind-side backing
B. Sight-side backing
C. Alley-dock backing
D. Straight-line backing

26. Which of the following type of skid is caused by excessive braking or sharp cornering?

A. Trailer jackknife
B. Tractor jackknife
C. Front-wheel skid
D. All-wheel skid

27. Which of the following type of skid is caused by a dry fifth wheel?

A. Trailer jackknife
B. Tractor jackknife
C. Front-wheel skid
D. All-wheel skid

28. If you are stopped on or by a one-way or divided highway, place reflective triangles _____ feet, _____ feet, and _____ feet toward the approaching traffic.

A. 200, 100, 10
B. 100, 100 , 200
C. 10, 100, 200
D. 10, 200, 100

29. When operating a 50-foot vehicle at speeds over 40 mph, you should leave _____ seconds between you and the vehicle ahead.

A. 5
B. 6
C. 7
D. 8

30. What is the definition of gross combination weight (GCW)?

A. The total weight of a powered unit including the trailer(s) and cargo
B. The maximum weight of material that can be transported
C. The total weight of a single vehicle plus its load
D. The weight transmitted to the ground by one axle or one set of axles

31. Under severe operating conditions, the recommended payload equals _____ percent of the maximum permissible payload.

A. 100
B. 80
C. 64
D. 60

32. The center of the payload on a truck-tractor unit is at what location?

A. Over the rear tires of the tractor
B. Over the rear tires of the trailer
C. Roughly the center of the trailer
D. Directly behind the fifth wheel

33. Which of the following trailers is loaded by using a ramp, blocks, bank or pile of dirt, or a ditch?

A. Van
B. Highboy
C. Low-bed
D. Hydraulic detachable gooseneck

34. What is the ideal slope for loading ramp constructed out of dirt?

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

35. What are used to secure boxes and pallets for transportation?

A. Web straps
B. Chains
C. Binders
D. Blocks

36. To restrain a crawler tractor weighting 65,000 pounds, you need a tiedown assembly of _____ pounds.

A. 95,000
B. 97,000
C. 97,500
D. 95,000

37. You should inspect cargo and securing devices within how many miles after beginning a trip?

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

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.

Adams, A., (2006). *Trucking: Tractor-Trailer Driver Handbook/Workbook*, 3rd ed. New York: Thomson Delmar Learning.

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Chapter 11

Truck Driving Safety

Topics

1.0.0 Defensive Driving

To hear audio, click on the box. 

Overview

Navy truck operators must, at all times practice *"courtesy on the road"* towards other drivers, pedestrians, and property. Courtesy distinguishes drivers who have few (if any) vehicular accidents/incidents, from those with an extensive history of road-related incidents. Drivers who practice courtesy on the road help prevent mishaps. Road courtesies are part of the basic "rules of the road" for driving under normal, hazardous, and special conditions. This chapter covers the basics of defensive driving.

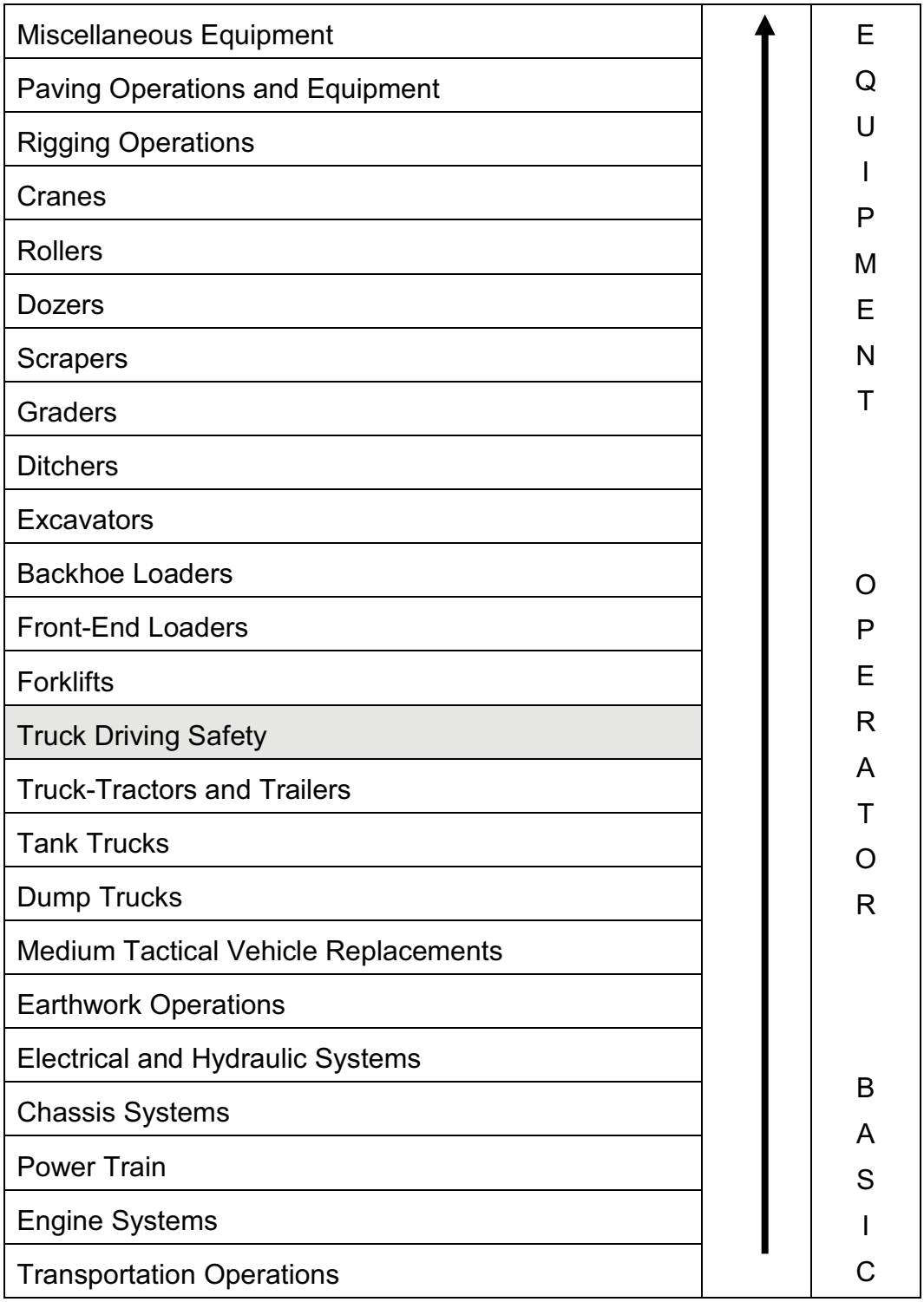
Objectives

When you have completed this chapter, you will understand how to drive a commercial vehicle safely.

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 DEFENSIVE DRIVING

A driver with even the most limited experience has seen discourtesy on the road. Common discourteous actions include: impatience, road hogging, and excessive speed. While discourteous drivers may be knowledgeable about driving, their lack of regard for others on the road indicates a lack of SAFETY knowledge. Safe drivers are *defensive drivers*.

1.1.0 Characteristics of a Defensive Driver

A defensive driver makes allowance for other drivers who lack skill and experience, learns to recognize mishap-producing situations far enough in advance to avoid them, yields to other drivers rather than risk mishap, understands drivers' responsibilities, and shows proper respect for driving regulations and the rights of others.

As a professional Equipment Operator (EO) you are expected to demonstrate an efficient, practical, unemotional, and courteous attitude; alert posture, and skilled performance behind the wheel. You are expected to handle vehicle controls smoothly and always to be aware of the vehicle's position relative to other cars and the environment. By keeping a safe distance from the vehicle ahead and obeying traffic control signals, you can minimize the need to slam on the brakes. Always keep the vehicle in the appropriate lane, signal turning well in advance, and avoid making sudden stops.

1.2.0 Rear-End Collisions

Most working areas for Navy trucks are considered industrial. In these areas, traffic is heavy most of the time. The size of the vehicles, combined with traffic congestion, often results in rear-end collisions.

1.2.1 Precautions to Avoid Rear-Ending another Vehicle

To avoid rear-ending another vehicle:

- Ensure there is enough room to stop at traffic control points.
- Maintain enough distance from the vehicle ahead to maintain visibility of its brake lights and tail lights.
- Watch traffic movement two or three vehicles ahead.

1.2.2 Precautions to Avoid Being Rear Ended by another Vehicle

To avoid being rear-ended:

- Ensure your brake and turn signals function properly.
- Actively use rear-view mirrors.
- Avoid stopping suddenly when possible.
- Signal well in advance for stops, lane changes, and turns.

1.3.0 Visibility

Visual awareness is critical to safe driving. Drivers not being fully aware of surrounding vehicles, pedestrians, and traffic patterns is a major cause of accidents. While all drivers

do look around, they often do not look far enough ahead, to the sides, and to the rear of the vehicle.

1.3.1 Foresight

Because stopping and changing lanes requires distance, knowing what traffic is doing all around you is very important. Look well ahead to make sure there is room to move safely.

Successful defensive drivers look ahead about the distance that is traveled in 12 to 15 seconds. At low speeds, that is about one block. At highway speeds, it is about a quarter of a mile. Neglecting to look 12-15 seconds ahead may force you to stop or change lanes too quickly. Safely looking ahead does not mean that keeping an eye on things closer to the vehicle isn't important. Safe drivers shift their attention back and forth, between near and far.

Be especially alert when nearing on and off ramps. Look for vehicles entering traffic, moving into your lane, or turning. Watch for brake lights of vehicles ahead to anticipate a need for speed or lane change far in advance.

Look for hills and curves—anything that might require a change in speed or a lane change. Pay attention to traffic signals and signs. If a light has been green for twenty seconds, start slowing in anticipation of a change to red.

1.3.2 Hindsight and Periphery

Knowing what is going on behind and to the sides of the vehicle is extremely important. Having the best knowledge of what's going on around your vehicle requires accurate adjustment of the side and rear mirrors. Adjust the mirrors PRIOR to beginning a trip.

Maximize the mirrors by quickly checking them often and understanding what you see. Many large vehicles have curved mirrors (***convex mirrors***) that show a wider area than flat mirrors. While curved mirrors are often helpful, everything they display appears smaller and further away than it actually is.

Check rear and side-view mirrors with regular, quick glances. Check more often if traffic is particularly congested. Remember, there are spots that the mirrors will not show; these are called ***blind spots*** (*Figure 11-1)*.

In addition to enabling you to maintain awareness of your surroundings, the mirrors provide a tool to check your own vehicle. Use the mirrors to keep an eye on the tires, open cargo, loose straps, ropes, chains, and tarps.

During lane changes, check the mirrors to make sure that no vehicles are alongside you or about to pass. Signal at least 100 feet (or five seconds) before changing lanes.

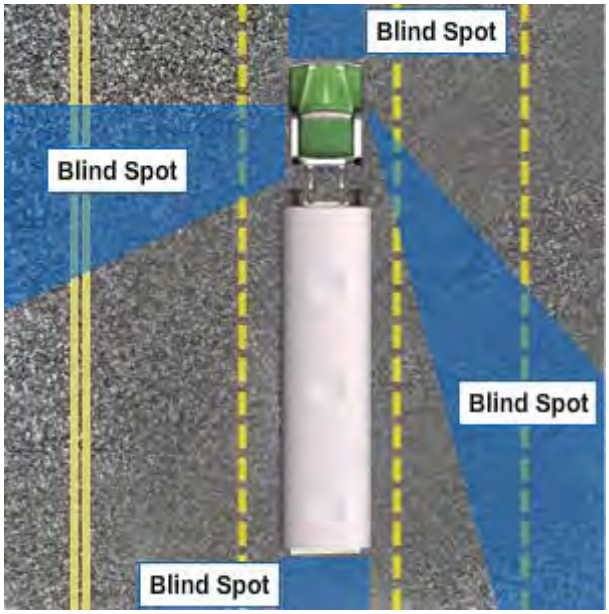


Figure 11-1 – Blind spots.

1.4.0 Communication

Other drivers will not know your intentions until you tell them.

1.4.1 Signals

Safe and appropriate use of signal indicators is critical to your safety and that of others:

- **Signal early.** Signal several seconds before turning. It is the best way to keep others from passing unsafely.
- **Signal continuously.** You need both hands on the wheel to turn safely. Do not cancel the signal until the turn is complete.
- **Cancel signal.** Turn the signal off as soon as the turn is complete.

Use your turn signal before changing lanes. Change lanes slowly and smoothly; that way a driver who may not have seen you will have an opportunity to avoid your vehicle. Also, warn drivers behind you when there is a need to slow down. A few light taps on the brake pedal--enough to flash the brake lights--should warn following drivers. Use the four-way flashers when stopped.

There are several additional situations in which warning other drivers is appropriate and encouraged:

- **Trouble ahead.** The size of your vehicle may make it hard for drivers behind you to see the hazards you can see. If you see a hazard that requires reduced speed, warn the drivers behind you by flashing the brake lights.
- **Tight turns.** Most passenger vehicle drivers do not know how slowly you must make a tight turn in a large vehicle. Give drivers behind you warning by braking early and slowing gradually.
- **Stopping on the road.** Truck and bus drivers sometimes stop in the road to unload cargo or passengers or to stop at a railroad crossing. Warn other drivers by flashing your brake lights. Do not stop suddenly, if possible.

Some drivers try to help out others by signaling when it is safe to pass. This is dangerous: avoid it.

1.4.2 Communicating Presence

Other drivers may not notice your vehicle even when it is in plain sight. Do your best to ensure other drivers are aware of you:

- **When passing**: Whenever you are about to pass another vehicle, pedestrian, motorcyclist, or bicyclist, assume they do not see you and be prepared for them to change lanes quickly and unsafely. If it is legal and safe, take advantage of the horn by gently tapping it.
- **When it is difficult to see**: At dawn or dusk, or in rain and/or snow, make your vehicle as visible as possible. Always have your headlights on in these conditions.

1.5.0 Speed Control

Driving too fast is a major cause of fatal crashes. Adjust speed depending on traction, curves, visibility, traffic, and hills.

1.5.1 Maximum Speed Limits

The speed limits posted on white signs indicate the maximum legal speed you can travel under ideal conditions. You may drive more slowly than the posted speed, but it is illegal to drive any faster. By law, you must drive more slowly if conditions make the posted speed unsafe.

1.5.2 Speed and Stopping

The sum of three inputs equal the total stopping distance: Perception Distance + Reaction Distance + Braking Distance = Total Stopping Distance (*Table 11-1)*.

Perception distance is the distance the vehicle moves from the time you see a hazard until your brain knows it. The perception time of an alert driver is about three-fourths of a second. At 55 mph, you travel 60 feet in that time.

Reaction distance is the distance traveled from the time your brain tells your foot to move from the accelerator until your foot is actually pushing the brake pedal. The average driver has a reaction time of three-fourths of a second. This accounts for an additional 60 feet traveled at 55mph.

Braking distance is the distance it takes to stop once the brakes are put on. At 55 mph on dry pavement with good brakes, it can take a heavy vehicle about 390 feet to stop, which is almost five seconds.

Table 11-1 – Stopping distance chart.

Miles Per Hour	How Far The Rig Will Travel in One Second	Driver Reaction Distance	Vehicle Braking Distance	Total Stopping Distance
30 mph	44 ft.	33 ft.	115 ft.	148 ft.
45 mph	66 ft.	50 ft.	260 ft.	310 ft.
50 mph	73 ft.	55 ft.	320 ft.	375 ft.
55 mph	81 ft.	60 ft.	390 ft.	450 ft.

1.5.3 Effect of Speed on Stopping Distance

Doubling your speed quadruples the distance required to stop, and gives your vehicle four times the destructive power if it crashes. High speeds increase stopping distance greatly. By slowing down a little, you can gain a lot in reduced braking distance.

1.5.4 Effect of Vehicle Weight on Stopping Distance

Brakes have to work much harder to stop a heavy vehicle. The brakes, tires, springs, and shock absorbers on heavy vehicles are designed to work best when the vehicle is fully loaded. Generally, *empty* trucks require *greater* stopping distances because an empty vehicle has less traction. A lighter truck can bounce and lock up its wheels, reducing the ability to brake.

1.5.5 Matching Speed to Road Surfaces

Steering and braking are only possible when the vehicle has traction. Traction is friction between the tires and the road. Slippery road conditions reduce traction and call for lower speeds. It takes longer to stop and is difficult to turn without skidding when surfaces are slippery. Wet roads tend to double the stopping distance, so reduce speed by about a third. On packed snow, reduce speed by half or more. If the surface is icy, it is not safe for driving. Move at a crawl and stop driving as soon as you can, or install chains if necessary.

Sometimes it is difficult to tell if the road is slippery. There are several road areas that tend to be more slippery:

- **Shaded areas**: Shady parts of the road remain icy and slippery long after open areas have melted.
- **Bridges**: When the temperature drops, bridges freeze before the road does.
- **Melting ice**: Ice that has just started to melt creates a layer of water on top of the ice, and is much more slippery than ice that is dry.
- **Black ice**: Black ice is a thin layer that is so clear that you can see the road underneath it. It makes the road look wet. Any time the temperature is below freezing and the road looks wet, assume that it is black ice.
- **Vehicle icing**: An easy way to check for ice is to open the window and feel the front of the mirror, mirror support, or antenna. If there is ice on the mirror, the road surface has probably started to ice up.
- **New rainfall**: Right after it starts to rain, the water mixes with oil left on the road by vehicles. This makes the road very slippery. If the rain continues, it washes the oil away.

1.5.6 Speed on Downgrades

A vehicle's speed increases on downgrades because of gravity. The most important objective is to select and maintain a speed that is not too fast for the:

- Total weight of the vehicle and cargo
- Length and steepness of the grade
- Road conditions and weather

If a speed limit is posted, or a sign indicates a maximum safe speed, do not exceed the posted speed. Also, look for and heed warning signs indicating the length and steepness of the grade. Use the braking effect of the engine as the principal method for controlling your speed on downgrades. The braking effect of the engine is greatest when it is near the governed RPMs and the transmission is in the lower gears. Slow the vehicle and shift your transmission to a low gear *before* starting down the grade and use appropriate braking techniques.

1.6.0 Manage Space

A safe driver keeps space all around the vehicle. When things go wrong, space allows for more time to think and take action. To have a space available when something goes wrong, manage the space. Managing space is important for all vehicles, but especially for the larger ones. The larger the vehicle, the more space it takes up, and the more space it requires for stopping and turning.

1.6.1 Space Ahead

Of all the space around the vehicle, the area ahead of the vehicle—the space being driven into—is most important. Space ahead of the vehicle is critical in case you must suddenly stop. According to accident reports, the vehicle that trucks and buses most often run into is the one in front of them. The most frequent cause of accidents is following too closely.

As a general rule, you need one second for each ten feet of vehicle length at speeds below 40 mph (*Figure 11-2)*. At higher speeds, you need two seconds for each ten feet of vehicle length. To know how much space your vehicle has, wait until the vehicle ahead passes a shadow on the road, a pavement marking, or some other obvious landmark. Then count the seconds it takes your vehicle to reach the marked spot.

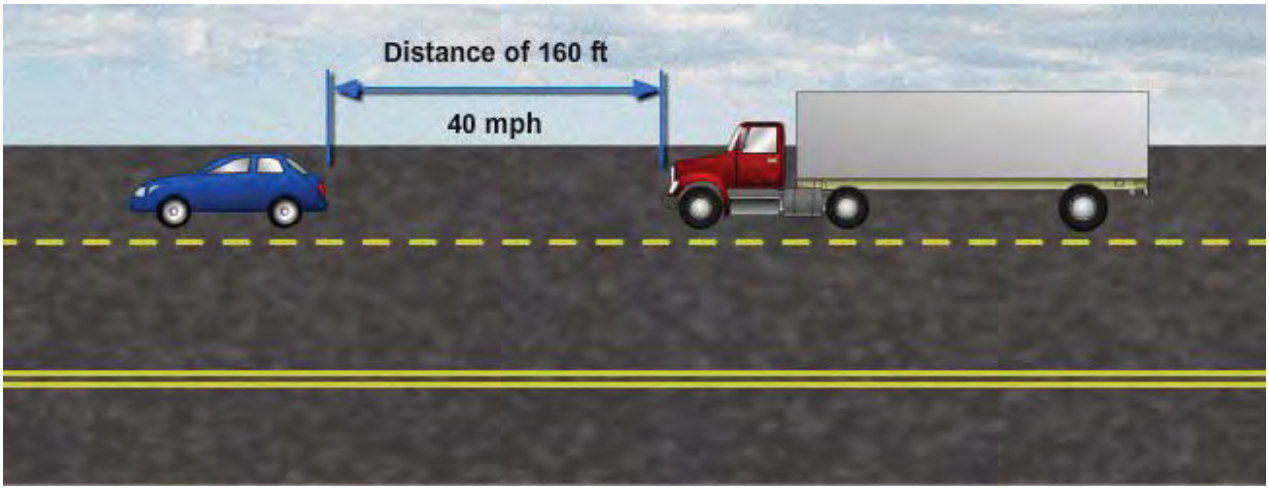


Figure 11-2 – Space Ahead.

1.6.2 Space Behind

You cannot stop other drivers from following too closely. But there are things you can do to make it safer:

- **Stay to the right.** Heavy vehicles are often tailgated when they cannot keep up with the speed of traffic, typically when traffic goes uphill. If a heavy load slows your vehicle, stay in the far right lane if possible. Going uphill, avoid passing another slow vehicle unless it can be passed quickly and safely.
- **Handle Tailgaters Safely.** In a large vehicle, it is often difficult to see if there is another vehicle close behind. If you are followed by tailgaters:
    - Minimize quick changes. If slowing down or turns are necessary, signal early and reduce speed gradually
    - Increase following distance of the vehicle in front of you, making it easier for the tailgater to pass you safely.
    - Do not increase your speed since it is safer to be tailgated at a low speed than a high speed.
    - Avoid giving tailgaters passive feedback by turning on taillights or flashing brake lights.

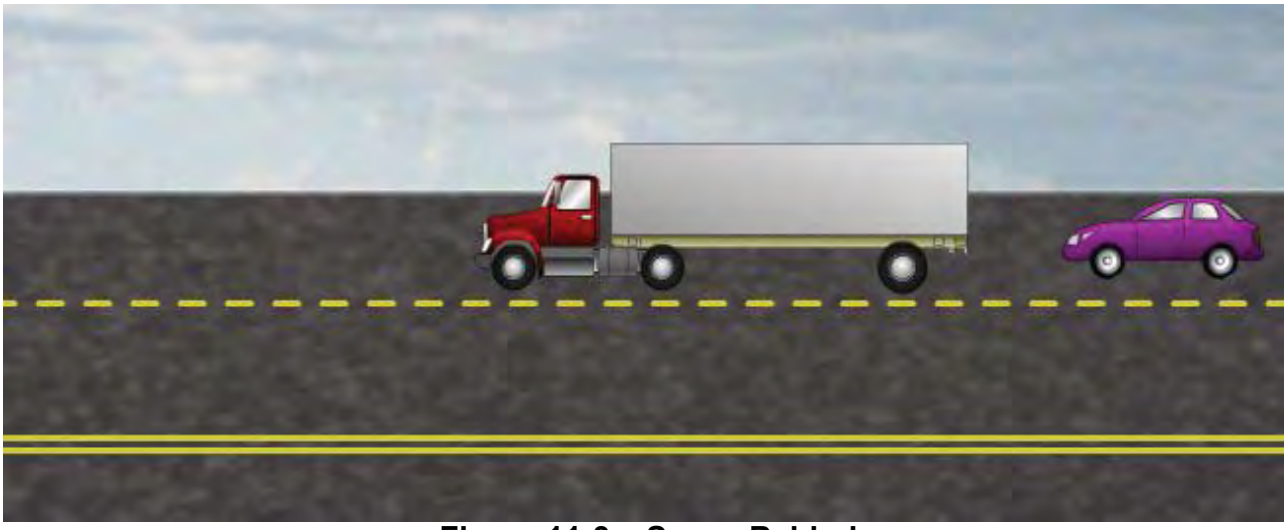


Figure 11-3 – Space Behind.

When a driver “cuts” in front of you, the normal reaction is to slam on the brakes and swerve out of the way. Swerving can result in cutting someone else off, potentially driving off the roadway, or driving into another lane of traffic.

If another driver “cuts” in front of you, it is safer to just *take your foot off the gas (Figure 11-3)*. This allows you to create space between your vehicle and the other driver without swerving into another lane. As much as you might feel entitled to react to the discourteous driver, doing so compromises your own safe driving.

1.6.3 Space to the Sides

Commercial vehicles are generally wide and take up most of a traffic lane. Safe drivers manage with what little space they have by keeping the vehicle centered in the lane and avoiding driving alongside other vehicles (*Figure 11-4)*.

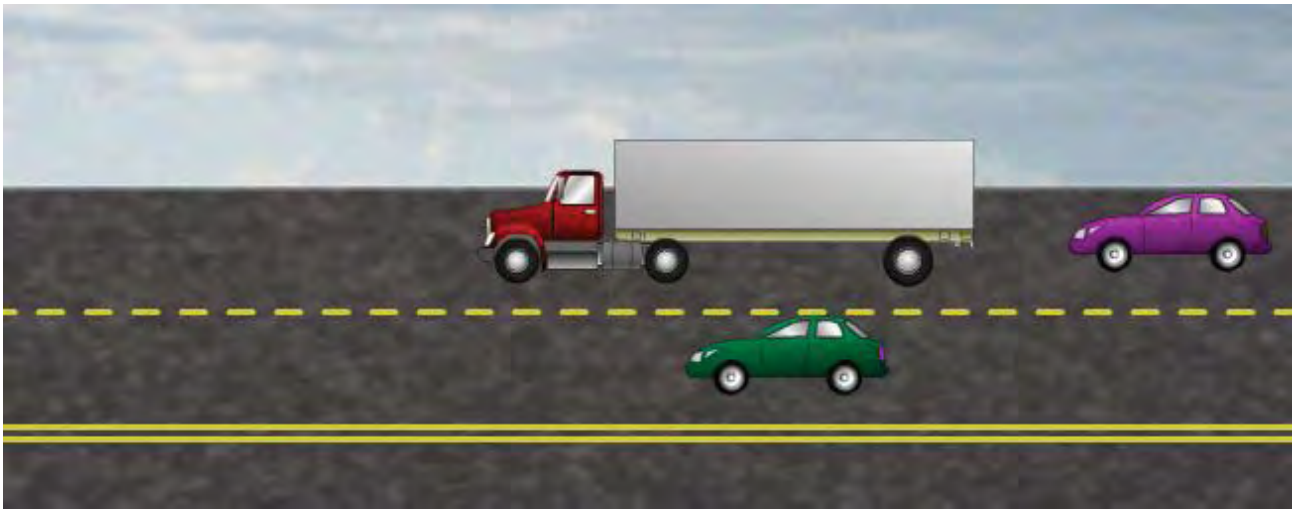


Figure 11-4 – Space to the Sides.

- **Staying Centered in a Lane.** Keep your vehicle centered in the lane to keep safe clearance on either side.
- **Traveling Next to Others.** There are two dangers in traveling alongside other vehicles:
    - Another driver may change lanes suddenly and turn into your vehicle.
    - You may be trapped when you need to change lanes.

Find an open spot where you are not near other traffic. When traffic is heavy, finding an open spot may be hard. If you must travel near other vehicles, try to keep as much space as possible between you and them.

- **Experiencing Strong Winds.** Strong winds make it difficult to stay in your lane. The problem is usually worse for lighter vehicles, and can be especially bad coming out of tunnels. As a general rule, do not drive alongside others if it is avoidable.

1.6.4 Space Overhead

Be aware of your overhead clearance in order to avoid hitting overhead objects (*Figure 11-5*). Keep in mind the following:

- Repaving or packed snow can change the clearance height of bridges and overpasses, making the posted clearances inaccurate.
- An empty cargo van rides higher than a loaded one. Clearing a bridge while loaded does not guarantee that the same vehicle will clear the bridge after being unloaded.
- If you are not sure there is a safe amount of space to pass under an object, take another route. Warnings are often posted on low bridges and underpasses, but sometimes they are not.
- Some roads can cause a vehicle to tilt, which can cause problems in clearing objects along the edge of the road. Where this is a problem, drive a little closer to the center of the road.
- Before backing into an area, get out and check overhanging objects (such as trees or electrical wires).

Figure 11-5 – Space Overhead.

1.6.5 Space Below

Many drivers forget about the space under their vehicles. That space can be very small when a vehicle is heavily loaded. Railroad tracks can stick up several inches, often particularly a problem on dirt roads and in unpaved yards where the surface around the the tracks can wear away(*Figure 11-6*). Do not take a chance on getting hung up. Drainage channels across roads can cause some vehicles to drag. Cross such depressions carefully.

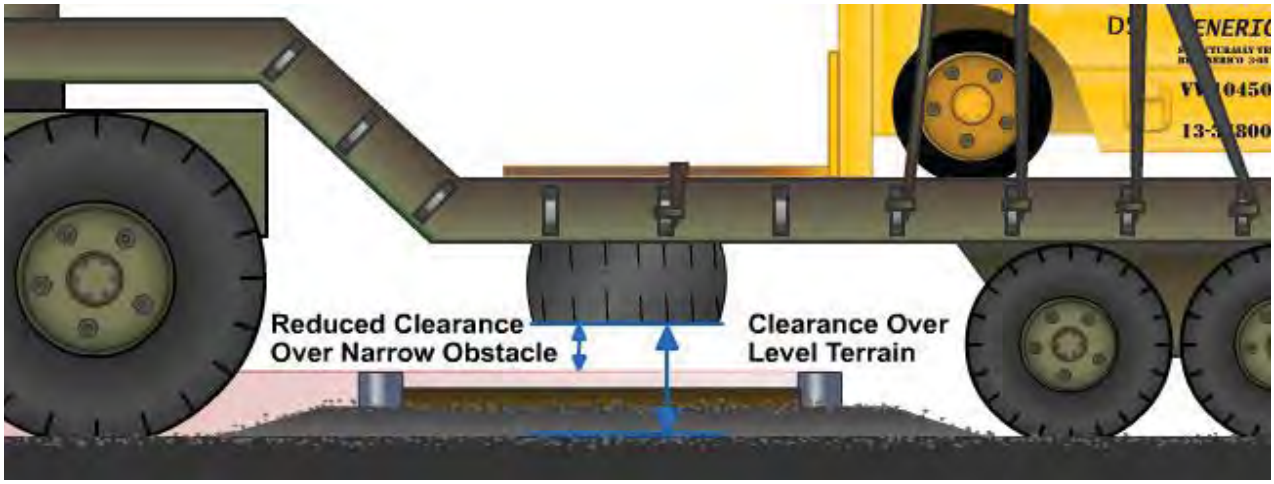


Figure 11-6 – Space Below.

1.6.6 Space for Turns

The space around the vehicle is important when turning. Wide turning and ***off tracking*** can cause large vehicles to hit other vehicles or objects during turns (*Figure 11-7)*.

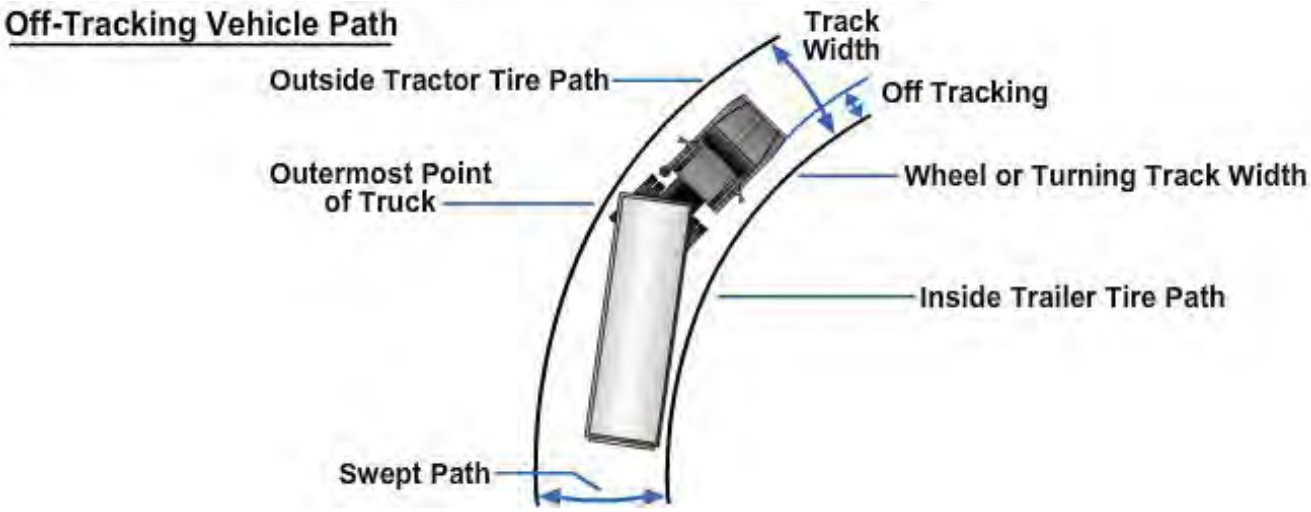


Figure 11-7 – Off Tracking.

Prevent Right Turn Related Accidents:

- Turn slowly to allow other drivers more time to avoid problems.
- Make every effort to stay in your turn lane, and turn wide as the turn is completed (*Figure 11-8)*. Also, keep your vehicle as close to the curb as possible, discouraging other drivers from passing on the right.
- Minimize wide turning left when beginning a turn. Other drivers may assume your intention is to turn left and they may attempt to pass on the right, resulting in a collision as you complete your right turn.

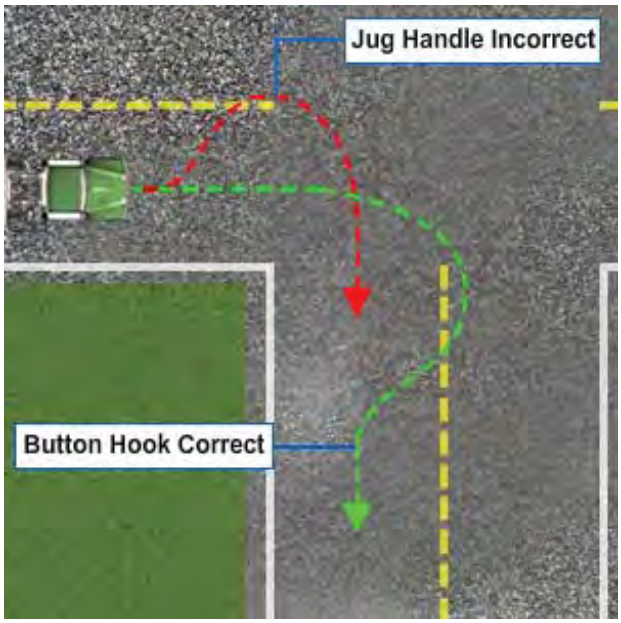


Figure 11-8 – Button hook turn.

- If a successful right turn requires your vehicle to cross into an oncoming traffic lane, be aware of traffic in that lane; give those vehicles room to go around or stop. **DO NOT** back up, which could result in hitting a vehicle behind you.

Prevent Left Turn Related Accidents: Make sure you have reached the center of the intersection before starting a left turn. Turning too soon may result in a collision between the left side of your vehicle and another vehicle (because of off tracking). If turning into a multi-lane street, enter the lane that is most available and safe. If there is more than one turning lane, use the right-most lane (*Figure 11-9)*, because you may have to swing right to safely make the turn. Always be aware during turns that drivers on the right may be difficult to see.

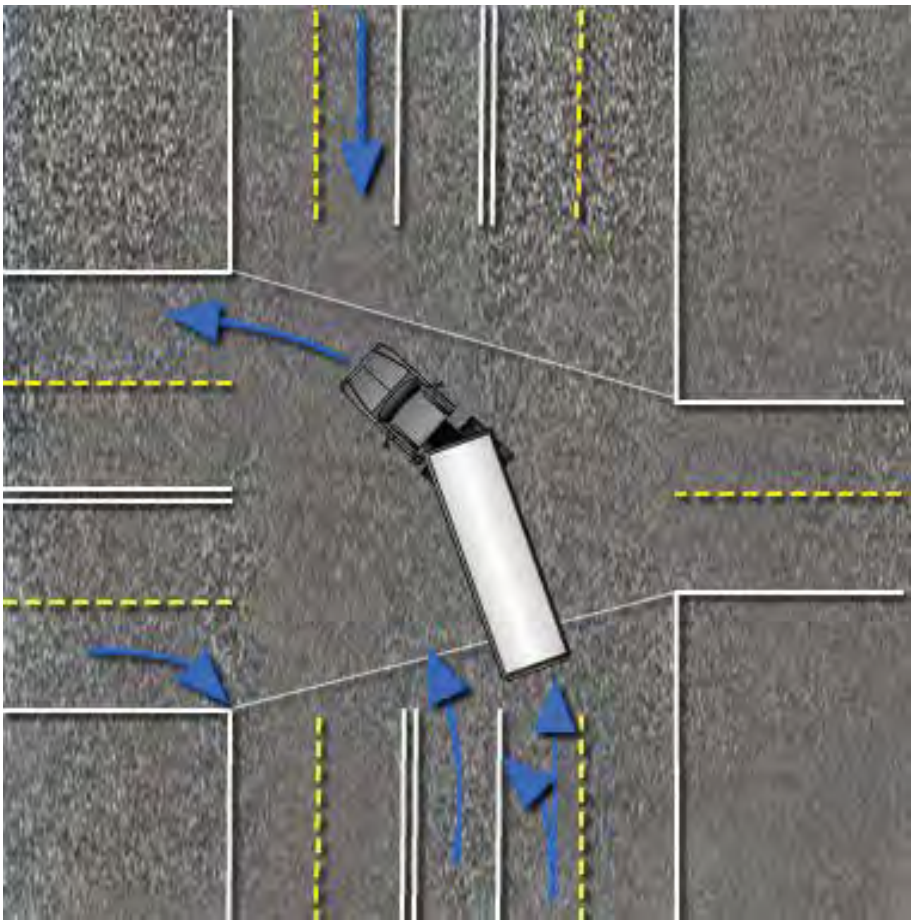


Figure 11-9 – Using right-most lane for left turns.

1.6.7 Space to Cross or Enter Traffic

Be aware of the size and weight of your vehicle when entering and crossing traffic, specifically:

- Because of slow acceleration and the space large vehicles require, you need a much larger gap to enter traffic than you would in a smaller vehicle.
- Acceleration varies with the load. Allow more room if your vehicle is heavily loaded (*Figure 11-10)*.
- Before you start across a road, make sure you can get all the way across before cross traffic reaches you. It is against the law to enter an intersection if you cannot get completely across it *before* the light turns red.

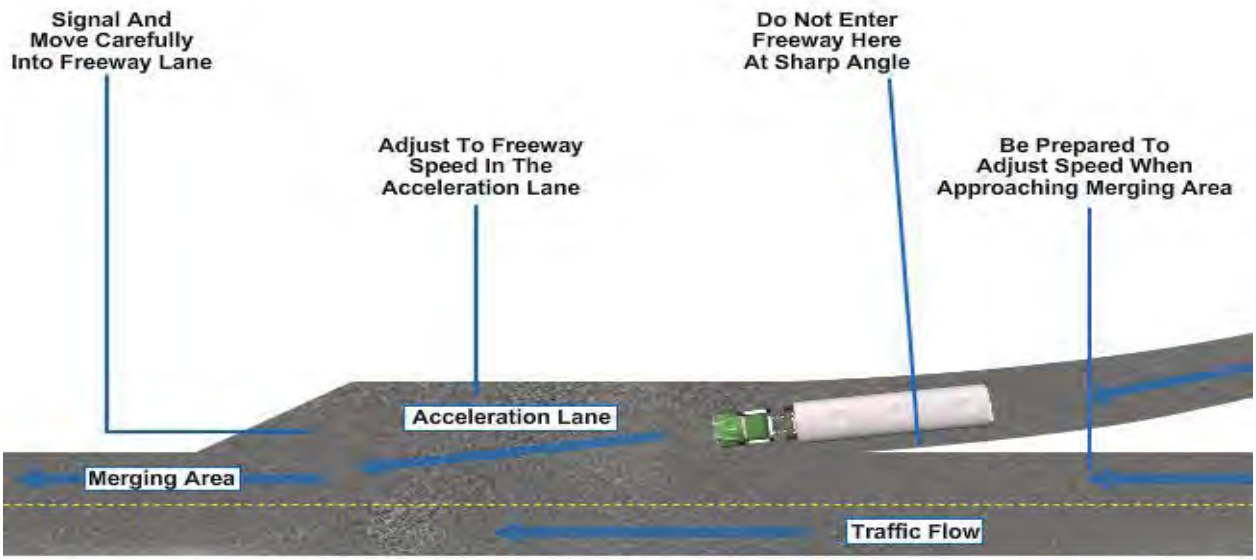


Figure 11-10 – How to enter the highway safely.

1.7.0 Driving at Night

More than half of all vehicle-related accidents happen at night. Drivers cannot see hazards as far in advance as they can in daylight, and as a result, have less time to respond, creating the potential for very serious accidents.

1.7.1 Human Factors

A person's sight is not ideal when driving at night, and can be minimized all the more when the bright headlights of another vehicle appear suddenly. It can take several seconds to recover from glare. Do not look directly at bright lights while driving at night. Look at the right edge of the road or your traffic lane.

Fatigue and lack of alertness is a greater issue at night. The body naturally wants to sleep, especially after midnight, a desire that intensifies if the driver has been on the road for an extend period of time. Drivers may not see hazards or be able to react as quickly, which increases the odds of an accident.

1.7.2 Roadway Factors

Roadway factors that influence your ability to drive safely at night include:

- **Poor lighting:** In the daytime there is usually enough light to see well. This is not true at night. Some areas may have bright street lights, but many areas have poor lighting. On most roads, you will probably have to depend entirely on your headlights.

  Less light decreases ability to see hazards. Road users who do not have lights are difficult to see: pedestrians, bicyclists, animals, etc.

  Even when there are lights, the road scene can be confusing. Traffic signals and hazards can be hard to see against a background of signs, shop windows, and other lights.

  When lighting is poor or confusing, drive slowly. Be sure you can stop within your sight distance.

- **Drivers under the influence**: Drivers under the influence of alcohol and/or drugs are a hazard to themselves and to others on the road. Be especially alert during closing times of businesses where alcohol is sold. Watch for drivers who have trouble staying in the traffic lane, difficulty maintaining a consistent speed, stop abruptly for no reason, or show other signs of driving under the influence of alcohol and/or drugs.

1.7.3 Vehicle Factors

Vehicle factors that influence your ability to drive safely at night time include:

- **Headlights:** At night your headlights are usually your main source of light. Low beam headlights allow visibility ahead to roughly 250 feet. High beam headlights allow visibility to between 350 and 500 feet. Make sure that your speed always allows you to stop within the range of your headlights. Otherwise, by the time you see a hazard, you will not have time to stop.

  Make sure your lights are clean, working, and in the correct location to maximize your field of vision before beginning a trip, and check the lights every time you stop.

  Turn on headlights when these conditions are present:

  - Half an hour after sunset to half an hour before sunrise
  - Snow, rain, fog, or other hazardous weather condition requires the use of windshield wipers
  - Visibility is insufficient to clearly see a person or vehicle for a distance of 1,000 feet.
- **Other lights:** To be more easily seen, clean and ensure functionality of:
  - Reflectors
  - Marker and clearance lights
  - Taillights
  - Identification lights
- **Turn signals and brake lights:** Turn signals and brake lights are especially important in increasing safety when driving at night. Make sure you have clean, working turn signals and stop lights.
- **Windshields and mirrors:** It is more important at night than in the daytime to have clean windshields and mirrors. Dirt on your windshield or mirrors can cause bright lights at night to create a glare, blocking your view. Clean the windshield on the inside and outside before every trip.

1.7.4 Night Driving Procedures

First and foremost, ensure that you are well rested and alert enough to drive safely at night. Do a complete pre-trip inspection of the vehicle. Check all lights and reflectors, and clean those within reach.

Avoid Blinding Others: Glare from headlights causes problems for drivers coming towards you as well as drivers headed in the same direction. Dim your headlights within 500 feet of an oncoming vehicle. Also dim your headlights when following another vehicle within 300 feet.

Avoid Glare from Oncoming Vehicles: Do not look directly at lights of oncoming vehicles. Look slightly to the right to minimize glare blindness.

Use High Beams Whenever Appropriate: Many drivers make the mistake of always using low beams. This cuts down on the ability to see ahead. Use high beams whenever it is safe and legal to do so. Also, minimize the light inside your vehicle.

Diffuse Interior Lights: A brightly lit cab makes seeing outside more difficult. Keep interior lights off, reduce the backlighting on your GPS and/or cell phone, and reduce the instrument lighting on the vehicle's dash gauges.

1.8.0 Driving on Slippery Surfaces

Driving slowly and smoothly is critical to safe driving on slippery roads. If the road is so slippery that you question your ability to drive safely, do not drive at all.

1.8.1 Hydroplaning

To hydroplane is to skim along the surface of water. When roads are wet, your vehicle may hydroplane, which can cause you to lose control and skid since the tires aren't touching the road (*Figure 11-11)*.

Hydroplaning is like water skiing; the tires lose their contact with the road and have little or no traction. You may not be able to steer or brake. Regain control by releasing the accelerator and pushing in the clutch. This will slow the vehicle and let the wheels turn freely. If the vehicle is hydroplaning, do not use the brakes to slow down. If the drive wheels start to skid, push in the clutch to let them turn freely.

Reduce the possibility of hydroplaning in the first place by driving more slowly when it rains, ensuring that your tires are at the correct air pressure, and checking that the tread on the tires is ideal.

Figure 11-11 – A hydroplaning tire.

1.8.2 Safety Guidelines

- Start gently and slowly. When first starting, get a feel for the road. Do not rush.
- Adjust turning and braking to current conditions:
    - Make turns as carefully as possible.
    - Do not brake any harder than necessary and do not use the engine brake or speed retarder—doing so can cause the driving wheels to skid.
- Adjust speed to conditions:
    - Do not pass slower vehicles unless it is necessary.
    - Go slowly and watch far enough ahead to maintain a steady speed.
    - Make best effort to maintain a constant speed.
    - Take curves at slower speeds and do not brake while in curves.

    - Be aware that as the temperature rises to the point of melting ice into water, the road becomes even more slippery.
- Adjust space to conditions:
    - Do not drive alongside other vehicles.
    - Increase distance between you and any vehicle you follow.
    - When a traffic jam is visible ahead, slow down or stop and wait for it to clear.
    - Anticipate stops early and slow down gradually.

When a vehicle passes through heavy rain or deep standing water, brakes get wet. Water on the brakes can cause them to weaken, apply unevenly, or grab. This can cause the brakes to fail, wheels to lock up, pulling to one side, or a jackknife if your vehicle pulls a trailer.

Avoid driving through deep puddles or flowing water if possible. If driving through water is unavoidable:

- Reduce your speed.
- Place the transmission in a lower gear.
- Gently brake. Gentle braking presses the linings against the brake drums (or discs) and keeps mud, silt, and water from getting in.
- Increase engine RPM and cross the water while keeping light pressure on the brakes.
- When out of the water, maintain light pressure on the brakes for a short distance to heat them up and dry them out. Maintain light pressure on the brakes only briefly, as brake drums and linings can overheat.
- Make a test stop when it is safe. Check the mirrors to be sure no one is following, then apply the brakes to be sure they are working.

1.8.3 Wet Brakes

When driving through water, reduce your speed to prevent the brake drums, engine, and ignition from getting wet. Apply foot pressure to the brake pedal just before entering and during passage through water when it is deep enough to enter the brakes. Test brake effectiveness immediately after leaving the water. If water has entered the brake drums and wet the linings, drive very slowly while gently applying pressure on the brake pedal to cause a slight drag, thereby squeezing the brake linings against the drums and forcing the water out of the linings.

Most roads are more slippery just after it begins to rain. This is because oil that has dropped from vehicles as they pass forms a film on the road. Under these conditions, proceed slowly because you will need at least twice the normal stopping distance to stop.

Summary

This chapter provided the knowledge necessary to safely operate a commercial vehicle.

In this chapter, you were introduced to the basic characteristics of a defensive driver and what distinguishes a safe driver from a reckless one.

The Truck Driving Safety topic provided you with the knowledge to:

- Avoid rear-end collisions
- Maximize visibility
- Control vehicle speed
- Manage space
- Drive safely at night, and under other imperfect conditions

Review Questions (Select the Correct Response)

1. Which of the following are common traits of discourteous drivers?

   A. Impatience
   B. Road hogging
   C. Excessive speed
   D. All of the above

2. What precautions should you take to avoid rear-ending someone?

   A. Have enough room to stop
   B. Keep enough distance between you and the vehicle in front of you at stops to see taillights and brake lights
   C. Watch vehicles that are two and three vehicles ahead of you
   D. All of the above

3. What is the appropriate reaction to wet roads?

   A. Reduce speed by a third
   B. Reduce speed by half
   C. Maintain current speed
   D. Tap the breaks regularly to keep them from getting wet

4. What action should an operator take if water has entered the brake drums and wet the linings?

   A. Drive very fast and slam on the brakes to dry the lining
   B. Drive very fast and gently apply the brakes to dry the linings
   C. Drive very slow and gently apply the brakes to dry the linings
   D. Drive very slow and slam on the brakes to dry the linings

5. The sum of what inputs equals the total stopping distance?

   A. Road conditions + Braking Distance
   B. Perception Distance + Reaction Distance + Braking Distance
   C. Vehicle Speed + Road Conditions
   D. Braking Distance + Vehicle Speed + Perception Distance

6. **(True or False)** An empty cargo van rides higher than a loaded one.

   A. True
   B. False

7. What is the easiest way to minimize the need for slamming on the brakes?

   A. Keeping your eyes on the road in front of you
   B. By keeping a safe distance away from other vehicles and obeying traffic control signals
   C. By lightly tapping on the brakes before slowing, and never exceeding the speed limit
   D. By always driving in the far right lane

8. Most working areas for Navy trucks are what?

   A. Industrial
   B. Residential
   C. Construction sites
   D. High traffic areas

9. At low speeds, what is the approximate distance traveled in 12 to 15 seconds?

   A. One block
   B. Three blocks
   C. One quarter of a mile
   D. Five blocks

10. What is the benefit of using convex mirrors?

   A. They take up less space than flat mirrors
   B. They show close up details that can't be seen in flat mirrors
   C. They display a wider area than flat mirrors
   D. They show more of what's happening directly behind your vehicle

11. How far in advance should signaling occur before changing lanes?

   A. 50 feet
   B. 75 feet
   C. 100 feet
   D. 200 feet

12. **(True or False)** It is safe to help others by signaling for them when it is safe to pass.

   A. True
   B. False

13. The distance the vehicle moves from the time you see a hazard until your brain knows it is known as what?

   A. Perception distance
   B. Reaction distance
   C. Braking distance
   D. Stopping Distance

14. How does doubling your speed affect the distance required to stop?

   A. Doubles it
   B. Triples it
   C. Quadruples it
   D. Reduces it by half

15. **(True or False)** Steering and braking are only possible when the vehicle has traction.

    A. True
    B. False

16. When traveling at high speeds, how much distance should you maintain between your vehicle and the vehicle in front of you?

    A. Two seconds per ten feet of vehicle
    B. One second per ten feet of vehicle
    C. 30 meters
    D. 50 meters

17. **(True or False)** When another driver “cuts” in front of you, it is safest to just take your foot off the gas.

    A. True
    B. False

18. How many feet of visibility do you have when driving with high beam headlights?

    A. 350-500
    B. 100-350
    C. 400-700
    D. 300-600

19. How many feet does it take to stop a heavy vehicle with good brakes on dry pavement at 55 mph?

    A. 115 feet
    B. 260 feet
    C. 320 feet
    D. 390 feet

20. **(True or False)** In an effort to stay in your lane, turn wide as the turn is completed.

    A. True
    B. False

Trade Terms Introduced in this Chapter

Blind Spots	The area to the side and slightly behind a driver's field of vision that is not reflected in the vehicle's rear and side view mirrors.
Convex Mirrors	A mirror that has a rounded surface that bulges outward, allowing the mirror to cover a wider field of view than a normal flat mirror.
Off Tracking	Multiple wheel tracks are referred to as 'off-tracking'. Off tracking changes with speed and roadway cross slope.

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.

California Commercial Driver Handbook, State of California, Department of Motor Vehicles, Sacramento, CA, 2009. http://dmv.ca.gov/pubs/comlhdbk/comlhdbk.pdf

Equipment Operator 3, NAVEDTRA 10692, Naval Education and Training Program Management Support Activity, Pensacola, FL, 2004. http://www.cityofabbeville.net/positions/equipment-operator-3.pdf

Federal Motor Carrier Safety Regulations Pocketbook, ORS-7A, U.S. Department of Transportation, Federal Highway Administration, Washington, DC, 2001

Navy Driver's Handbook, NAVFAC MO-403, Naval Facilities Engineering Command, 200 Stovall Street, Alexandria, VA, 1980.

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Chapter 12

Forklifts

Topics

To hear audio, click on the box. 

Overview

The forklift is a piece of equipment critical to the Navy Construction Force (NCF) mission. Forklifts support construction operations whenever there is a need to lift, load, or unload materials or supplies. This chapter covers basic forklift information, including types of forklifts used by NCF, forklift components, controls and attachments, center of balance, technical operation terms, principle of operations and safety.

Objectives

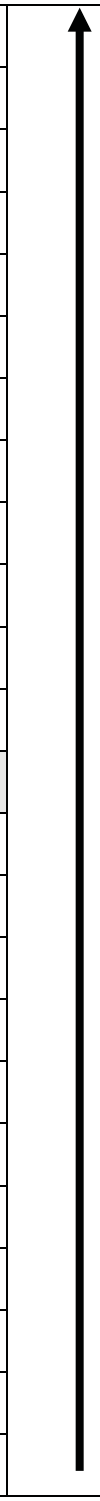
When you have completed this chapter, you will be able to do the following:

1. Understand the use of forklifts.
2. Identify types of forklifts used by NCF.
3. Identify the major components on forklifts.
4. Identify the forklift controls and instruments.
5. Understand the center of balance on forklifts.
6. Identify technical terms used in forklift operations.
7. Understand the principles of forklift operations.
8. Understand how to perform forklift operations.
9. Understand forklift 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.

Miscellaneous Equipment		EQUIPMENT
Paving Operations and Equipment		
Rigging Operations		
Cranes		
Rollers		
Dozers		
Scrapers		
Graders		
Ditchers		
Excavators		
Backhoe Loaders		OPERATOR
Front-End Loaders		
Forklifts		
Truck Driving Safety		
Truck-Tractors and Trailers		
Tank Trucks		
Dump Trucks		
Medium Tactical Vehicle Replacements		
Earthwork Operations		
Electrical and Hydraulic Systems		BASIC
Chassis Systems		
Power Train		
Engine Systems		
Transportation Operations		

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 FORKLIFTS

Forklifts are materials-handling equipment (MHE). The term “materials handling” describes an ongoing activity for every construction project or operation requiring picking up and moving raw materials, processed parts, finished products, tools, equipment, supplies, or maintenance items. Every operation requiring lifting, lowering, or moving an item is classified as materials handling. Forklifts are specifically designed to perform these tasks under varied conditions.

1.1.0 Types of Forklifts used by NCF

There are various types of forklifts. Those used by NCF fall into two broad categories, warehouse forklifts and rough terrain forklifts. This section briefly describes the basic warehouse forklift as well as four different rough terrain forklifts including the 4K, 6K, 11K and 12K. The “K” associated with each number denotes a 1000 pounds of forklift lifting capacity. For example, a 4K forklift is rated to carry a (4 X 1000lbs.) or 4000 lbs. load.

1.1.1 Warehouse Forklift

The most common types of warehouse forklifts are electric, gasoline, or propane powered and have solid, semisolid, or pneumatic rubber tires. NCF uses gasoline-powered pneumatic rubber-tired warehouse forklifts.

Figure 12-1 – Warehouse Forklift.

As the name implies, warehouse forklifts are typically used in warehouses or on hard-surfaced outdoor storage areas. The warehouse forklift (*Figure 12-1*) is designed to pick up, carry, and stack loads of supplies and equipment. Standard warehouse forklifts have lifting capacities from 2,000 to 15,000 pounds and lifting heights from 100 to 210 inches. They are equipped with a telescopic mast which allows loads to be lifted beyond the height of the collapsed mast. The height the forks can raise before the inner slides move upward from the mast, increasing the overall height.

1.1.2 4K Rough-Terrain (RT) Forklift

The 4K RT forklift (*Figure 12-2*) is a diesel powered, rubber-tired, self-contained, mechanized materials-handling vehicle designed to lift loads up to 4,000 pounds with a 24-inch load center to a maximum height of 100 inches. The 4K RT forklift can load and unload flatcars, flatbed trailers, cargo aircraft, and landing craft. It is also used to transport heavy-crated boxes, containers, and palletized loads of heavy equipment and supplies. The 4K is primarily used in rough terrain consisting of unprepared or unstable surfaces, such as beaches, deep sand, snow, ice, or mud. It is used both indoors and outdoors and is capable of fording streams or pools of water up to 30 inches deep. It can be transported by tractor-trailer or military aircraft.

Figure 12-2 – 4K Rough Terrain Forklift

1.1.3 6K Rough-Terrain (RT) Forklift

The 6K RT forklift (*Figure 12-3*) is a diesel powered all-wheel drive, all-wheel steer materials-handling piece of equipment capable of lifting 6,000-pound loads to a height of 200 inches. Designed to handle loads over rough terrain consisting of unprepared or unstable surfaces, such as beaches, deep sand, snow, ice, or mud, the 6K RT is used primarily for loading and unloading flatbed trailers, landing craft, and other types of cargo vessels.

A hydraulic-operated forklift mechanism, mounted on the front of the 6K RT forklift, provides for lifting, reaching, tilting, and sliding loads.

A unique design feature of the rough-terrain forklift is an oscillating hydraulic cylinder allowing rotation of the forklift frame about its longitudinal axis when being operated over rough terrain. The operator controls the rotation by manipulating the control that

activates the oscillating hydraulic cylinder. The 6K RT forklift is also equipped with a power shift transmission for smooth acceleration and deceleration and easy handling.

Figure 12-3 – 6K Rough Terrain Forklift.

1.1.4 11K Millennia Military Vehicle (MMV)

The 11K MMV is known as a rough terrain forklift, telescopic material handler, or "telehandler" (*Figure 12-4*). The forks on a telehandler are mounted on a carriage attached to the end of a three-section telescoping boom. An internal hydraulic ram cylinder and chain extends and retracts the boom. The three-section box-type boom extends outward and upward from the machine frame.

Figure 12-4 – 11K Rough Terrain Forklift “Telehandler”.

Control of the boom's telescoping and vertical movements is facilitated by an electrical signal from a multi-function joystick in the cab. As in a traditional forklift, buttons on the joystick allow the operator to switch joystick control to fork tilt, spread, and side shift.

With four-wheel drive, three steering modes, high ground clearance, frame leveling, and a powerful turbo-charged diesel engine, the MMV can transport materials through a wide variety of rugged terrain, including deep mud, water, sand, snow, and unimproved roads. The MMV has an 11,000 pound lifting capacity, a maximum lift height of 42 feet, and a maximum reach of 29 feet. It has a maximum off-road speed of 35 miles per hour and a cruising range of 425 miles. The MMV is also air transportable.

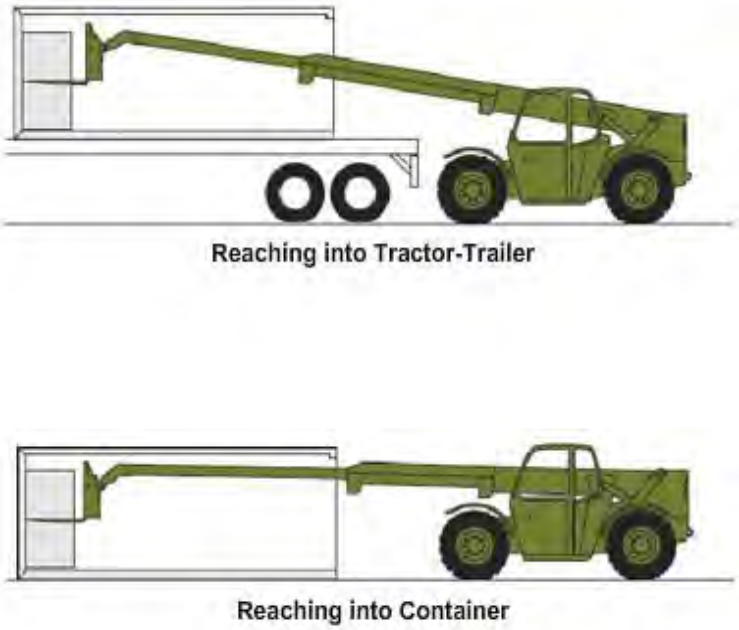


Figure 12-5 – 11K MMV Reaching Capability.

Unlike traditional lift trucks, the MMV military telehandler can reach deep into trucks or shipping containers (*Figure 12-5*), lift loads over trenches or other obstacles, and pick up loads from above or below grade. The MMV can also be fitted with different attachments for added versatility in the field.

1.1.5 12K

The Lift-King 12K forklift has a lifting capacity of 12,000 pounds at a load center to a height of 120 inches (*Figure 12-6*). The 12K forklift is equipped with forklift oscillation, load side shift, lift interrupt, fork positioning, four-wheel and two-wheel-crab steering selection, and counterweight lowering.

Figure 12-6 – 12K Rough Terrain Forklift.

The 12K forklift is equipped with an inching control which the operator controls with the inching pedal located to the left of the brake pedal. Pressing the inching pedal slightly varies the amount of oil pressure in the transmission, allowing the forklift to be “inched” along slowly while the engine is operated at high speed for fast lifts. Fully pressing the inching pedal disengages the transmission. The same type of inching pedal is also found on the 4K RT described in detail later in this chapter.

NOTE

Do not use the inching pedal as a clutch or under high-torque requirements.

To prevent raising the lift-king forklift mast while the forklift is inside an aircraft and causing extensive damage, the mast is equipped with a lift interrupt device which prevents lifting the fork assembly over 43 inches above the ground. To lift loads higher than 43 inches, the operator must press the red-colored manual lift interrupt override button, which allows the forks to reach maximum lift height.

The lift-king forklift is air transportable; however, the front carriage assembly and rear counterweight must be removed. The procedure of carriage removal is as follows:

1. Lower the forks to the ground and tilt the mast slightly forward to produce slack in the lifting chains.
2. Remove the lower chain anchor pins.
3. Raise the mast above the carriage rollers and back the forklift out, leaving the forks and carriage on the ground.

NOTE

For reinstallation, the procedures are simply reversed.

The procedure for counterweight removal is as follows:

4. Remove the two bolts (one on each side of the forklift) that secure the counterweight.
5. Lower the counterweight lifting arm to rest the counterweight on the ground (hydraulic control lever is located in the back of the operator’s cab to the right of the seat).
6. Remove the pin from the shackle to disconnect the arm from the counterweight. Remember to store bolts and pin in the toolbox.
7. Drive the forklift away from the counterweight.

NOTE

When the lift-king forklift is transported on a tractor-trailer, seal the exhaust pipe to prevent autorotation of the turbocharger turbine due to wind velocity. Failure to do so can result in damage to the turbine bearing due to lack of lubrication.

Test your Knowledge (Select the Correct Response)

1. Operations that require raising, lowering, or moving an item are classified as what type of operation?

   A. Weight handing
   B. Materials handling
   C. Storage movement
   D. Construction movement

2. The 4K forklift is capable of fording streams or pools of water of what depth?

   A. 12 inches
   B. 24 inches
   C. 30 inches
   D. 36 inches

3. What component on the 6K RT forklift allows rotation of the forklift frame about its longitudinal axis?

   A. Articulating hydraulic cylinder
   B. Longitudinal hydraulic cylinder
   C. Oscillating hydraulic cylinder
   D. Directional hydraulic cylinder

4. **(True or False)** The MMV is able to reach deeper inside a tractor-trailer to lift materials.

   A. True
   B. False

5. The lift interrupt device on the lift–king forklift prevents the forks from being raised above what maximum height?

   A. 43 inches
   B. 60 inches
   C. 96 inches
   D. 120 inches

6. What is the purpose of sealing the exhaust pipe when transporting the lift-king forklift on a tractor– trailer?

   A. Prevents rainwater from entering the engine
   B. Prevents insects from entering the engine
   C. Prevents autorotation of the turbocharger turbine
   D. Prevents vandals from sabotaging the engine

2.0.0 MAJOR COMPONENTS

This section provides details on the major components found on the 4K RT and the MMV telehandler described earlier. While the 4K RT is one of many different types of rough terrain forklifts, its features are representative of a basic mast assembly-type rough terrain forklift. However, while the 11K MMV is also categorized as a rough terrain forklift, it has unique features and capabilities that distinguish it from other traditional rough terrain forklifts.

2.1.0 Major Components of a 4K RT

The major 4K RT components addressed in this section include the steering system, the body, and the mast assembly. This section provides an overview of these major components. Always consult the operator's manual for more details before operating any material-handling equipment.

2.1.1 4K RT Steering System

The primary steering system components include pivot pins, steering cylinders, steering wheel and shipping locking pin (*Figure 12-7*).

Figure 12-7 – 4K RT forklift steering components.

Two heavy duty steel pivot pins mounted in bushings located at the top and bottom chassis connection points secure the front chassis to the rear chassis, which allows the front chassis to pivot to steer the vehicle.

Two hydraulic steering cylinders, one mounted on each side of the vehicle, extend or retract as the steering wheel is turned. The two cylinder housings are attached to the front chassis, the cylinder rods to the rear chassis. The extension and retraction of the cylinders forces the chassis to pivot around the pivot pins to turn the vehicle.

The steering wheel is connected to the steering column and steering gear, which controls the flow of hydraulic oil to and from the steering cylinders. A hydraulic pump mounted on the transmission provides power steering assist, which reduces operator input and fatigue.

The heavy duty steel shipping lock pin installs in mating holes in the front and rear chassis to prevent articulation when shipping or jacking the forklift. The shipping pin

must be removed to allow normal operation. Do not install the pin when towing the forklift.

2.1.2 4K RT Body

The M4K body consists of two sections, the operator's compartment, or cab, and the engine compartment (*Figure 12-8*).

The cab has a roll over protective structure (ROPS) constructed of heavy duty steel bolted to the front chassis. It is designed to protect the operator from injury due to falling material and truck rollover. The operator's cab contains an operator seat, control pedals, steering wheel, and lift controls to operate the forklift, as well as gauges and indicators to monitor the forklift systems.

Figure 12-8 – 4K RT forklift operator's cab and engine compartment.

The engine compartment, located behind the cab, houses the engine, which is covered by metal side panels. The radiator grill, tow bar, pintle hook, and chains are located on the rear body section (*Figure 12-9*). The heavy duty steel tow bar is stored in a vertical position when not in use. It and the chains are used to tow the forklift. The pintle hook is used for connecting towed loads to the forklift truck.

Operators may drive the 4K forklift to project sites under its own power without any special preparation; however, when performing the prestart operational check, the operator must ensure the safety pin is disengaged before operating.

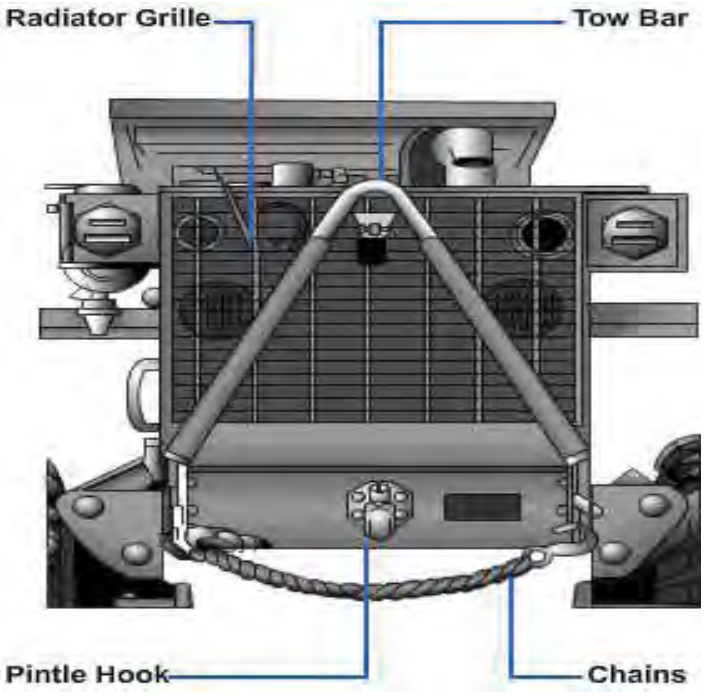


Figure 12-9 – 4K RT tow bar and chains.

The safety pin prevents the forklift from articulating, which prevents steering.

WARNING

Failure to disengage the pin may cause serious injury or death. The 4K forklift can be towed rearward using the tow bar located on the rear of the vehicle.

NOTE

Ensure you follow local standard operating procedures (SOP) prior to performing this operation.

The towing procedure for the 4K (RT) forklift is as follows:

1. Remove the pin securing the tow bar in the vertical position; lower the tow bar into the towing position, and attach it to the pintle hook on the towing vehicle.

2. Disconnect the hook end of the two safety chains from the forklift and attach them to the towing vehicle.

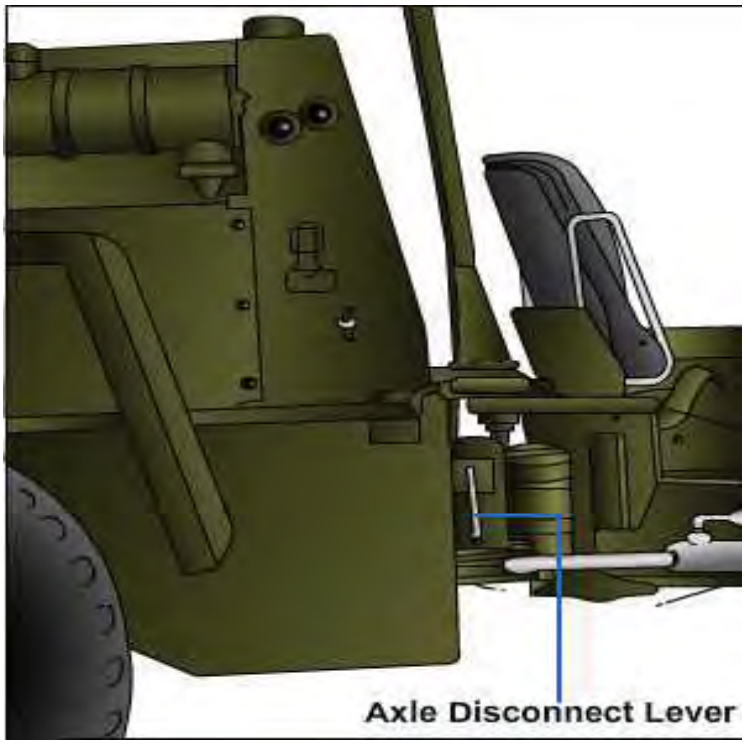


Figure 12-10 – 4K RT axle disconnect lever.

3. Push the axle disconnect lever to the right toward the front chassis to disconnect the axles for towing (*Figure 12-10*).

4. The axle disconnect lever controls the engagement of the transmission output shaft to the front and rear axles. To engage the axles for operation, push the lever to the left, towards the rear of the vehicle.

5. Open the steering bypass valve by turning it counterclockwise (*Figure 12-11*). The steering bypass valve allows the front chassis to pivot freely on the rear chassis when towing the forklift. For normal steering control, close the valve by turning the knob clockwise fully.

Figure12-11 – 4K RT Steering bypass valve.

⚠ CAUTION ⚠

Verify that the steering bypass valve is closed before operating the 4K forklift.

6. Remove the safety pin (*Figure 12-12*), if installed. The safety pin must not be installed when the forklift is being towed.

⚠ CAUTION ⚠

Before pushing the forklift, install the safety pin to prevent the forklift from articulating and damaging the tow bar.

NOTE

Do not tow the forklift faster than 35 mph.

Figure 12-12 – 4K RT Chassis lock pin.

2.1.3 4K RT Mast Assembly

The M4K mast assembly consists of three components: the mast, the forks, and the carriage (*Figure 12-13*).

The mast is the vertical assembly that raises and lowers the load. Hydraulic lift cylinders, controlled by the Lift control lever, raise and lower two lift chains attached to the carriage. Two hydraulic tilt cylinders activated by the Tilt control lever tilt the mast forward and rearward.

Constructed of heavy duty steel, the forks are mounted to the carriage. Locking notches on the carriage and locking lugs on the forks allow the operator to adjust fork width (*Figure 12-14*).

The forks and other attachments

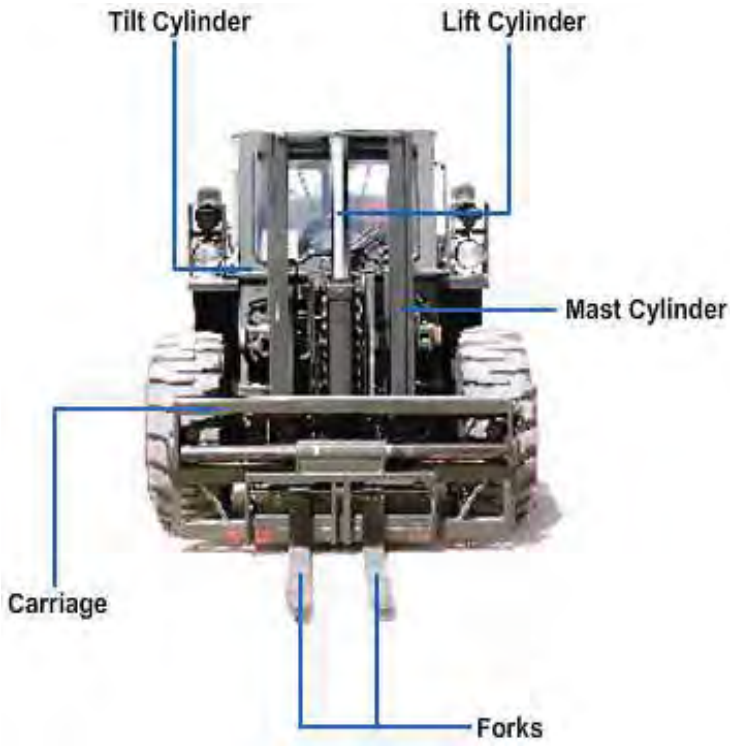


Figure 12-13 – 4K RT Mast Assembly.

mount to the carriage. The carriage is mounted onto the mast rail and moves up and down it by means of chains and hydraulic cylinders. The carriage also has rotation and side shift fork capability. A hydraulic rotation cylinder controlled by the rotate control lever actuates carriage rotation clockwise and counterclockwise.

The side shift cylinder controlled by the shift control lever moves the forks to the right and left.

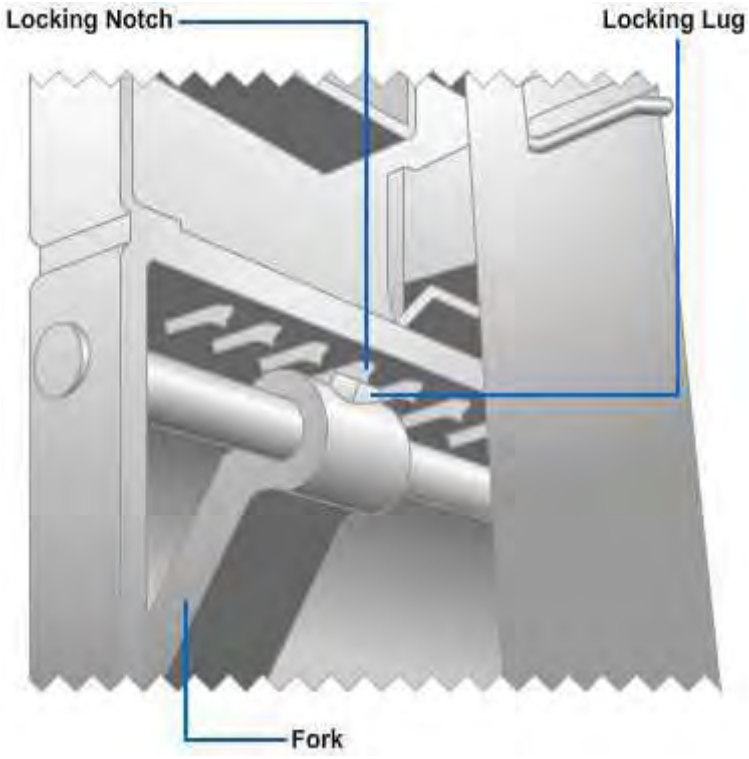


Figure 12-14 – Forklift locking notches and locking lugs.

2.2.0 Major Components of a 11K MMV

The major MMV components addressed in this section include the steering system, the body and the mast assembly.

2.2.1 MMV Steering System

The MMV steering system components include a conventional steering wheel and a steering selection switch.

The steering wheel, located in the center of the instrument panel, controls MMV direction.

The steering mode selector, located on the left instrument panel, is used to select different steering modes (*Figure 12-15*). The three steering modes are front wheel steer, crab steer and four wheel steer.

To engage the different steering modes, turn the steering mode selector until the notch at the top points to the desired steering mode selection and slips into the detent position.

Figure 12-15 – 11K MMV Steering mode selector.

CAUTION

Do not change steering modes unless you are at a complete stop and all four tires are in the straight-ahead position.

WARNING

Never use four wheel steering mode when traveling at high speed. Rapid turning in this mode can cause tip over. Use only front wheel steering mode at high speeds, and slow the vehicle when turning.

WARNING

Never use crab steering mode when traveling at high speed. Rapid turning in this mode can cause tip over. Use only front wheel steering mode at high speeds, and slow the vehicle when turning.

2.2.2 MMV Body

The MMV body consists of the two sections or areas: the operator's compartment, or cab, and the engine compartment (*Figure 12-16*).

Figure 12-16 – 11K MMV Operator's Cab and engine compartment.

The side mounted, enclosed, heated and air conditioned cab is ergonomically designed with conveniently placed controls. It also protects an operator from falling objects and roll over.

The engine compartment is located to the right of the operators cab and separated from it by the telescoping boom. A large swing-up door allows easy engine access.

2.2.3 MMV Mast Assembly

The MMV does not use a conventional forklift mast assembly. Instead, it uses a three-section telescoping boom (*Figure 12-17*). The telescoping boom is extended and retracted by an internal hydraulic cylinder and chain. The boom is raised and lowered by a large hydraulic cylinder located under the boom, which is attached to the forklift chassis.

Figure 12-17 – 11K MMV telescoping mast assembly.

The MMV uses conventional heavy duty steel forks which are mounted to the carriage. Locking notches on the carriage and locking lugs on the forks allow the operator to adjust fork width. The carriage has a tilt up and down capability. In addition the carriage has side shift capability.

Test your Knowledge (Select the Correct Response)

7. The safety pin on the 4K forklift prevents the forklift from performing which of the following operations?

   A. Lifting
   B. Oscillating
   C. Traveling
   D. Articulating

8. **(True or False)** The pivot pin on the M4K must be removed before towing the forklift.

   A. True
   B. False

9. Which of the following is NOT a steering mode available on the MMV?

   A. Crab
   B. Four-wheel
   C. Counter
   D. Front wheel

10. What component on the MMV is similar to the mast found on a conventional forklift?

   A. Carriage
   B. Forks
   C. Telescopic boom
   D. Cab

3.0.0 CONTROLS

Various controls are used to operate forklifts. This section details the transmission, lifting, and brake and throttle controls unique to the 4K and 11K forklifts.

3.1.0 4K RT Controls

While it is true different forklift models have slightly different control configurations, the controls used to operate the 4K RT are similar to those found in most mast assembly type rough terrain forklifts. Remember, even with proper training, operators should always consult the operator's manual when using a forklift for the first time or if they have not operated a particular forklift model for an extended period of time, as models do change. The forklift controls described in this section include transmission controls, located on the left instrument panel, lifting controls located on the right instrument panel, and the brake and throttle controls located on the front/floor at the operator's feet.

3.1.1 4K RT Transmission Controls

The transmission controls include the speed selector and the direction selector, both of which are located on the left instrument panel.

The speed selector is a three position control lever with numeric labels mounted to the instrument panel. Position 1 provides the greatest pulling power and lowest speed. Position 3 is the high gear; it provides the highest speeds (*Figure 12-18*).

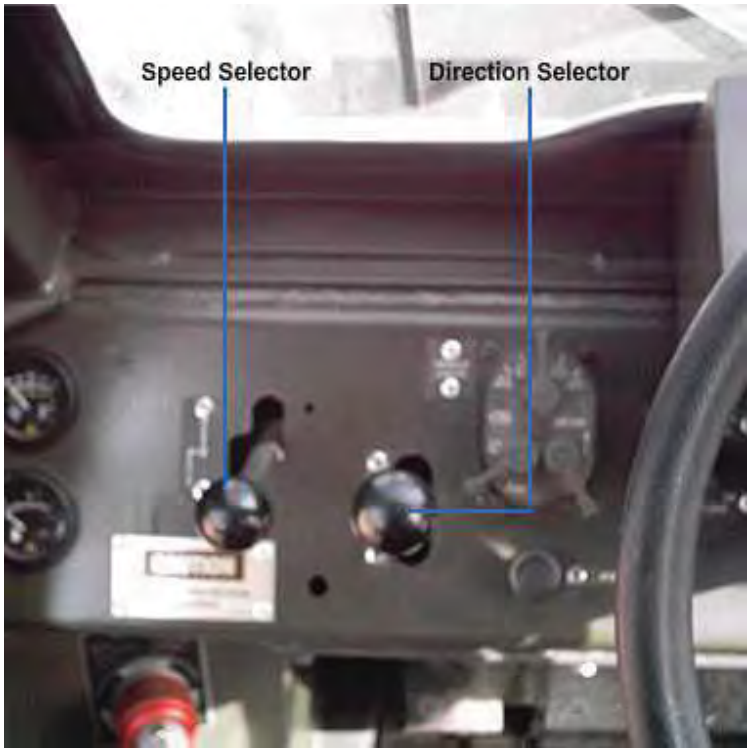


Figure 12-18 – 4K RT transmission controls.

The direction selector is a three position control lever. (*Figure 12-19*). Moving the control lever selects forward, neutral, or reverse direction of travel. A back-up alarm sounds when reverse is engaged.

3.1.2 4K RT Lifting Controls

The 4K RT uses four individual lifting control levers, located on the right instrument panel, to rotate, lift, shift, and tilt loads. Each lever is spring loaded, which brings the lever back to a neutral or centered position when released. Each lever also has a corresponding label located to the left of the control lever (*Figure 12-19*).

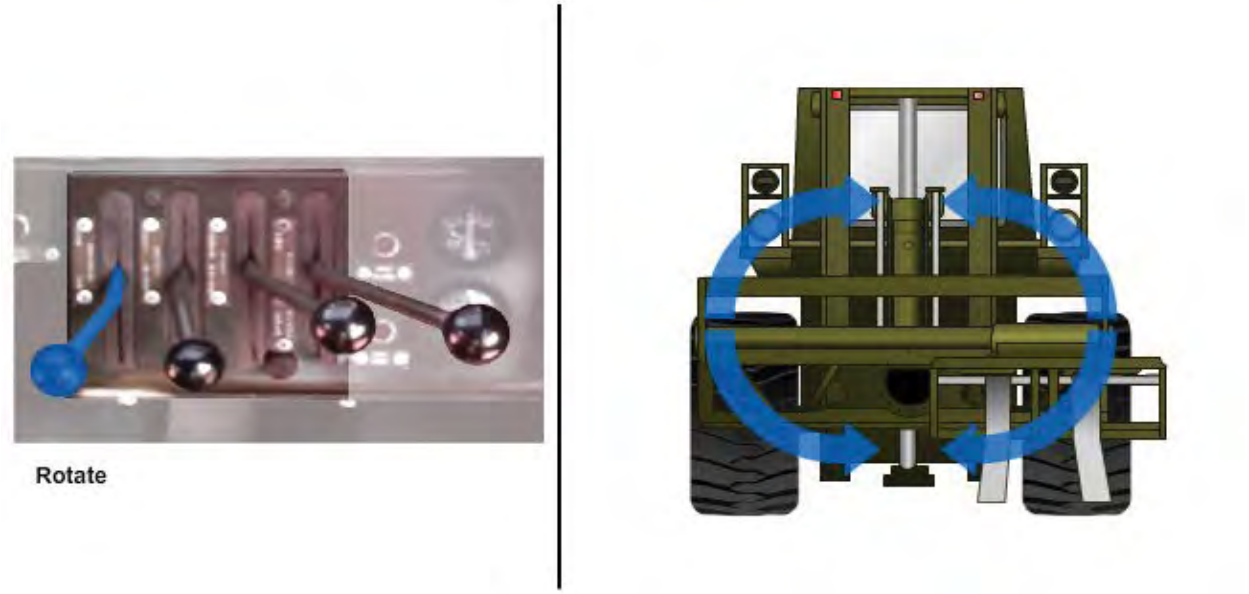


Figure 12-19 – 4K RT lifting controls.

The rotate control lever rotates the forklift carriage. Holding the lever in the forward position rotates the carriage clockwise, and holding the lever down rotates the carriage counterclockwise.

The lift control raises and lowers the carriage. Holding the lever in the forward position lowers the carriage and holding the lever down raises the carriage.

The shift control lever moves the forks left and right on the carriage. Holding the lever forward moves the forks to the left, and holding the lever down moves the forks to the right.

The tilt control level actuates hydraulic cylinders mounted to the forklift frame and mast. Holding the lever forward tilts the mast forward and holding the lever back tilts the mast back.

3.1.3 4K RT Brake and Throttle Controls

The 4K RT brake and throttle controls located on the floor of the operator cab include the declutch pedal, service brake pedal, and accelerator (*Figure 12-20*). Each spring loaded control is actuated by the pressing action of the operator's feet.

Pressing the declutch pedal applies the service brake and shifts the transmission into neutral regardless of the position of the direction selector. Releasing the pedal releases the service brake and returns the transmission to the range selected on the direction selector.

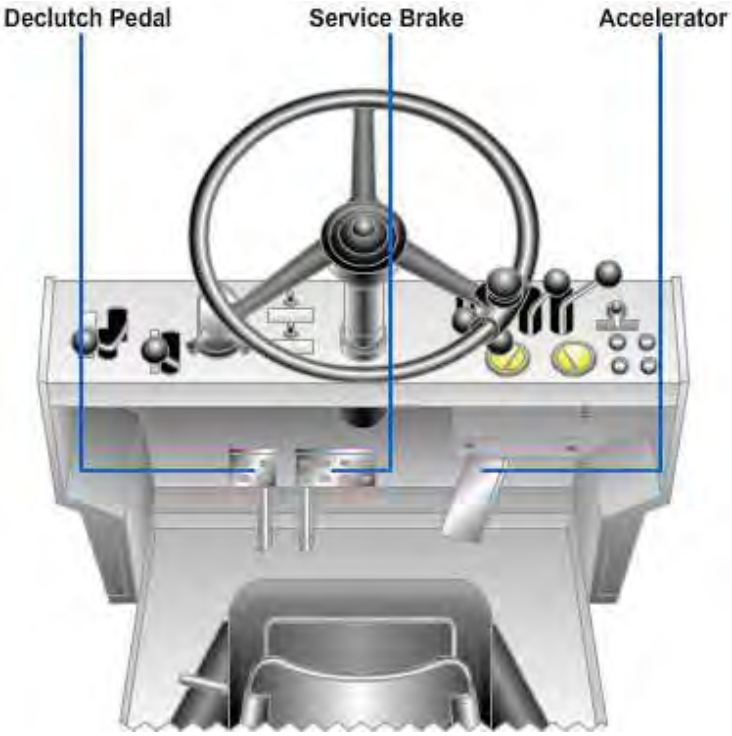


Figure 12-20 - 4K RT brake and throttle control.

The Service brake pedal actuates the shoe and drum hydraulic brakes on each wheel to slow or stop the forklift.

The accelerator controls engine speed.

3.2.0 MMV Controls

Many of the controls used to operate an MMV are very similar to the controls used to operate a conventional rough terrain forklift. However, with the advent of new technology, the MMV employs control features that may be new to many forklift operators. This section describes transmission controls, lifting controls, and brake and throttle controls.

3.2.1 MMV Transmission Controls

MMV transmission direction and speed selection are integrated into one control lever located on the left side of the steering column (*Figure12-21*).

Figure 12-21 – 11K MMV direction RT and speed control.

Direction selection of forward/neutral/reverse is

achieved by moving the level up and down.

Speed selection is achieved by twisting the grip end of the level. The speed selector range is one through four. The transmission has four forward gears and three reverse gears. The first gear has the highest torque and pulling power. Higher gears are used for higher ground speeds.

NOTE

Shifting to the next higher gear may be done while the vehicle is in motion.

CAUTION

When downshifting, allow the engine speed to slow down before shifting to the next lower gear.

Figure 12-22 – 11K MMV joystick lifting controller.

3.2.2 MMV Lifting Controls

Unlike conventional forklifts which use several control levers to operate the mast assembly, the MMV uses one multi-function joystick located to the right of the operator to control the mast assembly operations (*Figure 12-22*).

The joystick is equipped with four buttons that enable it to operate in three specific modes. Three buttons are located on the top of the joystick and one under it. The joystick controls boom movement, attachment tilt, and frame sway control. The logic panel located in front of the joystick illuminates the specific mode with the movement of the joystick and the selected buttons.

Two functions can be accomplished at the same time by moving the joystick in between quadrants. The speed of the function is dependent on the amount of input or travel placed into the joystick. Increasing the engine speed also increases the function speed.

NOTE

Be aware that joystick modes will change immediately upon depression or release of any button when the joystick is in an off-center position.

3.2.3 MMV Brake and Throttle Controls

MMV brake and throttle controls are located on the floor of the operator cab. The MMV brake is located in the center of floor board and the accelerator is located to the right.

Test your Knowledge (Select the Correct Response)

11. **(True or False)** The MMV uses the same type of lifting controls as conventional forklifts.

    A. True
    B. False

12. Which position on 4K RT speed selector provide the greatest pulling power

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

4.0.0 ATTACHMENTS

Attachments provide versatility which allows a forklift to work more effectively and efficiently. However, it must be remembered attachments can affect and reduce the capacity of a forklift by altering the center of gravity of a load.

4.1.0 Fork Extensions

Forklift extensions also known by the term tine (fork) extender are designed in two configurations: bare tine extender and rollerized tine extenders (*Figure 12-23*).

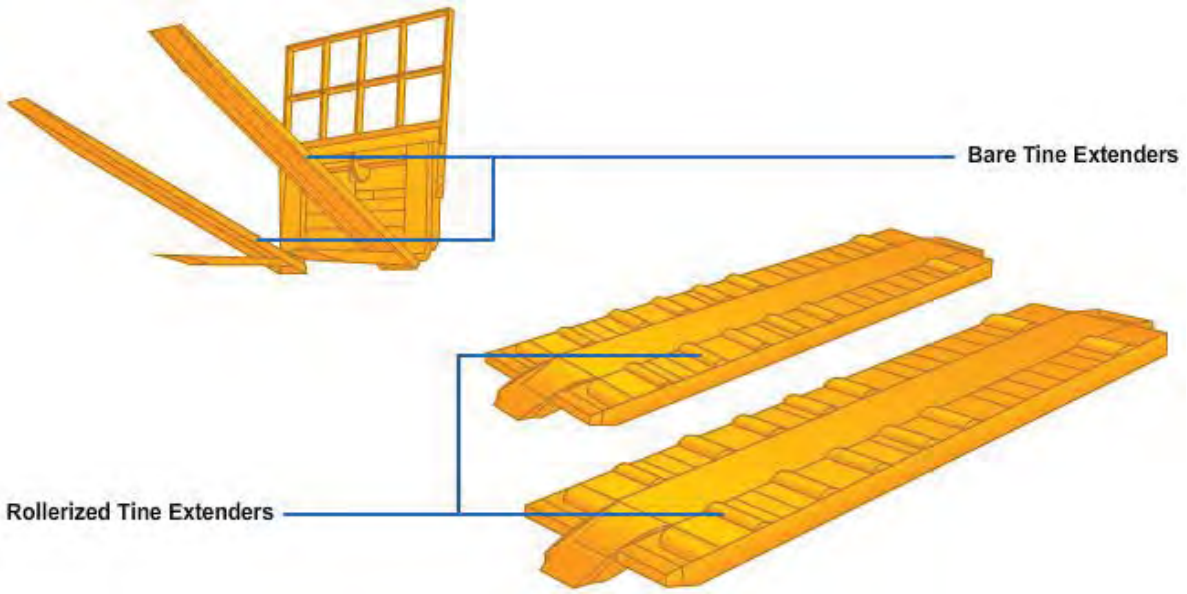


Figure 12-23 – Forklift extensions.

An extender provides additional length to the forklift tines, which eases the loading of tractor-trailers and Air Force 463L pallets (*Figure 12-24*). The extender moves the center of the gravity of the load outward from the forklift, thus reducing the weight it can lift. The operator must be aware of these restrictions when using the extensions to handle large or bulky loads.

4.2.0 Drum-Handling Attachment

The forklift drum handling attachment is used to lift, move and handle filled 55 gallon drums. NCF uses three drum handling attachments (*Figure 12-25*).

The first is mounted to the carriage, which uses specially shaped and spaced forks design to cradle up to 3 fully loaded drums.

The second attachment is mounted on the forks and consists of side rails with specially designed hooks suspended at the front and rear. This attachment is lowered over the drums until the hooks drop into position over the drum rims.

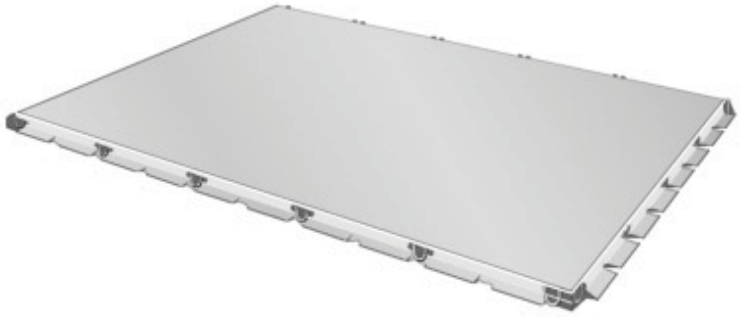


Figure 12-24 – 463L Cargo Pallet.

The drum-handling attachment is vertically operated and handles one filled drum at one time.

Figure 12-25 – Forklift drum attachments.

Test your Knowledge (Select the Correct Response)

13. **(True or False)** A forklift attachment may reduce the capacity of the forklift by changing the center of gravity of the load.

    A. True
    B. False

14. Which of the following forklift attachments is used when handling Air Force 463–L pallets?

A. Crane boom
B. Pallet handling
C. Drum handling
D. Fork extension

5.0.0 CENTER of BALANCE

Understanding center of balance is a critical safe forklift operation. On most forklifts, the center of balance (C/B) is located under the operator's seat, as shown in *Figure 12-26*.

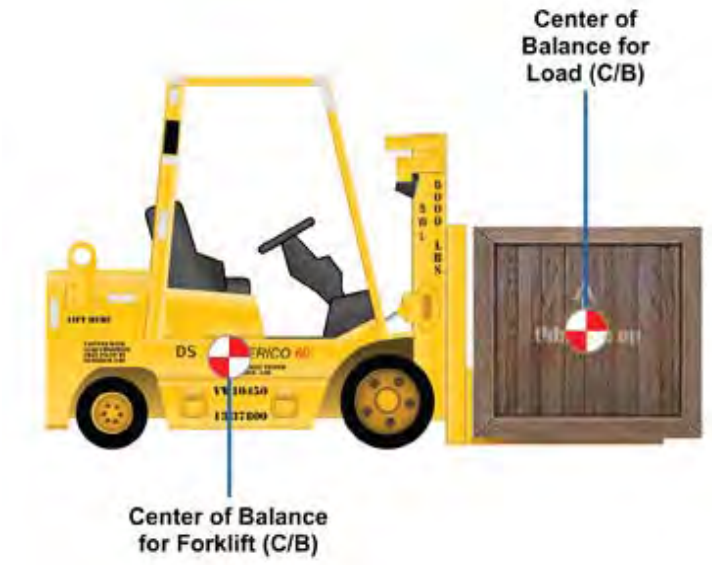


Figure 12-26 – Forklift center of balance.

Lifting a load creates a combined center of balance (C C/B), as shown in *Figure 12-27*.

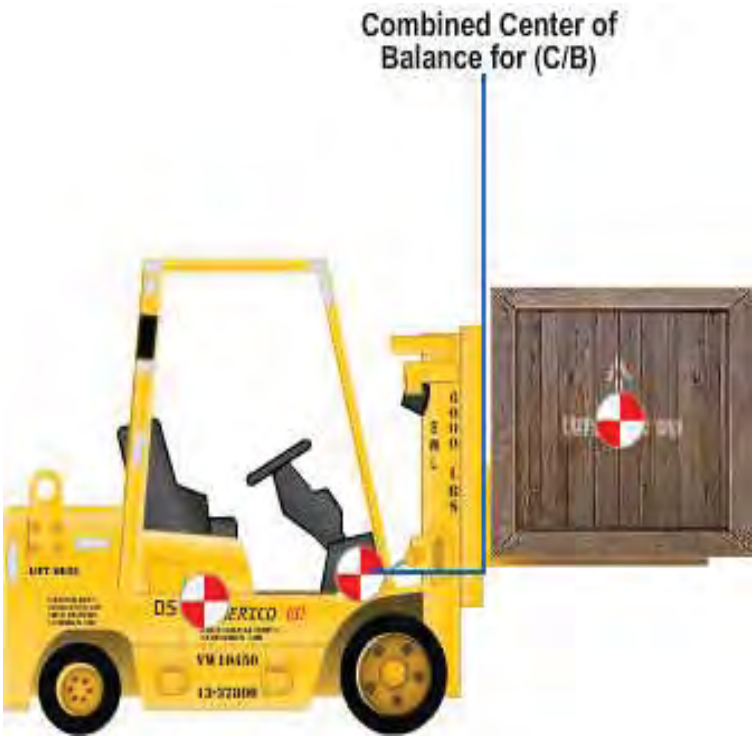


Figure 12-27 – Forklift combined center of balance.

Raising the load changes the C C/B, as shown in *Figure 12-28*.

Figure 12-28 – Forklift combined center of balance with a load.

⚠ CAUTION ⚠

A forklift is designed to lift its maximum capacity with the load centered on the forks, not with the tip of the forks.

The operator should know where the center of balance (C/B) is before lifting any load. If the C/B is to one side as shown in *Figure 12-29*, the load can flip off the forks when lifting, positioning or moving.

Figure 12-29 – Forklift center of balance to the side.

The load C/B should be centered and positioned as far back as possible on the forks (*Figure 12-30*).

Figure 12-30 – Forklift center with centered load.

Test your Knowledge (Select the Correct Response)

15. On most forklifts, the center of balance (C/B) is at what location?

A. Above the rear axle
B. Above the front axle
C. Under the operator's seat
D. Under the engine compartment

6.0.0 TECHNICAL TERMS USED in OPERATIONS

Every industrial operation uses unique terminology or vocabulary, the same is true for forklift operations. The following terms are used to describe forklift mast operational dimensions.

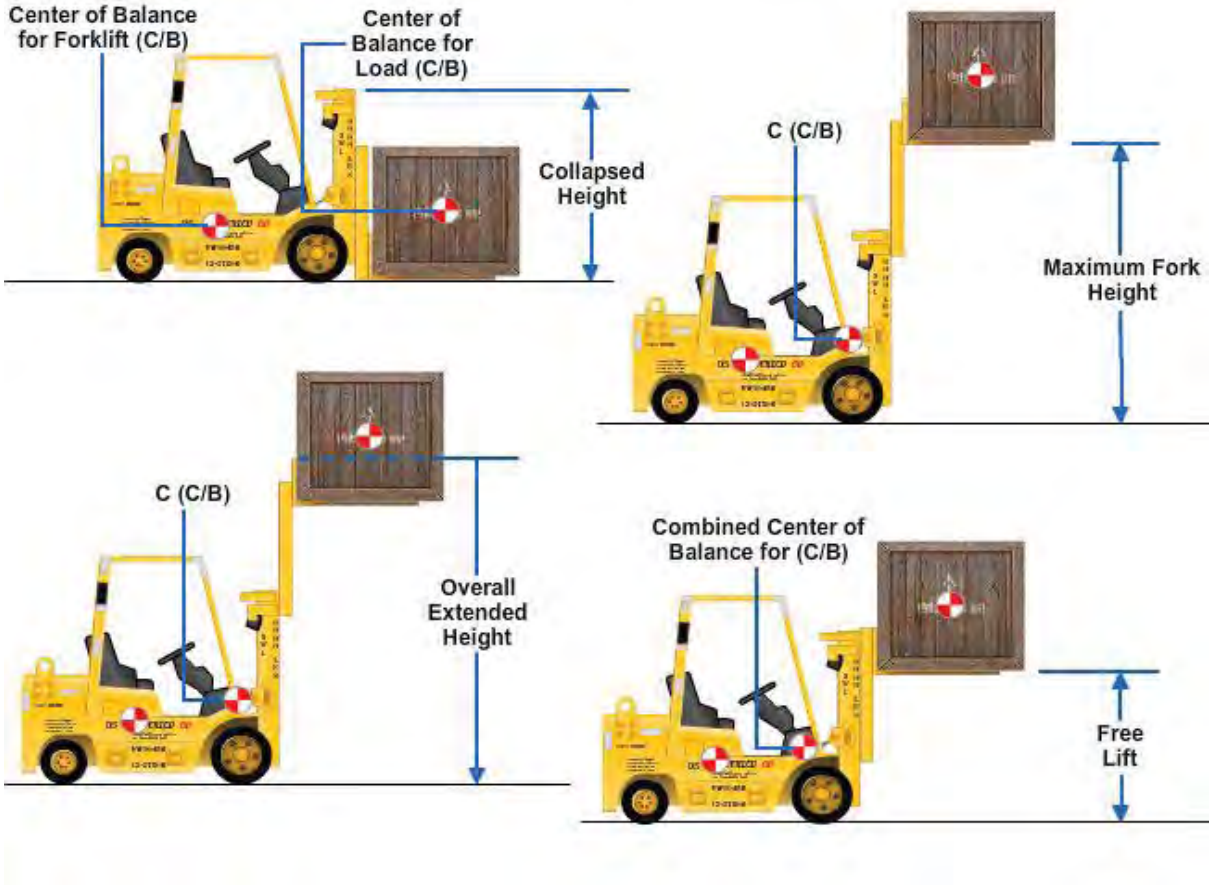


Figure 12-31 – Technical forklift operation terms.

6.1.0 Collapsed Height

Collapsed height is the distance from the floor/ground to the top of the mast when the forks are in their lowest position (*Figure 12-31*).

6.2.0 Maximum Fork Height

Maximum fork height is the distance from the floor/ground to the top of the forks when the mast is fully raised (*Figure 12-31*).

6.3.0 Overall Extended Height

Overall extended height is the distance from the floor/ground to the top of the load backrest extension when the mast is fully raised (*Figure 12-31*).

6.4.0 Free Lift

Free lift is the distance the forks may be raised before the collapsed mast height is increased (*Figure 12-31*).

Test your Knowledge (Select the Correct Response)

16. Which term is used to describe the maximum forklift assembly height?

    A. Collapsed Height
    B. Maximum Fork Height
    C. Overall Extended Height
    D. Free Lift

7.0.0 PRINCIPLES of OPERATION

Forklifts operate on the simple principle of a fulcrum. A load on the forks must be counterbalanced by the counterweight and weight of the forklift. The fulcrum, or pivot, is the center of the wheel or drive axle (*Figure 12-32*).

A forklift must be physically small and compact to work in confined areas, yet large enough to provide working space for both the operator and maintenance personnel. It must handle maximum loads and stack them safely and still have an upright, minimum load, and collapsed height to maneuver in areas with low-overhead clearance. It must be able to negotiate inclines, either empty or loaded.

Figure 12-32 – Forklift operates as a fulcrum.

7.1.0 Operations

Before operating a forklift, an operator must have proper authorization and possess a thorough understanding of the operator's manual and safety precautions. A qualified operator should guide an inexperienced operator through several operating and load-handling iterations before the novice operator operates the forklift without supervision. Basic education in safe operation and load-handling techniques is absolutely necessary to ensure the proper operation. Education also teaches the operator to anticipate unexpected events that may occur as a part of normal forklift operations.

NOTE

A forklift is only as safe as its operator. Only authorized, properly trained and licensed personnel are permitted to operate it.

7.1.1 Picking up a Load

Typically, most loads handled by forklifts are palletized or in boxes. A standard pallet is 40 by 48 inches (*Figure 12-33*). Mount-out boxes consisting of several different sizes also have stringers on the bottom similar to pallets allowing fork access.

Figure 12-33 – Standard wooden pallet.

Use the following technique to lift palletized materials:

1. Position the forklift squarely in front of the load and raise the forks to the proper level, halfway between the top and bottom boards of the pallet.
2. Slowly insert the forks into the pallet until the load rests against the fork faces. If the mast is not in a vertical position, the forks may hang up in the pallet when they are inserted.

NOTE

If the pallet or load is against a wall or obstruction and the forks are longer than the pallet, you will have to pick up the pallet and back up the forklift until there is enough room to reposition the forks entirely under the pallet.

3. Lift the load just enough to clear the floor (or stack beneath the load being removed). Then tilt the mast or forks back enough to cradle the load. The load should always be carried as low as possible for maximum stability and vision.

WARNING

Overloading a forklift is strictly prohibited. The forklift can safely lift and carry no more than its rated capacity. Among the dangers of overloading include injury to the operator, damage to the cargo, and damage to the pump and lift mechanism. Additionally, overloading causes wear on the tires, engine, or electric motor. Also, a forklift will tip forward if the load on the forks exceeds the lift capacity of the forklift. The manufacturer has established the forklift rating (expressed in pounds of load on the fork) and the allowable distance in inches from the heel of the forks to the center of gravity of the load. This distance is known as the load center.

7.1.2 Traveling with a Load

Carrying material with a forklift to move it from one location to another requires skill and concentration. The techniques for carrying loads with a forklift are as follows:

Tilt the mast as far back as the load will permit when carrying a load, and raise the load only high enough to clear obstructions. Always change speed gradually, as sudden starts and stops will cause the load to shift. Gradual starts and stops also prevent rapid wear of equipment components.

Always know the ground clearance of the forklift truck and the traveling surface.

NOTE

If the load is so bulky that vision is obstructed, drive in reverse. Be sure to take extra care when driving in reverse, because you do not have a constant view of the load; therefore, you usually need a backing guide.

Figure 12-34 – Forklift travel on an incline.

Ascend and descend a grade with the load pointing upgrade when operating a loaded forklift on an incline (*Figure 12-34*). Normally, the direction of travel is determined by the direction the operator can see best. This is why forklifts are built with reverse as well as forward travel. On grades of 10 percent or more, both forklift and load stability demand the load be kept upgrade.

Handle each load within the rated capacity of the forklift. The rated capacity is the weight the forklift can handle safely. The forklift data plate rating indicates the maximum safe load that can be lifted. The forklift data plate rating indicates the maximum safe load the forklift can lift (*Figure 12-35*). Never exceed the maximum rating.

Figure 12-35 – Forklift data plate.

However, there are conditions when the safe working load needs

to be much less than the maximum rated capacity. The data plate rating does not apply for weak floors, uneven terrain, special load-handling attachments, or loads with a high center of gravity. Under these conditions, the safe working load is well below the rated capacity.

Under special conditions, reduce the load to maintain forklift stability.

Only handle stable loads. Many loads are made up of unstable items that can be easily dislodged. This rule is critical to operator safety when the forklift is not equipped with an overhead guard or roll over protection structure (ROPS).

Center the weight of wide loads between the forks; otherwise, the load may topple off the forks when turning a corner or hitting a bump.

Watch “swing” when handling long loads. Failure to watch clearance at the ends of the load can cause you to strike persons or objects (*Figure 12-36*).

Keep the load against the carriage by maintaining a slight backward tilt.

Do not travel with the load raised higher than 6 inches from the floor/ground until ready to deposit the load. Carrying elevated loads reduces forklift stability.

Drive carefully, observe all traffic rules and maintain full control of the forklift at all times.

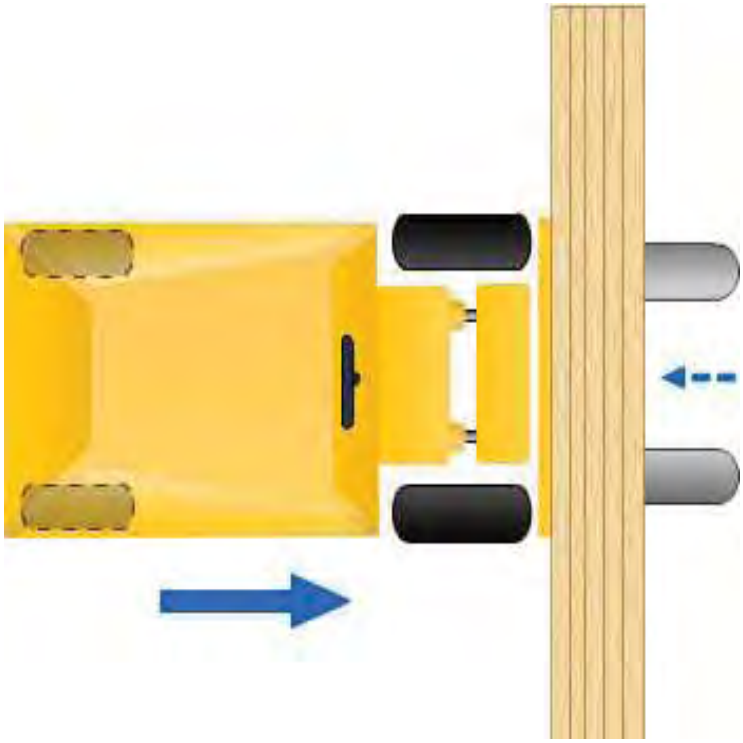


Figure 12-36 – Forklift carrying a wide load must watch for swing.

7.1.3 Placing a Load

When loading and stacking material, move the forklift truck forward until the load arms are entirely under the load to be lifted. Ensure the load is centered on the arms and that it is well-seated against the face of the lifting carriage. When picking up round objects, first tilt the carriage forward so the forks slide along the floor or ground under the object to be lifted (*Figure 12-37*). Then decelerate,

Figure 12-37 – Lifting round materials.

tilt backward, and accelerate until there is enough backward tilt of the mast to allow safe handling of the load.

NOTE

Lifting speed is controlled by the speed of the engine and the extent the control lever is pulled. Engine speed has no effect on lowering speed.

Never race the engine while hoisting a load. Too much engine speed will not increase the speed of the hoisting mechanism but may result in fast wear and possible damage to the engine. From practice and experience, you will be able to determine the best hoisting speed by sound, sight, and feel. When a load has been raised to the desired height, ease the hoist lever to the neutral position and move the forklift to the base of the stack on which the load is to be placed.

Although a load maybe placed on or removed from a stack by using the hoist lever, operators will learn from practice that they can place or remove a load can entirely with the tilting mechanism. The tilting mechanism is designed to raise the load arms slightly, as the mast is tilted backwards.

Practice raising the load while the forklift draws near the stack to reduce strain on the engine and the brakes. Study the problem of load handling, and keep in mind that carefully planned operations produce the most work with reduced operator fatigue.

Lift and lower with the mast vertical or tilted slightly back. Tilt elevated loads forward only when they are directly over the unloading place. If the load or lifting mechanism is raised to pick up or deposit a load, reduce the tilt in either direction. Remember the side stability of the load and do not tilt back any farther than is necessary.

CAUTION

Under no condition should additional counterweights be added to any materials handling equipment to increase its stability or lifting capacity.

7.1.4 Unloading a Flatbed Truck

Use the following procedure when unloading a flatbed truck:

1. Position the forklift at either side of the truck bed.
2. Manipulate the control levers to obtain the appropriate fork height and angle.
3. Drive the forks into the pallet opening or under the loose material. Use care not to damage any material.
4. Adjust the control as required to lift the material slightly off the bed.
5. Tilt the forks back to keep the pallet or other materials from sliding off the forks.
6. Retract the boom or back the forklift away from the truck.
7. Lower the forks to the travel position and move material to desired area.
8. Position the forklift so the material can be placed in the desired area.
9. Lower the boom until the material set on the required surface.
10. Adjust the forks with boom lever to relieve the pressure under the pallet.
11. Slowly back the forklift away from the pallet.
12. Repeat the cycle until the truck is unloaded.

7.1.5 Changing Attachments

Some forklifts, particularly telehandlers, use a coupler system which allows an operator to easily change attachments. The coupler is activated with switches located next to the steering wheel or on some models the coupler is controlled with a joystick after the switch is activated.

Before detaching the forks from the forklift, the hydraulics need to be disengaged. Typically, there is a diverter valve on the hydraulic hoses which must be closed. Check the operator's manual for the correct procedures. If an attachment is not secured properly, it can fail, causing property damage and significant injury.

WARNING

The hydraulic system is under pressure. Follow the safety procedures listed in the operator's manual for relieving pressure before disconnecting hydraulic hoses. The release of fluids under pressure can cause significant injury.

To attach the coupler to the fork or other attachments, position the coupler in line with the attachment. Tilt the coupler forward so that it is below the level of the hooks. Move the forklift forward or extend the boom until the coupler contacts the carriage. Tilt the coupler back until the lower part of the carriage contacts the coupler, and then secure the attachment to the coupler.

Test your Knowledge (Select the Correct Response)

17. What simple principle does a forklift operate on?

    A. Leverage
    B. Fulcrum
    C. Elevation
    D. Lifting

18. **(True or False)** A forklift can safely lift and carry no more than its rated capacity.

    A. True
    B. False

19. When carrying a load with a forklift, the forklift should ascend or descend inclines in what manner?

    A. With the load pointing downgrade
    B. With the load pointing upgrade
    C. With the load parallel to the grade
    D. With the load diagonal to the grade

20. When should more weights be added to the counterweights of materials–handling equipment to increase the stability or lifting capacity of the equipment?

    A. During weight tests
    B. During maximum lifts
    C. When traveling down inclines
    D. Never

8.0.0 SAFETY

Safety is a vital part of forklift operations. Many forklift safety practices are as simple and clear as those for driving the family automobile. However, because a forklift is a special machine not typically operated on a daily basis, an operator must exercise more caution and receive training to properly operate a forklift.

The techniques for safe forklift operations are as follows:

1. Avoid lifting or hitting anything that is likely to fall on you or other personnel in the area. A forklift equipped with an overhead guard or ROPS and a load backrest extension provides reasonable protection against falling objects. However, these safeguards cannot protect against every potential impact. A forklift without an overhead guard provides no protection. For this reason, never attempt to pickup any loose, unstable, or stacked load if it appears any part of the elevated load might topple through or over the top of the carriage or fall on anybody standing nearby. Avoid hitting certain objects, such as stacked material, that could become dislodged and fall. Do not move a forklift around with the load carriage elevated.

Figure 12-38 – Lifting platform.

2. Use a secured safety platform when lifting personnel. A forklift is built for only one person—the operator. Because of potentially hazardous conditions, it is unauthorized for anyone to ride on the forks of a forklift or hitch a ride in any manner. If a forklift is used to elevate workers, a safety platform must be secured to the forks. The platform is specially built and must be secured to prevent it from slipping on the forks. The platform should have a solid floor and handrails (*Figure 12-38*).
3. Keep arms and legs inside the operator's compartment.
4. The operator and all other personnel should keep clear of the hoisting mechanisms. NEVER PUT HANDS, ARMS, HEAD, OR LEGS THROUGH THE HOISTING MECHANISM. This rule applies to the operator and riggers. A rigger should not be near the load or hoisting mechanism while the operator is picking up, hoisting, or depositing a load.
5. Never allow anyone under the load.

6. Report damaged or faulty equipment immediately—do not operate an unsafe forklift. Never operate a forklift when it is not running properly.
7. Avoid bumps, holes, slick spots, and loose materials that may cause the forklift to swerve or tip over. Different forklift models are designed to operate under specific conditions. Although large forklifts can adapt to uneven ground, this does not mean a larger forklift cannot lose balance under unstable ground conditions. Select the smoothest areas when moving material.
8. Travel slowly in narrow aisles and around corners, especially blind corners. To help avoid collisions, sound the horn in advance.
9. Lower the carriage completely and set the parking brake before leaving a forklift. Block the wheels when parking on an incline or when working on the forklift. These rules apply under all conditions, even when leaving a forklift unattended for a moment. A driverless forklift does not have to move far in close quarters to cause serious injury.
10. Do not turn on an incline. For stability, do not drive a forklift along the side of an incline. Always keep either the rear end or front end of the forklift pointed up or down the slope.
11. Do not fill the fuel tank while the engine is running.
12. Sudden starts and stops cause premature wear of forklift part including axles, gears, and tires. Nearby personnel may also be injured and materials may be damaged by forklift sudden starts and stops.
13. The operator must anticipate restrictive clearance situations. The operator must be aware that the forks will sometimes protrude beyond the front of a load. This can result in striking objects or lifting or nudging other materials. The operator must be aware of overhead obstacles, as many serious mishaps have been caused by forklift carriage and overhead guards striking pipes, beams and other overhead objects. When operating forklifts with rear axle steering, the operator must monitor the tail swings as they can cause personal injury or property damage.

CAUTION

Failure to keep a careful watch in the direction of travel can result in property damage to or personal injury.

Test your Knowledge (Select the Correct Response)

21. **(True of False)** The operator should sound the horn as a warning when traveling with a forklift down narrow aisles and around blind corners.

    A. True
    B. False

Summary

This chapter presented information specific to material-handling equipment, also known as forklifts. While there are many different types of forklifts, the chapter addressed warehouse and rough terrain forklifts, those used to accomplish the NCF mission.

In addition to describing the different forklift types, components, controls and attachments, this chapter addressed the center of balance principle unique to forklift operation. As is important with all equipment operation, this chapter included technical operation terms, and principles of forklift operation. Finally and most importantly, this chapter addressed safe forklift operation.

Review Questions (Select the Correct Response)

1. Which of the following components on a warehouse forklift permits loads to be lifted beyond the height of the collapsed mast?

   A. Fork extension
   B. Boom extension
   C. Telescopic mast
   D. Counterweight

2. What term is used to describe the height the forks can raise before the inner slides move upward from the mast to increase the overall height?

   A. Immediate lift
   B. Free lift
   C. Chain lift
   D. Max lift

3. What is the function of the axle disconnect lever on the 4K forklift?

   A. Disconnects transmission output to the front axle only
   B. Disconnects transmission output to the rear axle only
   C. Disconnects front and rear axle steering
   D. Disconnects transmission output to the front and rear axle

4. **(True or False)** On the 4K forklift, the steering bypass valve allows the front chassis to pivot freely on the rear chassis when towing the forklift.

   A. True
   B. False

5. **(True or False)** The safety pin must be installed when the 4K forklift is being towed.

   A. True
   B. False

6. What is the maximum travel speed when towing the 4K forklift?

   A. 55 mph
   B. 45 mph
   C. 35 mph
   D. 25 mph

7. **(True or False)** The inching pedal on the lift–king forklift should be used as a clutch pedal during normal operations.

   A. True
   B. False

8. What part of the forklift performs as the fulcrum?

   A. The counterweight
   B. The drive axle
   C. The hoist cylinder
   D. The forks

9. _____ _____ is the distance from the floor/ground to the top of the load backrest extension when the mast is fully raised.

   A. Collapsed Height
   B. Maximum Fork Height
   C. Overall Extended Height
   D. Free Lift

10. **(True or False)** When carrying a load with a forklift, the operator should always carry the load as high as possible to obtain maximum stability and vision.

    A. True
    B. False

11. **(True or False)** A forklift should be operated in reverse when a bulky load obstructs operator vision.

    A. True
    B. False

12. Which of the following is NOT a special condition that would require the operator to reduce the load weight a forklift is lifting?

    A. Weak flooring
    B. Uneven terrain
    C. Compacted surfaces
    D. Loads with a high center of gravity

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.

A Guide to Forklift Operator Training, North Carolina Department of Labor, Raleigh, NC, 2008.

Forklift Safety Guide State of Washington, Department of Labor and Industries, 2007

Industrial Truck Operator Training Guide, Oregon Occupational Safety and Health Division, Salem, OR.

Lifting Operator's and Service Manual, LK 16000, Mainline Construction Equipment, 7135 Islington Avenue, Woodbridge, Ontario, 1985.

MAC Affiliation Training Program, MAC Pamphlet 50-13, Department of the Air Force, Headquarters, Military Airlift Command, Scott Air Force Base, IL, 1987.

Operators Manual, Truck, Forklift, DED, Pneumatic Tire, Articulated Frame Steer, 4 K Rough Terrain, Army Model MHE 237, Headquarters Department of Army, Washington DC, 1990.

Rough Terrain Forklift Truck, Model M4KN (4,000 Pounds), J. I. Case Company, Racine, WI, 1989.

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Chapter 13

Front-End Loaders

Topics

To hear audio, click on the box. 

Overview

As an Equipment Operator in the Naval Construction Force (NCF), you will be tasked to perform various operations using a front-end loader.

This chapter provides you the information needed to successfully execute those operations. It describes the types of front-end loaders used by NCF and includes description of major components, controls, and attachments. In addition, this chapter explains how to perform front-end loader operations and list safety practices.

With this information and practice, you are on your way to becoming a great Equipment Operator.

Objectives

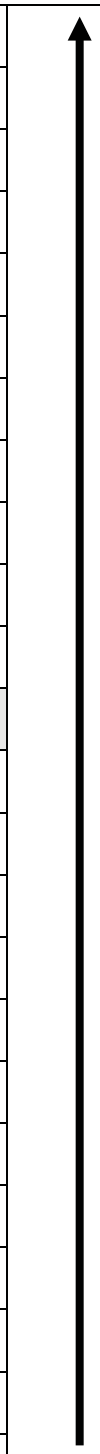
When you have completed this chapter, you will be able to do the following:

1. Understand the use of front-end loaders.
2. Identify types of front-end loaders used by NCF.
3. Identify the major components of front-end loaders.
4. Identify the controls on front-end loaders.
5. Identify front-end loader attachments and their use.
6. Understand how to perform front-end loader operations.
7. Understand front-end loader 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.

Miscellaneous Equipment		EQUIPMENT OPERATOR BASIC
Paving Operations and Equipment		
Rigging Operations		
Cranes		
Rollers		
Dozers		
Scrapers		
Graders		
Ditchers		
Excavators		
Backhoe Loaders		
Front-End Loaders		
Forklifts		
Truck Driving Safety		
Truck-Tractors and Trailers		
Tank Trucks		
Dump Trucks		
Medium Tactical Vehicle Replacements		
Earthwork Operations		
Electrical and Hydraulic Systems		
Chassis Systems		
Power Train		
Engine Systems		
Transportation Operations		

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 FRONT-END LOADERS

Front-end loaders, also simply known as loaders, are self-contained, diesel powered units mounted on rubber tires or tracks. They are characterized by a large bucket on front which the operator sits facing. The bucket is mounted on one or two lift arms activated by a hydraulic system. Front-end loaders are available in various sizes and capabilities. They are primary used for transporting and loading materials such as asphalt, dirt, and quarry rock into dump trucks; however, they can also be used to ***backfill*** ditches and create ***stockpiles***. The large bucket can be replaced with other attachments, such as forks to lift loads or a backhoe to excavate trenches. For this reason, front-end loaders are one of the most versatile and capable pieces of equipment used in the NCF.

1.1.0 Types of Front-End Loader Used By Naval Construction Force

The NCF uses three types of front-end loaders, the wheel front-end loader, skid steer loader, and crawler front-end loader.

1.1.1 Wheel Front-End Loader

The wheel front-end loader is mounted on large rubber tires that provide traction on unstable surfaces, allowing the wheel front-end loaders to perform on side slopes (*Figure 13-1*). The tires also provide relatively low ground bearing pressure which enables performance of a large variety of jobs. In addition, the tires permit the loader to travel from one job site to another under its own power. Wheel front-end loaders have a power-shift transmission, with forward and reverse gear ranges, that permits mobility while maintaining a high rate of production. The hydraulic system provides the operator positive control of the front-end attachment and assistance with articulated steering. The pivot point, which permits a tight turning radius, is located in front of the operator’s cab and the engine is located in the rear, behind the cab.

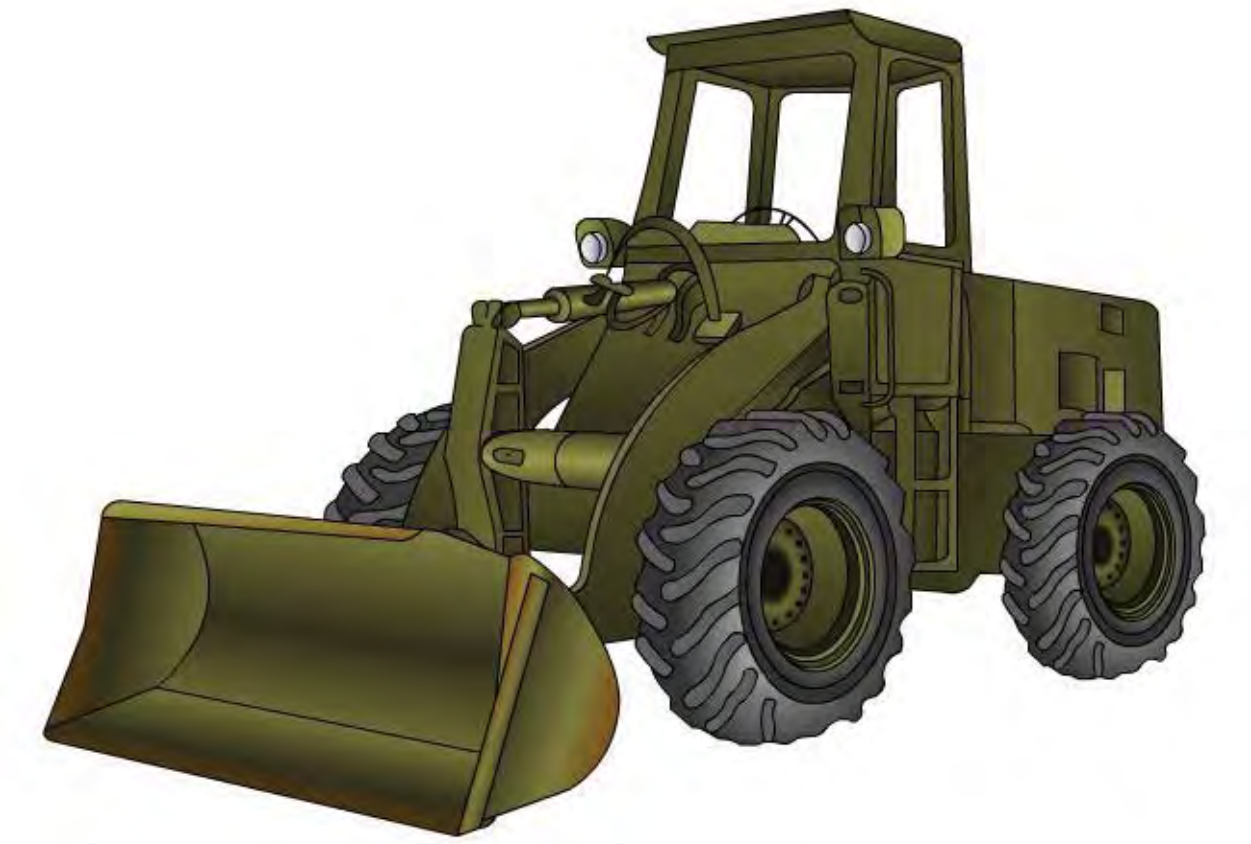


Figure 13-1 – Wheel front-end loader.

1.1.2 Skid Steer Loader

Like the wheel front-end loader, the skid steer is mounted on rubber tires; however, unlike the wheel front-end loader, it has a rigid frame (*Figure 13-2*). In addition, the skid steer is typically four-wheel drive with the left-side drive wheels independent of the right-side wheels. This allows the skid steer to maneuver in tighter places and rotate in place. On the skid steer loader, the lift arms are run alongside the operator's cab. The pivot point is located behind the cab, which is fully-enclosed. Skid steer loaders have attachments similar to those of a wheel front-end loader.

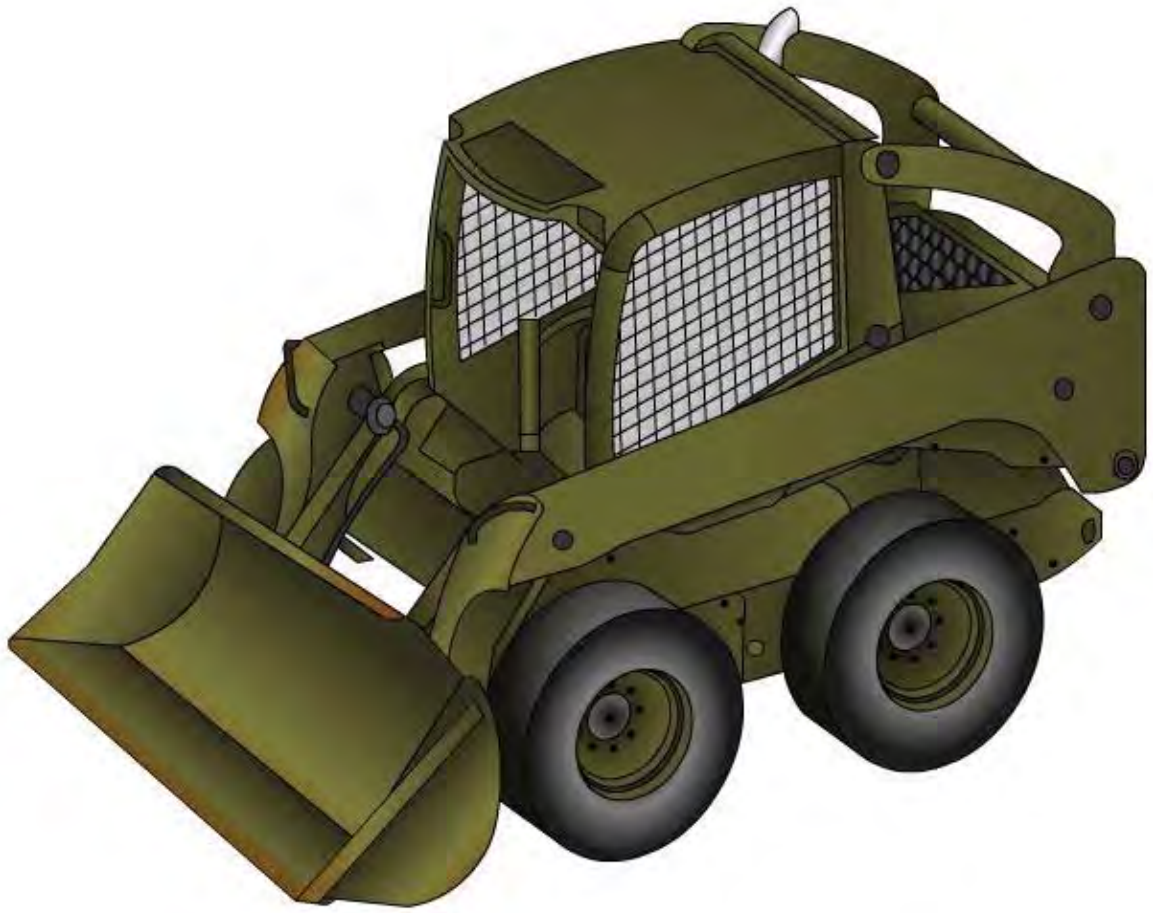


Figure 13-2 – Skid steer loader.

1.1.3 Crawler-Mounted Front-End Loader

The crawler-mounted front-end loader has tracks instead of tires (*Figure 13-3*). It has a low ground bearing pressure that enables it to operate in areas where the wheel front-end loader cannot go. It has an ***oscillating undercarriage*** that improves traction and stability and reduces frame impact. Its box-section main frame provides durability and resistance to twisting. The crawler-mounted front-end loader has a lower speed than a wheel loader. This decreases its mobility; however, it can be operated on greater side slopes than the wheel front-end loader. The crawler tracks are normally semi-***grouser*** shoes (*Figure 13-4*) that permit it to work on firm ground with little damage to the surface.

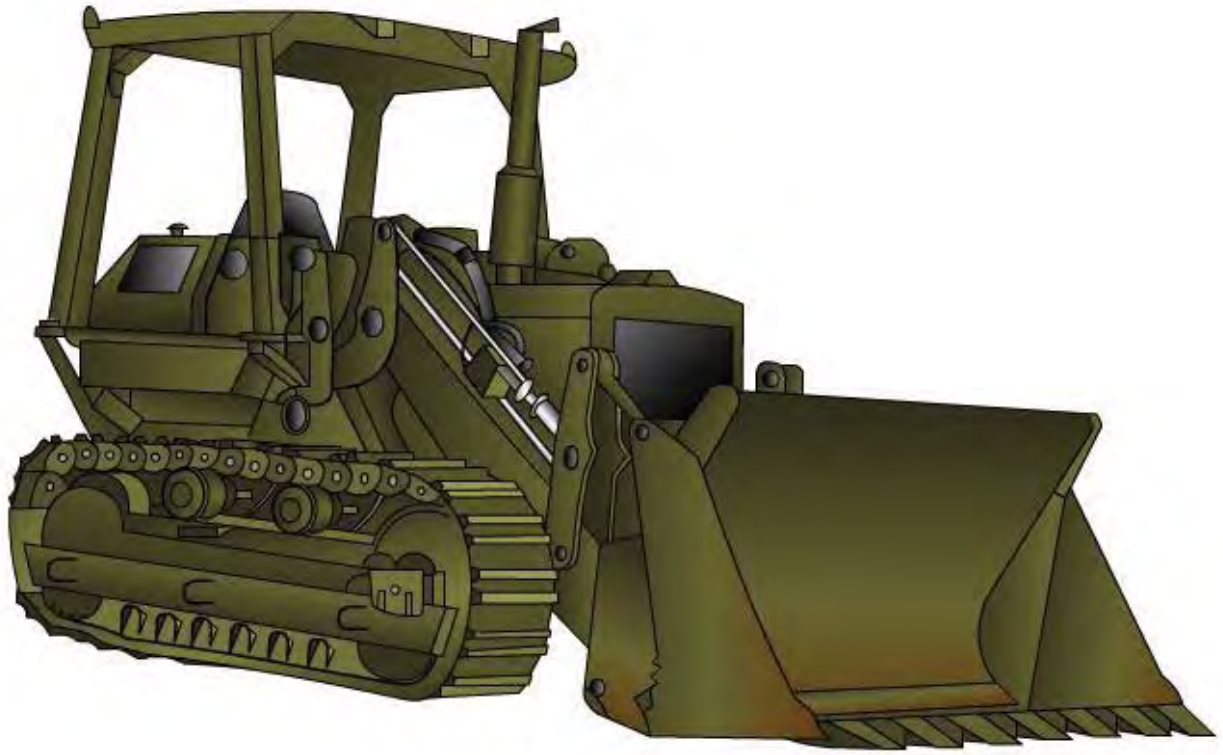


Figure 13-3 – Crawler-mounted front-end loader.

Figure 13-4 – Semi-grouser shoes.

Test your Knowledge (Select the Correct Response)

1. **(True or False)** Front-end loaders are primary used for transporting and loading materials.

   A. True
   B. False

2. **(True or False)** The crawler-mounted loaded can operate in greater side slopes than the wheel loader.

   A. True
   B. False

2.0.0 MAJOR COMPONENTS

Major components and controls on front-end loaders vary among the makes and models. You are responsible for reading the operator's manual for specific information. *Figure 13-5* shows the major components of a Caterpillar 924G wheel front-end loader.

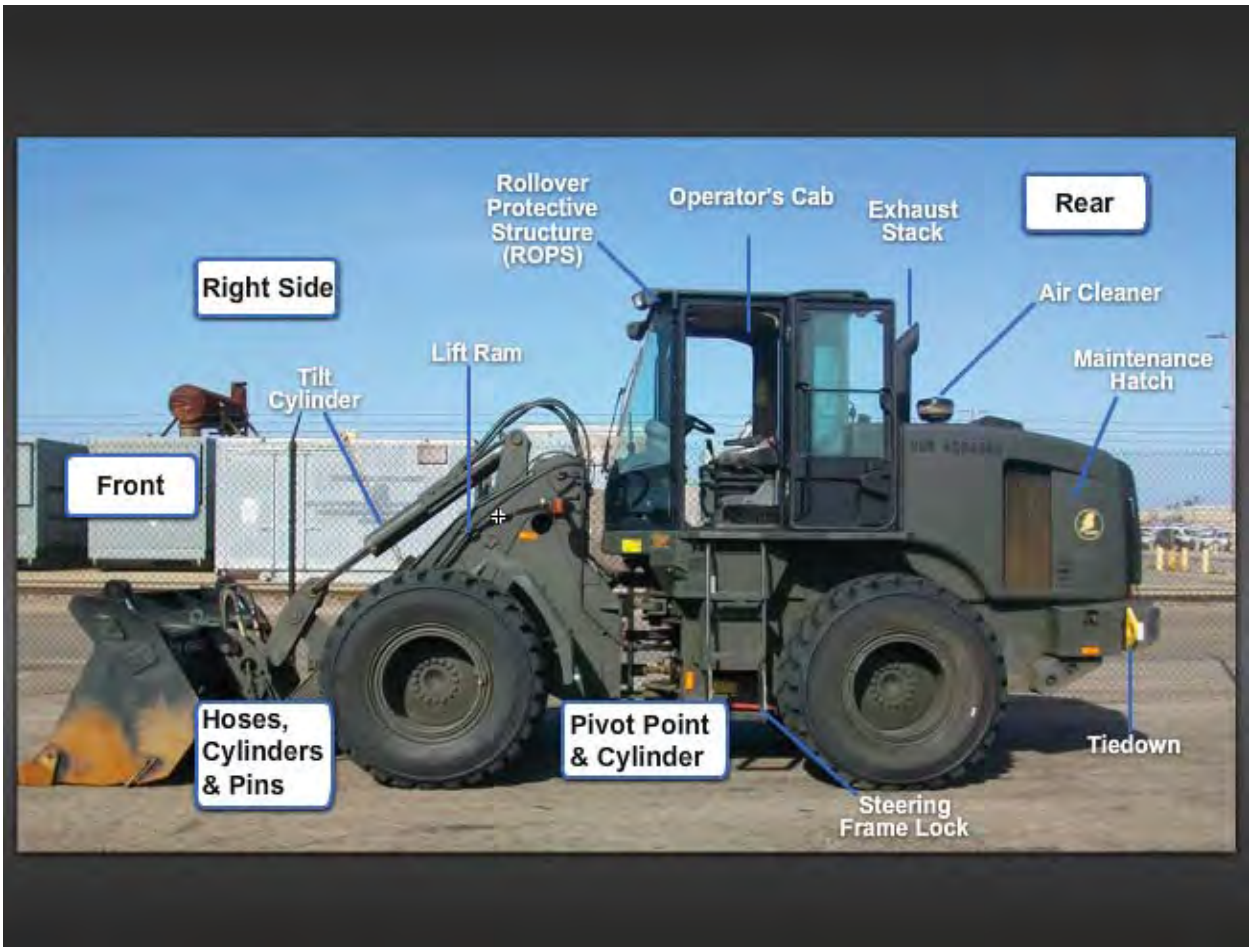


Figure 13-5 – Major components.

2.1.0 Operator’s Cab

The operator’s cab is the central location of most instruments and controls. It is fully enclosed by a rollover protective structure. This protects the operator, instruments and controls against harsh weather.

2.2.0 Rollover Protective Structure

The rollover protective structure (ROPS) is a removable bolt-on frame that provides the operator a safe environment in the event of a rollover.

2.3.0 Operator’s Cab

The operator’s cab is the central location of most instruments and controls. It provides the operator, instruments, and controls protection against harsh weather.

2.4.0 Engine

The engine is located in the rear of the front-end loader. It provides powers to the transmission and hydraulic system.

2.5.0 Air Cleaner

The air cleaner prevents dust and debris from entering the air induction system by filtering out such elements.

2.6.0 Exhaust Stack

The exhaust stack directs engine fumes away from operator.

2.7.0 Maintenance Access Hatch

The maintenance access hatch provides access to the engine.

2.8.0 Lift Arm

The Caterpillar 924G has a single piece boom-style lift arm to raise and lower the bucket or front attachment. The arm is mounted at the front of the frame and attached to the bottom of the attachment.

Some front-end loaders are equipped with a pair of lift arms to raise and lower the front attachment.

2.9.0 Lift Cylinders

The Caterpillar 924G has a pair of lift cylinders located under the lift arm. They are only seen when the lift arm is raised. Each lift cylinder is double acting to raise and lower the lift arm and subsequently the front attachment. The lift cylinders provide four lift positions: raise, hold, lower, and float.

2.10.0 Tilt Cylinder

Whereas some front-end loaders are equipped with a pair of tilt cylinders, the Caterpillar 924G has one large tilt cylinder attached to the top of the bucket. It is a double-acting hydraulic cylinder that provides three bucket tilt positions: back, hold, and forward (dump position).

2.11.0 Bucket

The bucket digs, lifts, and carries dirt. It can be changed out to accommodate other types of attachments. The bucket sits close to the front-end loader when it is in the down position, making the loader stable and compact for moving loads. As the bucket rises, it moves away from the loader and then straight up.

2.12.0 Lift Cylinders

The Caterpillar 924G has a pair of lift cylinders located under the lift arm. They are only seen when the lift arm is raised. Each lift cylinder is double acting to raise and lower the lift arm and subsequently the front attachment. The lift cylinders provide four lift positions: raise, hold, lower, and float.

2.13.0 Coupler Cylinders

The coupler system allows the operator to quickly change attachments without leaving the cab. A switch in the operator's cab activates the hydraulic coupler cylinders for positive tool engagement or disengagement.

2.14.0 Steering Cylinders

The Caterpillar 924G has a pair of steering cylinders that permit center-point articulation and a steering angle of 40° in each direction.

2.15.0 Steering Frame Lock

The steering frame lock prevents articulation when transporting the front-end load.

Test your Knowledge (Select the Correct Response)

3. The lift cylinders provide which of the following lift positions?

    A. Raise, lower, and hold
    B. Raise, lower, hold, and float
    C. Raise, lower, hold, and dump
    D. Raise, lower, hold, and tilt

4. Which of the following cylinders engages and disengages the front-end attachment?

    A. Tilt cylinder
    B. Lift cylinder
    C. Coupler cylinder
    D. Steering cylinder

3.0.0 CONTROLS

Front-end loaders have two types of controls; those that move the machine and those that operate the bucket or front attachment.

3.1.0 Steering Controls

The following section describes the steering controls on the Caterpillar 924G. Located on the right-hand side of the operator, these controls are shown in *Figure 13-6.*

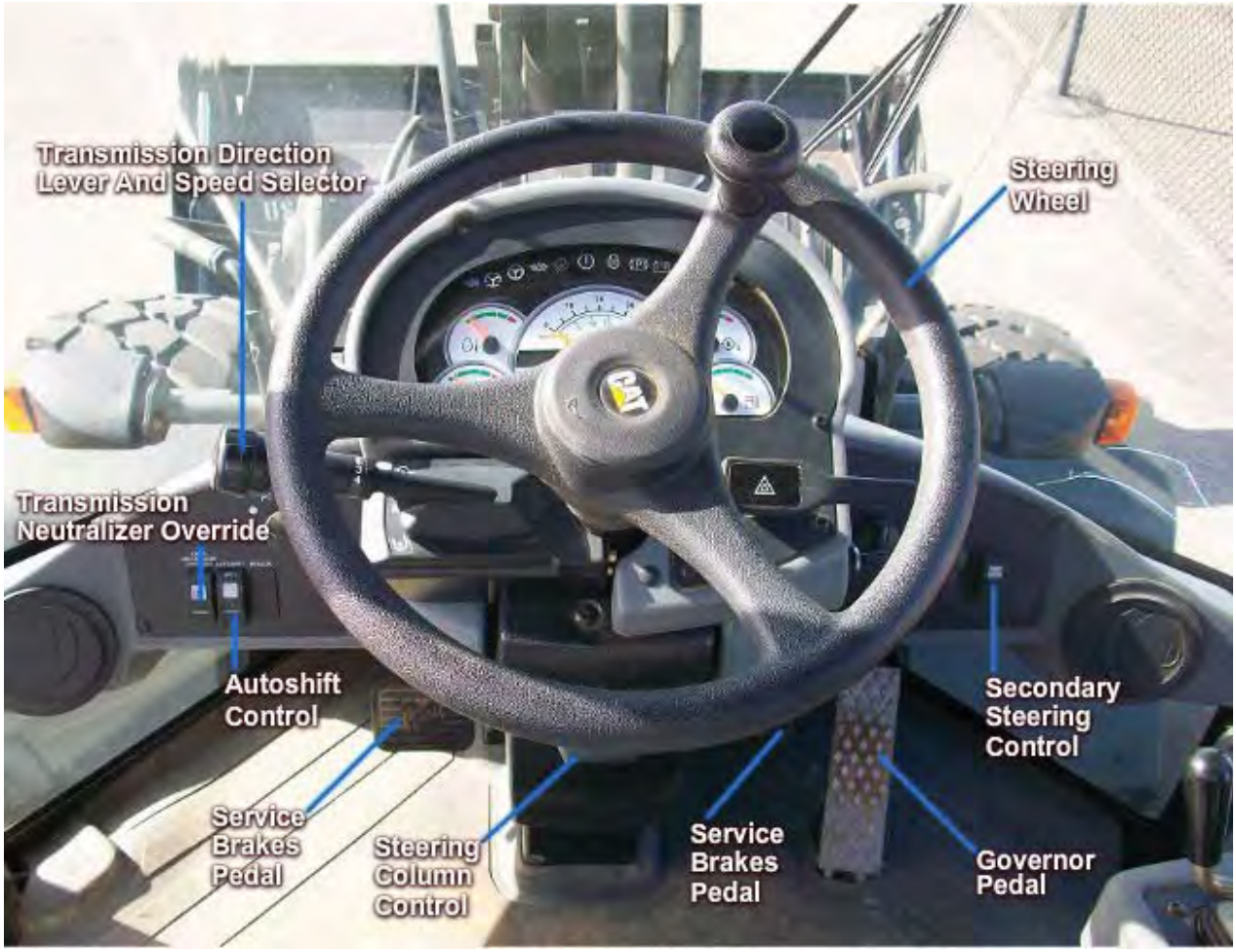


Figure 13-6 – Steering controls.

3.1.1 Steering Wheel

The Caterpillar 924G has a steering wheel to control steering direction. Only when the steering frame is unlocked, the loader will turn in the same direction as the steering wheel.

Not all front-end loaders have steering wheels; instead, some have joysticks to control steering direction. By moving such a joystick left, the loader will steer left. By moving it right, the loader will steer right.

3.1.2 Transmission Direction Lever

On the Caterpillar 924G, the transmission direction lever is located on the steering console.

- To move the loader forward, move the transmission direction lever up.
- To move the loader in reverse, move the lever down.
- When the lever is in the center (neutral) position, the loader should not move.

Figure 13-7 – Transmission direction control joystick.

Instead of having a transmission direction lever like the Caterpillar 924G, other types front-end loaders have a joystick like the one shown in *Figure 13-7*. These joysticks have a transmission control switch for forward, neutral, and reverse; however, they still use a steering wheel to control steering direction.

The John Deere 325 skid steer, does not have a steering wheel; instead it has a left and right steering lever (*Figure 13-8*). The right steering lever controls the right-side drive wheels. The left steering lever controls the left-side drive wheels.

Figure 13-6 – Steering controls

- To move the skid steer forward, at the same time push both the left and right steering lever forward.
- To move the skid steer in reverse, at the same time pull both levers back.
- To make a short turn, at the same time push one lever forward and pull the other lever back.
- To stop the loader, slowly return the levers to the center position.

3.1.3 Speed Selector

The speed selector is part of transmission direction lever on the Caterpillar 924G. Rotate the transmission lever to the desired speed: first speed, second speed, third speed, and forth speed.

3.1.4 Governor Pedal

Located on the floor of the operator's cab, the governor pedal controls the engine speed.

- To increase engine speed, press down on the governor pedal.
- To decrease speed, release the pedal.

3.1.5 Service Brake Pedals

The left and right service brake pedals slow down the loader's ground speed for normal braking.

3.1.6 Transmission Neutralizer Override

The transmission neutralizer override puts the transmission in neutral when the brake pressure reaches the pressure setting. This permits a faster engine speed, creating a better hydraulic response, which may be desired in order to raise the bucket while positioning the bucket at the same time. The transmission is held in neutral until the brake is released.

- When the switch is in the center position, the transmission neutralizer is enabled.
- To disable the transmission neutralizer, press down on bottom half.
- To enable the transmission neutralizer, press down on top half of the switch.

3.1.7 Steering Column Tilt Control

The steering column tilt control is used to adjust the steering column.

- Pull the steering column tilt lever and move the steering column to the desired position. Release the steering column tilt lever, and the steering column will remain in the desired position.

3.1.8 Autoshift Control

When the autoshift control is in the centered position, the transmission is in automatic mode. The loader's ***engine control module (ECM)*** will automatically upshift or downshift the transmission. When the bottom of the autoshift control is pressed down, the transmission is in the manual mode. The loader's ECM will shift the transmission into the speed the operator selects. The desired speed is selected on the transmission direction lever and speed selector. When the top of autoshift control is pressed down, the transmission is in the economy mode, allowing the transmission to operate in the same way as the automatic mode except that the transmission will shift at a lower engine rpm.

3.1.9 Secondary Steering Control

The secondary steering control engages the secondary steering system. This system provides steering control under the following conditions:

- The engine has been started and the start switch key is in the on position.

- The primary steering system has failed, causing low or unavailable steering oil pressure. In this case, an audible alarm will sound, and a light indicator will come on.

3.2.0 Loader Controls

The following describes the loader controls on a Caterpillar 924G. These right-side controls are shown in *Figure 13-9*.

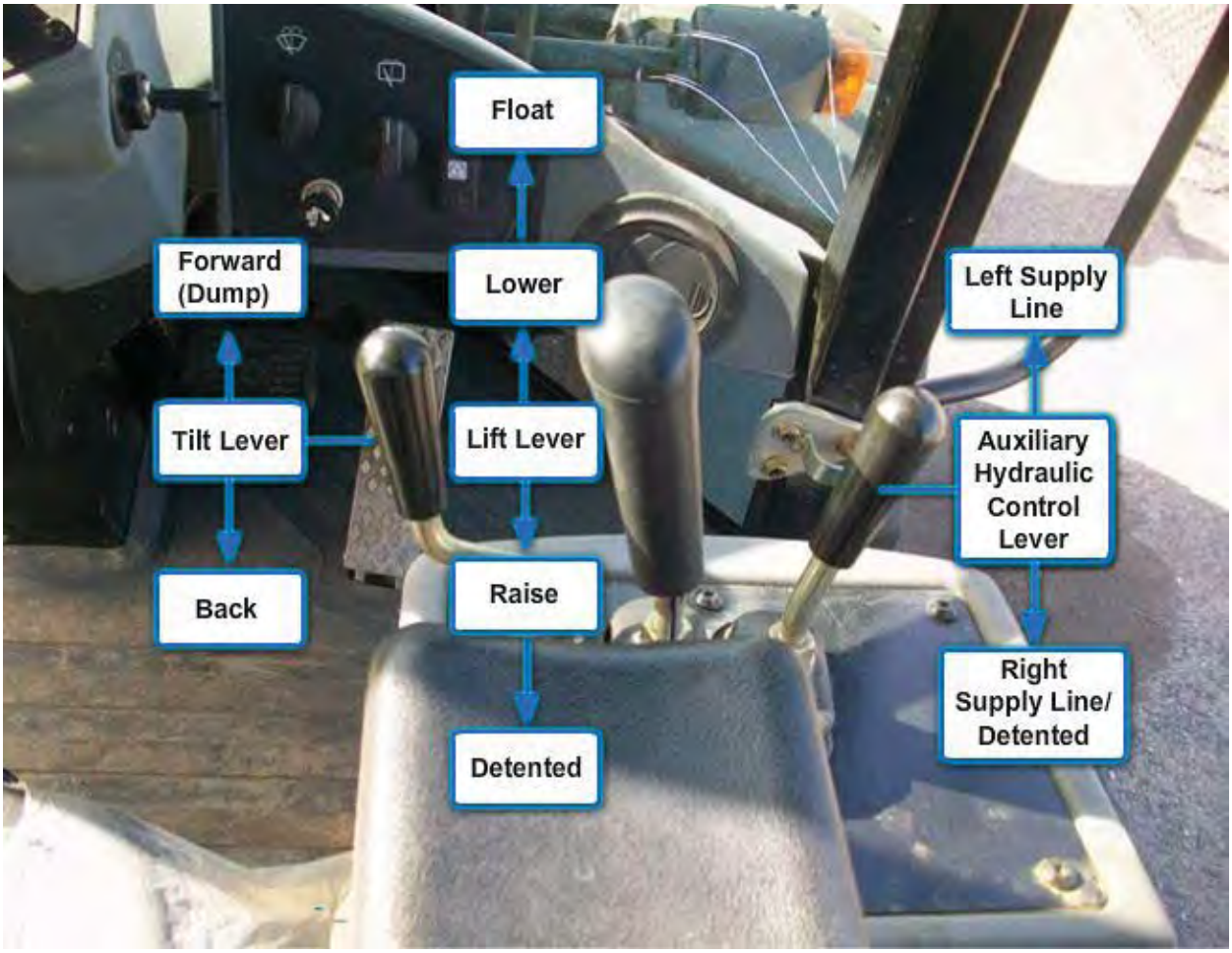


Figure 13-9 – Loader controls.

3.2.1 Lift Lever

The lift lever raises and lowers the front attachment, usually a bucket. On the Caterpillar 924G, this lever has the following positions: dump, hold, and tilt back.

- To lower the bucket, slightly push the lift lever forward.
- To lower the bucket so that it will float with the contour of the ground, completely push the lever forward until it locks in position by a ***detent***. The lever will remain locked until it is pulled out. Once released, it will return to the center position.

⚠ CAUTION ⚠

Never use the float position to lower a loaded bucket. Machine damage can result if a bucket falls too fast.

- To raise the bucket, slightly pull the lever back.

- When the lever is completely pulled back, it will lock in position. The lever will remain locked while bucket will continues to rise until it reaches the lift kickout height. Then, the lever will return to the center position.
- When the lever is in the center position, the up and down movement of the bucket is suspended.

3.2.2 Dump Lever

The dump lever tilts the bucket forward and back. On the Caterpillar 924G, this has four positions: forward, center, slightly and completely back.

- To tilt the bucket forward so that it dumps material out, push the dump lever forward.
- To tilt the bucket back, slightly pull the lever back.
- When the lever is completely pulled back, it will lock in position. The lever will remain lock while bucket will continue to tilt back until it reaches the preset location for the tilt kickout. Then, the lever will return to the center position.
- When the lever is in the center position, the tilt movement of the bucket is suspended.

Instead of having separate lift and tilt levers, some front-end loaders have a single joystick to lift and tilt the bucket.

The joystick in *Figure 13-10* has five vertical positions and three horizontal positions.

- To raise and lower the bucket, the joystick is moved in the same manner as the lift lever on the Caterpillar 924G; however, to tilt the bucket, the joystick is moved left and right.
- To tilt the bucket forward, move the joystick right.
- To tilt the bucket back, move the joystick left.

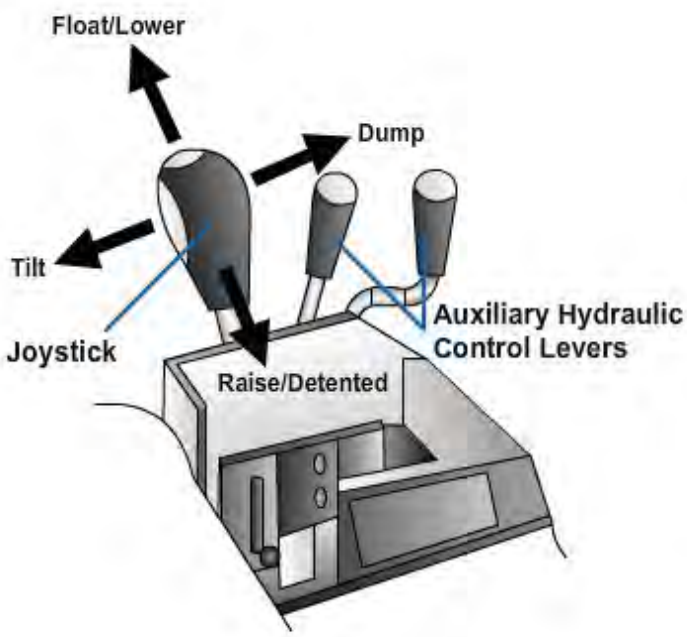


Figure 3-10 – Lift and tilt joystick.

The John Deere 325 skid steer does not have tilt or lift lever or a joystick. Instead, it has a left foot pedal that lifts the bucket and a right foot pedal that tilts the bucket (*Figure 13-11*).

- To raise the bucket, press down on the heel-end of the left foot pedal.
- To lower the bucket, slightly press down on the toe-end.

CAUTION

Operators must use caution because the bucket moves faster the farther the foot pedal is pressed down.

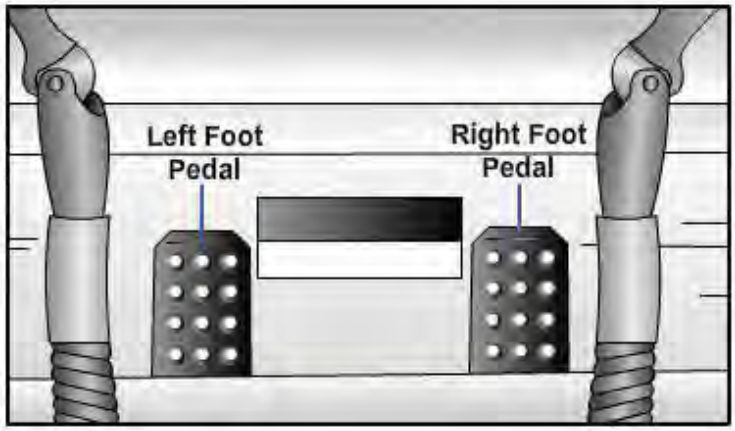


Figure 13-11 – Skid steer foot pedals.

- To float the bucket, completely press down on the toe-end of the pedal until it locks in position. The pedal will remain locked, until the heel-end is pressed down.
- Once released, the pedal will return to neutral-hold position, whereupon the up and down movement of the bucket will stop.

Figure 13-12 shows the left foot pedal in operation.

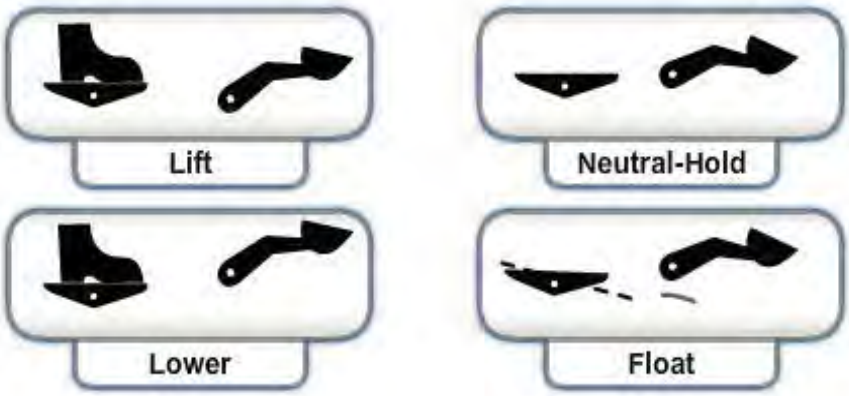


Figure 13-12 – Left foot pedal in operation.

- To tilt the bucket back, press down on the heel-end of the right foot pedal.
- To tilt the bucket forward, press down on the toe-end.
- Once released, the pedal will return to neutral-hold position, whereupon the tilt movement of the bucket will stop.

Figure 13-13 shows the right foot pedal in operation.

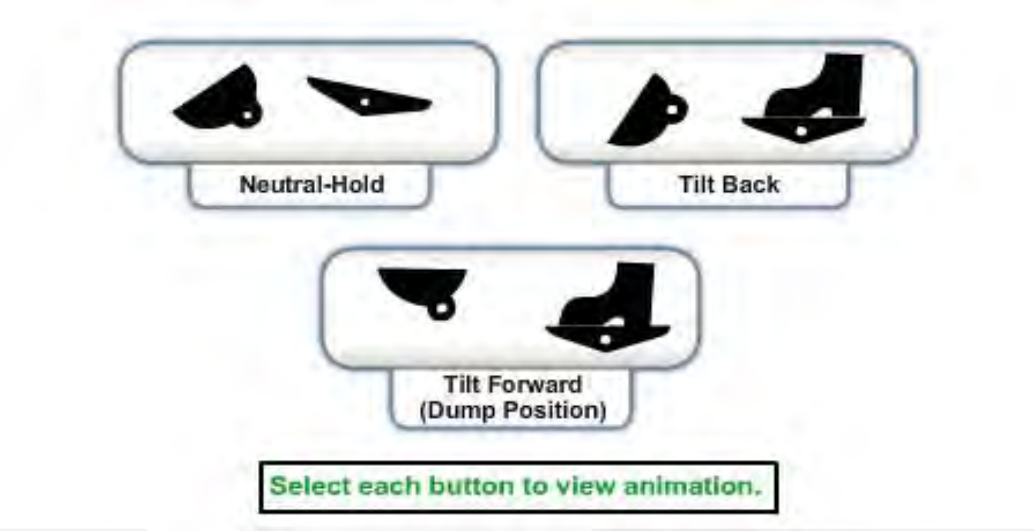


Figure 13-13 – Right foot pedal in operation.

3.2.3 Auxiliary Hydraulic Lever

The third lever on the Caterpillar 924G is the auxiliary hydraulic lever. It pressurizes the left and right supply lines in order to operate attachments, such as the clamshell bucket and forks.

- To pressurize the left supply line, push the auxiliary hydraulic lever forward.
- To pressurize the right supply line, pull it back. While the lever is retained in the back position, turn the auxiliary flow control clockwise to increase flow or counter-clockwise to decrease flow.
- When the lever is in the center position, neither the left or right supply line is pressurized.

NOTE

Not all auxiliary hydraulic controls are levers; instead, some are switches, as shown earlier in *Figure 13-7*.

3.2.4 Engine Speed Control

When activated, the engine speed control allows an operator to increase or decrease engine speed.

- To activate the engine speed control, press the top half of the left engine speed control.
  - To increase the desired speed, press the bottom of the right engine speed control.
  - To decrease speed, press the top half.

When the desired speed is reached, press on the top of the right engine speed control to set the machine speed.

- To temporarily disengage the engine speed control, press down on the service brake pedal.
  - To resume the preset speed, press the bottom half of the right engine speed control.
- To disengage the engine speed control, press the bottom half of the left engine speed control. This will erase the preset speed.

Gear changes can be initiated by changing the set speed for the engine speed control or by increasing the load on the machine. The engine speed control will activate in all forward and reverse gears. The engine speed control will remain active during automatic upshifts and downshifts.

3.2.5 Hydraulic Lockout Control

As a safety precaution, the hydraulic lockout control prevents the levers from accidently being moved.

- To lock the levers, press the top half of the hydraulic lockout control.
- To unlock levers, press the bottom half.

3.2.6 Kickout and Positioner Control

The kickout and position control limits the bucket tilt angle and lift height.

- To activate the bucket tilt and lift kickout, press the top half of the kick and positioner control.
- To deactivate the bucket tilt and lift kickout, press the bottom half. This will affect the kickout controls, the float detent, and the auxiliary detents.

NOTE

The detents for the hydraulic control lever do not operate when the kickout control is in the off position.

3.2.7 Bucket/Fork Selector Control

The bucket/fork selector control allows an operator to select the tilt kickout for both the bucket and forks.

- To select the preset angle for the bucket tilt kickout, press the bottom half of the bucket/fork selector control.
- To select the preset angle for the forks tilt kickout, press the top half.

3.2.8 Quick Coupler Control

The quick coupler control engages and disengages the coupler pins.

- To engine the coupler pins, press the top half of the quick coupler control.
- To disengage the pins, press the bottom half.
- To make sure that the coupler pins are fully engaged into the work tool, tilt the front attachment downward onto the ground and apply slight downward pressure. Then, back up the machine. If there is movement between the attachment and the coupler pins, the attachment is not installed properly.

3.2.9 Ride Control

Travel at high speeds over rough terrain causes bucket movement and a swinging motion. The ride control system acts as a shock absorber by dampening forces from the bucket. This helps to stabilize the entire machine.

Test your Knowledge

5. How would an operator on a caterpillar 924G engage float?

   A. Completely push the lift lever forward until it locks in position by a detent.
   B. Completely pull the lift lever back until it locks in position by a detent.
   C. Completely push the dump lever forward until it locks in position by a detent.
   D. Completely pull the dump lever back until it locks in position by a detent.

6. What lever is used to operate such attachments as the clamshell bucket and forks?

   A. Lift lever
   B. Dump lever
   C. Bucket/fork control
   D. Auxiliary hydraulic lever

4.0.0 ATTACHMENTS

Attachments contribute to the efficient performance of front-end loaders. Some front-end loaders used by the NCF are procured with bucket, forklift, and backhoe attachments. These interchangeable attachments make front-end loaders an ideal piece of equipment for construction projects, eliminating the need for numerous pieces of equipment.

Quick-disconnect hydraulic hose fittings and hydraulic controlled locking pins permit changing these attachments easily (*Figure 13-14*).

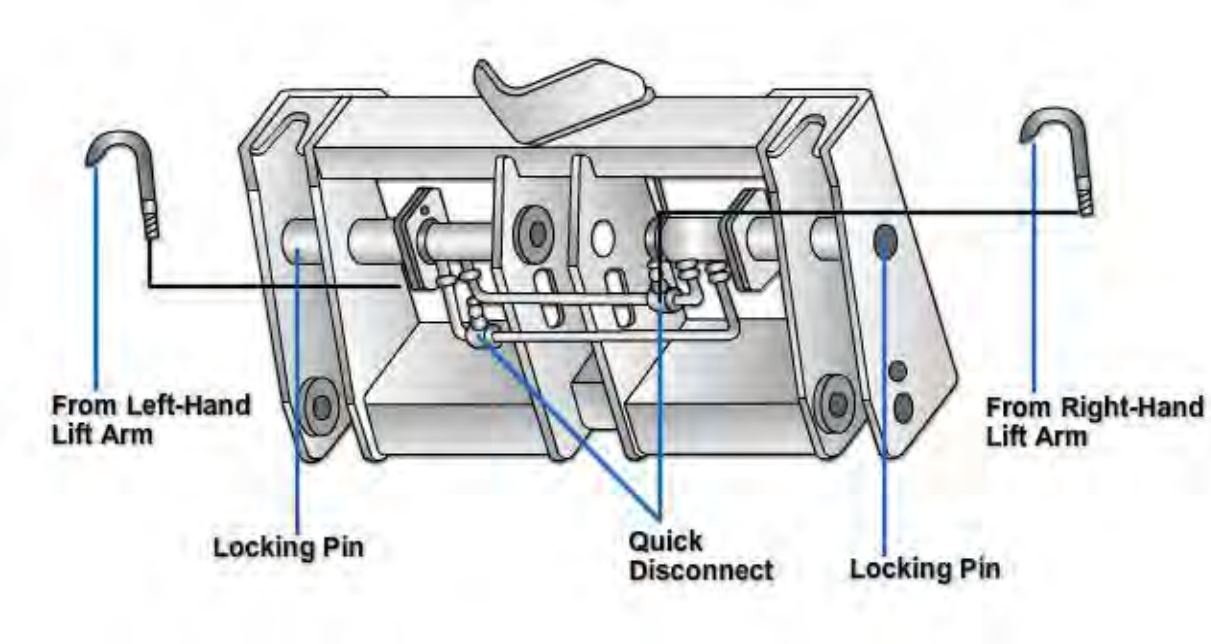


Figure 13-14 – Attachment connection.

4.1.0 Buckets

Several types of buckets can be attached to the front-end loader. The most commonly used are the general-purpose bucket, the multi-purpose bucket, and the rock bucket. These buckets have unique usage and loading capacities. Wheel and crawler loaders may come equipped with all three types. Skid steers have similar type buckets.

4.1.1 General-Purpose Bucket

The general-purpose bucket is a single-piece bucket constructed of heavy-duty, all-welded steel with bolted or welded replaceable cutting edges (*Figure 13-15*). Also attached are bolt-on replaceable teeth (*Figure 13-16*) that allow use of the bucket for excavation of medium-to-hard materials.

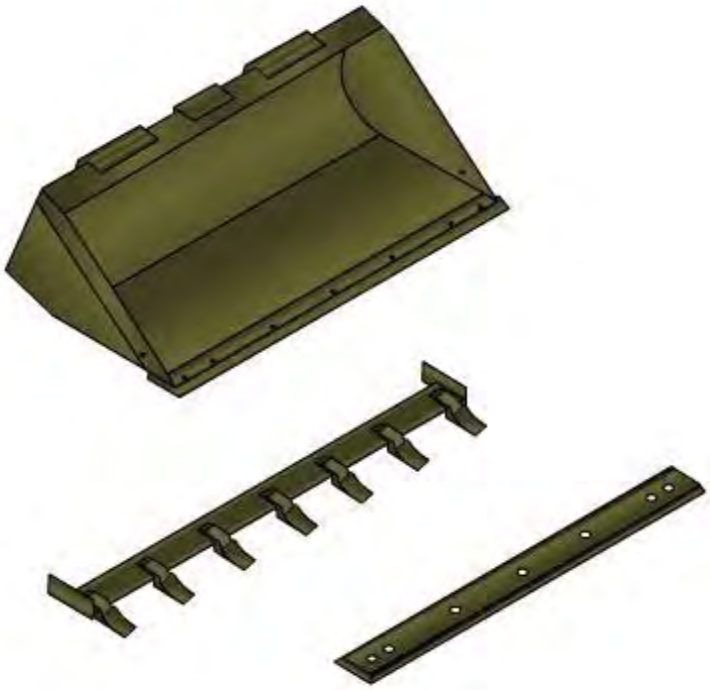


Figure 13-15 – General-purpose bucket.

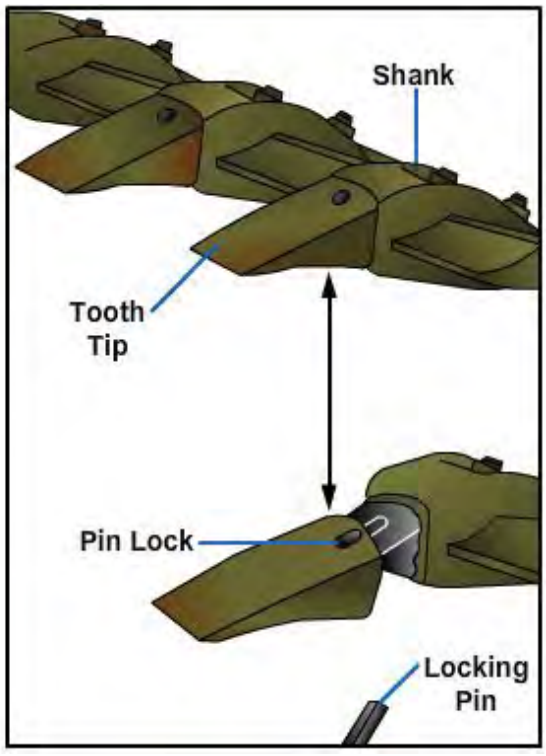


Figure 13-16 – Bucket teeth.

4.1.2 Multi-Purpose Bucket

Like the general-purpose bucket, the multi-purpose bucket, also known as the four-in-one bucket, is constructed of heavy-duty, all-welded steel with bolted or welded replaceable cutting edges (*Figure 13-17*). This bucket also has bolt-on replaceable teeth attached that provide for excavation of medium-to-hard materials.

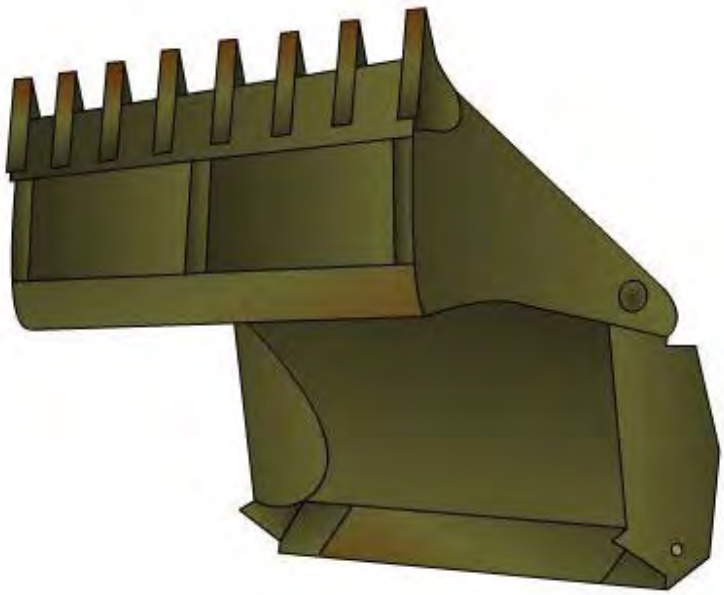


Figure 13-17 – Multi-purpose bucket.

Unlike the general-purpose bucket, the multi-purpose bucket has a two-piece construction that makes it more versatile than the general-purpose single-piece bucket. With the use of auxiliary hydraulic lines, the multi-purpose bucket can be used as a clamshell for grabbing material, a dozer for pushing material, a scraper or skid shovel for finishing or spreading material.

4.2.0 Forks

Forks are useful tools at remote project sites (*Figure 13-18*). They are made of heavy-duty steel with two movable tines for handling cargo, as shown in *Figure 13-19*. They can be attached to the loader's lift arms in place of the bucket or attached to the bucket itself.

When using the forks, caution must be taken to not overload the loader.

Figure 13-18 – Forks.

Figure 13-19 – Loader handling cargo.

4.3.0 Backhoe Attachment

The backhoe attachment shown in *Figure 13-20* is used to dig trenches, combat fighting positions, building footers, and foundations because of the positive pressure created by the hydraulic system. Its digging depth is limited by the length of the boom and dipper stick. The backhoe dumps the material into trucks to be hauled away or into piles alongside the excavation to be used as backfill material. Its dumping range is also limited to the length of the boom and dipper stick.

The backhoe is attached to the loader frame with a rigid coupling. The hydraulics use a quick-disconnect coupling to tap the loader hydraulic system for a power source.

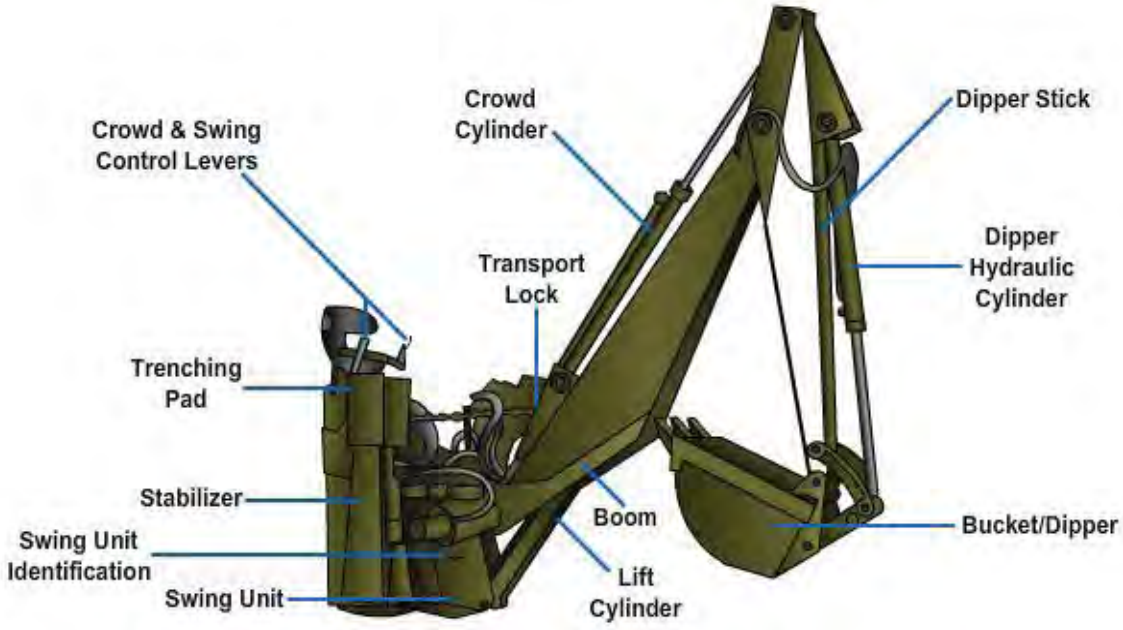


Figure 13-20 – Backhoe attachment.

4.4.0 Skid Steer Attachments

Broom attachments are commonly used on skid steers loaders. Such attachments include angling and pick-up brooms. The angling broom features hydraulic angling with parallel swing arms that allow the broom to stay centered on the skid steer through the entire swing. The pick-up broom utilizes an over-the-brush method to optimally sweep and deposit dirt and debris into an integrated hopper bucket for collection, transport, and dumping. These attachments are used to clear parking lots, airport runways, and streets.

Another attachment commonly seen on skid steers is the auger. The auger has a hydraulic motor that drives the auger through the ground while it moves material up, along its axis of rotation. It is capable of drilling straight holes in level or sloped terrain. It also features reverse rotation for quick back out when it encounters obstructions.

Test your Knowledge (Select the Correct Response)

7. Which of the following type of bucket has a two piece construction?

   A. General-purpose bucket
   B. Multi-purpose bucket
   C. Rock bucket
   D. Medium-to-hard bucket

8. The length of these components limit the digging depth of the backhoe attachment?

   A. Swing unit and dipper stick
   B. Boom and dipper stick
   C. Boom and dipper
   D. Swing unit and dipper

5.0.0 OPERATIONS

Before any operation, you must select the most efficient front-end loader for the project. Critical factors to consider include the type and volume of material being handled. Front-end loaders are excellent for excavating soft to medium-hard material. However, their production rates decrease rapidly when excavating medium to hard material. Another consideration is how high the material must be raised. To be efficient in loading trucks, the front-end loader must be able to dump over the side of the truck's dump bed. A front-end loader attains its highest production rate when working on a flat, smooth surface with enough space to maneuver. In poor underfoot conditions or when there is a lack of space to operate, other equipment may be more effective.

5.1.0 Bucket-Loading

When loading a bucket from a ***bank*** or stockpile, keep the cutting edge flat. Tilting the bucket too far back forces the flat of the cutting edge against the bank, preventing the bucket from digging. This maneuver is nonproductive, causing waste of time and power, and can damage the tilt cylinder and linkage.

When loading large rocks or other solid objects, you can get greater force and penetration by digging under the rock with the bucket (*Figure 13-21*). Lifting the rock with the bucket while pushing increases traction and reduces wheel or track spinning.

Excessive wheel and track spinning causes premature wear and tear. It also creates ruts and pitches that can cause the front-end loader to tilt.

Remember, a smooth working area is safer, more comfortable, and increases production.

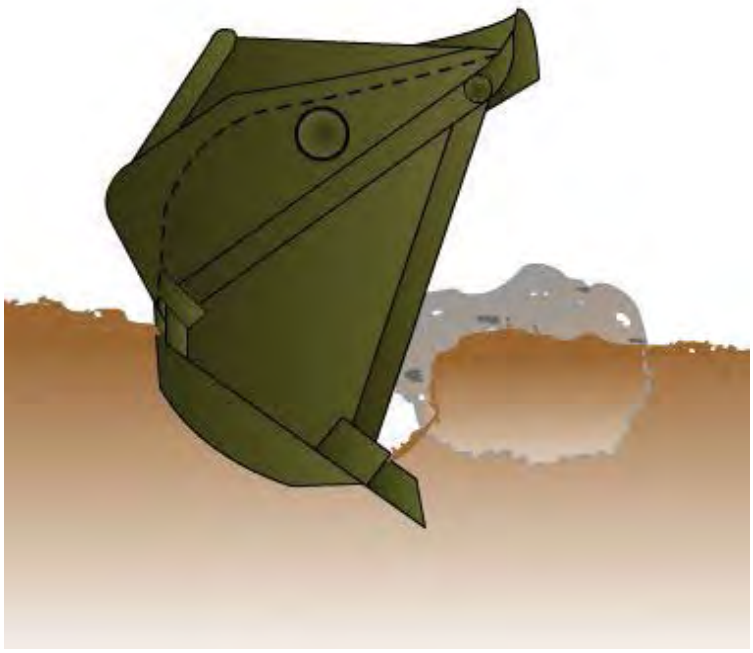


Figure 13-21 – Bucket position for loading rocks or other solid objects.

The steps to load a bucket are as follows:

Step 1. Place the bucket parallel to the ground so its cutting edge contacts the bank or stockpile.

Step 2. Move the front-end loader forward at a slow speed and increase the power.

Step 3. While penetrating into the material, raise the bucket.

Step 4. Crowd the material into the bucket and roll the bucket back to prevent spilling.

Step 5. Maintain the bucket in an upward position while backing away, to prevent spillage.

Figure 13-22 shows these steps in operation.

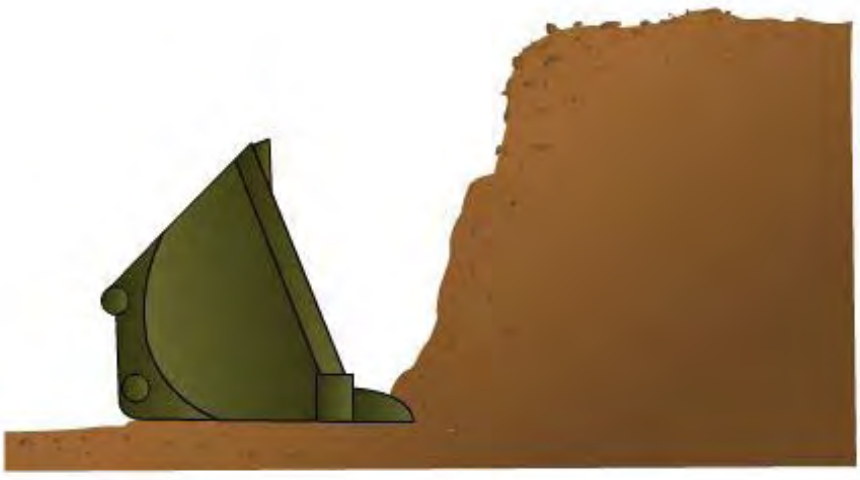


Figure 13-22 – Bucket loading.

5.2.0 Loading Methods

There are two commonly used methods of loading dump trucks, the “Y” and the “I” Methods. The space available determines the method to use.

When using the “Y” or “I” Method, keep the truck close to the work area to minimize the distance the front-end must travel. In addition, always try to load from the operator’s side. When the truck is being loaded ensure that the truck operator either stays in the cab (on cab-protected trucks) or away from the truck and front-end loader. When possible, load the truck downwind to prevent dirt and dust from blowing back into your face.

5.2.1 “Y” Method

The “Y” Method is recommended for large open areas (*Figure 13-23*). The dump truck remains stationary, while the front-end loader moves between the stockpile and dump truck in a Y-shaped pattern.

Figure 13-23 – “Y” Method.

The following are the steps to perform the “Y” loading method:

Step 1. Position the front-end loader at about a 30-degree to 45-degree angle from the bank or stockpile.

Step 2. With the bucket lowered 1 to 2 inches off the ground, head the front-end loader toward the bank or stockpile in low gear.

Step 3. Move the front-end loader into the material and manipulate the lift and tilt control levers, simultaneously curling back the bucket and raising the boom slightly until the bucket is full and completely rolled back. Maintain power without spinning the tires.

Step 4. Hold the bucket in the upright and curled position and back away from the bank or stockpile. Never transport a loaded bucket in fully raised position.

Step 5. Approach the dump truck at a 90-degree angle, lifting the bucket high enough to clear the dump truck.

Step 6. Proceed slowly forward until the bucket is over the dump truck. Do not touch the dump truck with the front-end loader’s front tires.

Step 7. Dump the bucket by rolling the bucket slowly forward. Do not let the bucket hit the dump truck. Remember to dump the load in the center of the dump bed as shown in *Figure 13-24*. Shake the bucket to loosen dirt from within.

Step 8. After dumping the load, back away from the truck; lower the bucket to carrying position, and return to the bank or stockpile.

Step 9. Repeat the above steps until the dump truck is loaded.

Figure 13-24 – Loading a dump truck.

5.2.2 "I" Method

The "I" Method is used for small areas (*Figure 3-25*). Both the front-end loader and truck move back and forward in an I-shaped pattern. The loader fills the bucket and backs away. The dump truck backs up between the stockpile and loader. When the dump truck is stationary, the loader dumps the load. After dumping, the loader backs away from the truck. The truck moves forward, allowing the loader to return to the stockpile.

Figure 13-25 – "I" Method.

The steps to perform the “I” loading method are as follows:

Step 1. Position the front-end loader so you are loading from the operator’s side.

Step 2. Fill the bucket.

Step 3. Back up far enough from the stockpile so that truck has room to move between the stockpile and front-end loader.

Step 4. By horning, signal the truck operator to backup.

Step 5. Proceed slowly forward until the bucket is over the dump truck. Do not touch the dump truck with the front-end loader’s front tires.

Step 6. Dump the bucket by rolling it slowly forward. Do not let the bucket hit the dump truck. Remember to dump the load in the center of the dump bed, as shown earlier in *Figure 13-24*. Shake the bucket to loosen dirt from within.

Step 7. After dumping the load, back away from the truck.

Step 8. After the truck moves forward, lower the bucket to carrying position and return to the stockpile.

Step 9. Repeat the above steps until the dump truck is loaded.

5.3.0 Excavating

A front-end loader can be used to excavate undisturbed and compacted soil for building foundation and other belowground areas. Such a task requires shallow cuts to keep traction on the loader and maintain production. Because the front-end loader works best when excavating above wheel level, a ramp should be constructed first (*Figure 13-26*). The ramp allows the front-end loader to work in a productive manner and provides an exit for the excavated material. The slope of the ramp depends on the type of front-end loader being operated; for example a crawler-mounted front-end loader may dig a more abrupt approach to the excavation.

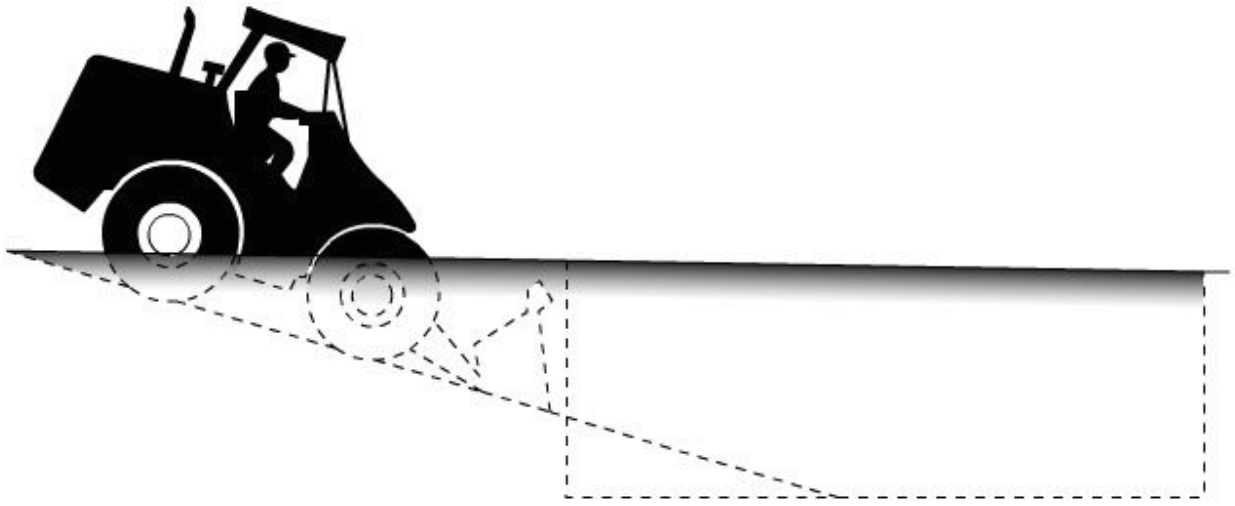


Figure 13-26 – Ramp construction.

The following are the steps to construct a ramp:

Step 1. Determine the starting point for the ramp. Start the ramp 8 feet away from where excavation will be.

Step 2. Position the bucket so it is pitched forward.

Step 3. Move the front-end loader forward, gradually penetrating the earth by lowering the lift control lever.

Step 4. Keep the front-end loader in as high a gear as possible without causing the wheels or tracks to spin excessively.

Step 5. Regulate the depth of cut using the lift control lever.

Step 6. Retract the bucket fully.

Step 7. Place the lift control lever in the raise position until the bucket is high enough to clear the surrounding area.

Step 8. Dump the loaded bucket into a stockpile or a haul unit.

Step 9. Repeat the above steps until the excavation is complete.

5.4.0 Transporting Material

Never transport a loaded bucket in the fully raised position. When transporting material, raise the lift arms to give the bucket the same ground clearance as provided by the loader axle. Keep the travel speed reasonable for safe operation.

5.5.0 Constructing a Stockpile

A front-end loader can be used to construct stockpiles. Stockpiles store material such as topsoil for future use. There are three stockpile configurations, standard, ramp and bin.

When constructing stockpiles, move each load only once and keep the travel distance short. Without hindering the work of others, construct stockpiles as close to the jobsite as possible.