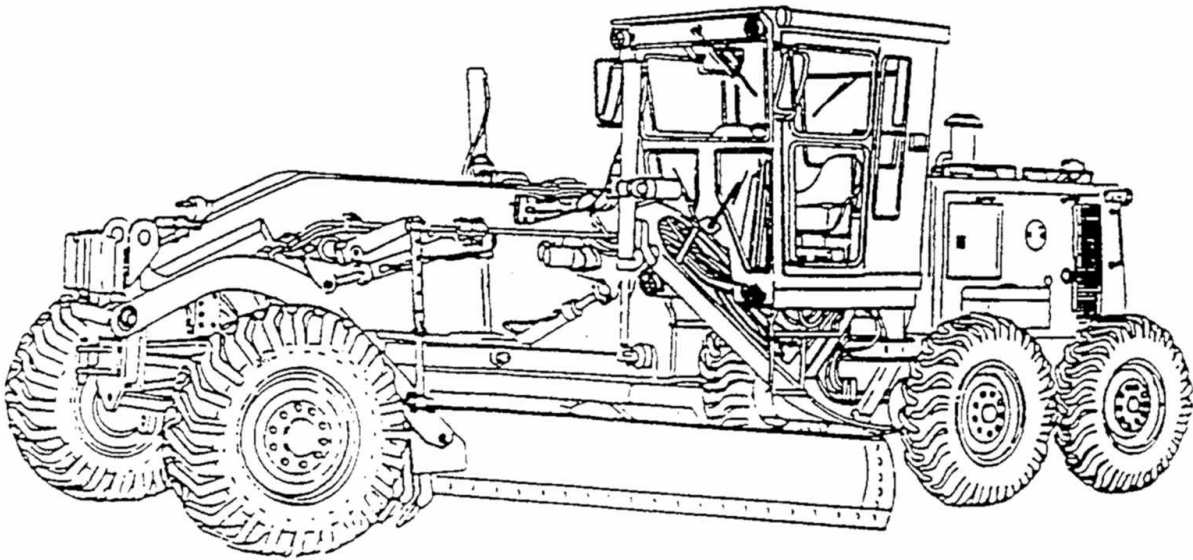


HEAVY CONSTRUCTION EQUIPMENT OPERATOR

GRADER PHASE



STUDENT GUIDE

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PREFACE

TO THE STUDENT: The purpose of this handout is to provide guidance and information on how to perform operator's preventive maintenance and operate a motorized grader. Within this handout are sections covering proper procedures for: Preventive maintenance, Scarifying, Leveling, and Crowing a Road.

OBJECTIVE

The objective of this handout is to provide the knowledge required to build the skills which are necessary to operate and maintain the motor grader proficiently in the following areas:

1. Operator Preventive Maintenance
2. Scarify
3. Leveling
4. V-Ditching

CHAPTER 1

1.What this document is: This is a job aid for performing tasks associated with the grader. It is to be used with the operators manual. Together, the two job aids provide a model for maintaining and operating the grader.

2.Who should use it:

- a. Students who are attending the Equipment Operators Course: the instructors of the course will provide instructions for its use.
- b. Graduates of the Equipment Operators Course: This job aid should be kept upon graduating from the course. It provides a valuable reference for accomplishing grader tasks. Tasks that are not trained in school (Unit Trained Tasks) are also covered in this job aid. Upon arriving at your first duty station you may learn how to do these tasks by using this reference in conjunction with the Technical Manual and Soldier's Manual.
- c. Supervisors of Heavy Construction Equipment Operators: This booklet provides the basic procedures for performing grader tasks. Chapter 2 can be used for an Introduction to Graders when cross-training. The other chapters may be used to instruct the basic procedures for performing a task.

3.How to use it:

- a. Chapter two is an introduction to the graders. It is used in a classroom environment. An instructor may use it for the lesson outline, however he must first study the references in order to "beef up" the material. The student uses it as an outline for taking notes.
- b. The following chapters cover a specific task for grader operations. Each chapter provides the following information:
 - (1) Purpose: A brief description of the reason for performing the task.
 - (2) Reference: Other sources of information about the task.
 - (3) Product: The products that result by performing the task.
 - (4) Procedures: How to perform the task.
- c. Every attempt has been made to follow established procedures and doctrine. In instances where it deviates from other references a note is made on the reason for doing so and the name of the reference.

4.Ordering and input information:

- a. Additional copies of this job aid can be obtained from:

Commandant,
US Army Engr. School
ATTN: ATSEL-T-CT-T
Fort Leonard Wood, MO 65473-6650

- b. Your input into this job aid is welcomed. Send your comments to:

Commandant,
US Army Engr. School
ATTN: ATSEL-T-CT-T
Fort Leonard Wood, MO 65473-6650

CHAPTER 2

1.PURPOSE: To prepare the student to be able to understand the technical training lessons that will follow. It will include a briefing and demonstration on the nomenclature, major operating components, related components, steering, air, cooling fuel, air induction, and electrical systems, controls and instruments, safety, and uses of the motor grader.

2.SAFETY: No jewelry or ID tags will be worn on phase. Nor horse playing at anytime. Hard hats and hearing protection will be worn when on or near the equipment. Duds will not be handled, if found, mark the location and inform an instructor.

3.REFERENCES:

- a. FM 5-434, Earthmoving Operations, 30 Sep 92
- b. Champion, 700 Series, Operators Manual
- c. John Deere, 670 Series, Operators Manual
- d. TM 5-3805-261-10, Grader, Heavy Road 130G, Mar 89
- e. STP 5-62E12-SM-TG, Tasks: 051-254-1051, 1052, &1053 Sep 85.

4.LESSON OUTLINE: In this book you will read about operator checks and controls on the grader. In addition, the procedures for starting, operating, and securing the grader. Some differences can be expected in the operation of various makes and models of graders. For detailed instruction on graders operation consult the technical manual or operators manual supplied by the manufactures of the grader concerned.

- a. Graders are multipurpose machines used for grading, shaping, bank sloping, and ditching. They are also used for mixing, spreading, side casting, leveling, crowning, light stripping operation, general construction, and road and runway maintenance. They are restricted to making shallow cuts in medium-hard material; they should not be used for heavy excavations. A grader cannot perform dozer-type work because of structural strength and location of its moldboard.
- b. The major function of the motor grader is for precise final shaping; it is used for finishing work and it levels earth already moved into position by bulldozers and scrapers. Secondary functions include V-ditching, bank sloping, and snow removal.
- c. Graders utilized here are the Caterpillar 130G, Champion 700 series, and John Deere 670 series. All graders are similar with minor differences, so no matte what type, the principles of operation and basic controls will vary little.

5. Major Operating Components

- a. Diesel powered engine
- b. The prime mover is a rubber-tired tractor, powered by a 4- to 6-cylinder diesel engine and started by an electric starting motor.
- c. Oil lubricated - lubrication reduces friction between moving parts. Friction is harmful because it wears out parts and generates heat. Lubrication is not confined to the use of grease. If the grader engine is not filled to proper oil level it isn't going to last very long.
- d. Perform a cold check and hot check - if the oil level is between the add and full marks, the level is "OK".
- e. Allow the engine to warm up and cool down 3 to 5 minutes to prevent damage to the turbo-charger.
- f. Water-cooled engine, equipped with a large capacity radiator. Check the coolant by removing the radiator cap. If the coolant is not visible, add coolant.
- g. Air induction system - A two stage system, first the pre-cleaner stops larger objects such as leaves. Second, a main filter assembly, which contains an inner and outer air filament to trap smaller objects.
- h. Transmission - a hydraulically powered unit. Power shift with multiple speed setting. A modulation pedal, also known as a clutch or inching pedal is utilized to place the grader in motion and to stop the grader in conjunction with the brake.
- i. Wheels and tires - Graders have 6 wheels, 4 rear drive wheels with two steering wheels (6x4). The tire treads are self-cleaning. The rear tires are mounted with the point of the V" meeting the ground first for traction. The front tire is reversed to prolong the tire life. Maintain tire pressure at 35 PSI.

WARNING: Improperly inflated tires can cause blowout resulting in personal injury or death.

- j. Tandem - The tandem drive of the grader allows for climbing over rocks, logs or humps. The tandems are two sets of two wheels, one in front of the other to provide traction and power. They are chain driven and oil lubricated. Single tandem drive for road travel and dual tandem drive for grading on the work site. Operators must manually lock in the differential on the Caterpillar and John Deere Graders. The Champion Grader operates with a limited slip differential and engages when the grader meets resistance.

6.Related Components:

- a. Scarifier Log - the scarifier is a hydraulically controlled unit with a set of teeth used to break up material too compacted to be penetrated by the blade. Scarifier attachments are not the same on all graders. The location and number of teeth on the scarifier log vary. The maximum number of teeth is used for moderate to hard soil. The minimum number of teeth is used for hard to very hard soil. To remove teeth from the log, remove every other shank. The key is to ensure the same amount of the teeth is on both sides of the scarifier log. A tooth consists of a shank and a cap. When the caps are worn to within $\frac{3}{4}$ " from the shank, replace the cap. A tooth or shank is held into place on the log by a lock pin. Shanks, caps or locks are components of the scarifier log. Never make sharp turns with the scarifier teeth in the ground. Making sharper turns damages the scarifier and possibly bends or breaks teeth.
- b. Moldboard - The moldboard with the cutting edge and end bits attached is called the blade. The blade is the working tool of the grader than can be lifted, lowered, rotated, pitched forward and backwards, shifted to the left or right, and angled horizontally. The leading point of the blade is referred to as the "toe", and the trailing point of the blade is referred to as the "heel". The moldboard length is 12 feet. The moldboard has two cutting edges and two end bits, all are bolted on. They act as wear plates and must be replaced when they are worn to within $\frac{3}{4}$ " of the moldboard.
- c. Circle - Located at the center of the grader, it's a tabletop apparatus that the moldboard is attached to. The moldboard lift cylinders are attached to the circle, one on the left and one on the right. In addition, the center shift cylinder is located on top of the circle. This cylinder shifts the circle left and right and is primarily used to align (straighten) the lift (heel) cylinder.
- d. Blade Pitch - The blade pitch is adjusted by a single hydraulic cylinder located center, on top of the moldboard that pushes and pulls the moldboard to produce a desired pitch. For a greater cutting action, the backward pitch is used. For a greater mixing

and rolling action on the material, pitch the blade all the way forward. When spreading, finishing and leveling surface material, pitch the blade halfway. This is the general grading position and it will extend the use of the cutting edge.

- e. Blade Side Shift - The ability to extend the blade to the left or right permits greater versatility in earth moving operations. A single cylinder, positioned parallel and attached to the back of the moldboard that extends and retracts. Primarily used in the wide side reach position.
- f. Wheel Lean - Wheel lean is used to minimize side draft while grading, also used to assist in steering. It is never used in conjunction when backing. Wheels must remain straight up and down while in the backing mode.
- g. Articulation - Some graders have frames that are hinged just forward of the engine with articulation controlled by a pair of hydraulic cylinders. This allows for an increase in productivity and stability. The articulated frame has a shorter turning radius than the conventional grader. This increased turning ability permits easier maneuvering in close quarters. There are three modes of steering.
 - (1) Straight Frame Mode - Used for long distance type grading.
 - (2) Crab Mode - Primarily used to clean out wet ditches.
 - (3) Articulation Mode - Used in tight working conditions.

7. Basic earth moving controls in the operators compartment of a Caterpillar 130G:

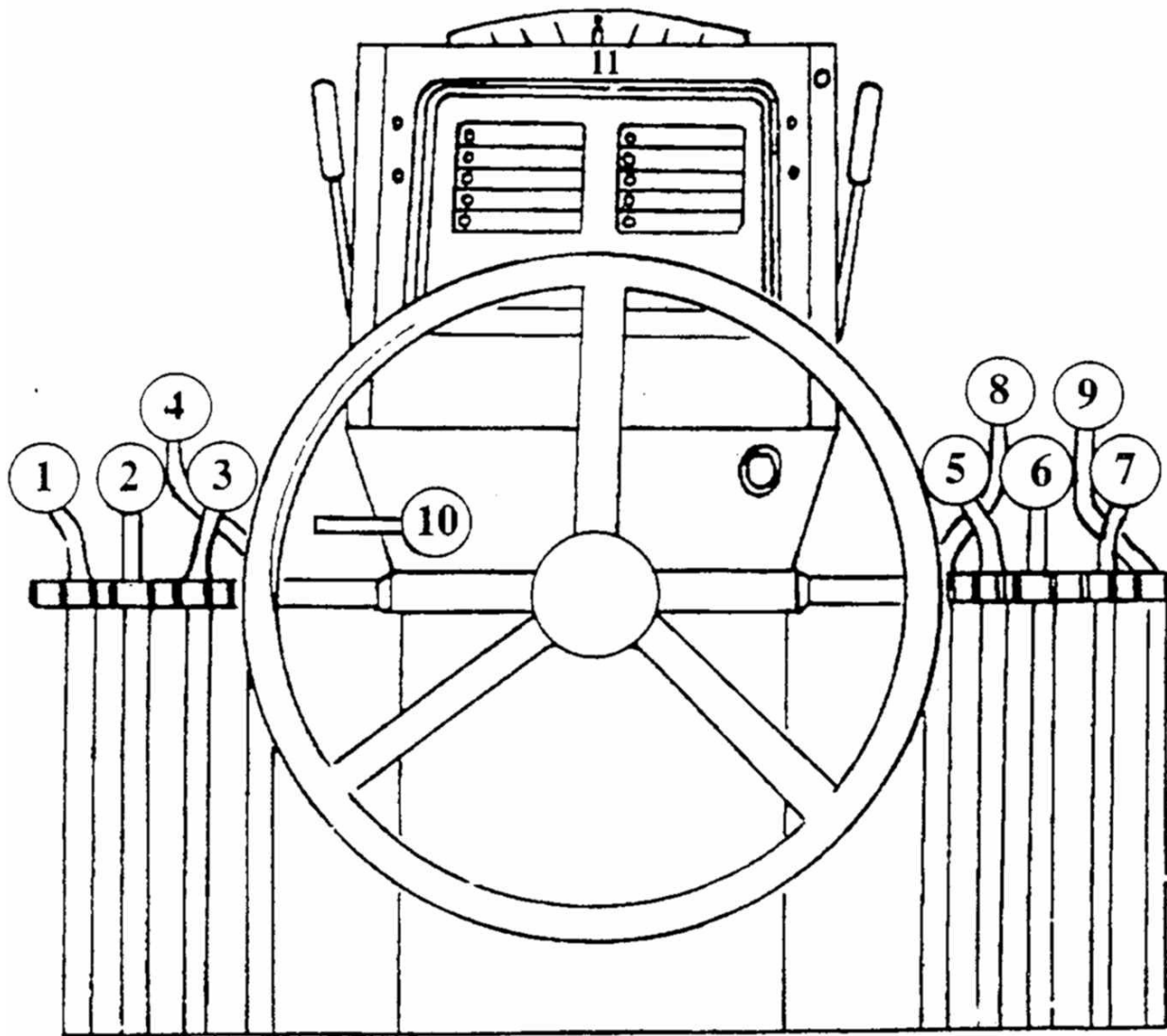
- a. The left lift cylinder - when the lever is pulled backward the left side of the moldboard will raise; when the control lever is pushed forward the left side of the moldboard will lower.
- b. The blade side shift lever, the moldboard shifts or slides to the right of the circle when the hydraulic control lever is pushed forward and shifts to the left of the machine when the control lever is pulled backward.
- c. Circle control lever - when the circle control lever is pushed forward the circle, with the moldboard attached will rotate clockwise. When the control lever is pulled backward, the circle with the moldboard attached will rotate counterclockwise.

- d. The blade pitch of the moldboard is changed hydraulically by pushing the lever forward the blade will pitch forward. Pull the lever backwards the blade will pitch backwards.
- e. Center shift control lever - push the control lever forward and the circle will shift to the right, pull back and the circle will shift to the left. Use caution to prevent metal-to-metal contact when shifting the circle. Always ensure the moldboard is 4 to 6 inches off the ground prior to shifting.
- f. Wheel lean lever - the front wheels of the grader will lean to the right when the lean wheel control lever is pushed forward, and to the left when the control lever is pulled backward.
- g. Right left cylinder lever - pulling the right side moldboard control lever backward raises the right side of the moldboard; pushing this lever forward lowers the moldboard.
- h. Articulation control lever - push the control lever forward and the rear of the grader articulates to the left, pull backwards and the rear of the grader articulates to the right. The articulation indicator on the steering console shows how the grader has articulated left or right.

NOTE: Before articulating the grader, be aware of the position of the grader blade. With the blade angled in an acute position, articulating the grader sharply can permit the blade to damage tires.

- i. Scarifier control lever - pushing the scarifier control lever forward lowers the scarifier; pulling the control backwards raises the scarifier.

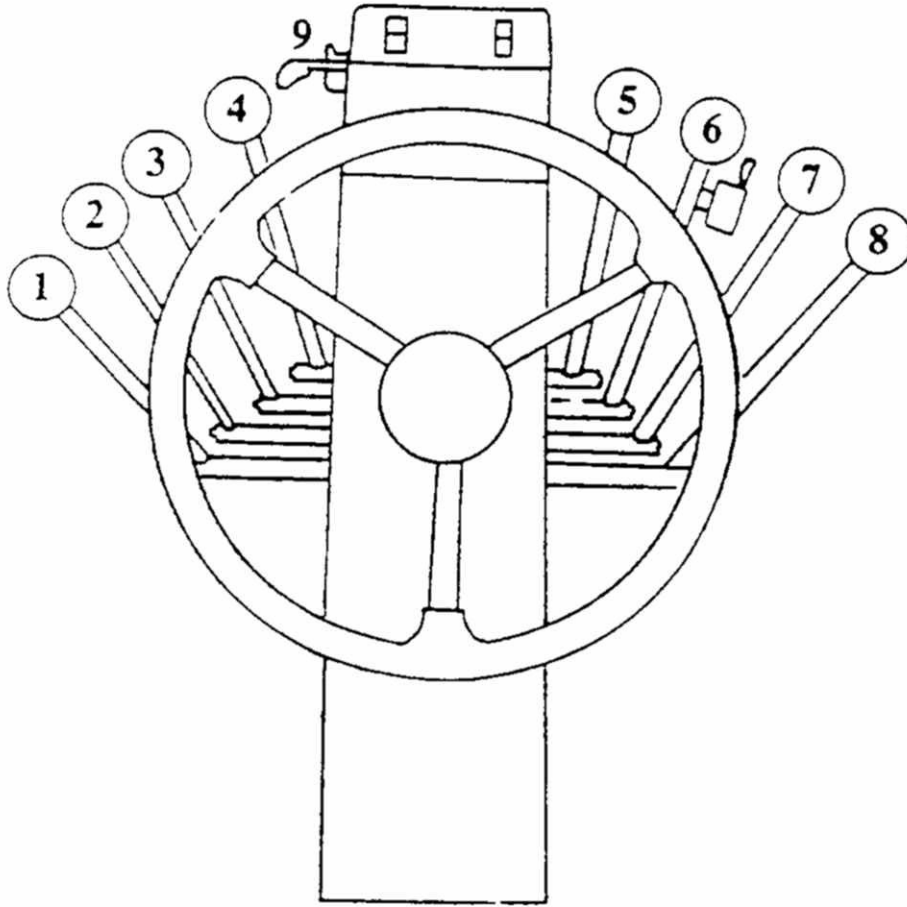
CATERPILLAR 130G



- 1. Left Lift Cylinder
- 2. Blade Side Shift
- 3. Circle Reverse
- 4. Blade Pitch
- 5. Center Shift
- 6. Wheel Lean

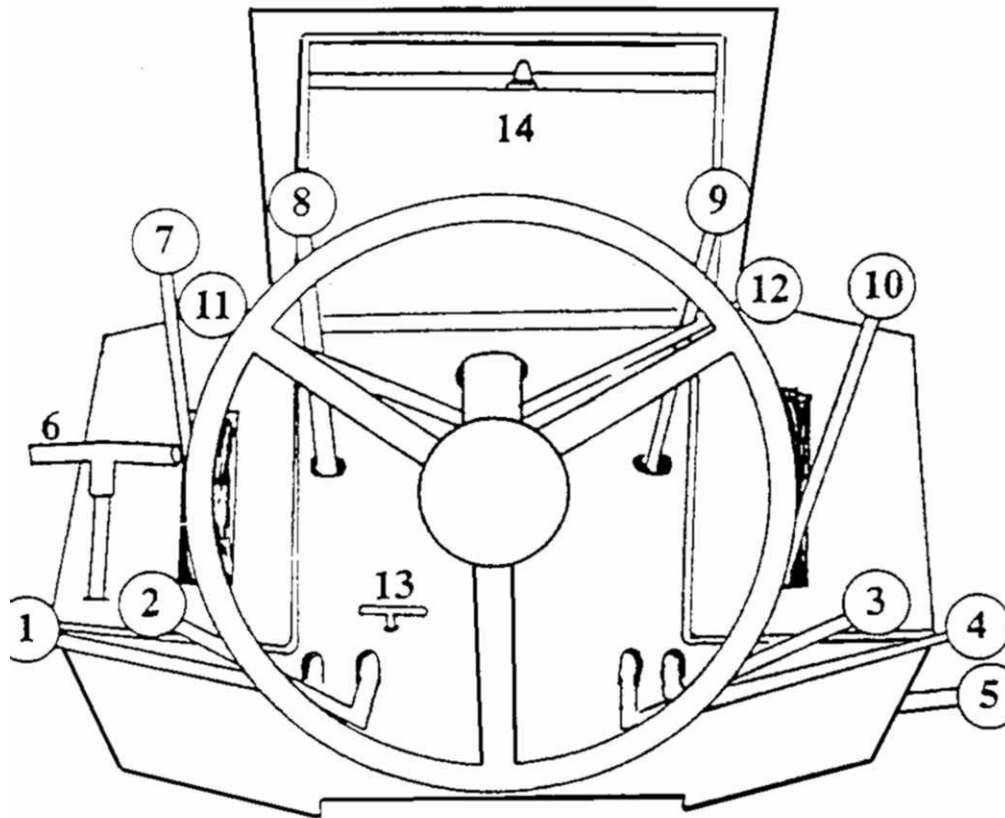
- 7. Right Lift Cylinder
- 8. Articulation
- 9. Scarifier
- 10. Turn Signal and Flasher
- 11. Articulation Gauge

CHAMPION 700 SERIES



1. Blade Pitch
2. Left Lift Cylinder
3. Side Shift
4. Circle Reverse
5. Center Shift
6. Wheel Lean and Articulation Device
7. Right Lift Cylinder
8. Scarifier
9. Turn Signal and Four-Way Flashers

JOHN DEERE 670 SERIES



- | | |
|-----------------------------------|--------------------------|
| 1. Scarifier | 8. Center Shift |
| 2. Blade Pitch Shift | 9. Wheel Lean |
| 3. Left Lift Cylinder | 10. Speed Selector Lever |
| 4. Right Lift Cylinder | 11. Articulation Left |
| 5. Hand Throttle | 12. Articulation Right |
| 6. Circle Reverse and Blade Shift | 13. Park Brake |
| 7. Transmission Selection Lever | 14. Articulation Gauge |

NOTE: Since most hydraulic controls function the same, it is key to note that when pushing a control lever forward the apparatus will either lower or move left. Thus a Reverse effect for pulling a control lever the apparatus will either raise or move right.

8.General Rules of Operation:

- a. Always engage the park brake when parking the grader. Also, ensure the park brake is disengaged prior to placing the transmission in gear.
- b. Grade in first gear only (for training purposes and safety).
- c. All grading and scarifying will be accomplished in a forward motion.
- d. Always set the hand throttle to full (maximum) RPMs to conduct any scarifying or earth moving operation.
- e. Never back the grader with the hand-throttle engaged. Always reduce the hand throttle to idle and use the foot throttle control pedal during backing operations.
- f. The foot throttle control pedal will be used during positioning maneuvers or traveling operation.
- g. In the event the grader must be stopped during earth moving or scarifying operations, use the deceleration pedal to temporarily reduce the RPMs.
- h. Graders equipped with a manual differential lock and unlock should be placed in the locked position upon entering the field of operation or when engaged in any earth moving operation. Be certain to unlock the differential when traveling to and from the field to prevent damage.
- i. Graders equipped with limited slip differential will automatically engage and disengage as traction is reduced or gained.

NOTE: When working on construction sites, do not over strip the area. Damage is also caused by erosion due to rain; dressing off the work area at the end of each day can minimize this erosion damage. After you have completed the project, restore the area as close as possible to its original state.

9.Safety:

- a. Each operator will complete a 360° walk around prior to mounting and after dismounting the motor grader.

(1) The 360° walk around prior to mounting is to quickly check over the grader looking for leaks or damage. In addition, the operator must be aware of any personnel or hazards in the immediate area.

(2) The 360° walk around after dismounting is to check for leaks or damage and to ensure the grader is properly and safely parked. Any discrepancies should be immediately corrected or action taken to report the discrepancies.

b. Operators must face the grader and maintain three points of contact when mounting or dismounting.

c. All personal protective safety equipment or gear will be utilized at all times.

(1) Operators will wear hard hats, hearing protection, and safety belts in the grader.

(2) Ground guides or additional personnel in the immediate area will wear hard hats and hearing protection.

d. Operators should make all adjustments to the rear view and side mirrors prior to starting the grader. Any adjustments to the cab fan will be made prior to turning them on. "DO NOT ADJUST THEM IF THEY ARE RUNNING!"

e. Operators are solely responsible for the safe and prudent operation of the motor grader. Operators will maintain control of the grader at all times.

HAND SIGNALS



COORDINATED BLADE END MOVEMENT

Left arm raised with thumb up, right arm down with thumb down.



COORDINATE BLADE END MOVEMENT

Right arm raised with thumb up, left arm down with thumb down.



LOWER END OF BLADE

Arm raised with thumb down and opposite arm to side



RAISE END OF BLADE

Arm raised with thumb up and opposite arm to side.

HAND SIGNALS



CIRCLE BLADE LEFT

Using left arm to make a circular motion indicates direction to circle blade.



CIRCLE BLADE RIGHT

Using right arm to make a circular motion indicates direction to circle blade.



SLIDE BLADE Left

(ROCK ARM)

Arm is bent across the body pointing in the direction of slide.

Also called SIDE SHIFT



SLIDE BLADE Right

(ROCK ARM)

Arm is bent across the body pointing in the direction of slide.

Also called SIDE SHIFT

HAND SIGNALS



SCARIFIER UP

Arm raised with fingers extended and spread.



SCARIFIER DOWN

Arm lowered with fingers extended and spread.



CENTER SHIFT LEFT

Arms form circle with fists together and offset from body in direction of shift.



CENTER SHIFT RIGHT

Arms form circle with fists together and offset from body in direction of shift.

HAND SIGNALS



WHEEL LEAN LEFT

Arms extended, finger joined,
Angled left



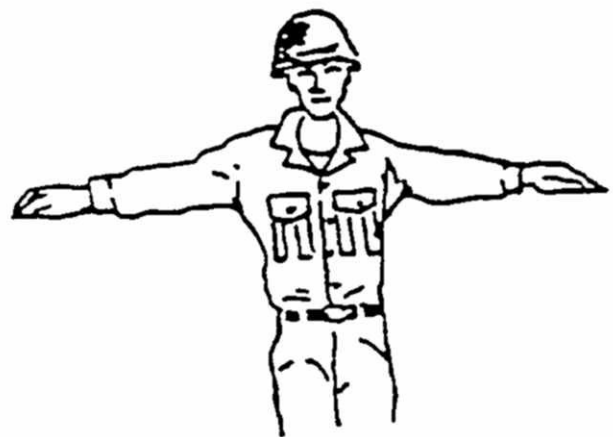
WHEEL LEAN RIGHT

Arms extended, finger joined,
Angled right



CARRY POSITION

Hands cupped and together.



PARKLINE POSITION

Arms extended out to both sides
Fingers joined.

HAND SIGNALS



BLADE PITCH DOWNA

Arms extended, fingers joined
Out to the side.



BLAED PITCH UP

Elbows bent and hands pulled into the chest.



STRAIGHTEN HEEL CYLINDER

Cylinder that is to be straight end is
Signified by a right or left bent arm

Opposite arm is placed on the bent
forearm, moving up and down

CHAPTER 3

PREVENTIVE MAINTENANCE CHECKS

1.PURPOSE: To provide the student with the guidelines and information necessary to maintain and operate the grader.

2.REFERENCE

- a. TM 5-3805-261-10
- b. Champion 700 Series Operator's Manual
- c. John Deere Model JD 670 Operator's Manual
- d. DA PAM 738-750

3.PREVENTIVE MAINTENANCE

a. Introduction:

NOTE: Thirty minutes will be used at the beginning of each day for before operator's maintenance and 30 minutes will be used at the end of each day for after operator's maintenance.

NOTE: A safety briefing will be conducted each day prior to the beginning of PMCS.

(1) Safety:

- (a) Make a 360° walk around inspection.
- (b) Use 3 points of contact in mounting and dismounting.
- (c) Wear a hard hat (construction safety helmet) when on or around the grader.
- (d) Wear hearing protection when equipment is running.
- (e) Ensure no smoking, sparks, or flames are around the batteries or fuel.
- (f) Always wear a seat belt when operating the grader.
- (g) Remove all jewelry, such as rings, watches, dog tags, and necklaces.

NOTE: Ensure the dispatch packet registration number and the grader registration number are the same.

NOTE: Students will perform weekly as well as before operator's maintenance if:

- They are operating the grader for the first time.
- They are the assigned operator, but have not operated the grader since the last weekly maintenance.

(2) Items to be inspected:

- (a) Locate the pre-operation checklist in the technical manual or the operator's manual for the specific model of grader.

- | | |
|----------|---|
| <u>1</u> | Caterpillar, Model 130G, TM 5-3805-261-10, page 2-23 thru 2-46. |
| <u>2</u> | Champion, 700 Series Operator's Manual, page 7-3 thru 7-26. |
| <u>3</u> | John Deere, Model JD 670 Operator's Manual, page 9. |

NOTE: Additional checks for the John Deere include:

- Over all structural damage
- Cracked and or leaking hydraulic lines or fittings
- All hydraulic cylinders
- Radiator reservoir
- Tires and tire pressure
- Cutting edge and end bits

- (b) Discuss each specific check, show its location, and explain each warning and caution.

(3) Starting procedures:

- (a) Locate the starting procedures in the technical manual or the operator's manual for the specific model grader.

- | | |
|----------|---|
| <u>1</u> | Caterpillar, Model 130G, TM 5-3805-261-10, page 2-46 thru 2-50. |
| <u>2</u> | Champion, 700 Series Operator's Manual, page 8-10 thru 8-11. |
| <u>3</u> | John Deere, Model JD 670 Operator's Manual, page 9 and 10. |

(4) Stopping procedures: Locate the stopping procedures in the technical manual or the operator's manual for the specific model of grader.

- 1 Caterpillar, Model 130G, TM 5-3805-261-10, page 2-54 thru 2-55.
- 2 Champion, 700 Series Operator's Manual, page 8-11.
- 3 John Deere, Model JD 670 Operator's Manual, page 12.

(5) Operational Controls:

- (a) Check for proper steering.
- (b) Check service brakes, slowly move the grader and check for proper operation.

(6) Refueling the Grader:

NOTE: Refueling will be accomplished on day 5, at approximately 1300 hrs. In the field, position the graders to expedite refueling.

(a) Safety:

- 1 Set the parking brake.
- 2 Lower the moldboard and scarifier to the ground.
- 3 Shut off the engine.
- 4 Dismount the grader (use three points of contact).

NOTE: Washing and lubrication of the grader will be accomplished on day 7.

(7) Weekly cleaning and service of the motor grader.

(a) Cleaning the interior:

- 1 On the parkline sweep out the cabs (operator compartments) and remove all dirt and trash.
- 2 Wash/wipe down all the glass to remove water spots or smudges.

(b) Lubricating the grader:

- 1 Locate the lubrication chart listed in the technical manual or operator's manual for the specific model of grader.
 - a Caterpillar, Model 130G, TM 5-3805-261-10.
 - b Champion, 700 Series Operator's Manual.
 - c John Deere, Model JD 670 Operator's Manual.
- 2 Using a clean rag, wipe off each grease fitting prior to lubricating it.

CHAPTER 4

LEVELING

1.PURPOSE: To provide the student with the guidelines and information necessary to properly scarify, level and crown a road with the motor grader.

2.SAFETY: Know and adhere to all hand signals. Maintain three points of contact when mounting or dismounting. Ground all attachments and engage park brake before dismounting. Make 360° walk-around before mounting and after dismounting. Seat belt will be worn. Go slow under dusty conditions. Adjust mirrors after each change of operators, and use mirrors when backing. Do not adjust defroster fans while they are running.

3.REFERENCES:

- a. FM 5-434, Earthmoving Operations, 30 Sep 92
- b. Champion, 700 Series, Operators Manual
- c. John Deere, 670, Operators Manual
- d. TM 5-3805-261-10, Grader, heavy Road, 130G, Mar 89
- e. STP 5-62E12-SM-TG, Tasks: 051-254-1051 & 1052, Sep 85

4.PRODUCTS: A grader operator who is capable of leveling, and ro maintaining a road.

5.PROCEDURES:

ENVIRONMENTAL: Be aware of these environmental considerations:

Damage is caused by erosion due to rain. Dressing off the work area at the end of each day can minimize this erosion damage.

Dust and exhaust created from use of equipment also affects the environment, avoid any unnecessary equipment usage.

Operator's must be constantly aware of any equipment leaks, and correct them before they become a hazard.

While moving on/off road terrain, avoid unnecessary damage to waterways or vegetation.

- a. Start the grader IAW TM/OM

6.Introduction to Leveling:

NOTE: It is essential that students become familiar with the controls and instruments of the piece of equipment that they will be operating.

NOTE: During control manipulation students will need the appropriate Technical Manual or Operator's Manual as well as their student guide. Students will receive a demonstration on each position and be given time to practice placing the blade and scarifier into those positions.

a. Sequence of events:

- (1) Park-line position
- (2) Carry (travel) position
- (3) Right hand general grade position
- (4) Left hand general grade position
- (5) Center windrow position
- (6) Scarifying position

NOTE: The grader should be placed in the park-line position at the start of class. Discuss the configuration of the grader and how each control lever will be utilized to execute that position.

b. Park-Line Position:

- (1) The blade is pitched all the way forward.
- (2) The toe of the blade is 3 to 4 feet behind the right front tire.
- (3) The left lift cylinder (heel) is straight up and down.
- (4) The blade is lightly touching the ground (no excessive down pressure).
- (5) The scarifier teeth are lightly touching the ground (same as the blade).

c. Carry position (execute this maneuver from the park-line position):

- (1) Fully raise the scarifier log.
- (2) Raise moldboard off the surface approximately 6".
- (3) Pitch the blade all the way to the rear (back).
- (4) Center shift all the way to the left.

- (5) Circle the blade counter-clockwise until the toe and heel are within parameters of the right front tire and left rear tandem tire (approximately 45°).
- (6) Raise the toe and heel of the moldboard. The toe cylinder is raised fully and the heel cylinder is raised until the moldboard is level.

NOTE: Pay particular attention while circling the blade so not to hit (damage) the scarifier or step.

d. Right hand general grade position (execute this maneuver from the carry position):

- (1) Lower the moldboard to within 6" to 8" from the surface (this will provide unrestricted movement and prevent metal-to-metal contact).
- (2) Circle the blade clockwise to within 50° to 60° of the main frame (ensure the toe is on the right side of the grader).
- (3) Pitch the blade halfway.
- (4) Center shift until the left lift (heel) cylinder is straight up and down.
- (5) Lean the front wheels to the left.
- (6) Lower the toe and the heel to the ground level.

e. Left hand general grade position (execute this maneuver from any position):

- (1) Ensure the scarifier log is fully retracted (up).
- (2) Ensure the moldboard is 6" to 8" off the surface and the blade is pitched halfway.
- (3) Circle the blade clockwise to within 50° to 60° of the main frame (ensure the toe is on the left side of the grader).
- (4) Center shift until the right lift (heel) cylinder is straight up and down.
- (5) Lean the front wheels to the right.
- (6) Lower the moldboard to the surface level.

f. Center windrow position (execute this maneuver from any position):

- (1) Ensure the scarifier log is fully retracted.

(2) Ensure the moldboard is 6" to

g. Scarifying position (execute this maneuver from any position):

(1) Ensure the scarifier log is fully retracted.

(2) Ensure the moldboard is 6" to 8" off the surface and the blade is pitched halfway.

(3) Circle the blade to 90° to the frame (straight across).

(4) Center shift until both lift cylinders are equally spaced to the main frame.

(5) Raise the moldboard to 12" off the surface.

(6) Lower the scarifier log to the surface.

NOTE: It is unsafe to back the grader in the center windrow or scarifying position. The blade extends out past the tires of the grader creating a safety risk.

NOTE: Never back the grader with the front wheels leaned. After completing each general grading position, always return the front wheels to straight up and down prior to executing the next position.

h. Establishing the working area.

i. Site survey (visual overview).

j. Determine the boundaries (starting and finishing points).

k. Define the requirements:

(1) Scarifying

(2) Leveling

(3) Crowning

1. Step One: Scarify the work site.

(1) Position the grader outside the working area of the project.

(2) Place the grader in the scarifying mode (position).

(a) Ensure the moldboard is high enough off the ground to allow unrestricted (free) movement.

(b) Rotate the moldboard so that it is 90° with the frame and adjust the height to 12" off the surface (level).

(c) Center shift until the lift cylinders are centered on the grader.

- (d) Pitch the blade halfway.
- (e) Ensure the front wheels are straight up and down.
- (f) Place the grader in forward motion.
- (g) Lower the scarifier log as it crosses the project starting point and penetrate the surface.
- (h) Scarify the entire length of the area to a minimum depth of 6".
- (i) Raise the scarifier log at the finish point.
- (j) Exit the project area and stop the grader.
- (k) Rotate the moldboard to a 50° angle and adjust the center shift to straighten the heel cylinder.
- (l) Return to the starting point and reposition the grader for a second scarifying pass.

NOTE: Each student will complete three scarifying passes, each pass will overlap one scarifier tooth.

CAUTION: Never back the grader in the scarifying position. Blade ends become a safety factor as they extend out past the width of the grader.

m. Step Two: Leveling the area.

- (1) Establish a procedure.
 - (a) Right to Left: Beginning at the right side of the area boundary, blade the material from the right side to the left side. Be certain to center the grader on the windrow for each consecutive pass leaving a windrow of material along the left boundary.
 - (b) Left to Right: The same procedure as right to left except that the starting point is on the left boundary line.
 - (c) Center to Right/Center to Left: Beginning at approximately the centerline of the area, blade the material (level) from the center starting point to the left boundary line. Reposition the grader to the center line again, blade the material (level) from the center starting point to the right boundary line.

NOTE: Leveling an area is nothing more than cutting the highs and filling the lows.

- 1 Determine right or left hand grade:
- a Position the grader outside the working area of the project approximately halfway or in the center of the width of the project area.
- b Ensure the moldboard is high enough off the surface to allow unrestricted movement.
- c Rotate the moldboard so as the toe is on the right side of the grader at an angle of 50° to 60° to the frame.
- d Ensure the blade is pitched halfway.
- e Center shift until the left lift (heel) cylinder is straight up and down.
- f Lean the front wheels to the left.
- g Lower the moldboard until the toe and the heel touch the ground (lightly).
- h Place the grader in motion, and as the moldboard crosses the project start line apply enough down pressure on both the heel and toe to penetrate the surface ½" (level).
- i Maintain a straight course, adjusting the moldboard slightly to carry the material the length of the project.
- j Be sure to feather the material out at the end of the pass.

NOTE: Feathering is a process that is accomplished by raising the moldboard in ½" to 1" increments, while in a forward motion. Two or three seconds are recommended between each upward adjustment until all the material in front of the moldboard passes under it.

- After the material is feathered to a smooth termination, stop the grader and straighten the front wheels.
- Raise both lift cylinders all the way.
- Position the grader so as to straddle the windrow just made, back to the starting point, ensure the windrow is between the wheels and do not drive on top of it.
- Stop the grader just outside the project boundary line.

NOTE: If your position at the far end of the project was executed correctly, as you face forward, you should be centered on the windrow and no additional adjustments are necessary.

- 2 Right Hand Grade
- a Lean the wheels to the left and lower the toe and the heel to the surface.
- b Place the grader in forward motion. As the moldboard crosses the starting line skim the surface that was cut on the previous pass with the toe of the moldboard. Increase heel pressure downward to cut approximately $\frac{1}{2}$ " and carry the material the full length of the project area.
- c Again feather the material at the end of the pass.
- d Stop the grader far enough forward that repositioning will not disturb the windrow.
- e Straighten the wheels and raise both lift cylinders all the way.
- f Return to the center of the project start point and align the grader so as the toe (in the left hand general grade position) overlaps no more than 12" on the first pass.
- g Position the grader in the left hand general grade position. Remember, skim the surface with the toe and apply enough down pressure on the heel to cut $\frac{1}{2}$ " and carry the material the full length of the project.
- h Complete tow passes, following the same procedures discussed earlier.

NOTE: A slight windrow should be aligning both right and left boundaries of the project.

- (d) Step 3, Crowning the Surface. Crowning establishes a high point on the traveling surface to direct water off the surface.
- 1 Position the grader so as the toe (in the right hand general grade position) is aligned just inside the windrow or project boundary (right side).
- 2 Lower the toe and heel to the surface (level).

- 3 Raise the heel approximately 2". Adjust the toe if necessary to maintain contact with the surface.
- 4 Place the grader in forward motion. As the toe of the moldboard crosses the project start point, apply enough down pressure to cut approximately 2".

NOTE: When applying up or down pressure on one lift cylinder (either the toe or the heel) the other end of the moldboard will slightly lower or raise. Therefore, adjustments are required to maintain the heel or toe to the desired setting.

- 5 Maintain a straight course along the inside boundary of the project.
- 6 Be sure to feather the material at the end of the cut (pass).
- 7 Stop the grader; ensure the front wheels are straight up and down.
- 8 Raise both lift cylinders up all the way and position the grader to straddle the windrow then back up to the starting point.
- 9 Stop the grader outside the project working area.
- 10 Position the grader so as the toe (in the left hand general grade) is aligned just inside the windrow or project boundary (left side).
- 11 Follow the same procedures as done in the previous pass (right hand general grade) except that it will be accomplished in the left hand general grade.
- 12 The windrow created from this pass should be touching or close to the windrow made by the first pass.
- 13 Again, feather the material at the end of the pass and be careful to straddle the windrow(s) as the grader is backing to the starting point.

NOTE: The final step in road construction with the motor grader is building the crown. This final pass is accomplished by cutting and spreading the windrow(s) that is (are) left by the two previous passes (right hand/left hand general grade). The final pass is accomplished in the "center windrow position".

- a Looking forward at the project, the grader should be centered on the windrow.

b

Place the grader in the center windrow position.

1. Rotate the moldboard so as it is 90° to the frame (straight across).
2. Center shift until both lift cylinders are centered on the grader.
3. Ensure the blade is pitched halfway.

NOTE: Do not lean the front wheels. The wheels will remain straight during this grading period.

4. Lower the moldboard to the surface. Determine the height of the windrow (Example: The windrow appears to 6") and raise it half the height of the windrow (Example: 3").
5. Place the grader in forward motion making only minor adjustments to the moldboard.
6. Continue to the end of the project or until all the material in front of the moldboard passes under it.

NOTE: Repeat any or all steps required to shape the lane/road to the desired specifications.

CHAPTER 5

V-DITCHING WITH THE MOTOR GRADER

1.PURPOSE: To provide the student with the guidelines and information necessary to construct a V-ditch with the motor grader.

2.SAFETY: Know and adhere to all hand signals. Maintain three points of contact when mounting or dismounting. Ground all attachments and engage park brake before dismounting. Make 360° walk-around before mounting and after dismounting. Seat belt will be worn. Go slow under dusty conditions. Adjust mirrors after each change of operators, and use mirrors when backing. Do not adjust defroster fans while they are operating.

3.REFERENCES:

- a. FM 5-434, Earthmoving Operations, 30 Sep 92.
- b. Champion, 700 Series, Operators Manual
- c. John Deere, 670 Series, Operators Manual
- d. TM 5-3805-261-10, Grader, Heavy Road, 30G, Mar 89
- e. STP 5-62E12-SM-TG, Tasks: 051-254-1051 & 1053, Sep 85

4.INTRODUCTION TO V-DITCHING:

- a. The purpose of ditches is to provide drainage for surface water. V-ditching along roadsides catch or channel the water off the road and require maintenance to reduce erosion. The training will consist of establishing the ditch and removing the material on the inside slope only.
- b. Identify the working area:
 - (1) Conduct a visual overview (site survey).
 - (2) Determine the start and finish points.
- c. Sequence of events:
 - (1) Marking cut
 - (2) Ditching cut
 - (3) Wide side reach
 - (4) Right hand general grade
 - (5) Center windrow

d. Step 1 - Begin the ditch by establishing a marking cut.

- (1) Position the grader outside the working area of the project.
- (2) Place the grader in ditching position.
 - (a) Ensure the moldboard is high enough off the surface to allow unrestricted movement.
 - (b) Ensure the blade is pitched halfway.
 - (c) Center shift until the left (heel) lift cylinder is straight up and down.
 - (d) Rotate the moldboard so as the toe is just behind the outside edge of the right front tire approximately 45° to the frame).
 - (e) Blade side shift if necessary to extend the moldboard edge (toe) to the outside edge of the right front tire.
 - (f) Raise the left (heel) lift cylinder all the way (closed).
 - (g) Lean the front wheels to the left (heel).

NOTE: The grader is now in the ditching position. Align the right front tire on top of the proposed ditch line. Make a visual check to the finish point of the ditch. Maintain control of the grader and do not permit it to deviate from the proposed ditch line.

- (3) Place the grader in motion and as the right front tire passes over the starting point of the ditch, lower the toe of the moldboard by pushing the right lift cylinder control lever forward.

NOTE: At this point the primary concern is to follow the proposed ditch line (Example: If stakes are utilized, ensure the right front tire is directly in line with the next stake).

- (4) At the completion of the marking cut, feather the material and raise the toe all the way. Continue the forward movement until the rear tires pass over and off the marking cut.
- (5) Straighten the front wheels and steer the grader to the right (approximately 45° to the ditch).
- (6) Back the grader along the outside edge of the windrow.
- (7) Reposition the grader at the starting point.

NOTE: At this point stop the grader just as the right front tire enters into the marking cut.

- (8) Lean the front tires to the left.

NOTE: After the initial ditch line cut (marking cut) make all remaining cuts count. The marking cut provides an excellent track for the grader to follow. The grader is already set up for the ditching cut.

e. Step 2 - Establishing the depth of the ditch (or cut).

- (1) Place the grader in forward motion and apply as much down pressure to the toe of the blade that the grader will handle.

NOTE: The maximum depth of the ditch (or cut) for this exercise will be 12".

- (2) Continue along the ditch line until the grader has reached the finishing point then follow the exit procedures discussed earlier.
- (3) If the depth of 12" was not achieved, reposition the grader to the starting point and make additional cuts.
- (4) If the depth of 12" was achieved, reposition the grader to the starting point. However, do not place the right front tire into the center (or directly on top) of the ditch. Position the grader so as the right front tire is approximately 12 to 15" to the left of the ditch centerline and stop the grader.

f. Step 3 - Move the loose material from the inside slope to establish the shoulder of the ditch. This task is accomplished by placing the grader in the wide side reach position.

- (1) Rotate the moldboard to 90° with the frame (straight across) and adjust the height of the blade to approximately 4 to 6" off the surface.

CAUTION: This will prevent damage to the saddle and circle on some graders.

- (2) Center shift all the way to the right.
- (3) Readjust the height of the blade to approximately 2" off the surface.
- (4) Blade side shift all the way to the right.
- (5) Lean the front wheels to the left.
- (6) Circle the moldboard counter-clockwise until the toe is approximately 12 to 15" from the outside edge of the right front tire.

NOTE: Do not adjust the moldboard height, especially the heel or left lift cylinder. The view is somewhat obscured because the heel is under the mainframe of the grader.

- (a) Place the grader in forward motion and maintain a position and course so as the toe of the moldboard (blade) passes directly over the center of the ditch.
- (b) Apply enough down pressure to skim the material from the shoulder- do not cut the shoulder.
- (c) As the grader passes the finishing point of the ditch, continue forward until all the material in front of the moldboard passes under it or is windrowed off the heel (it may be necessary to feather the material).
- (d) Continue forward until enough space is available to position the grader to back-up and straddle the windrow.
- (e) Stop the grader and place the moldboard only in the right hand general grade position.

NOTE: Do not back the grader in the wide side reach position. Again, a safety factor is apparent; the moldboard would be extended out past the tires of the grader. By placing the moldboard in the right hand general grade position the safety factor is minimized and the moldboard is positioned to execute the next maneuver.

- (f) Ensure the front wheels are straight up and down prior to backing the grader.
- (g) Back the grader to the starting point by straddling the windrow.
- (h) Stop the grader outside the starting point of the project and lean the wheels to the left.
- (i) Lower the toe and the heel of the moldboard to the surface (level).
- (j) Raise the heel approximately 2 to 3" and ensure that toe is just touching the surface.
- (k) Place the grader in forward motion and maintain a straight course by keeping the grader centered on the windrow.
- (l) Skim the shoulder (road edge) with the toe and spread the windrow to form the surface of the road.

NOTE: With the heel raised approximately 3", the loose material from the ditch should pass under and off the heel of the moldboard.

- (m) At the end of the pass ensure the material is feathered prior to stopping the grader.
- (n) Straighten the front wheels and raise both lift cylinders all the way.
- (o) Reposition the grader at the finishing end of the project. The grader should be positioned to establish a V-ditch (going the opposite direction) on the other side of the project area.

NOTE: At this point park the grader and switch operators. The next operator will establish the ditch on the other side of the road (project edge) using the same procedures just discussed. After both ditches have been established and the material is graded into a center windrow, the second operator will complete the final pass to spread the windrow. Position the grader in the center windrow position, (estimate the height of the windrow) cut half the height of the windrow and spread it evenly across the road surface to create the crown.

NOTE: Brief the following environmental considerations:

- While moving on/off road terrain, avoid unnecessary damage to waterways or vegetation.
- Dust and exhaust created by the use of equipment also affects the environment, avoid any unnecessary equipment usage.
- Operator's must be constantly aware of any equipment leaks, and correct them before they become a hazard.
- Damage is caused by erosion due to rain, this erosion damage can be minimized by dressing off the work area at the end of each day.