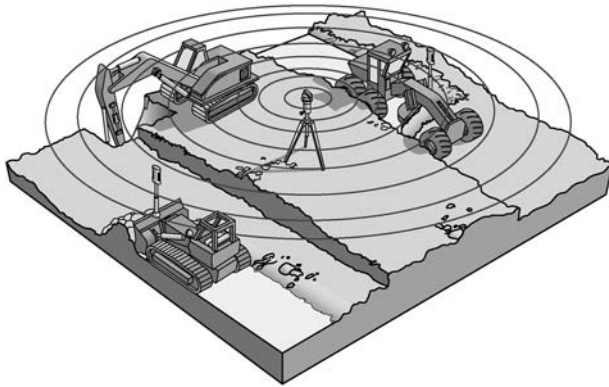


TECHNICAL MANUAL

OPERATOR'S, UNIT AND DIRECT SUPPORT MAINTENANCE MANUAL (INCLUDING REPAIR PARTS AND SPECIAL TOOLS LIST)



Laser Leveling Equipment (LLE)

USED WITH MODEL 130G Grader,
D7F, D7G, D7H, and D7R Dozers,
613B and 621B Scrapers,
and HYEX

Contract No. DAAE07-01-C-T009

Approved for public release;
distribution is unlimited.

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WARNING

Degreasing Solvent (MIL-PRF-680, Type II) is TOXIC and flammable. Wear protective goggles and gloves, use only in a well-ventilated area, avoid contact with skin, eyes, and clothes, and do not breathe vapors. Keep away from heat or flame. Never smoke when using solvent; the flash point for degreasing solvent type II is 200° F (93° C). Failure to comply may result in injury or death to personnel.

WARNING

If personnel become dizzy while using cleaning solvent, immediately get fresh air and medical help. If solvent contacts skin or clothes, flush with cold water. If solvent contacts eyes, immediately flush eyes with water and get immediate medical attention. Do not use diesel fuel, gasoline, or benzene (benzol) for cleaning.

WARNING

Adhesives, solvents, and sealing compounds burn easily and give off vapors that are harmful to the skin and clothing. To avoid injury or death, keep away from open fire when using these materials, and use only in well-ventilated areas. If adhesives, solvents, or sealing compounds contact the skin or clothing, wash immediately with soap and water, and rinse thoroughly. Failure to comply may result in injury or death to personnel.

WARNING

Unsafe welding practices can cause serious injury from fire, explosions, or harmful agents. Allow only authorized personnel to weld or cut metals, and follow safety precautions in TC 9-237. Protective clothing and goggles must be worn, adequate protective equipment must be used, a suitable fire extinguisher must be kept nearby, and requirements of TC 9-237 must be strictly followed. Failure to comply may result in serious injury or death to personnel.

WARNING

Allow solder to cool before handling wire. Failure to comply may result in injury to personnel.

WARNING

CARC paint contains isocyanate (HDI), which is highly irritating to skin and respiratory system. High concentrations of HDI can produce symptoms of itching and reddening of skin, a burning sensation in throat and nose, and watering of the eyes. In extreme concentrations, HDI can cause cough, shortness of breath, pain during respiration, increased sputum production, and chest tightness. The following precautions must be taken whenever using CARC paint:

WARNING

ALWAYS use air line respirators when using CARC paint, unless air sampling shows exposure to be below standards. Use chemical cartridge respirator if air sampling is below standards.

WARNING

DO NOT let skin or eyes come in contact with CARC paint. Always wear protective equipment (gloves, ventilation mask, safety goggles, etc.).

WARNING

DO NOT use CARC paint without adequate ventilation.

WARNING

NEVER weld or cut CARC-coated materials.

WARNING

DO NOT grind or sand painted equipment without high-efficiency air purifying respirators in use.

WARNING

BE AWARE of CARC paint exposure symptoms; symptoms can occur a few days after initial exposure. Seek medical help immediately if symptoms are detected.

WARNING

Battery acid (electrolyte) is extremely harmful. Always wear safety goggles and rubber gloves, and do not smoke when performing maintenance on batteries. Injury will result if acid contacts skin or eyes. Wear rubber apron to prevent damage to clothing.

WARNING

Remove all jewelry, such as rings, dog tags, bracelets, etc. If jewelry contacts Battery Terminal, a direct short may result in instant heating of tools, damage to equipment, and injury or death to personnel.

WARNING

Exercise extreme caution when working under tilt platform. Falling platform could result in serious injury or death to personnel.

WARNING

Turn battery disconnect switch OFF prior to performing maintenance in immediate battery area or working on electrical system. Failure to comply can result in electrical shock to personnel or damage to equipment.

WARNING

Always disconnect the negative (-) battery cable before servicing the battery or positive (+) battery cable. Failure to comply can result in electrical shock to personnel or damage to electrical system.

WARNING

Do not allow battery cable ends to contact each other or the machine. Failure to comply can result in damage to battery or electrical system.

WARNING

Do not smoke when using cleaning solvent. Never use it near an open flame. Be sure there is a fire extinguisher nearby and use cleaning solvent only in a well-ventilated area.

WARNING

Use caution when using cleaning solvents. Cleaning solvents evaporate quickly and can irritate exposed skin if solvents contact skin. In cold weather, contact of exposed skin with cleaning solvents can cause frostbite.

WARNING

Do not start or move Blade Pro® Motor Grader Control System while anyone is under the 130G Grader. Failure to comply could result in severe injury or death to personnel.

WARNING

Keep all personnel and equipment away from blade during calibration. Blade may move suddenly, causing injury or death to personnel, or damage to equipment.

WARNING

To avoid injury to personnel, ensure 130G Grader is shut OFF and blade is on the ground.

WARNING

Do not look into 1145-2 Laser Transmitter for a long period of time. Failure to comply may cause injury to personnel.

INSERT LATEST UPDATED PAGES / WORK PACKAGES. DESTROY SUPERSEDED DATA.

LIST OF EFFECTIVE PAGES / WORK PACKAGES

NOTE: The portion of text affected by the changes is indicated by a vertical line in the outer margins of the page. Changes to illustrations are indicated by miniature pointing hands. Changes to wiring diagrams are indicated by shaded areas.

Dates of issue for original and changed pages / work packages are:

Original..... 0... 30 November 2005

TOTAL NUMBER OF PAGES FOR FRONT AND REAR MATTER IS 24 AND TOTAL NUMBER OF WORK PACKAGE PAGES IS 436 CONSISTING OF THE FOLLOWING:

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**OPERATOR’S, UNIT AND DIRECT SUPPORT
MAINTENANCE MANUAL
(INCLUDING REPAIR PARTS AND SPECIAL TOOLS LIST)**

FOR

**LASER LEVELING EQUIPMENT (LLE)
USED WITH MODEL 130G Grader, D7F, D7G, D7H,
and D7R Dozers, 613B and 621B Scrapers, and HYEX**

Contract No. DAAE07-01-C-T009

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this publication. If you find any mistakes, or if you know of a way to improve the procedures, please let us know. Submit your DA Form 2028 (Recommended Changes to Publications and Blank Forms), through the Internet, on the Army Electronic Product Support (AEPS) website. The Internet address is <http://aeprs.ria.army.mil>. If you need a password, scroll down and click on “ACCESS REQUEST FORM.” The DA Form 2028 is located in the ONLINE FORMS PROCESSING section of the AEPS. Fill out the form and click on SUBMIT. Using this form on the AEPS will enable us to respond quicker to your comments and better manage the DA Form 2028 program. You may also mail, fax, or e-mail your letter or DA Form 2028 direct to: AMSTA-LC-LPIT / TECH PUBS, TACOM-RI, 1 Rock Island Arsenal, IL, 61299-7630. The e-mail address is TACOM-TECH-PUBS@ria.army.mil. The fax number is (DSN) 793-0726 or Commercial (309) 782-0726.

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HOW TO USE THIS MANUAL

This manual is for commercially available equipment that has been approved for military use. This is a Commercial Off-The-Shelf (COTS) Manual with supplemental data to support military-specific maintenance. This manual is designed to help operate and maintain the Laser Leveling Equipment. Listed below are some of the features included in this manual to help locate and use the needed information:

- A front cover Table of Contents is provided for quick reference to chapters and sections that will be used often.
- Warning, caution, and note headings, subject headings, and other essential information are printed in bold type, making them easier to see.
- In addition to text, there are exploded-view illustrations showing how to take a component off and put it back on. Cleaning and inspection criteria are also included where necessary.
- Chapter 1 of this manual describes the Laser Leveling Equipment and provides equipment data.
- Chapter 2 of the manual describes the Gradio[®] Display System, used with dozers and scrapers.
- Chapter 3 of the manual describes the Blade Pro[®] Motor Grader Control System, used with 130G Graders.
- Chapter 4 of the manual describes the Bucket-Pro[™] System, used with Hydraulic Excavator (HYEX).
- Chapter 5 of the manual describes the use of the 1145-2 Laser Transmitter and Tripod, that can be used with the Gradio[®] Display System, the Blade Pro[®] Motor Grader Control System, or the Bucket-Pro[™] System.
- Appendix A covers the References used in this manual.
- Appendix B covers the Maintenance Allocation Chart (MAC).
- Appendix C covers the Repair Parts and Special Tools List (RPSTL).
- Appendix D covers the Components of End Item (COEI) and Basic Issue Items (BII) Lists.
- Appendix E covers the Additional Authorized List (AAL).
- Appendix F covers the Expendable/Durable Supplies and Materials List.
- Appendix G covers the Decal Guide.
- Appendix H covers the Illustrated List of Manufactured Items.
- Appendix J covers the Torque Limits.
- Appendix K covers the Mandatory Replacement Parts.

Follow these guidelines when using this manual:

- Read all WARNINGS and CAUTIONS before performing any procedures.
- Read through this manual and become familiar with the contents.
- Read the entire procedure before attempting to perform any maintenance task.

CHAPTER 1

INTRODUCTION

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1-1. SCOPE.

a. Type of Manual/Model Numbers/Equipment Name.

This manual is used for operation, maintenance, and installation of Laser Leveling Equipment used on the 130G Grader, the D7F, D7G, D7H, and D7R Dozers, the 613B and 621B Scrapers, and the HYEX.

b. Purpose of Equipment.

The laser diode emits a thin, round beam of light. Energy in this light is at a wavelength that will activate light-sensitive cells in the receiver.

The mechanism in the laser rotates the beam at a constant 600 revolutions per minute. The light beam remains perpendicular to the axis of rotation at all times.

As the beam rotates about the axis, it describes a “plane” similar to a CD-ROM, with a radius of 1,000 ft (305 m). In theory, the beam does not waver from the plane.

As the rotating beam strikes the receiver, it activates cells at 600 times per minute (10 times per second). This happens so fast that it gives the appearance of a solid plane of light. This solid plane of light establishes a reference above ground. It can be adjusted up or down by mounting the laser on a tripod.

The Laser Transmitter mounted in relation to the cutting edge (on mast) allows the Operator to “transfer” the plane to the ground the Operator is working. It does this by showing the Operator which direction to move the cutting edge to keep the distance from the ground to the light plane constant.

1-2. MAINTENANCE FORMS AND RECORDS.

Department of the Army forms and procedures used for equipment maintenance will be those prescribed by DA PAM 738-750, The Army Maintenance Management System (TAMMS) (Maintenance Management UPDATE).

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1-3. EQUIPMENT IMPROVEMENT REPORT AND MAINTENANCE DIGEST (EIR MD) AND EQUIPMENT IMPROVEMENT REPORT AND MAINTENANCE SUMMARY (EIR MS).

The quarterly Equipment Improvement Report and Maintenance Digest (EIR MD), TB 43-0001-62 series, contains valuable field information on equipment covered in this manual. Information in the TB 43-0001-62 series is compiled from some of the Equipment Improvement Reports that have been prepared on equipment covered in this manual. Many of these articles result from comments, suggestions, and improvement recommendations that were submitted to the EIR program. The TB 43-0001-62 series contains information on equipment improvements, minor alterations, proposed Modification of Work Orders (MWOs), warranties (if applicable), actions taken on recommendation submitted on the DA Form 2028 (Recommended Changes and Blank Forms), and advance information on proposed changes that may affect this manual. Significant maintenance articles, including minor alterations and field-fixes, are republished in the Equipment Improvement Report and Maintenance Summary (EIR MS) for TACOM Equipment (TM 43-0143). Refer to the TB 43-0001-62 series and TM 43-0143 periodically for the most current and authoritative information on the equipment. The information will help maintenance personnel to do a better job and will advise them of the latest changes to this manual. Also refer to DA PAM 310-1, Consolidated Index of Army Publications and Blank Forms, and Appendix A, References, of this manual.

1-4. SUBMITTING QUALITY DEFICIENCY REPORTS (QDR).

If your equipment needs improvement, let us know. Send us a QDR. You, the user, are the only one who can tell us what you don't like about your equipment. Let us know why you don't like the design or performance. Put it on an SF368 (Quality Deficiency Report). Mail it to:

Commander
U.S. Army Tank-automotive and Armaments Command
ATTN: AMSTA-TR-PQDR
Warren, MI 48397-5000

A reply will be sent to you.

1-5. DESTRUCTION OF ARMY MATERIEL TO PREVENT ENEMY USE.

Refer to TM 750-244-6 for instructions covering destruction of Army materiel to prevent enemy use.

1-6. WARRANTY INFORMATION.

Trimble warrants all manufactured products to be free of defects in materials and workmanship for a period of one (1) year from the date the product is put into service. Components not manufactured by Trimble, but sold as a part of the system, will carry a 90-day warranty, or the manufacturer warranty, whichever is greater.

Trimble warrants all installations on all heavy construction equipment to be free of defects in materials and workmanship for a period of one (1) year from the date the installation is completed. This Installation Warranty will apply only when Trimble personnel or authorized personnel conduct the installation.

The Trimble warranty for products and/or installation is valid worldwide.

Trimble or its Authorized Service Center will repair or replace, at its option, any defective part or component of which notice has been given during the warranty period.

This warranty does not cover any evidence of neglect, abuse, accident, or any attempt to repair equipment by other than factory-authorized personnel and/or parts authorized in this manual. For nonwarranty repairs, the cost of the repair and, if required, travel and per diem expenses to and from the place where repairs are made will be charged to the purchaser at the prevailing rates.

Customers should send unit(s), freight prepaid, to the nearest Authorized Service Center for warranty repairs. In countries with Trimble Service Centers, the repaired units will be returned, freight prepaid, to the customer.

Warranties for specific models of Laser Leveling Equipment may exceed one (1) year, and may cover use and/or abuse. For details on these warranties, consult that model's operating instructions manual.

Trimble will not be held responsible for any consequential loss or damage of any kind.

Checking and maintaining calibration of all equipment is the responsibility of the user.

Trimble policy for repair turnaround time for all Department of Defence (DoD) Agencies has been in effect since 1994. This policy is as follows:

- **In-House Repairs:** Completed in 1 to 48 hours, depending on the extent of service required.

If the repairs required are extensive and the Trimble Service Center is unable to complete the repair within 48 hours, that DoD Agency will be offered a loaner to use until that repair is completed. If that item is under warranty, there will be no cost to that agency. If that item is not under warranty, a rental fee may apply.

NOTE

This policy covers service work conducted at Trimble Service Centers anywhere in the world.

- **On-Site/On-Machine (Grader, Dozer, Scraper, Paver, etc.) Repairs:** Completed in 1 to 48 hours, depending on the extent of service required. Does not include travel time to site where repairs are to be conducted.

If the repairs required are extensive and the on-site Trimble Service personnel are unable to complete the repair within 48 hours, that DoD Agency will be offered a loaner to use until that repair is completed. If that item is under warranty, there will be no cost to that agency. If that item is not under warranty, a rental fee may apply.

NOTE

This policy covers service work conducted by Trimble Service Centers anywhere in the world.

Warranty: Standard commercial warranty is one (1) year on parts, labor, and installation from the date of installation (In Service date).

1-7. REFERENCE INFORMATION.

This listing includes a nomenclature cross-reference list and a list of abbreviations used in this manual.

a. Abbreviations.

AEPS	Army Electronic Product Support
AAL	Additional Authorization List
AISI	Automated Integrated Survey Instrument
amp	Amperes
ANSI	American National Standards Institute
AOAP	Army Oil Analysis Program
BII	Basic Issue Item
C	Centigrade
CAGE	Commercial and Government Entity

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CBR	Chemical, Biological, Radiological
CKT	Circuit
cm	Centimeter
COEI	Components of End Item
COTS	Commercial Off-The-Shelf
cps	Cycles Per Second
CTA	Common Table of Allowance
DA	Department of the Army
DoD	Department of Defense
EIR -MD	Equipment Improvement Report and Maintenance Digest
EIR -MS	Equipment Improvement Report and Maintenance Summary
F	Fahrenheit
ft	Foot
HDI	Isocyanate
HYEX	Hydraulic Excavator
in.	Inch
I.D.	Inside Diameter
O.D.	Outside Diameter
kg	Kilogram
LACV	Lift and Articulation Check Valve
lb-ft	Pound-Foot
lb.	Pound
LCD	Liquid Crystal Display
LED	Light-Emitting Diode
LLE	Laser Leveling Equipment
m	Meter
MAC	Maintenance Allocation Chart
mm	Millimeter
N·m	Newton Meters
NPSM	National Pipe Straight Mechanical
NSN	National Stock Number
OC	On-Condition
OL	Over Limit
ORS	O-Ring Seal
PMCS	Preventive Maintenance Checks and Services
QDR	Quality Deficiency Reports
rpm	Revolutions Per Minute
RPSTL	Repair Parts and Special Tools List
SAE	Society of Automotive Engineers
SMR	Source, Maintenance, and recoverability
TACOM	Tank-automotive and Armaments Command
TAMMS	The Army Maintenance Management System
TM	Technical Manual
TMDE	Test, Measurement, and Diagnostic Equipment
U/M	Unit of Measure
UOC	Usable on Code
v	Volts
Vac	Volts alternating current
Vdc	Volts direct current

b. **Definitions of Technical Terms.**

Actual Blade Slope – The monitored slope of the blade, which is used to calculate desired cross-slope. Actual blade slope and desired cross-slope are equal only when the blade is perpendicular to the machine’s direction of travel.

Benchmark – A point of reference from which measurements may be made.

Calculated Cross-Slope – The cross-slope is calculated by using the information provided by the machine-mounted sensors and calculated with the Blade Pro® Motor Grader Control System.

Desired Cross-Slope – The slope that is marked on the job plans. This may be referenced from the centerline of the road to the 1/4 crown, from shoulder to shoulder, or from shoulder to ditch, depending on the plans. This is the slope entered into the Blade Pro® Motor Grader Control System’s Operator Interface Box.

Elevation – The height above or below a set point.

Mainfall – The slope of the machine in the direction of travel.

Percent Slope – The change in elevation between two points divided by the distance between the points and multiplied by 100.

$$\frac{\text{Elevation A} - \text{Elevation B}}{\text{Distance}} \times 100 = \text{Percent (\%)} \text{ Slope}$$

Plane – A flat or level surface.

Resultant Cross-Slope – The measured slope perpendicular to the direction of the machine’s travel.

Slope – The change in elevation between two points in relation to the measured distance between the points (e.g., 1/4 in. per 1 ft [6.4 mm per 30.5 cm]).

CHAPTER 2

GRADIO[®] DISPLAY SYSTEM

(D7F, D7G, D7H, AND D7R DOZERS AND 613B AND 621B SCRAPERS)

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Gradio [®] Display System Installation for Scrapers.....	2-16	2-26

SECTION I. GRADIO[®] DISPLAY SYSTEM GENERAL INFORMATION

2-1. SCOPE.

Chapter 2 is used for operation, maintenance, and installation of the Gradio[®] Display System used on the D7F, D7G, D7H, and D7R Dozers and the 613B and 621B Scrapers.

2-2. EQUIPMENT CHARACTERISTICS, CAPABILITIES, AND FEATURES.

- a. **Characteristics.** The RT2S Laser Receiver and DR2 Display are ideal for applications where the RT2S Laser Receiver must be mounted many feet from the Operator (or at an inconvenient location), such as on Dozers and Scrapers. The cableless feature means the DR2 Display can be mounted optimally without routing the cables around or through complex or articulating machine joints.

The MM2E Manual Mast is used in machine control applications where changes in the benchmark elevations are minimal and when manual adjustments of the RT2S Laser Receiver's height do not present a safety risk.

TM 5-6675-348-13&P

The RM2E-3 Rigid Mast is used in machine control applications where changes in the benchmark elevations are minimal and when manual adjustments of the RT2S Laser Receiver's height do not present a safety risk.

b. Capabilities.

- (1) The Gradio[®] Display System is capable of operating in temperatures from -20 to 140° F (-29 to 60° C).
- (2) Normal Gradio[®] Display System operating range (between RT2S Laser Receiver and DR2 Display) is up to a 100-ft (30.5 m) radius.

c. Features.

- (1) The RT2S Laser Receiver is an omnidirectional, 360-degree receiver that accepts signals from the 600-rpm rotating lasers.
- (2) The RT2S Laser Receiver translates and sends elevation information to the DR2 Display via low-power radio communication.



12-/24-Vdc bulbs may be used. To avoid damage to equipment, ensure proper bulb is installed for machine's electrical system.

- (3) Five channels of grade data (high coarse, high fine, on-grade, low fine, and low coarse) are displayed for the Operator through bright lenses in the DR2 Display.
- (4) The RT2S Laser Receiver is a self-contained, battery-powered unit that can be mounted in an optimum position without concern for cable routing and subsequent cable damage.
- (5) The MM2E Manual Mast provides a mount for the RT2S Laser Receiver to slip over and clamp into place.
- (6) The MM2E Manual Mast has increment/decrement mast tape to indicate changes in position of the MM2E Manual Mast.
- (7) The RM2E-3 Rigid Mast has increment/decrement mast tape to indicate changes in position of the RM2E-3 Rigid Mast.
- (8) The RM2E-3 Rigid Mast Quick-Release Pin enables easy removal of the RM2E-3 Rigid Mast from the mast mount.
- (9) The RM2E-3 Rigid Mast Lanyard Chain connects the Quick-Release Pin to the RM2E-3 Rigid Mast tube to prevent loss when disconnected.

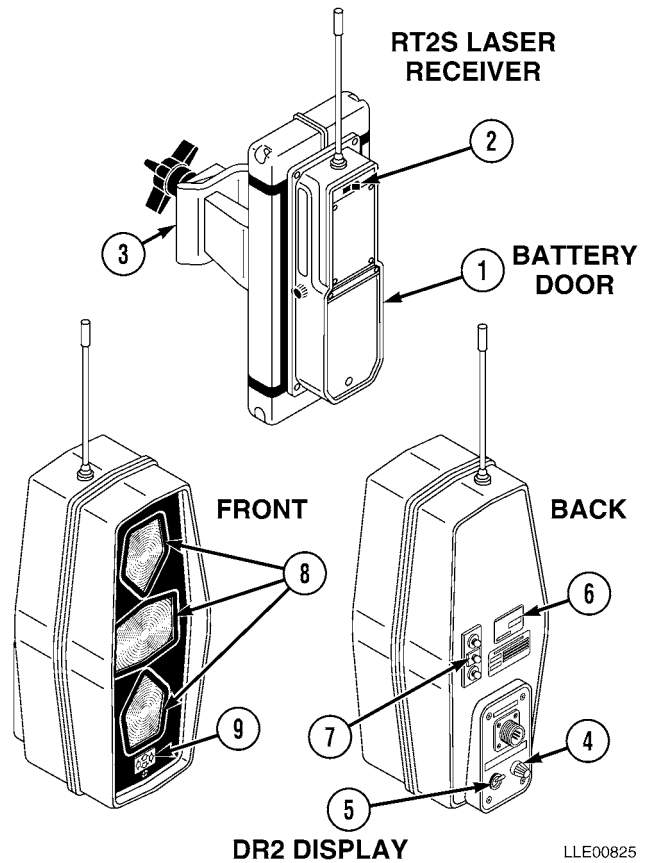
2-3. LOCATION AND DESCRIPTION OF MAJOR COMPONENTS.

- (1) **BATTERY DOOR.** Holds four alkaline, C-size batteries.
- (2) **ON/OFF SWITCH.** Used to turn the RT2S Laser Receiver ON and OFF.



12-/24-vdc bulbs may be used. To avoid damage to equipment, ensure 24-v bulbs are installed for 24-v electrical system and 12-v bulbs are installed for 12-v electrical system.

- (3) **RT2S LASER RECEIVER CLAMP.** "Universal" design allows RT2S Laser Receiver to be mounted on 1 1/2-in. to 2-in. (3.81 cm to 5.1 cm) diameter round tubing or 1 1/2-in. to 1 3/4-in. (3.81 cm to 4.45 cm) square tubing.
- (4) **OVERLOAD PROTECTION.** A 5-amp fuse is used to protect the DR2 Display.
- (5) **DISPLAY CONTROL SWITCH.** Turns the DR2 Display on in either bright or dim DR2 Display mode for day or night use.

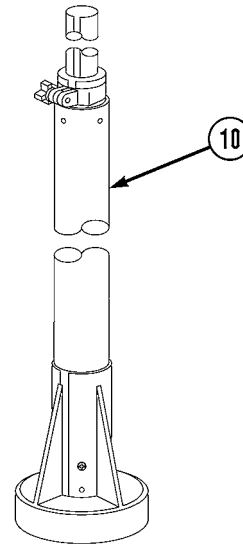


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- (6) **CHANNEL INDICATION.** Designates channel configuration of the RT2S Laser Receiver or the DR2 Display. Channels must match for proper operation. Matching channels have the same color heat shrink tubing on the antenna.
- (7) **OPERATOR SETUP LAMPS.** Light-emitting diodes (LED) on the back of the DR2 Display reflect activity of the DR2 Display panel lights. This allows for one-soldier setup.
- (8) **GRADE INDICATOR LAMPS.** Used to communicate grade information to the Operator.
- (9) **OUT-OF-BEAM INDICATOR.** LEDs on the DR2 Display panel indicate which direction the RT2S Laser Receiver must be moved to intercept the laser beam.

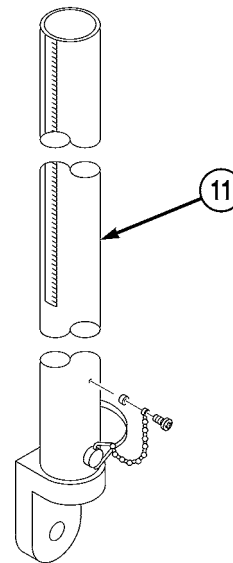
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- (10) **MM2E MANUAL MAST.** A manually telescoping receiver mount with increment/decrement tape on the telescoping mast tube, that allows RT2S Laser Receiver to be positioned at known intervals.



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- (11) **RM2E-3 RIGID MAST.** A rigid receiver mount with increment/decrement tape, that allows the RT2S Laser Receiver to be moved at known intervals.



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2-4. EQUIPMENT DATA.

Table 2-1. Gradio® Display System Equipment Data

Model	Item
RT2S Laser Receiver DR2 Display	<p>DIMENSIONS</p> <p>Length: 11.3 in. (28.7 cm) Width: 4.5 in. (11.4 cm) Depth: 7.9 in. (20.1 cm)</p> <p>Length: 13.5 in. (34.3 cm) Width: 5.0 in. (12.7 cm) Depth: 6.5 in. (16.5 cm)</p>
MM2E Manual Mast RM2E-3 Rigid Mast	<p>MAST HEIGHT</p> <p>Retracted: 4.9 ft (1.5 m) Extended: 8.8 ft (2.7 m)</p> <p>3.9 ft (1.2 m)</p>
RT2S Laser Receiver DR2 Display	<p>ANTENNA LENGTH</p> <p>Height: 7.2 in. (18.3 cm)</p> <p>Height: 7.2 in. (18.3 cm)</p>
RT2S Laser Receiver DR2 Display MM2E Manual Mast RM2E-3 Rigid Mast	<p>WEIGHT</p> <p>5.1 lb. (2.3 kg) 7.3 lb. (3.3 kg) 33 lb. (15 kg) 6 lb. (2.7 kg)</p>
MM2E Manual Mast RM2E-3 Rigid Mast	<p>TAPE INCREMENTS</p> <p>0.01 ft (0.0030 m) 0.01 ft (0.0030 m)</p>
RT2S Laser Receiver DR2 Display	<p>ELECTRICAL SYSTEM</p> <p>Four C-size alkaline batteries provide 40 to 60 hours of use. Ni-Cad batteries (supplied with charging kit) provide 24 hours of use per overnight charge. DO NOT TRY TO CHARGE ALKALINE BATTERIES.</p> <p>12 or 24 Vdc from electrical system</p>

SECTION II. GRADIO® DISPLAY SYSTEM PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS)

Preventive Maintenance Checks and Services (PMCS) means systematic caring for, inspecting, and servicing equipment to keep it in good condition and to help prevent breakdowns. As the Operator, your mission is to:

- a. Be sure to perform your PMCS each time you operate the Gradio® Display System. Always do your PMCS in the same order so it becomes a habit. Once you've had some practice, you'll quickly spot anything wrong.
- b. Do your Before PMCS just before you operate the Gradio® Display System. Pay attention to WARNINGS, CAUTIONS, and NOTES.
- c. Do your During PMCS while you operate the Gradio® Display System. Pay attention to WARNINGS, CAUTIONS, and NOTES.
- d. Do your After PMCS right after operating the Gradio® Display System. Pay attention to WARNINGS, CAUTIONS, and NOTES.
- e. Do your Weekly PMCS once a week.
- f. Use DA Form 2404 or DA Form 5988-E (Equipment Inspection and Maintenance Worksheet) to record any faults that you don't immediately fix.

2-5. PMCS PROCEDURES.

- a. The PMCS Table (Table 2-2.) lists inspections and care required to keep your Gradio® Display System in good operating condition. This table is set up so you can do Before and After PMCS while walking around the equipment.
- b. The "Interval" column tells you when to do a certain check or service.
- c. The "Procedure" column tells you how to do required checks and services. Carefully follow these instructions.
- d. The "Not Fully Mission Capable If" column tells you when your Gradio® Display System is nonmission capable and why the Gradio® Display System cannot be used.
- e. When something looks wrong that you cannot fix, write down the problem on your DA Form 2404 or DA Form 5988-E. Immediately report the problem to your supervisor.
- f. When you do your PMCS, you will always need a rag or two. Following are checks that are common to the entire Gradio® Display System.

WARNING

- Degreasing Solvent (MIL-PRF-680, Type II) is TOXIC and flammable. Wear protective goggles and gloves, use only in a well-ventilated area, avoid contact with skin, eyes, and clothes, and do not breathe vapors. Keep away from heat or flame. Never smoke when using solvent; the flash point for degreasing solvent type II is 200° F (93° C). Failure to comply may result in injury or death to personnel.
 - If personnel become dizzy while using cleaning solvent, immediately get fresh air and medical help. If solvent contacts skin or clothes, flush with cold water. If solvent contacts eyes, immediately flush eyes with water and get immediate medical attention. Do not use diesel fuel, gasoline, or benzene (benzol) for cleaning.
 - Adhesives, solvents, and sealing compounds burn easily and give off vapors that are harmful to the skin and clothing. To avoid injury or death, keep away from open fire when using these materials, and use only in well-ventilated areas. If adhesives, solvents, or sealing compounds contact the skin or clothing, wash immediately with soap and water, and rinse thoroughly. Failure to comply may result in injury or death to personnel.
- (1) **Keep It Clean.** Dirt, grease, oil, and debris only get in the way and may cover up a serious problem. Clean as you work. Use degreasing solvent (MIL-PRF-680, type II) on all metal surfaces. Use soap and water when you clean rubber or plastic material.
 - (2) **Rust and Corrosion.** Check Gradio® Display System brackets for rust and corrosion. When any bare metal or corrosion exists, clean surface and apply a coat of paint. Report bare metal or corrosion to your supervisor.
 - (3) **Bolts, Nuts, and Screws.** Check all bolts, nuts, and screws for obvious looseness, missing, bent, or broken condition. You can't check them all with a tool, but look for chipped paint, bare metal, or rust around bolt heads. When you find a bolt, nut, or screw you think is loose, tighten it or report it to your supervisor.
 - (4) **Welds.** Look for loose or chipped paint, rust, or gaps where parts are welded together. When you find a bad weld, report it to your supervisor.
 - (5) **Electric Wires and Connectors.** Look for cracked, frayed, or broken insulation, bare wires, and loose or broken connectors. Tighten loose connectors. Report any damaged wires to your supervisor.
 - (6) **Hydraulic Lines and Fittings.** Look for wear, damage, and leaks; ensure clamps and fittings are tight. Stains around a fitting or connector can mean a leak. If a leak comes from a loose fitting or connector, tighten it. If something is broken or worn out, report it to Unit Maintenance.
 - (7) When you check operating conditions, check to see if component is serviceable.

2-6. SHORTENED MAINTENANCE INSTRUCTIONS.

Local conditions of extreme heat, dust, cold, or wetness dictate that service intervals shall be shortened.

2-7. ADDITIONAL MAINTENANCE INSPECTIONS.

Additional maintenance inspections are required for the following reasons:

- a. Prolonged storage. Inspect Gradio® Display System components that have been stored for a period of 3 months or more.
- b. Initial preparation upon receipt.
- c. Preparation for storage.

2-8. PMCS COLUMN ENTRY EXPLANATION.


- a. **Item No. Column.** The checks and services are numbered in interval order showing a walk-around sequence around the Gradio® Display System. Use these numbers in the “Item No.” column on DA Form 2404 or DA Form 5988-E when recording faults that you don’t immediately fix.
- b. **Interval Column.** This column indicates when the lubrication, check, and/or service should be performed.
- c. **Location, Item to Check/Service Column.** The underlined items listed in this column are divided into groups indicating the portion of the equipment of which they are a part (e.g., brakes, fuel, engine). Under these groupings, a few common words are used to identify the specific item being checked.
- d. **Procedure Column.** This column contains procedures required to perform the checks and services.
- e. **Not Fully Mission Capable If Column.** This column contains the criteria that cause the equipment to be classified as NOT READY/AVAILABLE because of an inability to perform its primary mission. An entry in this column will:
 - (1) Identify conditions that make the equipment not available for readiness reporting purposes.
 - (2) Deny use of the equipment until corrective maintenance has been performed.

2-9. GRADIO® DISPLAY SYSTEM OPERATOR’S PMCS TABLE.

Table 2-2. Gradio® Display System Operator’s PMCS (Before/After)

Item No.	Interval	Location	Procedure	Not Fully Mission Capable If:
		Item to Check/Service		
1.	Before/After	Gradio® Display System RT2S Laser Receiver	Wipe dirt and dust from all metal components with dry cloth. Inspect housing of the RT2S Laser Receiver for damage or cracks. Inspect windows for cracks, scratches, and dirt. Clean windows with clean water and soft cloth. Check antenna for breaks or cuts that will allow antenna to rotate.	Windows are cracked. Antenna rotates.

Table 2-2. Gradio® Display System Operator's PMCS (Before/After) (Cont)

Item No.	Interval	Location	Procedure	Not Fully Mission Capable If:
		Item to Check/Service		
2.	Before/After	Gradio® Display System DR2 Display	<p>Wipe dirt and dust from all metal components with dry cloth.</p> <p>Inspect windows for cracks, scratches, and dirt. Clean windows with clean water and soft cloth.</p> <p>Inspect bottom mounting hole of DR2 Display for dirt and debris.</p> <div style="text-align: center;">  <p>CAUTION</p> </div> <p>To avoid damage to equipment, fuse must be replaced with 5-amp fuse.</p> <p>Ensure overload protection fuse in DR2 Display is not burned out.</p> <p>Check antenna for breaks or cuts that will allow antenna to rotate.</p> <p>Check bulbs for operation.</p>	<p>Windows are cracked.</p> <p>Fuse is burned out.</p> <p>Antenna rotates.</p> <p>Bulbs do not operate.</p>
3.	Before/After	Electrical Cables	Ensure electrical cables are not frayed, cracked, or exposed.	Cables are frayed, cracked, or exposed wires are evident.
4.	Before/After	Electrical Connections	Ensure connector on back of DR2 Display is free of dirt and damage.	Connector is damaged.
5.	Before/After	MM2E Manual Mast	Ensure MM2E Manual Mast will extend and retract.	MM2E Manual Mast will not extend or retract.
6.	Before/After	MM2E Manual Mast Mounting Plate	Check welds for cracks or breaks.	Any welds are cracked or broken.
7.	Before/After	RM2E-3 Rigid Mast	Check RM2E-3 Rigid Mast for damage.	RM2E-3 Rigid Mast is bent.
8.	Before/After	RM2E-3 Rigid Mast Mounting Bracket	Check welds for cracks or breaks.	Any welds are cracked or broken.
9.	Before/After	Voltage Protection Cable	Ensure cable is not frayed, cracked, or exposed.	Cable is frayed, cracked, or exposed wires are evident.

SECTION III. GRADIO[®] DISPLAY SYSTEM OPERATION

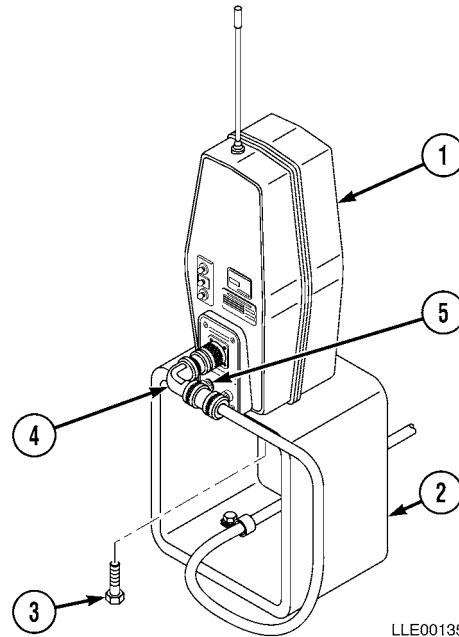
2-10. GRADIO[®] DISPLAY SYSTEM INSTALLATION OF COMPONENTS.

a. DR2 Display.



- The color of the shrink tubing on the antenna indicates the frequency of the display and must match in color with the heat shrink tubing on the antenna of the RT2S Laser Receiver. If the heat shrink tubing does not match, the Gradio[®] Display System will not operate.
- Two adjacent frequency systems will/can cross-communicate. If two adjacent frequencies cross-communicate, the Gradio[®] Display System will not operate properly.

- (1) Attach DR2 Display (1) to mounting bracket (2) with screw (3).
- (2) Connect Power Cable (4) to back of DR2 Display (1).
- (3) Adjust DR2 Display bright/dim switch (5) as needed.

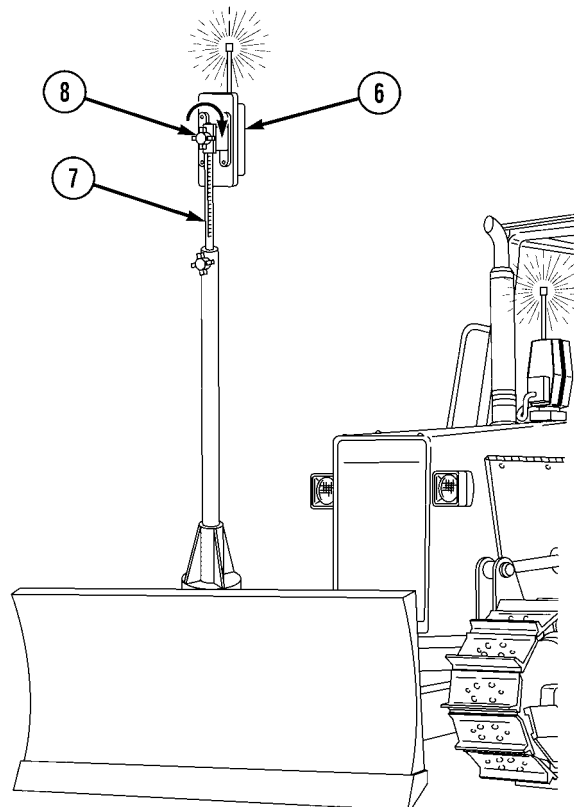


b. RT2S Laser Receiver.



The color of the shrink tubing on the antenna indicates the frequency of the display and must match in color with the heat shrink tubing on the antenna of the RT2S Laser Receiver. If the heat shrink tubing does not match, the Gradio[®] Display System will not operate.

- (1) Turn on RT2S Laser Receiver (6).
- (2) Slide RT2S Laser Receiver (6) over MM2E Manual Mast (7).
- (3) Rotate RT2S Laser Receiver Knob (8) clockwise to secure RT2S Laser Receiver (6) to MM2E Manual Mast (7).



2-11. GRADIO® DISPLAY SYSTEM SETUP.

a. Setup for Dozer.

- (1) Place cutting edge (1) on benchmark.
- (2) If finished grade is benchmark elevation, move RT2S Laser Receiver (2) up/down using MM2E Manual Mast (3), and adjust until ON-GRADE symbol (4) (solid green bar) appears on DR2 Display (5).

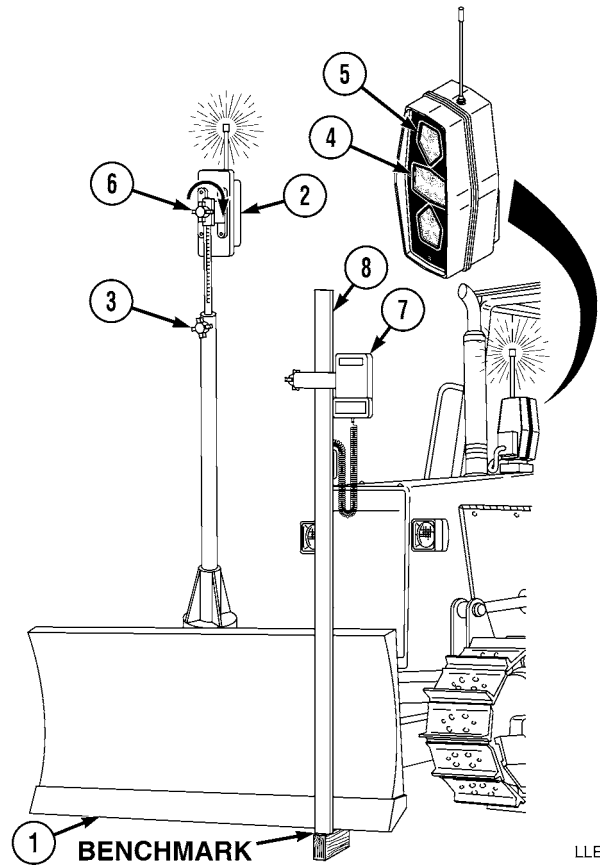
NOTE

Moving the RT2S Laser Receiver up on the MM2E Manual Mast lowers the blade cutting edge. Moving the RT2S Laser Receiver down on the MM2E Manual Mast raises the blade cutting edge.

- (3) If finished grade is below benchmark elevation, raise RT2S Laser Receiver (2) using MM2E Manual Mast (3).

Example: If the final grade is 2 in. (5.1 cm) below benchmark, raise RT2S Laser Receiver 2 in. (5.1 cm).

- (4) Secure MM2E Manual Mast (3) by rotating MM2E Manual Mast Adjusting Knob (6) clockwise.
- (5) After making a short pass, check grade with 1275 Laser Receiver (7) on Grade Rod (8) (refer to Chapter 5). Adjust machine-mounted RT2S Laser Receiver (2) up/down using MM2E Manual Mast to desired grade, if needed.



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b. Setup for Scraper.

- (1) Place cutting edge (1) on benchmark.
- (2) If finished grade is benchmark elevation, move RT2S Laser Receiver (2) up/down on Scraper Rigid Mast (3), adjust until ON-GRADE symbol (4) (solid green bar) appears on DR2 Display (5).

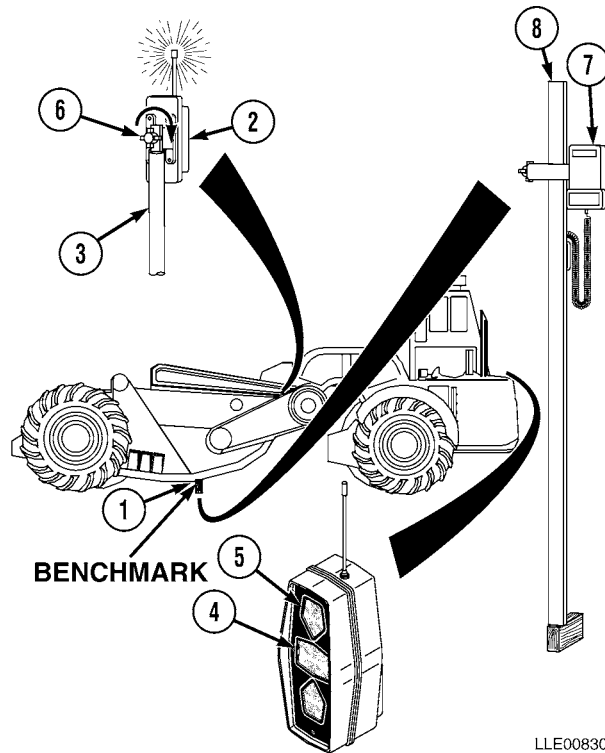
NOTE

Moving the RT2S Laser Receiver (2) up on the Scraper Rigid Mast (3) lowers the blade cutting edge. Moving the RT2S Laser Receiver (2) down on the Scraper Rigid Mast (3) raises the blade cutting edge.

- (3) If finished grade is below benchmark elevation, raise RT2S Laser Receiver (2) on Scraper Rigid Mast (3).

Example: If the final grade is 2 in. (5.1 cm) below benchmark, raise RT2S Laser Receiver 2 in. (5.1 cm).

- (4) Secure RT2S Laser Receiver (2) by rotating RT2S Laser Receiver (2) Adjusting Knob (6) clockwise.
- (5) After making a short pass, check grade with 1275 Laser Receiver (7) on Grade Rod (8) (Refer to Chapter 5). Adjust machine-mounted RT2S Laser Receiver (2) up/down on Scraper Rigid Mast (3) to desired grade, if needed.



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2-12. GRADIO® DISPLAY SYSTEM OPERATION.

The RT2S Laser Receiver determines if cutting edge is too high, too low, or on grade in relation to the benchmark. When the RT2S Laser Receiver transmits the grade information to the DR2 Display, the DR2 Display shows the Operator which direction the cutting edge should be adjusted (raised/lowered), if needed.

Ideal grade indication to maintain during normal operation is flashing yellow high (down) arrow, or flashing (green) On-Grade Bar. It is not desirable to cut below grade.

During Gradio® Display System operations using the RT2S Laser Receiver, watch the DR2 Display and operate the Dozer or Scraper normally.

Grade Indicator Lamp	Correction Indicated	Distance from Grade
Solid High Arrow	Coarse Lower	0.11 to 0.28 ft (0.03 to 0.09 m)
Flashing High Arrow	Fine Lower	0.015 to 0.11 ft (0.005 to 0.03 m)
Flashing On-Grade Bar	None	±0.015 ft (±0.005 m)
Flashing Low Arrow	Fine Raise	0.015 to 0.11 ft (0.005 to 0.03 m)
Solid Low Arrow	Coarse Raise	0.11 to 0.28 ft (0.03 to 0.09 m)

SECTION IV. GRADIO® DISPLAY SYSTEM TROUBLESHOOTING

This section covers Gradio® Display System troubleshooting. The Gradio® Display System Fault Index, Table 2-3., lists faults for the Gradio® Display System.

Table 2-3. Gradio® Display System Fault Index

Fault No.	Description	Page
2-1.	Gradio® Display System Does Not Operate	2-14

2-13. GRADIO® DISPLAY SYSTEM TROUBLESHOOTING INSTRUCTIONS.

Table 2-4. Gradio® Display System Troubleshooting

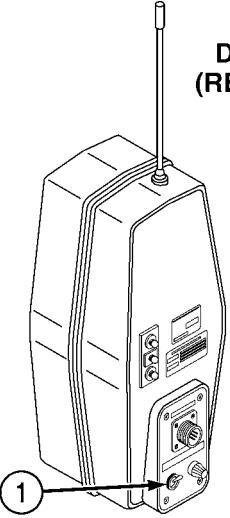
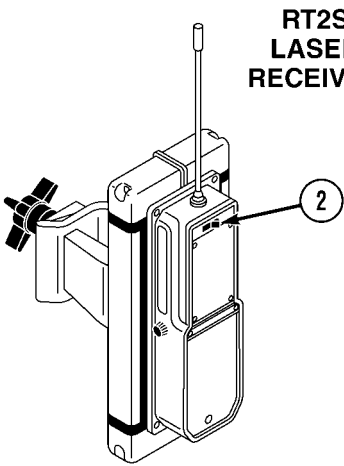
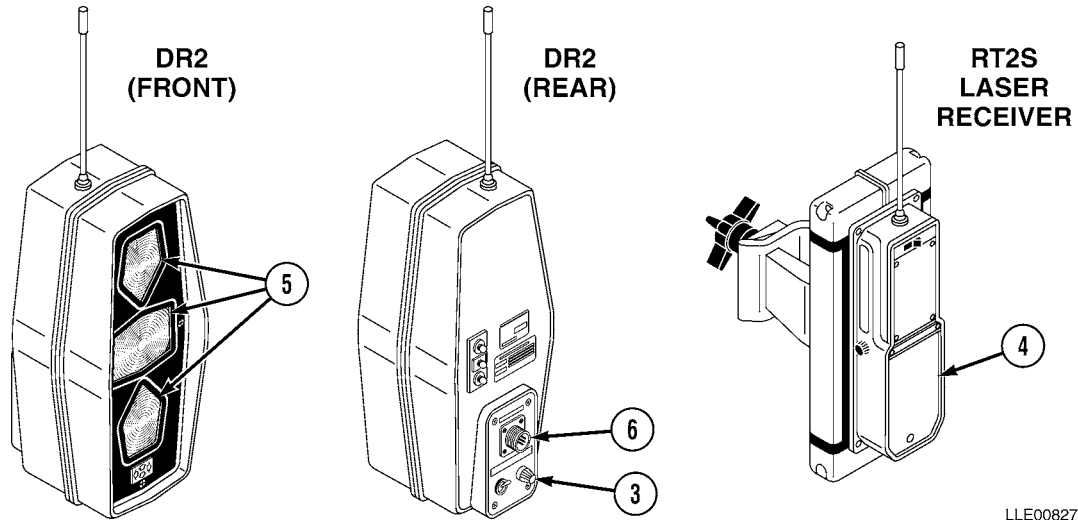
Malfunction	Test or Inspection	Corrective Action
FAULT 2-1. GRADIO® DISPLAY SYSTEM DOES NOT OPERATE.		
 <p>DR2 (REAR)</p>	 <p>RT2S LASER RECEIVER</p>	LLE00826
Step 1.	Ensure 1145-2 Laser Transmitter is correctly set up and operating (Chapter 5). Verify with RT2S Laser Receiver.	<p>If 1145-2 Laser Transmitter is correctly set up and operating, go to Step 2.</p> <p>If 1145-2 Laser Transmitter is not correctly set up and operating, go to Chapter 5.</p>
Step 2.	Check bright/dim switch (1) on DR2 Display for proper position.	<p>If bright/dim switch is in wrong position, move switch to correct position.</p> <p>If bright/dim switch is damaged or faulty, return switch to manufacturer.</p>
<div style="border: 2px dashed black; padding: 5px; width: fit-content; margin: 0 auto;">CAUTION</div>		
<p>Dash number on back of RT2S Laser Receiver must match dash number on the DR2 Display. If dash numbers are not the same, the equipment will fail to operate.</p>		
Step 3.	Check RT2S Laser Receiver ON/OFF switch (2) and channel compatibility with DR2 Display.	<p>If dash numbers are not the same, replace with compatible parts.</p>

Table 2-4. Gradio® Display System Troubleshooting (Cont)

Malfunction	Test or Inspection	Corrective Action
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Step 4. Check 5-amp fuse (3) on rear of DR2 Display.

CAUTION

To avoid damage to equipment, fuse must be replaced with 5-amp fuse.

If fuse is faulty, replace.

Step 5. Check battery, terminals, and connections (4) in RT2S Laser Receiver.

NOTE

As battery output degrades, display may exhibit the following symptoms: loss of flashing on grade or flashing fine correction (solid light will appear), abnormal display, or loss of all lights (5).

If symptoms occur, replace batteries.

Step 6. Check Power Cable, at DR2 Display end, for 22 to 28 Vdc (Para 2-14).

If voltage is faulty, replace Power Cable.

Step 7. Check for good connection at Power Cable connector (6).

If cable connection is poor, properly connect Power Cable connector (6).

2-14. GRADIO[®] SYSTEM TROUBLESHOOTING INSTRUCTIONS.

a. Measurements Required for Troubleshooting.



Use properly sized test leads and ensure care is used when checking for resistance, continuity, or voltage at connectors, or damage to equipment may result.

(1) Resistance measurements.

- (a) Connect red test lead to Volt-Ohm input connector and black lead to COM input connector on meter.
- (b) Set function/range switch to desired Ohm position. If magnitude of resistance is not known, set switch to highest range, then reduce until satisfactory reading is obtained.
- (c) If resistance being measured is connected to circuit, disconnect power from circuit.
- (d) Connect test leads to circuit being measured. When measuring high resistance, be careful not to contact adjacent points, even if insulated. Some insulators have relatively low insulation resistance, which can affect resulting measurement.
- (e) Read resistance value on digital display.

(2) Continuity checks.

- (a) Place function/range switch in any Ohm range.

NOTE

Some meters show "1+m", or simply "1" when function/range switch is in any Ohm position.

- (b) Connect red test lead to Volt-Ohm input connector and black lead to COM input connector on meter. When test leads are separated or measuring an out-of-range resistance, digital display will indicate "OL" (Over Limit).
- (c) Put one test probe at one end of wire or circuit to be tested. Use other test lead to trace circuit. When continuity is established, Ohm symbol will appear in upper left corner of digital display. If contact in wire is maintained long enough (about 1/4 second), the OL will disappear and resistance value of wire or circuit will appear next to symbol.
- (d) If multimeter does not work in this manner, learn how it operates before performing troubleshooting.

(3) Voltage measurements.

- (a) Connect red test lead to Volt-Ohm input connector and black lead to COM input connector on meter. If DC-AC switch is present, ensure it is set to DC position.
- (b) Set function/range switch to desired voltage position. If magnitude of voltage is not known, set switch to range which will be able to read most voltages seen on equipment (typically, 200-V range will do). Reduce range until satisfactory reading is obtained.

b. General Wire Test Procedures.



Use properly sized test leads and ensure care is used when checking for resistance, continuity, or voltage at connectors, or damage to equipment may result.

- (1) Wire voltage drop test.
 - (a) Disconnect connector from component (e.g., light, relay, motor, etc.) at working end of circuit.
 - (b) Check connector terminal(s) for damage. Repair or replace connector as necessary.
 - (c) Set up conditions that will create voltage at working end of wire.
 - (d) Check for required voltage at working end of wire.
 - 1 If required voltage is not measured at working end of wire, go to Step (e).
 - 2 If required voltage is measured at working end of wire, fault has not been isolated. Continue with fault isolation tests or notify supervisor.
 - (e) Disconnect first connector in line from working end of wire to power source.
 - (f) Check for required voltage at working end of wire.
 - 1 If required voltage is not measured at working end of wire, go to Step (g).
 - 2 If required voltage is measured at working end of wire, fault is in the section of wire that was most recently disconnected. Repair wire and perform voltage test again.
 - (g) Repeat Steps (d) and (e) until all sections of suspect wire are tested.
- (2) Wire continuity test.
 - (a) Disconnect wire from component (e.g., light, relay, motor, etc.) at working end of circuit and from power end of circuit.
 - (b) Set equipment conditions that will create desired circuit.
 - (c) Check continuity from power end of wire to working end of wire.
 - 1 If continuity is not measured, go to Step (d).
 - 2 If continuity is measured, fault has not been isolated. Continue with fault isolation tests or notify supervisor.
 - (d) Disconnect first connector from working end of wire in line to power source.
 - (e) Check continuity.
 - 1 If continuity is not measured, go to Step (f).
 - 2 If continuity is measured, fault is in section of wire most recently disconnected. Repair wire and perform continuity test again.
 - (f) Repeat Steps (d) and (e) until all sections of suspect wire are tested.

TM 5-6675-348-13&P

- (3) Wire harness shorting wires test.
 - (a) Disconnect wire harness connector with wire suspected of damage.
 - (b) Set multimeter select switch to Ohm.
 - (c) Connect positive (+) multimeter lead to harness connector terminal of suspect wire.
 - (d) Connect negative (-) multimeter lead to all terminals in harness connector.
 - 1 If continuity is measured, suspect wire and wire where continuity is measured are shorting together. Repair wires.
 - 2 If continuity is not measured, all wires are OK.
- (4) Wire repair. Refer to TM 43-0158 for detailed instructions concerning electrical wiring repairs. Wire harness repair is limited to splicing and taping of wires at Unit Maintenance. If wire harness cannot be repaired, notify Direct Support Maintenance.

SECTION V. GRADIO[®] DISPLAY SYSTEM MAINTENANCE

2-15. GRADIO[®] DISPLAY SYSTEM INSTALLATION FOR DOZER.

This Task Covers:

- a. Installation.
- b. Follow-On Maintenance.

INITIAL SETUP

Models

- D7F Dozer (TM 5-2410-233-Series)
- D7G Dozer (TM 5-2410-237-Series)
- D7H Dozer
- D7R Dozer

Tools and Special Tools

- Tool Kit, Automotive Maintenance, Common No. 2, Item 2, Appendix B
- Tool Kit, Electric, Item 3, Appendix B
- Tool Kit, Welders, Item 4, Appendix B

Materials and Parts

- Cloth, Lint-Free, Item 3, Appendix F
- Paint, Spray, Black, Item 8, Appendix F
- Rags, Wiping, Item 9, Appendix F
- Solder, Lead-Tin Alloy Item 10, Appendix F
- Tags, Identification, Item 13, Appendix F
- Ties, Cable, Item 15, Appendix F
- Kit, Voltage Protection, Item 1, Appendix K
- Label, Warning, Welding/Jump Starting; Item 2, Appendix K
- Mount, MM2E Manual Mast, Item 3, Appendix K

Personnel Required

- MOS 62B
- MOS 44B

Equipment Condition

- Engine OFF
(TM 5-2410-233-Series)
(TM 5-2410-237-Series).
- Seat removed
(TM 5-2410-233-Series)
(TM 5-2410-237-Series).
- Main Power Cable disconnected
(TM 5-3805-233-Series)
(TM 5-3805-237-Series).

TM 5-6675-348-13&P

a. Installation.

CAUTION

The leveling procedure must be performed on a hard surface, such as concrete or asphalt. Failure to comply will cause the system to not operate properly.

NOTE

To ease leveling of the blade, park the Dozer on level ground.

- (1) Using a straightedge and level on top edge of blade (1), level blade.
- (2) Measure and mark center of blade (1).
- (3) Cut two 8-in. (20.3 cm) metal plates (3) at a 45-degree angle.

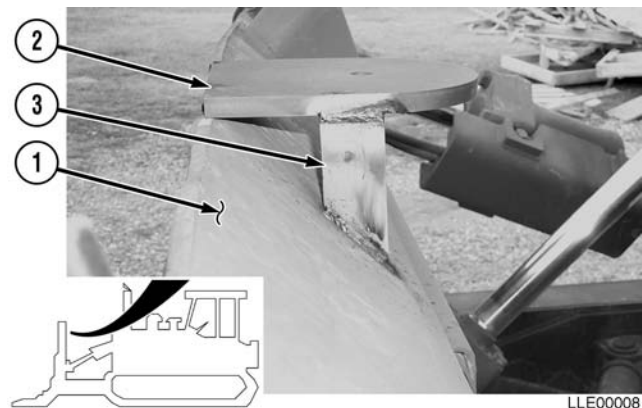
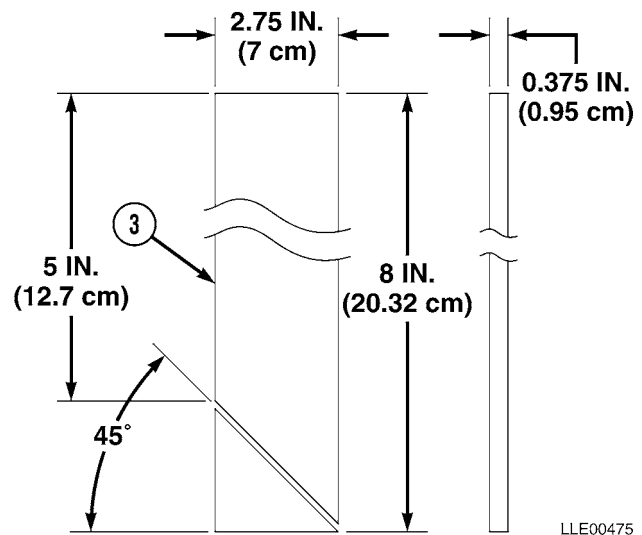
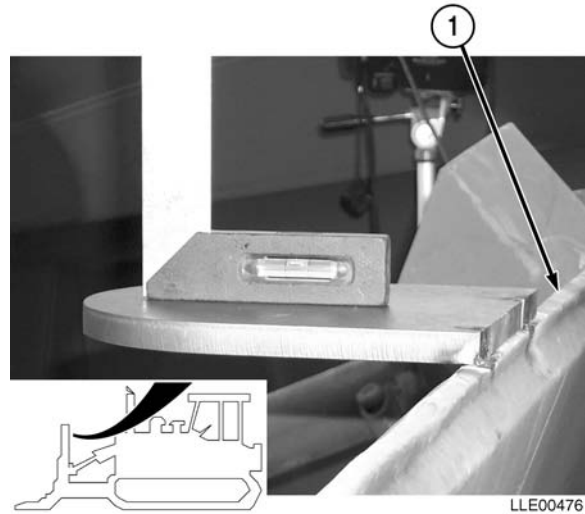
WARNING

Unsafe welding practices can cause serious injury from fire, explosions, or harmful agents. Allow only authorized personnel to weld or cut metals, and follow safety precautions in TC 9-237. Protective clothing and goggles must be worn, adequate protective equipment must be used, a suitable fire extinguisher must be kept nearby, and requirements of TC 9-237 must be strictly followed. Failure to comply may result in serious injury or death to personnel.

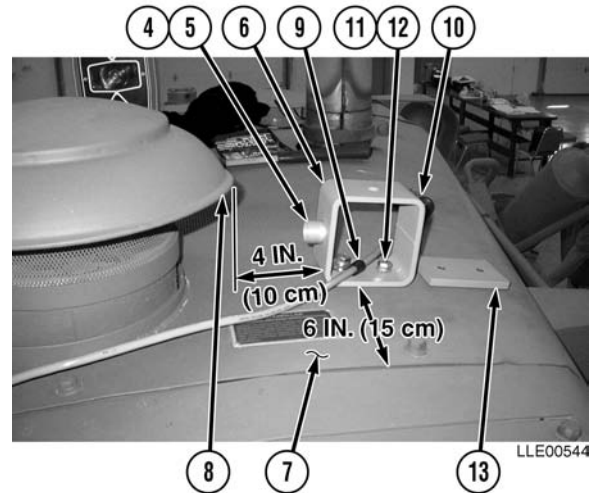
NOTE

This procedure is repeated on both sides of Mast Mount. Left side is shown.

- (4) Center and level Mast Mount (2) at center of Blade (1) and weld.
- (5) Weld two metal plates (3) to Mast Mount (2) and Blade (1).



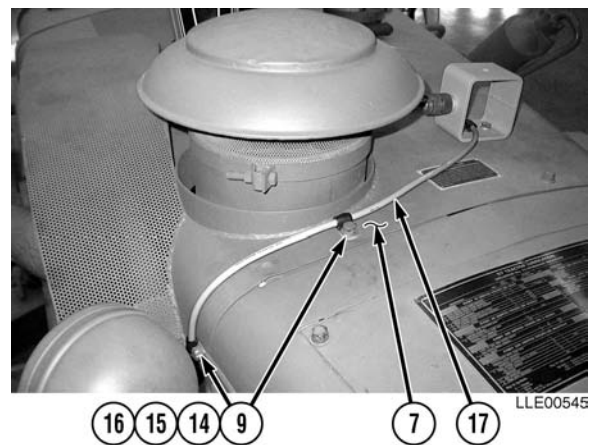
- (6) Install Connector Holder (4) and screw (5) in Display Mount (6).
- (7) Tighten screw (5).
- (8) Locate Display Mount (6) 6 in. (15.2 cm) from rear edge of Engine Cover (7) and 4 in. (10 cm) from Air Cleaner Cover (8).
- (9) Mark two holes for Display Mount (6) installation on Engine Cover (7).
- (10) Center punch and drill two 1/2-in. (13 mm) holes in Engine Cover (7).
- (11) Install Loop Clamp (9) 12 in. (30.5 cm) from female end of Power Cable (10).



NOTE

Display Mount Plate installs under Engine Cover.

- (12) Install Display Mount (6), two lockwashers (11), hex head bolts (12), Loop Clamp (9), and Display Mount Plate (13) on Engine Cover (7).
- (13) Tighten hex head bolts (12).
- (14) Remove two hex head bolts (14), lockwashers (15), and flat washers (16) from Engine Cover (7).
- (15) Install two Loop Clamps (9) on Power Cable (17).
- (16) Install two Loop Clamps (9) on Engine Cover (7) with two previously removed flat washers (16), lockwashers (15), and hex head bolts (14).
- (17) Tighten hex head bolts (14).



TM 5-6675-348-13&P

NOTE

Steps (18) and (19) require the aid of an assistant.

- (18) Route Power Cable (17) through Engine Compartment (18), under floorboards (19), through front side of Seat Compartment (20).



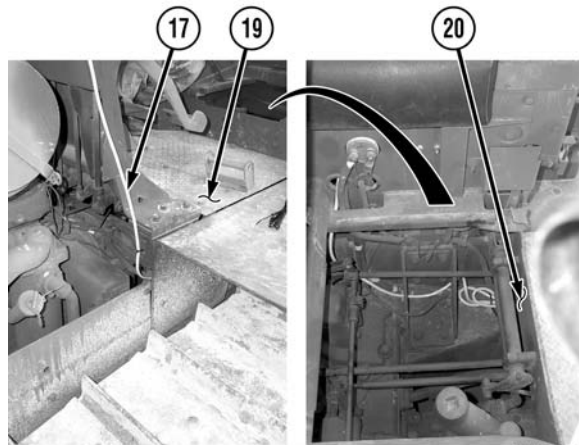
18 17

LLE00546

NOTE

- Install cable ties as needed.
- Leave excess Power Cable coiled and Power Cable tied under seat.

- (19) Route Power Cable (17) through left side of Seat Compartment (21) and along existing Battery Cables (22) into Battery Box (23).
- (20) Strip approximately 12 in. (30.5 cm) of insulation from end of Power Cable (17).



SEAT SHOWN REMOVED FOR CLARITY

LLE00547



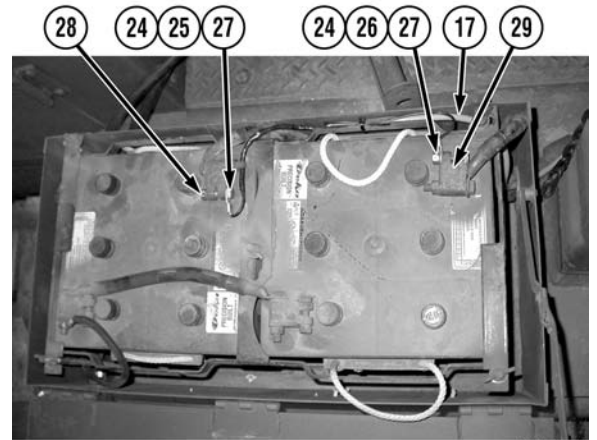
23 22 17 21

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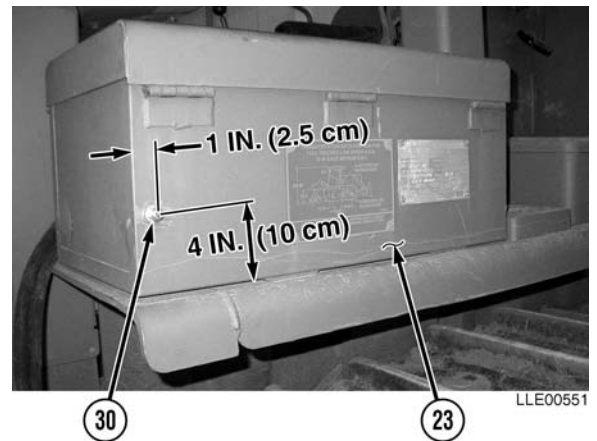
WARNING

Allow solder to cool before handling wire. Failure to comply may result in injury to personnel.

- (21) Solder two connections (24) to Red Wire (25) and Black Wire (26).
- (22) Remove two nuts (27).
- (23) Install Red Wire (25) on Positive (+) Battery Terminal (28).
- (24) Install Black Wire (26) on Negative (-) Battery Terminal (29).
- (25) Install and tighten nuts (27).
- (26) Drill one 1/2-in. (13 mm) hole (30) in lower left corner of Battery Box (23), approximately 1 in. (2.54 cm) from side and 4 in. (10 cm) from bottom.



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WARNING

CARC paint contains isocyanate (HDI), which is highly irritating to skin and respiratory system. High concentrations of HDI can produce symptoms of itching and reddening of skin, a burning sensation in throat and nose, and watering of the eyes. In extreme concentrations, HDI can cause cough, shortness of breath, pain during respiration, increased sputum production, and chest tightness. The following precautions must be taken whenever using CARC paint:

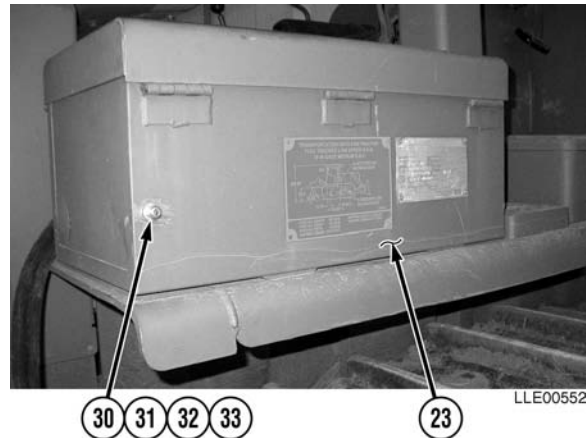
- ALWAYS use air line respirators when using CARC paint, unless air sampling shows exposure to be below standards. Use chemical cartridge respirator if air sampling is below standards.
- DO NOT let skin or eyes come in contact with CARC paint. Always wear protective equipment (gloves, ventilation mask, safety goggles, etc.).
- DO NOT use CARC paint without adequate ventilation.
- NEVER weld or cut CARC-coated materials.
- DO NOT grind or sand painted equipment without high-efficiency air purifying respirators in use.
- BE AWARE of CARC paint exposure symptoms; symptoms can occur a few days after initial exposure. Seek medical help immediately if symptoms are detected.

(27) Remove paint from hole (30) in Battery Box (23).

(28) Install Voltage Protection Cable (31), washer (32), and nut (33).

(29) Tighten nut (33).

(30) Apply black spray paint to Diode connection (31).



WARNING

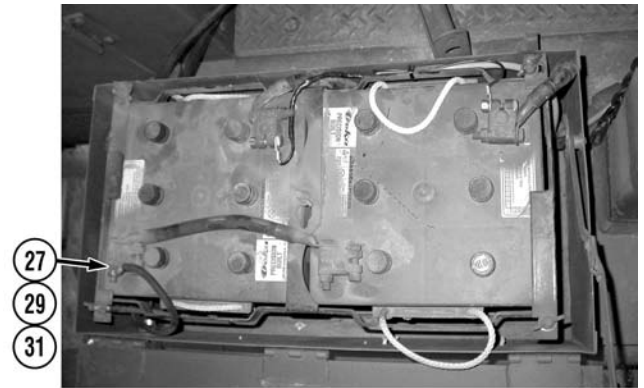
- Battery acid (electrolyte) is extremely harmful. Always wear safety goggles and rubber gloves, and do not smoke when performing maintenance on batteries. Injury will result if acid contacts skin or eyes. Wear rubber apron to prevent damage to clothing.
- Remove all jewelry, such as rings, dog tags, bracelets, etc. If jewelry contacts Battery Terminal, a direct short may result in instant heating of tools, damage to equipment, and injury or death to personnel.
- Exercise extreme caution when working under tilt platform. Falling platform could result in serious injury or death to personnel.
- Turn Battery Disconnect Switch OFF prior to performing maintenance in immediate battery area or working on electrical system. Failure to comply can result in electrical shock to personnel or damage to equipment.
- Always disconnect the negative (-) Battery Cable before servicing the battery or positive (+) Battery Cable. Failure to comply can result in electrical shock to personnel or damage to electrical system.
- Do not allow Battery Cable ends to contact each other or the machine. Failure to comply can result in damage to battery or electrical system.

(31) Install Voltage Protection Cable (31) on Negative (-) Battery Terminal (29) with nut (27).

(32) Tighten nut (27) on Negative (-) Battery Terminal (29).

b. Follow-On Maintenance.

- (1) Install Seat
(TM 5-2410-233-Series)
(TM 5-2410-237-Series).
- (2) Connect Main Power Cable
(TM 5-2410-233-Series)
(TM 5-2410-237-Series).
- (3) Start Engine
(TM 5-2410-233-Series)
(TM 5-2410-237-Series).



LLE0055C

END OF TASK

2-16. GRADIO[®] DISPLAY SYSTEM INSTALLATION FOR SCRAPERS.

This Task Covers:

- a. Installation.
- b. Follow-On Maintenance.

INITIAL SETUP

Models

- 613B Scraper (TM 5-3805-260-Series)
- 621B Scraper (TM 5-3805-248-Series)

Tools and Special Tools

- Tool Kit, Automotive Maintenance, Common No. 2, Item 2, Appendix B
- Tool Kit, Electric, Item 3, Appendix B
- Tool Kit, Welders, Item 4, Appendix B

Materials and Parts

- Cloth, Lint-Free, Item 3, Appendix F
- Paint, Spray, Black, Item 8, Appendix F
- Rags, Wiping, Item 9, Appendix F
- Solder, Item 10, Appendix F
- Tags, Identification, Item 13, Appendix F
- Ties, Cable, Item 15, Appendix F
- Kit, Voltage Protection, Item 1, Appendix K
- Label, Warning, Welding/Jump Starting, Item 2, Appendix K
- Mount, RM2E Rigid Mast, Item 4, Appendix K

Personnel Required

- MOS 62B
- MOS 44B

Equipment Condition

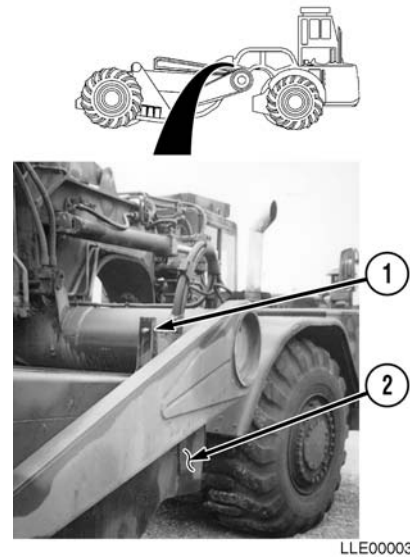
- Engine OFF
 - (TM 5-3805-260-Series)
 - (TM 5-3805-248-Series).
- Wheels chocked
 - (TM 5-3805-260-Series)
 - (TM 5-3805-248-Series).
- Main Power Cable disconnected
 - (TM 5-3805-260-Series)
 - (TM 5-3805-248-Series).

a. Installation.

WARNING

Unsafe welding practices can cause serious injury from fire, explosions, or harmful agents. Allow only authorized personnel to weld or cut metals, and follow safety precautions in TC 9-237. Protective clothing and goggles must be worn, adequate protective equipment must be used, a suitable fire extinguisher must be kept nearby, and requirements of TC 9-237 must be strictly followed. Failure to comply may result in serious injury or death to personnel.

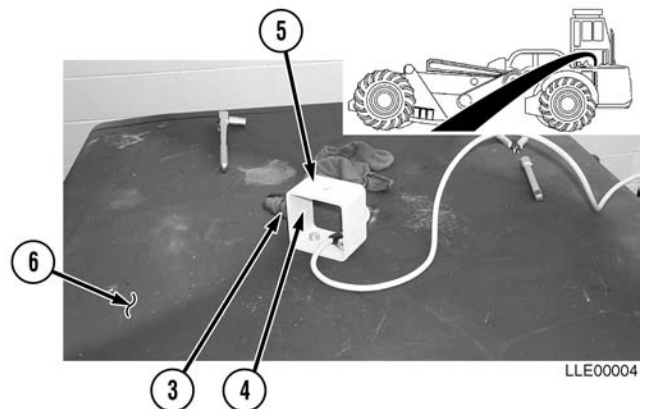
- (1) Weld supplied Rigid Mast Mount (1), holes up, to right side of Bowl (2).



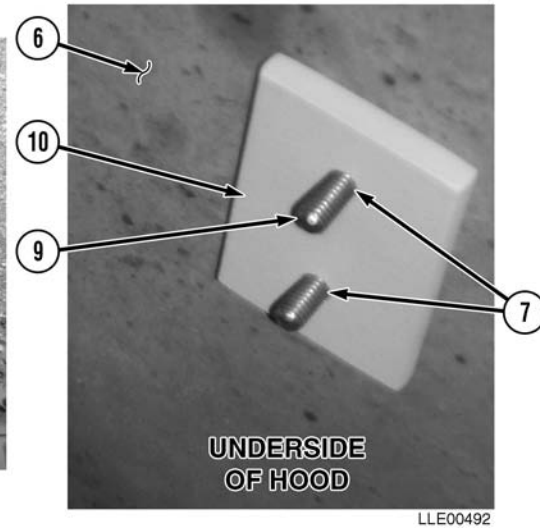
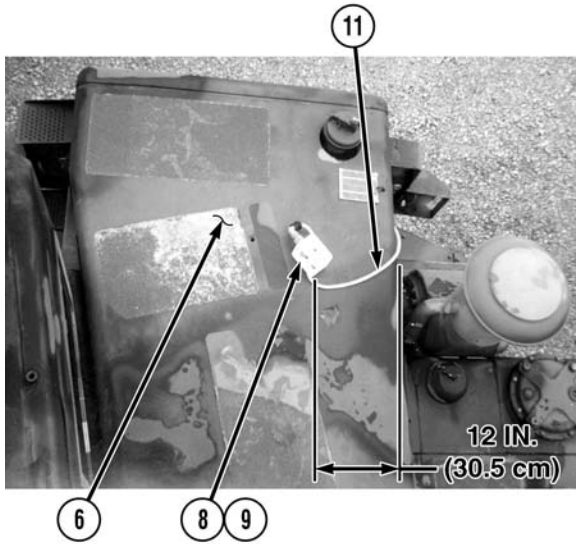
- (2) Install Connector Holder (3) and screw (4) on Display Mount (5).
- (3) Tighten screw (4).

NOTE

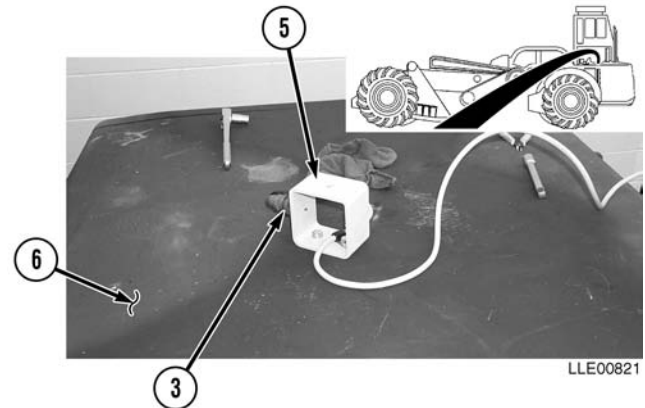
- The Display Mount should be mounted in clear view from the Operator's Seat.
- Steps (4) through (10) require the aid of an assistant.
- Position connector holder towards front of Scraper.



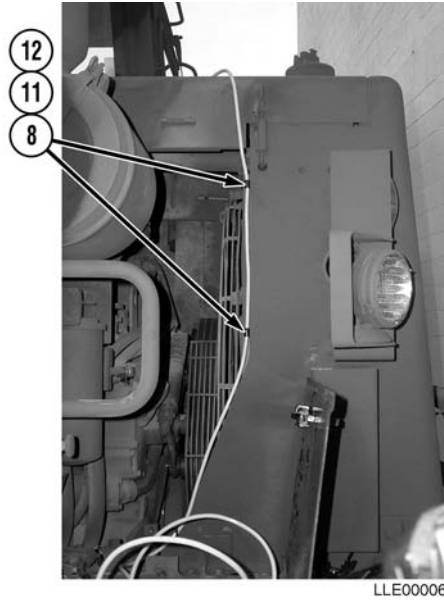
- (4) Place Display Mount (5) on Hood (6).



- (5) Use existing hole in Hood (6) for left side of Display Mount hole (7). Right side hole located 12 in. (30.5 cm) from right side of Hood (6).
- (6) Mark right side Display Mount (5) hole on Hood (6).
- (7) Center punch and drill 1/2-in. (13 mm) hole (7) in Hood (6).
- (8) Install Display Mount (5), Loop Clamp (8), two bolts (9), Display Mount Plate (10) to Hood (6).
- (9) Leave approximately 12 in. (30.5 cm) of Power Cable (11) past Loop Clamp (8).
- (10) Tighten bolts (9).
- (11) Attach Power Cable (11) to Connector Holder (3).



- (12) Remove two bolts (12).
- (13) Install Power Cable (11), two Loop Clamps (8), and existing bolts (12).
- (14) Tighten bolts (12).
- (15) Strip approximately 12 in. (30.5 cm) of insulation from end of Power Cable (11).

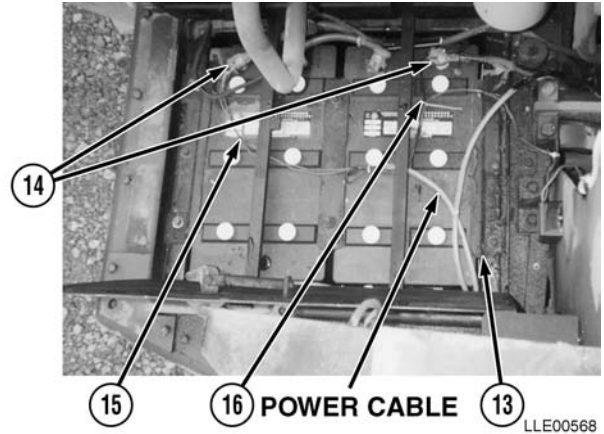


- (16) Route Power Cable (11) into left side of Battery Box (13).

WARNING

Allow solder to cool before handling wire. Failure to comply may result in injury to personnel.

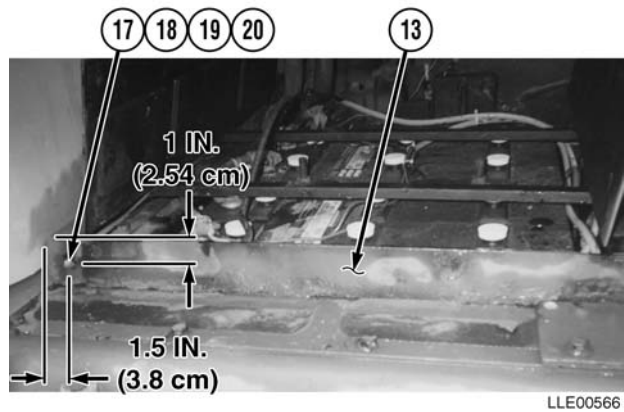
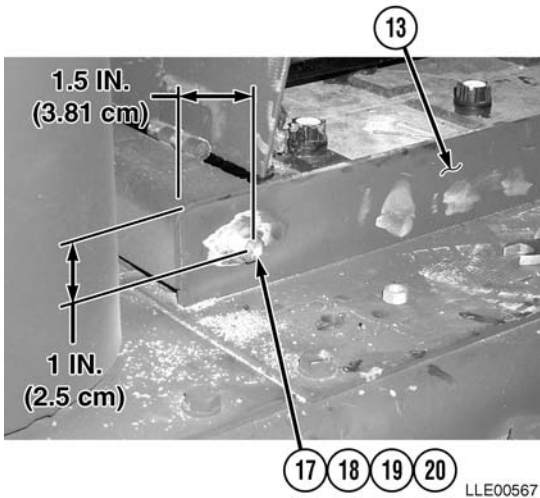
- (17) Solder two connections (14) to Red Wire (15) and Black Wire (16).



WARNING

CARC paint contains isocyanate (HDI), which is highly irritating to skin and respiratory system. High concentrations of HDI can produce symptoms of itching and reddening of skin, a burning sensation in throat and nose, and watering of the eyes. In extreme concentrations, HDI can cause cough, shortness of breath, pain during respiration, increased sputum production, and chest tightness. The following precautions must be taken whenever using CARC paint:

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- DO NOT let skin or eyes come in contact with CARC paint. Always wear protective equipment (gloves, ventilation mask, safety goggles, etc.).
- DO NOT use CARC paint without adequate ventilation.
- NEVER weld or cut CARC-coated materials.
- DO NOT grind or sand painted equipment without high-efficiency air purifying respirators in use.
- BE AWARE of CARC paint exposure symptoms; symptoms can occur a few days after initial exposure. Seek medical help immediately if symptoms are detected.



- (18) Drill one 1/2-in. (13 mm) hole (17) in rear corner of Battery Box (13), approximately 1 1/2-in. (3.81 cm) from rear of Battery Box and 1 in. (2.54 cm) down from top.
- (19) Clean paint from hole (17) in Battery Box (13).
- (20) Install Diode Protection Cable (18), washer (19), and nut (20).
- (21) Tighten nut (20).
- (22) Using black spray paint, paint hole (17) in Battery Box (13).

WARNING

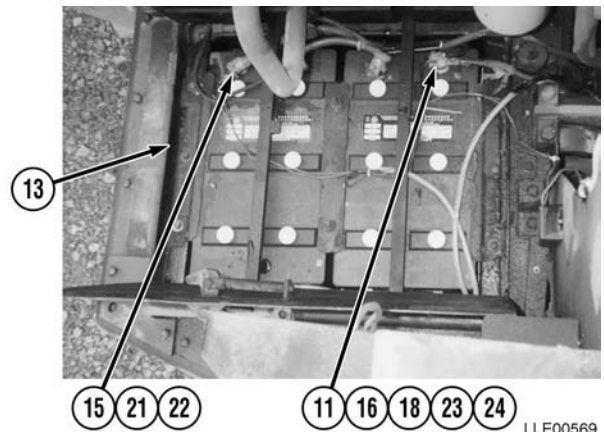
- Battery acid (electrolyte) is extremely harmful. Always wear safety goggles and rubber gloves, and do not smoke when performing maintenance on batteries. Injury will result if acid contacts skin or eyes. Wear rubber apron to prevent damage to clothing.
- Remove all jewelry, such as rings, dog tags, bracelets, etc. If jewelry contacts Battery Terminal, a direct short may result in instant heating of tools, damage to equipment, and injury or death to personnel.
- Exercise extreme caution when working under tilt platform. Falling platform could result in serious injury or death to personnel.
- Turn battery disconnect switch OFF prior to performing maintenance in immediate battery area or working on electrical system. Failure to comply can result in electrical shock to personnel or damage to equipment.
- Always disconnect the negative (-) battery cable before servicing the battery or positive (+) battery cable. Failure to comply can result in electrical shock to personnel or damage to electrical system.
- Do not allow battery cable ends to contact each other or the machine. Failure to comply can result in damage to battery or electrical system.

(23) Install Red Wire (15) and nut (21) to Positive (+) Battery Terminal (22).

(24) Tighten nut (21).

(25) Install Black Wire (16) and Diode Protection Cable (18) to Negative (-) Battery Terminal (23) with nut (24). Coil excess Power Cable (11) and Diode Protection Cable (18) in Battery Box (13).

(26) Tighten nut (24).



b. Follow-On Maintenance.

- (1) Connect Main Power Cable (TM 5-3805-260-Series) (TM 5-3805-248-Series).
- (2) Start Engine (TM 5-3805-260-Series) (TM 5-3805-248-Series).
- (3) Remove Chocks (TM 5-3805-260-Series) (TM 5-3805-248-Series).

END OF TASK

CHAPTER 3

BLADE PRO[®] MOTOR GRADER CONTROL SYSTEM (130G GRADER)

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SECTION I. BLADE PRO[®] MOTOR GRADER CONTROL SYSTEM GENERAL INFORMATION

3-1. SCOPE.

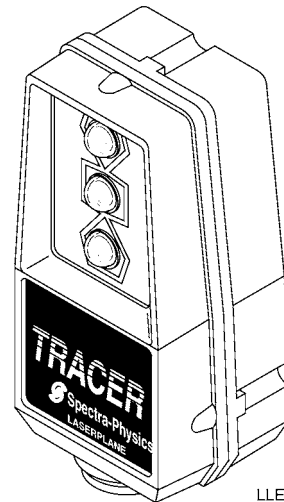
Chapter 3 is used for operation and maintenance of the Blade Pro[®] Motor Grader Control System used on the 130G Grader with the Tracer[®] Sonic Grade Controller or the R2S-S Laser Receiver with EM2E-24 Electric Mast flexibility.

3-2. EQUIPMENT CHARACTERISTICS, CAPABILITIES, AND FEATURES.

a. Characteristics.

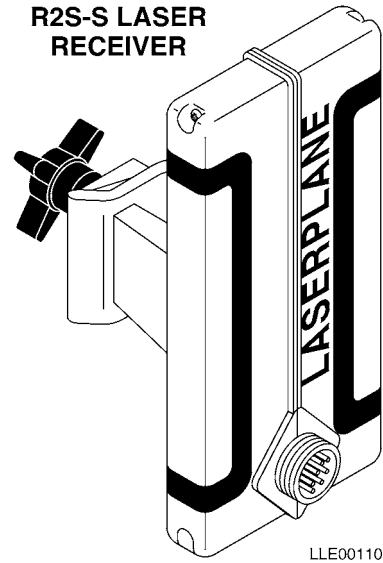
- (1) The Blade Pro[®] Motor Grader Control System automatically controls elevation and/or cross-slope of the 130G Grader's cutting edge with an Operator Interface Box. Three essential precision sensors, read by the Blade Pro[®] Motor Grader Control System, accurately determine the blade's cross-slope relative to the direction of travel. The Blade Slope Sensor is mounted in the frame pocket of the rotation circle to determine the blade's slope. The Circle Rotation Sensor is mounted at the hydra-swivel component to determine the blade's rotation. The Mainfall Slope Sensor is mounted on right side of Gooseneck Panel of the 130G Grader to measure the slope in the direction of travel. The blade's actual cross-slope is compared to the desired cross-slope, and is corrected as needed.
- (2) Tracer[®] Sonic Grade Controller uses sonic technology to establish an elevation reference (e.g., a curb and gutter, a string line, a previous pass, or an existing surface). Once elevation is set, any elevation deviations are sent to the Remote Interface Box. The Remote Interface Box provides correction outputs to hydraulic valve to maintain relative distance between Tracer[®] Sonic Grade Controller and reference surface.

**TRACER[®] SONIC
GRADE CONTROLLER**

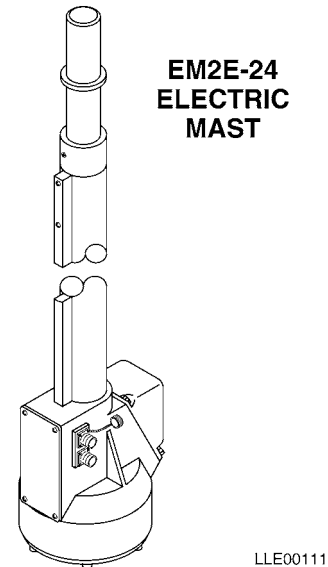


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- (3) The R2S-S Laser Receiver is an omnidirectional, 360-degree receiver that detects the position of the laser reference plane and transmits these signals to the Remote Interface Box. These signals are processed to indicate the relative position of the R2S-S Laser Receiver to the laser reference plane.



- (4) The EM2E-24 Electric Mast is a telescoping mount driven by an electric motor. The EM2E-24 Electric Mast electronically measures vertical movement and sends the signals to the Remote Interface Box for processing.



b. Capabilities.

- (1) The blade's elevation on one or both sides can be controlled by using the Tracer[®] Sonic Grade Controller to trace an existing surface, a string line, a curb and gutter, or a previous pass. The R2S-S Laser Receiver with EM2E-24 Electric Mast, in combination with the 1145-2 Laser Transmitter, provides a constant grade reference up to 1,000 ft (305 m) away from the 1145-2 Laser Transmitter.
- (2) The Tracer[®] Sonic Grade Controller replaces contact-type followers that often give inaccurate or inconsistent results.

c. Features.

- (1) The Blade Pro[®] Motor Grader Control System's automatic blade control is achieved through the Hydraulic Control Valve. The Hydraulic Control Valve provides electrical-to-hydraulic interface for controlling the blade's elevation and cross-slope.

NOTE

Initial installation of these system components is to be conducted by Direct Support personnel.

- (2) Installation kits for the Blade Pro[®] Motor Grader Control System provides all the necessary cables, hydraulic hoses, hydraulic fittings, mounting brackets, and fasteners to ensure proper installation and operation.

TM 5-6675-348-13&P

- (3) The Tracer[®] Sonic Grade Controller features:
 - (a) Temperature compensation - Automatically compensates for temperature changes that occur on the job. Ensures consistent results from dawn to dusk.
 - (b) Rugged housing - Built to withstand the harsh environment of a construction job site.
 - (c) Visible display - Bright incandescent lamps indicate (to the Operator) the status of blade position in reference to grade.
 - (d) Out-of-range indication - Flashing High and Low lamps indicate reference is higher than elevation set point. Solid High and Low lamps indicate that reference is lower than elevation set point.
 - (e) Plug compatibility between the Tracer[®] Sonic Grade Controller, the R2S-S Laser Receiver, and the EM2E-24 Electric Mast.
 - (f) The Operator can lock on to a new reference elevation by pressing the RESET button.
- (4) The R2S-S Laser Receiver features:
 - (a) Electrical connection - A control box, and a 7-pin electric mast or a stand-alone display interface connector.
 - (b) Receiver clamp - Allows the receiver to slide over the mast and securely clamp into place.
- (5) The EM2E-24 Electric Mast features:
 - (a) The EM2E-24 Electric Mast is used on 130G Graders that require remote adjustment of the R2S-S Laser Receiver's height from the cab of the 130G Grader and when a numerical display of the EM2E-24 Electric Mast movement is required.
 - (b) Receiver plug - Provides a mount for the R2S-S Laser Receiver to slip over and clamp into place.
 - (c) Electrical connectors:
 - 1 One 10-pin control box interface connector
 - 2 One 7-socket receiver interface connector
 - (d) Electrical connector cap - Seals the electrical connector to make it water and dust resistant.

3-3. LOCATION AND DESCRIPTION OF MAJOR COMPONENTS.

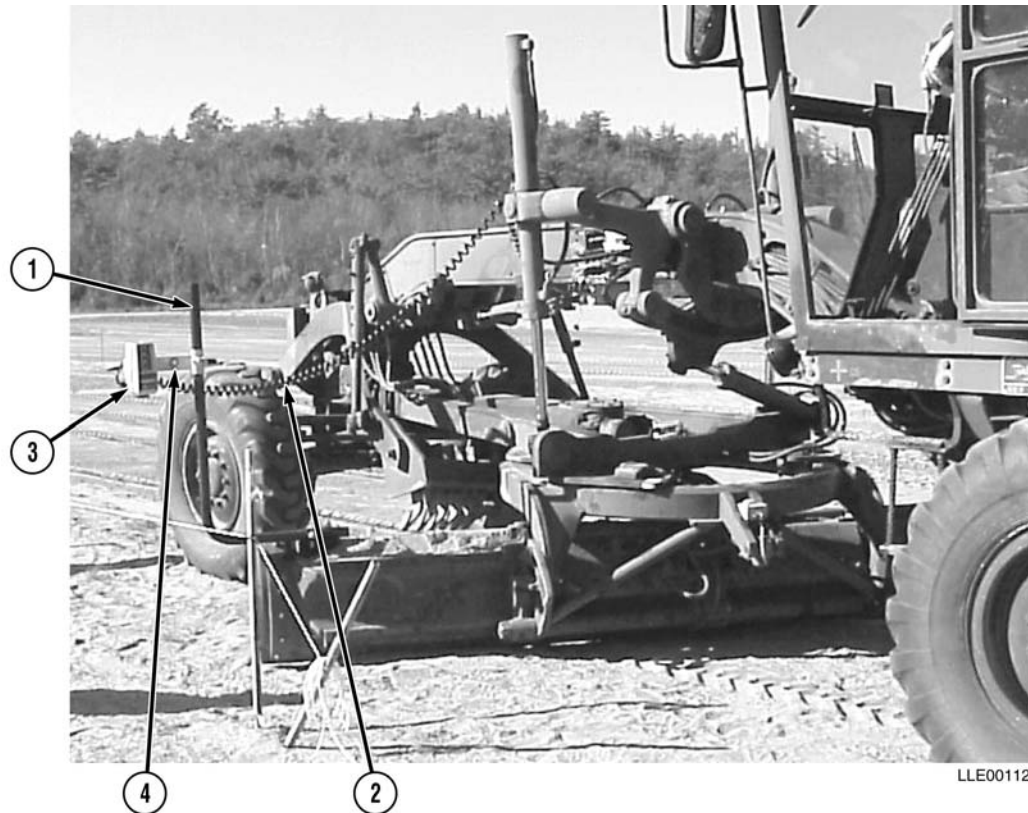


Figure 3-1. Blade Pro[®] Motor Grader Control System Component Placement

- (1) **TRACER[®] SONIC GRADE CONTROLLER POLE.** Mounts to the end of the blade to provide mounting for the Tracer[®] Sonic Grade Controller. Tracer[®] Sonic Grade Controller poles are stowed in the Tracer[®] Clamp and Base Mount Assembly when not in use.
- (2) **COIL CORD FROM TRACER[®] SONIC GRADE CONTROLLER TO REMOTE INTERFACE BOX.** This cable is also used when connecting to EM2E-24 Electric Mast.
- (3) **TRACER[®] SONIC GRADE CONTROLLER.** Establishes an elevation reference.
- (4) **BRACKET FOR TRACER[®] SONIC GRADE CONTROLLER.** Locks to the pole mount and attaches to the Tracer[®] Sonic Grade Controller. Allows for adjustment of the Tracer[®] Sonic Grade Controller to be parallel with the cutting edge.

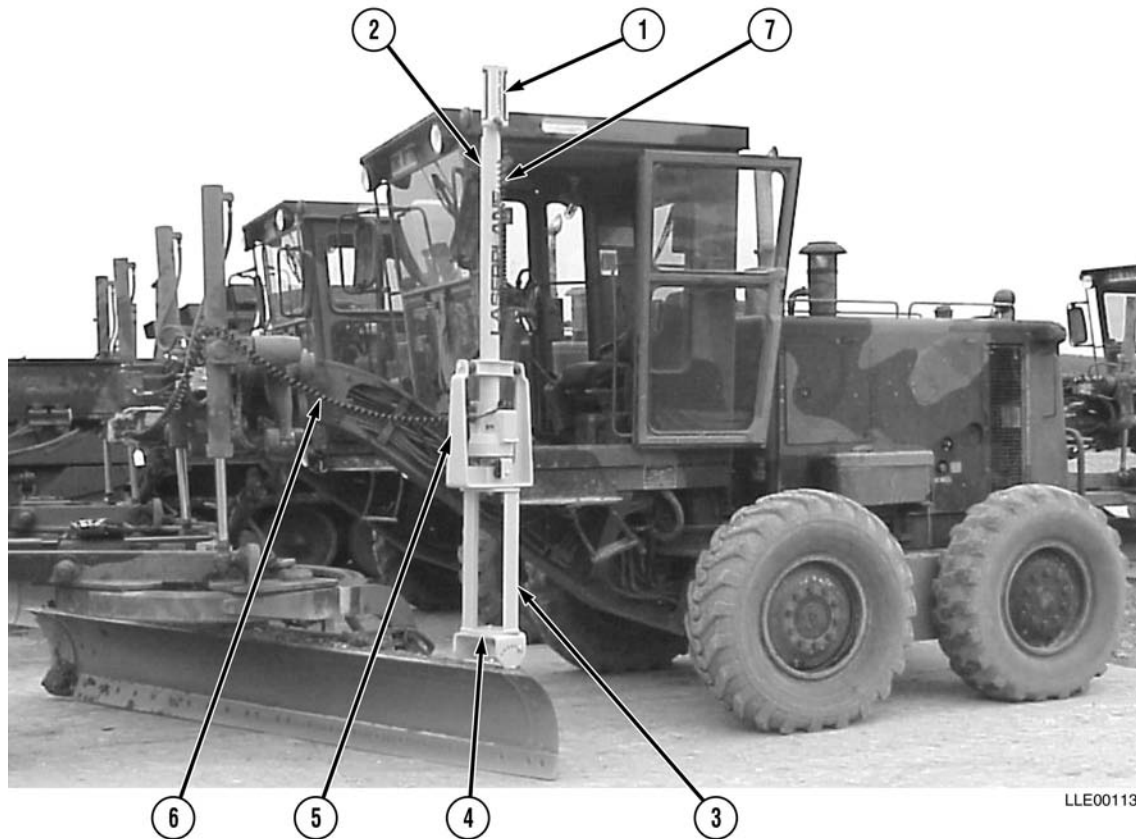
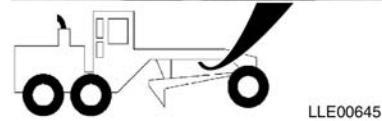
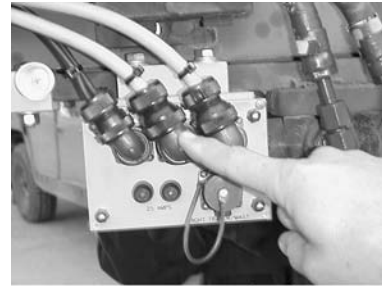


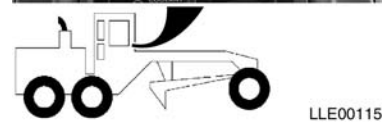
Figure 3-2. Blade Pro[®] Motor Grader Control System Mast Component Placement

- (1) **R2S-S LASER RECEIVER.** Detects the laser beam and sends correction signals to the Remote Interface Box. Corrections are then sent to raise/lower the grader blade.
- (2) **EM2E-24 ELECTRIC MAST.** This is a telescoping mast for the R2S-S Laser Receiver, and is mounted to the top edge of the blade. The EM2E-24 Electric Mast, with the R2S-S Laser Receiver, electronically measures vertical movement and sends signals to the Remote Interface Box for processing.
- (3) **MAST RISER.** Attaches between the mast mount and the shock mount. Adds to the overall height of the mast assembly to ensure the R2S-S Laser Receiver's height over the cab can be obtained.
- (4) **MAST MOUNT.** Used to connect the mast assembly to the machine blade. The unit is adjustable so that the EM2E-24 Electric Mast can be put in plumb position if the blade is rolled.
- (5) **SHOCK MOUNT.** Attaches to the EM2E-24 Electric Mast as part of the mast assembly. Protects the EM2E-24 Electric Mast and the R2S-S Laser Receiver from vibration.
- (6) **COIL CORD FROM EM2E-24 ELECTRIC MAST TO REMOTE INTERFACE BOX.**
- (7) **COIL CORD FROM R2S-S LASER RECEIVER TO EM2E-24 ELECTRIC MAST.**

- a. **Remote Interface Box.** Central controller and processor for all sensors, inputs, and elevation devices. Output signals are provided to the control valves and the Operator Interface Box.



- b. **Operator Interface Box.** Located in front of the Operator; provides easy access to all Blade Pro[®] Motor Grader Control System control functions.



- (1) The operating status is indicated with Light-Emitting Diodes (LEDs) (2) and (3), which indicate the operating status of the right and left sides.

Green (2) Indicator → Automatic Operation

Red (3) Indicator → Manual Operation

Solid Green (2) with Flashing Red (3) → Inactive Automatic

- (2) The Operator Interface Box uses bright LEDs to indicate the blade's position relative to the desired grade. Operation status windows (7) use a back-lighted Liquid Crystal Display (LCD) to indicate percent (%) slope, direction of slope, elevation, and error messages. Customized functions and features can also be displayed when in SETUP mode.

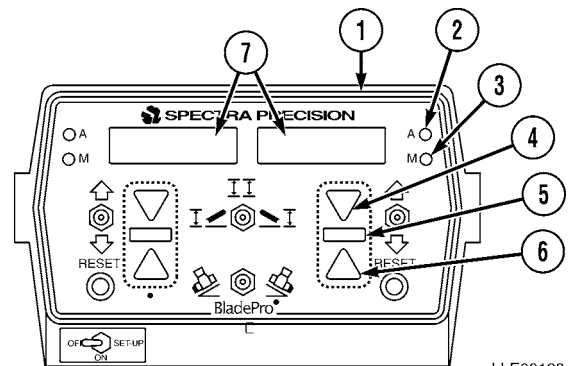



Table 3-1. Blade Pro[®] Motor Grader Control System Operator Interface Box Light Indicators

Type of Grade	LED Indicator
Coarse Lower	Solid Yellow (4)
Medium Lower	Flashing Yellow (4)
Fine Lower	Flashing Yellow and Green (4 and 5)
ON GRADE	Flashing Green (5)
Fine Raise	Flashing Yellow and Green (5 and 6)
Medium Raise	Flashing Yellow (6)
Coarse Raise	Solid Yellow (6)

LCD Display Symbols

Percent Slope* 0.0%
 Rise/Run* 1/4 in. (0.64 cm)
 Direction of Slope > Blade is rising to the left
 < Blade is rising to the right

Elevation  Elevation device is in range

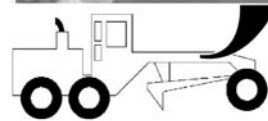
 Elevation device is out of range or is not hooked up

* Display symbol is user-selectable.

NOTE

The Mainfall Slope Sensor and the Blade Slope Sensor are the same and can be interchanged. Calibration is required if interchanged.

c. **Mainfall Slope Sensor.** Measures the slope of the 130G Grader in the direction of travel.



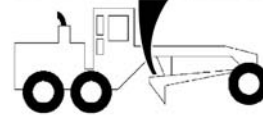
LLE00646

d. **Blade Slope Sensor.** Measures the actual slope across the blade.



LLE00647

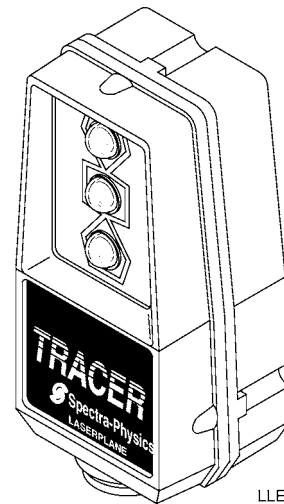
- e. **Circle Rotation Sensor.** Measures the angle of the blade relative to the 130G Grader's A-frame. When the blade is perpendicular to the A-frame, 0-degree rotation is achieved.



LLE00648

- f. **Tracer® Sonic Grade Controller.** Mounted at the top outside edge of the blade, the Tracer® Sonic Grade Controller uses sonic waves or an R2S-S Laser Receiver to determine the location and distance to a reference surface. Once the Tracer® Sonic Grade Controller has been locked onto a reference (e.g., a string line, a curb and gutter, or a previous pass), any change in the set point distance causes a correction signal to be sent to the Remote Interface Box.

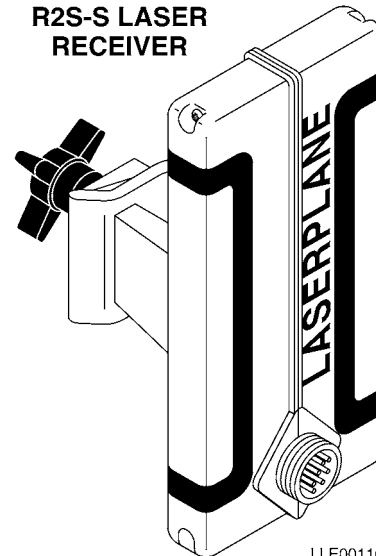
**TRACER® SONIC
GRADE CONTROLLER**



LLE00109

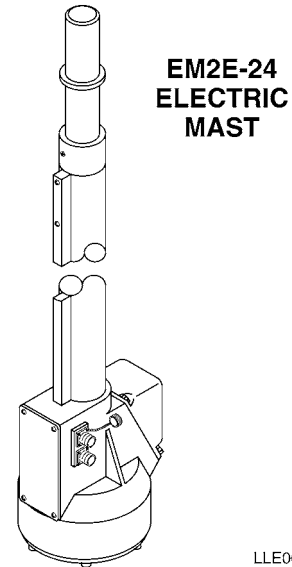
- g. **R2S-S Laser Receiver.** Detects the laser beam and sends correction signals to the Remote Interface Box. Corrections are then sent to raise/lower the grader blade.

**R2S-S LASER
RECEIVER**



LLE00110

- h. **EM2E-24 Electric Mast.** This is a telescoping mast for the R2S-S Laser Receiver, and is mounted to the top edge of the blade. The EM2E-24 Electric Mast, with the R2S-S Laser Receiver, electronically measures vertical movement and sends signals to the Remote Interface Box for processing.



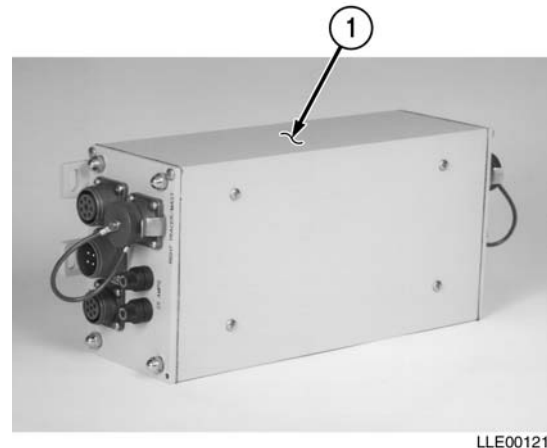
- i. **Hydraulic Control Valves.** Accepts signals from the Remote Interface Box and provides proportional correction rates for raising and lowering on both sides of the blade.



NOTE

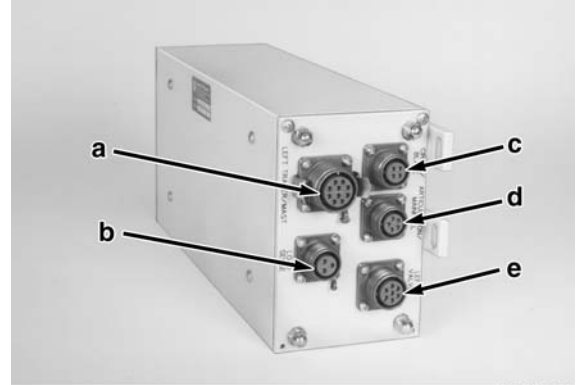
Initial installation of these system components is to be conducted by Direct Support personnel.

- j. **Blade Pro[®] Motor Grader Control System Features, Functions, and Specifications.** The Remote Interface Box (1) provides necessary system electrical interface to the Blade Slope Sensor, the Mainfall Slope Sensor, the Circle Rotational Sensor, the Tracer[®] Sonic Grade Controller, the R2S-S Laser Receiver, and the EM2E-24 Electric Mast. All signal processing and control outputs occur at the Remote Interface Control Box. Control signals are provided to the Hydraulic Control Valves. Communications output is provided between the Remote Interface Control Box and the Operator Interface Box for display information and to allow the Operator to interface with the system. All programmable functions are stored at the Remote Interface Control Box in nonvolatile memory. If power loss occurs, all settings are kept.



(1) Left-Side Connections.

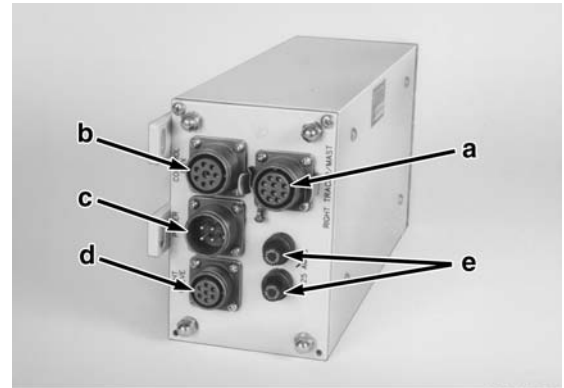
- (a) 10-Socket (Left Elevation Input)
- (b) 3-Socket (Load Sensing Valve)
- (c) 4-Socket (Blade Rotation, and Blade Slope Sensors)
- (d) 5-Socket (Mainfall Slope Sensors)
- (e) 7-Socket (Left Hydraulic Valve)



LLE00122

(2) Right-Side Connections.

- (a) 10-Socket (Right Elevation Input)
- (b) 8-Socket (Operator Interface Box)
- (c) 4-Pin (System Power)
- (d) 7-Socket (Right Hydraulic Valve)
- (e) Overload Protection (Fuse)



LLE00137

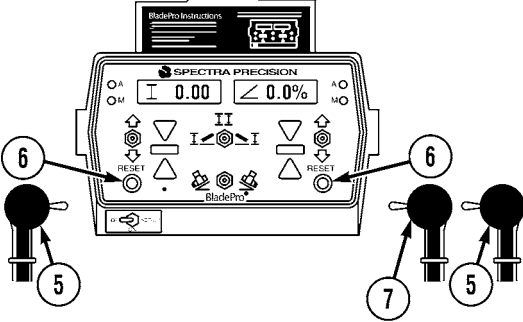
Table 3-2. Blade Pro[®] Motor Grader Control System Operator Interface Box Controls

Key	Controls or Indicator	Function
<p style="text-align: right;">LLE00650</p>		
<p>1. OFF/ON/SET-UP:</p>	<p>In left position In center position In right position</p>	<p>System is OFF. System is ON. Operator has access to the following SET-UP functions: Elevation Reference, Customize, Test, Slope Speed, and Elevation Speed. (For more information on SET-UP options, refer to Section III)</p>

Table 3-2. Blade Pro[®] Motor Grader Control System Operator Interface Box Controls (Cont)

Key	Controls or Indicator	Function
<p style="text-align: right;">LLE00650</p>		
<p>2. OPERATION MODE SWITCH: Selects the side(s) of the blade to be controlled by elevation or slope.</p>	<p>In left position</p> <p>In center position</p> <p>In right position</p>	<p>Elevation controls the left side of the blade. The cross-slope controls the right side of the blade.</p> <p>Elevation controls the left side of the blade.</p> <p>Elevation controls the right side of the blade.</p> <p>Cross-slope controls the left side of the blade.</p> <p>Elevation controls the right side of the blade.</p>
<p>3. DIRECTION OF SLOPE:</p>		<p>Changes the blade's direction of slope. The blade slope symbol > < will change in the display window to show the direction of the slope.</p>
<p>4. INCREASE/ DECREASE:</p>		<p>The value in the display window always increases when toggled up. The value in the display window always decreases when toggled down. The left Increase/Decrease switch operates the left display window. The right Increase/Decrease switch operates the right display window. Note that when you adjust the cross-slope value, the number will not go below 0.0%. This makes sure the Increase/Decrease switch always operates the same way. (For applications that adjust through 0.0%, refer to Para 3-23)</p>

Table 3-2. Blade Pro[®] Motor Grader Control System Operator Interface Box Controls (Cont)

Key	Controls or Indicator	Function
 <p style="text-align: right; margin-right: 100px;">LLE00649</p>		
5. RIGHT/LEFT (R/L) SWITCH:		Provides remote switching of the system from automatic to manual operation at the manual control levers.
6. RESET SWITCH:		Resets Tracer [®] Sonic Grader Controller reference to a new surface or object.
7. REMOTE SWITCH:		Function of the switch is selected in SETUP mode. Options include Elevation Offsets, Slope Offsets, and Auto Raise/Lower. (For further details on these options, refer to Para 3-23)

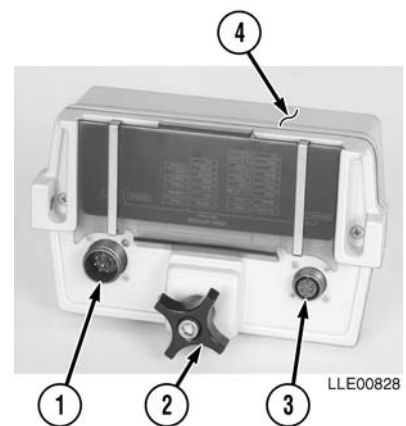
3-4. BLADE PRO[®] MOTOR GRADER CONTROL SYSTEM MOUNTING AND ADJUSTMENTS.

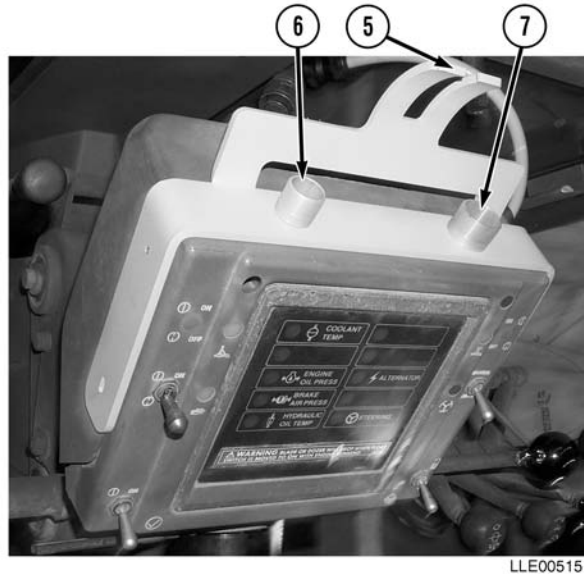
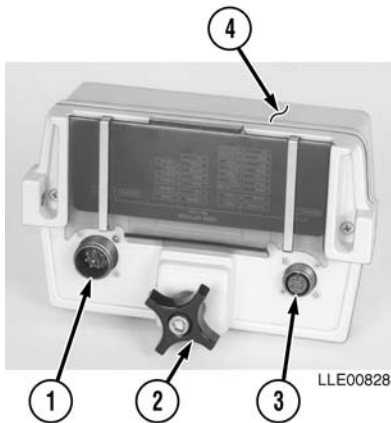
a. Operator Interface Box.

- (1) Serial Communication Connector
- (2) Mounting Knob
- (3) Remote Switch Connector

b. Operator Interface Box Removal.

- (1) Disconnect Remote Switch Connector (3) from back of Operator Interface Box (4).
- (2) Disconnect Serial Communication Connector (1) from back of Operator Interface Box (4).
- (3) Loosen mounting knob (2) on back of Operator Interface Box (4).





- (4) Pull Operator Interface Box (4) up from mounting bracket (5).
- (5) Attach loose connectors (1) and (3) to provided dust covers (6) and (7) on side of the mounting bracket (5).

c. Operator Interface Box Viewing Angle Adjustment.

- (1) Loosen mounting knob (2) on back of Operator Interface Box (4).
- (2) Rotate Operator Interface Box (4) for best viewing angle, then tighten mounting knob (2).

3-5. BLADE PRO[®] MOTOR GRADER CONTROL SYSTEM SPECIFICATIONS.

Blade Slope Sensor Resolution	0.01% slope
Mainfall Slope Sensor Resolution	0.01% slope
Circle Rotation Sensor Resolution	0.1 degree
Articulation Sensor Resolution	0.1 degree
Cross-Slope Resolution	0.01% slope
*Cross-Slope Accuracy	1/4 in./10 feet
Cross-Slope Range	±19.99%

* System accuracy is affected by the tightness of the machine. (Refer to Para 3-23 for more information about determining the machine's slope.)

SECTION II. BLADE PRO[®] MOTOR GRADER CONTROL SYSTEM PMCS

3-6. BLADE PRO[®] MOTOR GRADER CONTROL SYSTEM PMCS INTRODUCTION.

Preventive Maintenance Checks and Services (PMCS) means systematic caring for, inspecting, and servicing equipment to keep it in good condition and to prevent breakdowns. As a Blade Pro[®] Motor Grader Control System Operator, your mission is to:

- a. Be sure to perform your PMCS each time you operate the Blade Pro[®] Motor Grader Control System. Always do your PMCS in the same order so it becomes a habit. Once you've had some practice, you'll quickly spot anything wrong.
- b. Do your Before PMCS just before you operate the Blade Pro[®] Motor Grader Control System. Pay attention to WARNINGS, CAUTIONS, and NOTES.
- c. Do your During PMCS while you operate the Blade Pro[®] Motor Grader Control System. Pay attention to WARNINGS, CAUTIONS, and NOTES.
- d. Do your After PMCS right after operating the Blade Pro[®] Motor Grader Control System. Pay attention to WARNINGS, CAUTIONS, and NOTES.
- e. Do your Weekly PMCS once a week.
- f. Use DA Form 2404 or DA Form 5988-E (Equipment Inspection and Maintenance Worksheet) to record any faults that you don't immediately fix.

3-7. PMCS PROCEDURES.

- a. PMCS Tables (Table 3-4., Table 3-5., and Table 3-7.) list inspections and care required to keep your Blade Pro[®] Motor Grader Control System in good operating condition. These tables are set up so you can do Before and After PMCS while walking around the Blade Pro[®] Motor Grader Control System.
- b. The "Interval" column tells you when to do a certain check or service.
- c. The "Procedure" column tells you how to do required checks and services. Carefully follow these instructions.
- d. The "Not Fully Mission Capable If" column tells you when your Blade Pro[®] Motor Grader Control System is nonmission capable and why the Blade Pro[®] Motor Grader Control System cannot be used.
- e. When something looks wrong that you cannot fix, write down the problem on your DA Form 2404 or DA Form 5988-E. Immediately report the problem to your supervisor.
- f. When you do your PMCS, you will always need a rag or two. Following are checks that are common to the entire Blade Pro[®] Motor Grader Control System.

WARNING

- Degreasing Solvent (MIL-PRF-680, Type II) is TOXIC and flammable. Wear protective goggles and gloves, use only in a well-ventilated area, avoid contact with skin, eyes, and clothes, and do not breathe vapors. Keep away from heat or flame. Never smoke when using solvent; the flash point for degreasing solvent type II is 200° F (93° C). Failure to comply may result in injury or death to personnel.
 - If personnel become dizzy while using cleaning solvent, immediately get fresh air and medical help. If solvent contacts skin or clothes, flush with cold water. If solvent contacts eyes, immediately flush eyes with water and get immediate medical attention. Do not use diesel fuel, gasoline, or benzene (benzol) for cleaning.
 - Do not smoke when using cleaning solvent. Never use it near an open flame. Be sure there is a fire extinguisher nearby and use cleaning solvent only in a well-ventilated area.
 - Use caution when using cleaning solvents. Cleaning solvents evaporate quickly and can irritate exposed skin if solvents contact skin. In cold weather, contact of exposed skin with cleaning solvents can cause frostbite.
- (1) **Keep It Clean.** Dirt, grease, oil, and debris only get in the way and may cover up a serious problem. Clean as you work. Use degreasing solvent (MIL-PRF-680, Type II) on all metal surfaces. Use soap and water when you clean rubber or plastic material.
 - (2) **Rust and Corrosion.** Check Blade Pro[®] Motor Grader Control System brackets for rust and corrosion. When any bare metal or corrosion exists, clean surface and apply a coat of paint. Report bare metal or corrosion to your supervisor.
 - (3) **Bolts, Nuts, and Screws.** Check all bolts, nuts, and screws for obvious looseness, missing, bent, or broken condition. You can't check them all with a tool, but look for chipped paint, bare metal, or rust around bolt heads. When you find a bolt, nut, or screw you think is loose, tighten it or report it to your supervisor.
 - (4) **Welds.** Look for loose or chipped paint, rust, or gaps where parts are welded together. When you find a bad weld, report it to your supervisor.
 - (5) **Electric Wires and Connectors.** Look for cracked, frayed, or broken insulation, bare wires, and loose or broken connectors. Tighten loose connectors. Report any damaged wires to your supervisor.
 - (6) **Hydraulic Lines and Fittings.** Look for wear, damage, and leaks; ensure clamps and fittings are tight. Stains around a fitting or connector can mean a leak. If a leak comes from a loose fitting or connector, tighten it. If something is broken or worn out, report it to Unit Maintenance.
 - (7) When you check operating conditions, check to see if component is serviceable.

3-8. SHORTENED MAINTENANCE INSTRUCTIONS.

Local conditions of extreme heat, dust, cold, or wetness dictate that service intervals shall be shortened.

3-9. ADDITIONAL MAINTENANCE INSPECTIONS.

Additional maintenance inspections are required for the following reasons:

- a. Prolonged storage. Inspect 130G Grader control components that have been stored for a period of 3 months or longer.
- b. Initial preparation upon receipt.
- c. Preparation for storage.

3-10. LEAKAGE CLASSIFICATION AND DEFINITION.

It is necessary for you to know how fluid leakage affects the status of the Blade Pro[®] Motor Grader Control System. Following are types/classes of leakage that Operator needs to know to be able to determine the status of the Blade Pro[®] Motor Grader Control System. Learn these leakage definitions and remember – when in doubt, notify your supervisor.

- Equipment operation is allowable with minor leakages (Class I or II) with exception of fuel leakage. Of course, consideration must be given to fluid capacity in the item/system being checked/inspected. When in doubt, notify your supervisor.
 - When operating with Class I and II leaks, continue to check fluid levels as required in your PMCS.
 - Any fuel leak or Class III leaks should be reported immediately to your supervisor.
- a. CLASS I – Leakage of fluid (as indicated by wetness or discoloration) not great enough to form drops.
 - b. CLASS II – Leakage of fluid great enough to form drops, but not enough to cause drops to drip from item being checked/inspected.
 - c. CLASS III – Leakage of fluid great enough to form drops that fall from item being checked/inspected.

3-11. GENERAL LUBRICATION INSTRUCTIONS.



Do not start or move Blade Pro[®] Motor Grader Control System while anyone is under the 130G Grader. Failure to comply could result in severe injury or death to personnel.

- a. **Intervals.** Intervals (On-condition or hard-time) and related man-hour times are based on normal operation. Man-hour time specified is time needed to do all services prescribed for a particular interval. On-condition (OC) oil sample intervals shall be applied unless changed by the Army Oil Analysis Program (AOAP) laboratory. Change hard-time interval when lubricants are contaminated or when you are operating equipment under adverse operating conditions, including longer-than-usual operating hours. Calendar interval will be extended during periods of low activity.

When extended, adequate preservation precautions must be taken. Hard-time intervals will be applied in the event AOAP laboratory support is not available. Hard-time intervals must be applied during the warranty period. Intervals shown in this lubrication section are based on calendar and hourly times or calendar times and mileage. An example of a calendar and hourly lubrication is: M/60 HR, in which M stands for monthly and 60 HR stands for 60 hours of 130G Grader operation. Lubrication is to be performed at whichever interval occurs first for the 130G Grader. Special lubrication intervals and services are shown by the use of an asterisk (*) symbol.

3-12. PMCS COLUMN ENTRY EXPLANATION.

- a. **Item No. Column.** The checks and services are numbered in interval order showing a walk-around sequence around the Blade Pro[®] Motor Grader Control System. Use these numbers in the “Item No.” column on DA Form 2404 or DA Form 5988-E when recording faults that you don’t immediately fix.
- b. **Interval Column.** This column indicates when the lubrication, check, and/or service should be performed.
- c. **Location, Item to Check/Service Column.** The underlined items listed in this column are divided into groups indicating the portion of the equipment of which they are a part (e.g., brakes, fuel, and engine). Under these groupings, a few common words are used to identify the specific item being checked.
- d. **Procedure Column.** This column contains procedures required to perform the checks and services.
- e. **Not Fully Mission Capable If Column.** This column contains the criteria that cause the equipment to be classified as NOT READY/AVAILABLE because of an inability to perform its primary mission. An entry in this column will:
 - (1) Identify conditions that make the equipment not available for readiness reporting purposes.
 - (2) Deny use of the equipment until corrective maintenance has been performed.

3-13. BLADE PRO[®] MOTOR GRADER CONTROL SYSTEM OPERATOR’S PMCS TABLE.

Table 3-4. Blade Pro[®] Motor Grader Control System Operator’s PMCS (Before/After)

Item No.	Interval	Location	Procedure	Not Fully Mission Capable If:
		Item to Check/Service		
1.	Before/After	Hydraulic Tubes and Fittings	Check all hydraulic tubes and fittings for leaks.	Class III leaks are evident.
2.	Before/After	PSV2 Hydraulic Valves	Check all hydraulic valves for leaks.	Class III leaks are evident.
3.	Before/After	Hydraulic Hoses	Check all hydraulic hoses for leaks.	Class III leaks are evident.
4.	Before/After	Electrical Cables and Coil Cords	Check all electrical cables to ensure none are frayed, cracked, or exposed. Check electrical connections to ensure they are free of dirt, debris, and damage. Check all screws and nuts for tightness. Ensure dust caps are in place when electrical connections are not being used.	Frayed, cracked, or exposed wires are evident. Connectors are damaged.

Table 3-4. Blade Pro[®] Motor Grader Control System Operator's PMCS (Before/After) (Cont)

Item No.	Interval	Location	Procedure	Not Fully Mission Capable If:
		Item to Check/Service		
5.	Before/After	Remote Interface Box	<p style="text-align: center;">CAUTION</p> <p>To avoid damage to equipment, fuse must be replaced with 25-amp fuse.</p> <p>Check 25-amp fuses to ensure they are not burned out.</p> <p>Check left and right socket connectors for any dirt, debris, or damaged connections.</p> <p>Check nuts and screws for tightness.</p>	<p>Fuse is blown. Replace before operating.</p> <p>Dirt, debris, and/or damaged connectors are present.</p> <p>Nuts or screws are loose.</p>
6.	Before/After	Mainfall Slope Sensor and Blade Slope Sensors	<p>Check electrical connectors for any dirt, debris, or damage.</p>	<p>Connectors are damaged.</p>
7.	Before/After	Circle Rotation Sensor	<p>Check electrical connectors for dirt, debris, or damage.</p> <p>Check screws for tightness.</p>	<p>Connectors are damaged.</p>
8.	Before/After	Tracer [®] Sonic Grade Controller	<p>Check electrical connectors and transducer for dirt, debris, or damage.</p> <p>Wipe dirt and dust from housing covers with damp cloth. Inspect exterior for damage or cracks.</p> <p>Wipe dirt and dust from transducer, using soft cloth or low-pressure air.</p>	<p>Connectors are damaged. Transducer is soiled, dented, or foil inside is ripped.</p>
9.	Before/After	R2S-S Laser Receiver	<p>Check electrical connections for dirt, debris, or damage.</p> <p>Wipe dirt and dust from metal housing cover with damp cloth.</p> <p>Inspect windows for cracks and ensure black dust seal is still in place.</p> <p>Clean windows with clean water or general purpose cleaner and soft cloth.</p> <p>Check and clean breather hole.</p>	<p>Connectors are damaged.</p> <p>Windows are cracked or black dust seal is missing.</p> <p>Breather hole is plugged.</p>

Table 3-4. Blade Pro® Motor Grader Control System Operator’s PMCS (Before/After) (Cont)

Item No.	Interval	Location	Procedure	Not Fully Mission Capable If:
		Item to Check/Service		
10.	Before/After	EM2E-24 Electric Mast	Check cap seal for wear and play. Check electrical connectors, dust cover, screw, and hardware for damage.	Connectors are damaged.
11.	Before/After	Operator Interface Box	Wipe dirt and dust from all metal components with damp cloth. Clean screen with general purpose cleaner and soft cloth. Inspect exterior for cracks and any damage to any electrical connectors.	Connectors are damaged.
12.	Before/After	Mast Mount Base	Check all welds for cracks.	Welds are cracked.

Table 3-5. Blade Pro® Motor Grader Control System PMCS (Quarterly)

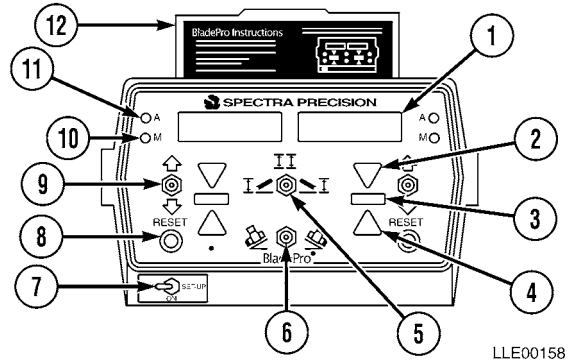
Item No.	Interval	Location	Procedure	Not Fully Mission Capable If:
		Item to Check/Service		
1.	Quarterly	Blade Pro® Sensor Calibration	Refer to Para 3-15	
2.	Quarterly	Valve Calibration	Refer to Para 3-16	

SECTION III. BLADE PRO[®] MOTOR GRADER CONTROL SYSTEM OPERATION

3-14. BLADE PRO[®] MOTOR GRADER CONTROL SYSTEM GENERAL INFORMATION.

Operator Interface Box Controls and Indicators.

1. Display Window.
2. Above-Grade Indicator (2) (Yellow)
3. On-Grade Indicator (2) (Green)
4. Below-Grade Indicator (2) (Yellow)
5. Mode Switch
6. Slope Switch
7. ON/OFF/SET-UP Switch
8. RESET Button (2)
9. Increase/Decrease Switch (2)
10. Manual LED (2) (Red)
11. Automatic LED (2) (Green)
12. Quick Instruction Cards



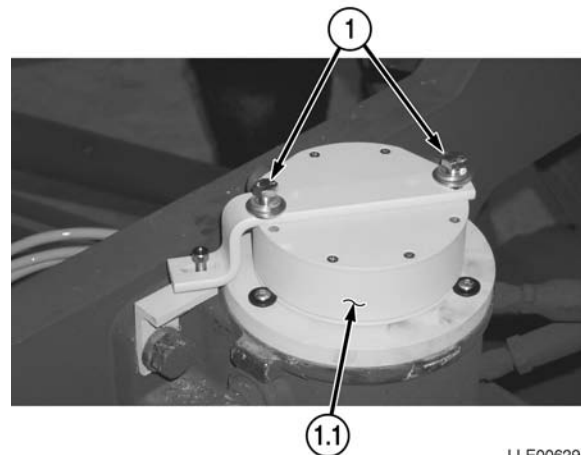
3-15. BLADE PRO[®] MOTOR GRADER CONTROL SYSTEM SENSOR CALIBRATION.

NOTE

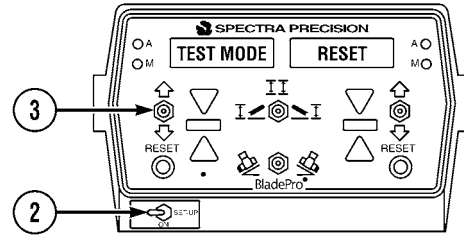
- Sensor calibration requires the aid of an assistant.
- Valve calibration and sensor calibration settings are specific for the make, model, bumper number, and serial number once calibration is completed.

a. Circle Rotation Sensor Calibration.

- (1) Rotate and align chisel marks on 130G Grader's Rotation Circle to draw bar reference.
- (2) Place cutting edge firmly on ground.
- (3) Loosen two bolts (1) on Rotation Sensor (1.1).

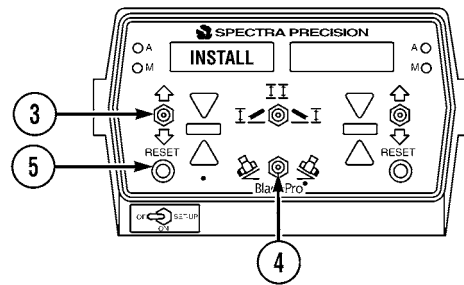


- (4) Set ON/OFF/SET-UP Switch (2) to SETUP position.
- (5) Toggle left Increase/Decrease (3) switch down until TEST MODE is displayed in left window and RESET is displayed in right window.



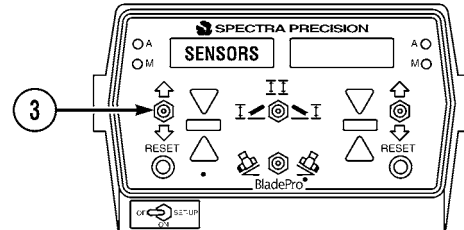
LLE00630

- (6) Push Slope switch (4) right, while at the same time pushing right RESET button (5) in, and right Increase/Decrease switch (3) down. INSTALL will be displayed in the left window.



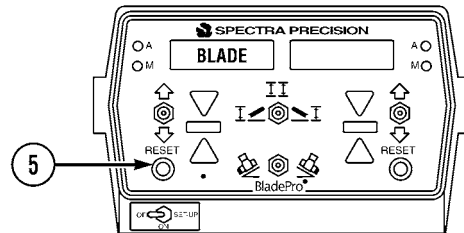
LLE00631

- (7) Toggle left Increase/Decrease switch (3) down until SENSORS is displayed in left window.



LLE00632

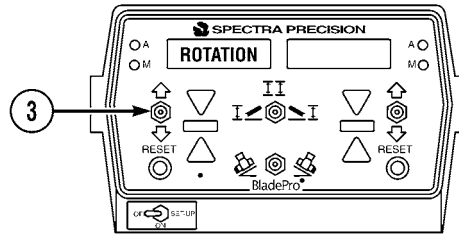
- (8) Press left RESET button (5). BLADE will appear in left window.



LLE00633

TM 5-6675-348-13&P

- (9) Toggle left Increase/Decrease switch (3) down until ROTATION is displayed in left window.
- (10) Manually turn Rotation Sensor (1.1) until display reads 0.00 +/- 4.00 degrees.



LLE00634

- (11) Tighten two bolts (1) on Rotation Sensor (1.1).

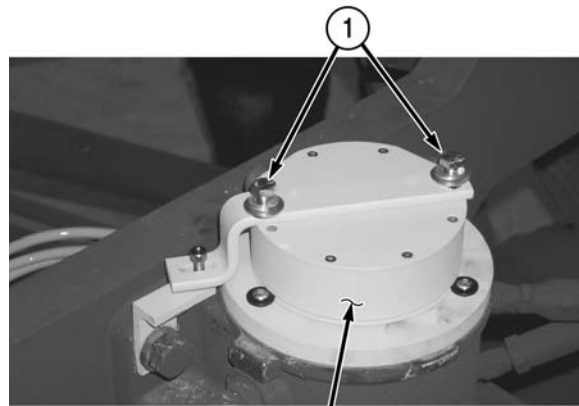
b. 130G Grader Setup.

- (1) Start 130G Grader (TM 5-3805-261-10).

NOTE

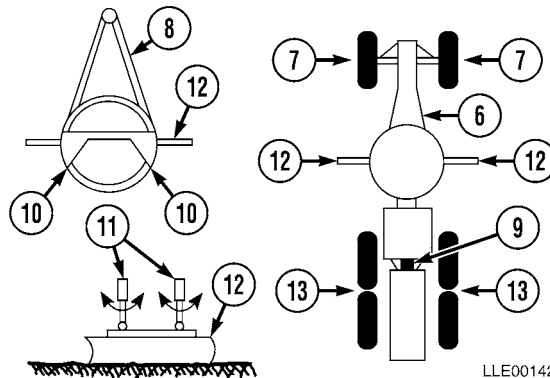
To ease sensor calibration, park 130G Grader on level ground.

- (2) Park 130G Grader (6) on solid material such as concrete, asphalt, or compacted soil.
- (3) Align front tires (7) vertically and position A-frame draw bar (8) directly centered under main frame of 130G Grader (6).
- (4) Align 130G Grader (6) so that no articulation (9) is in 130G Grader (6).
- (5) Rotate and align circle marks (10) to A-frame draw bar (8) reference.
- (6) Place cutting edge firmly on ground until cylinder sockets are not supporting any weight. Cylinder rods (11) should rotate freely.
- (7) Mark position of blade (12) edges and center front tires (7), then mark a line approximately 2 ft (61 cm) long that is parallel to wheels. Mark center of rear tandems (13), then mark a line 2 ft (61 cm) long that is parallel to wheels.



1.1

LLE00629



LLE00142

c. Blade Pro® Motor Grader Control System Sensor Calibration.

CAUTION

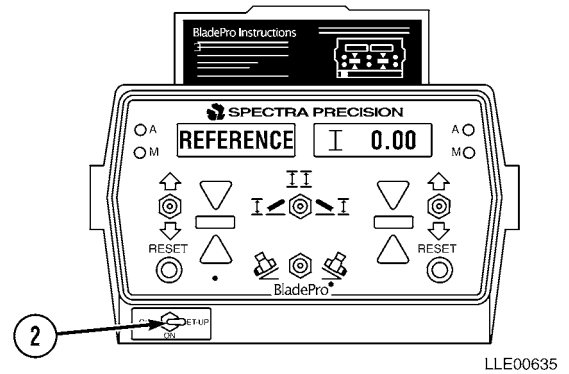
- Sensor calibration must be done when you change cutting edges or tires and/or remove/install sensors from one grader to another grader.
- Sensor calibration should be redone if 130G Grader is not cutting to proper grade.

NOTE

Below is the calibration procedure for FULL CALIBRATE.

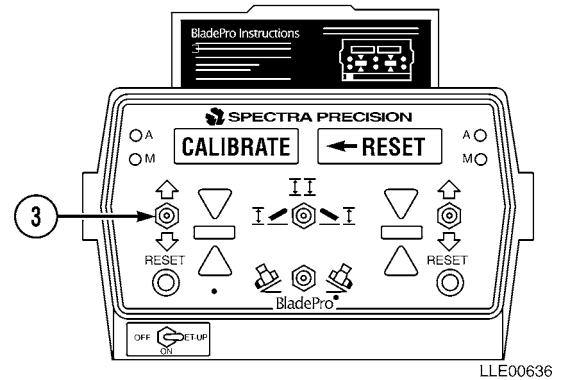
- (1) Set OFF/ON/SET-UP switch (2) to SET-UP.

Left Display	Right Display
REFERENCE	0.00



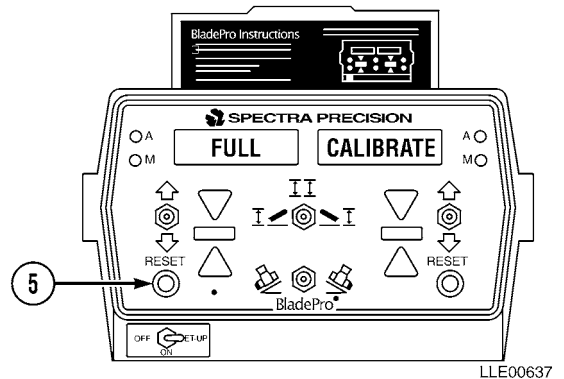
- (2) Toggle left Increase/Decrease toggle switch (3) down until following appears:

Left Display	Right Display
CALIBRATE	RESET



- (3) Press left RESET button (5) to enter CALIBRATE.

Left Display	Right Display
FULL	CALIBRATE



TM 5-6675-348-13&P

- (4) Press left RESET button (5) to enter FULL CALIBRATE.

Left Display	Right Display
INITIAL	POSITION

CAUTION

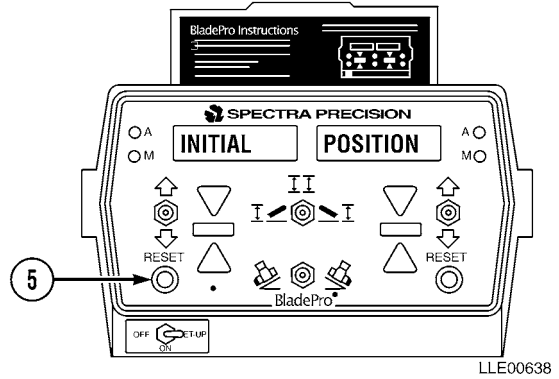
Do not disturb 130G Grader while averaging sensors, or calibration will not be correct.

NOTE

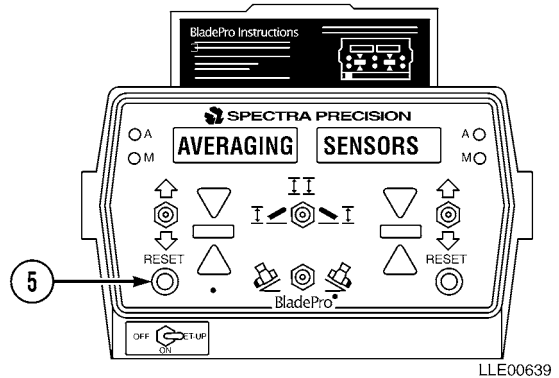
After pressing the left RESET button, AVERAGING SENSORS will appear and flash for 5 seconds. The system has calibrated the Circle Rotation Sensor and has stored the first reading for the Blade Slope Sensor and the Mainfall Slope Sensor.

- (5) Press left RESET button (5) to calibrate initial position.

Left Display	Right Display
AVERAGING	SENSORS

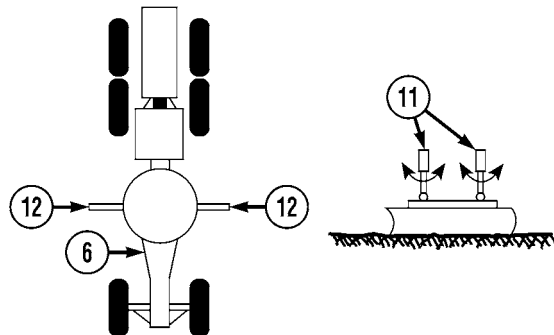


LLE00638



LLE00639

- (6) Raise blade (12), turn 130G Grader (6) 180 degrees, and position blade (12) on marks made in the previous step. Place blade firmly on ground so that Cylinder Rods (11) are not supporting any weight. Cylinder Rods (11) should rotate freely.



LLE00640

- (7) Press left RESET button (5) to calibrate BLADE Sensor.

Left Display	Right Display
BLADE	POSITION

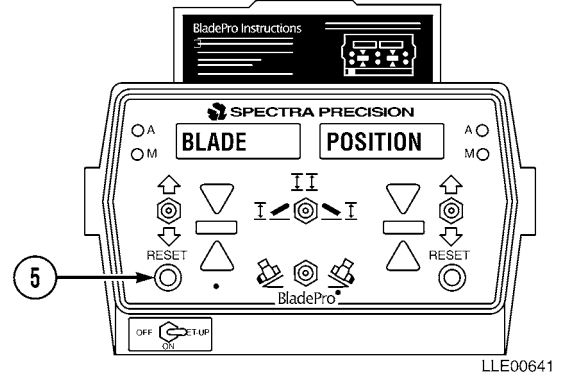


Do not disturb 130G Grader while averaging sensors, or calibration will not be correct.

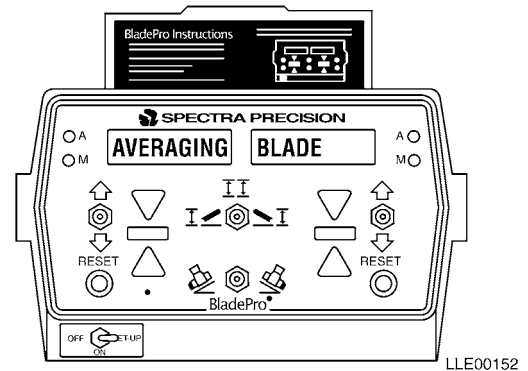
NOTE

AVERAGING BLADE will appear and flash for 5 seconds. The system has now stored a second reading for the Blade Slope Sensor.

Left Display	Right Display
AVERAGING	BLADE

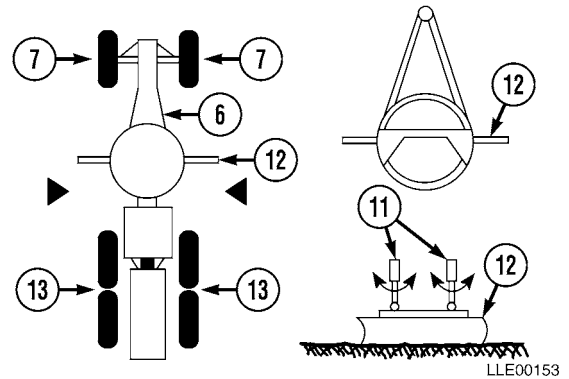


LLE00641



LLE00152

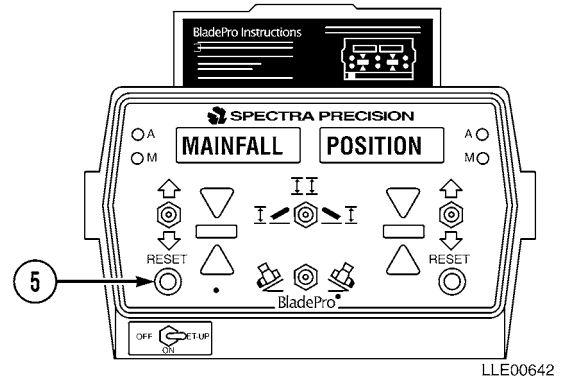
- (8) Raise blade (12) and position 130G Grader (6) on wheel mark (7) and wheel mark (13) made in previous step. Place blade (12) firmly on ground so that cylinders (11) should rotate freely.



LLE00153

- (9) Press left RESET button (5) to calibrate Mainfall Slope Sensor.

Left Display	Right Display
MAINFALL	POSITION

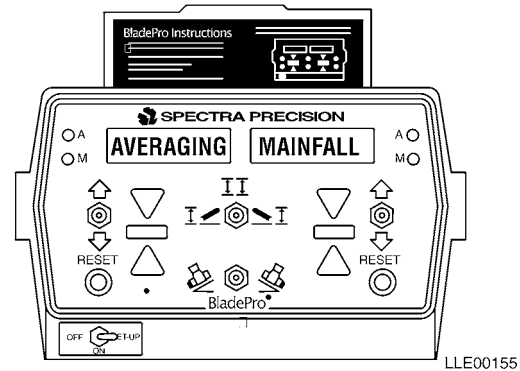


LLE00642

NOTE

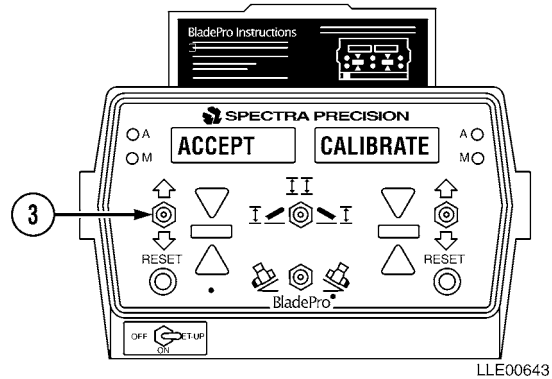
AVERAGING MAINFALL Sensor will appear and flash for 5 seconds. The system has now stored a second reading for the Mainfall Slope Sensor.

Left Display	Right Display
AVERAGING	MAINFALL



- (10) The Blade Pro® Motor Grader Control System is asking for verification that new calibration values are to be used. If new calibration values are not to be used, press left Increase/Decrease toggle switch (3) down and no change will be made to previous calibration.

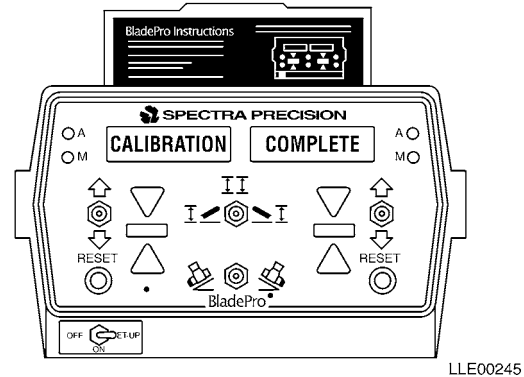
Left Display	Right Display
ACCEPT	CALIBRATE



NOTE

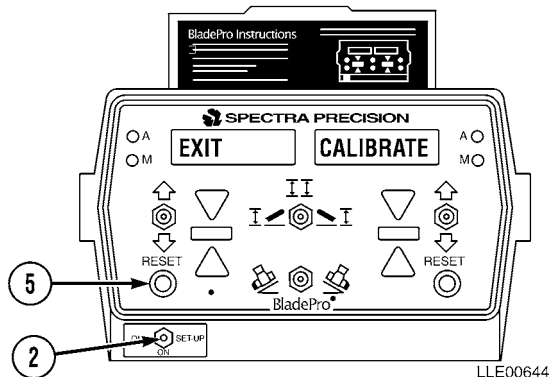
If new settings are to be used, press left RESET button.

Left Display	Right Display
CALIBRATION	COMPLETE



- (11) Press left RESET button (5) to exit calibration.

Left Display	Right Display
EXIT	CALIBRATE



- (12) Move OFF/ON/SET-UP switch (2) to ON position.

3-16. **BLADE PRO[®] MOTOR GRADER CONTROL SYSTEM VALVE CALIBRATION.**

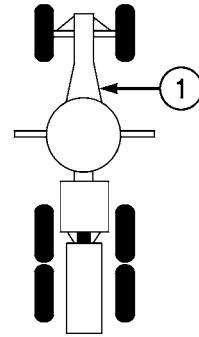
a. **130G Grader Setup.**

- (1) Start 130G Grader (1) (TM 5-3805-261-10).

NOTE

To ease 130G Grader setup, park grader on level surface.

- (2) Park 130G Grader (1) on solid material such as concrete, asphalt, or compacted soil.



LLE00823

b. **Blade Pro[®] Motor Grader Control System Valve Calibration.**

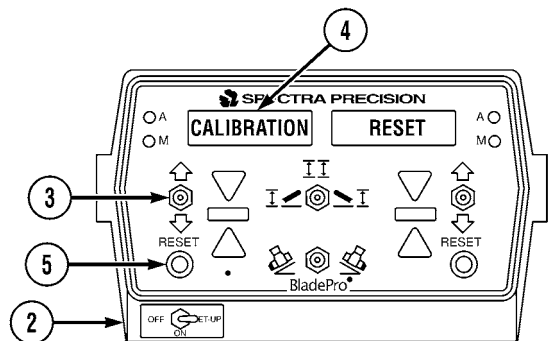


- Valve calibration is required whenever you change hoses, lift cylinders, or any other repairs to the hydraulic system. Failure to perform valve calibration could result in improper equipment performance or damage to equipment.
- Perform the sensor calibration procedures prior to performing the valve calibration procedures. Failure to comply could result in improper 130G Grader performance.
- Operate the machine until the hydraulic oil has reached normal operating temperature before starting the valve calibration. Failure to comply could result in improper Blade Pro[®] Motor Grader Control System performance.

NOTE

- Blade Pro[®] Setup will be displayed across both windows for a few seconds, then REFERENCE and 0.00 will be displayed.
- Ensure 130G Grader is on level ground, A-frame is centered, and blade is perpendicular to frame.
- Valve calibration and sensor calibration settings are specific for the make, model, bumper number, and serial number once calibration is completed.

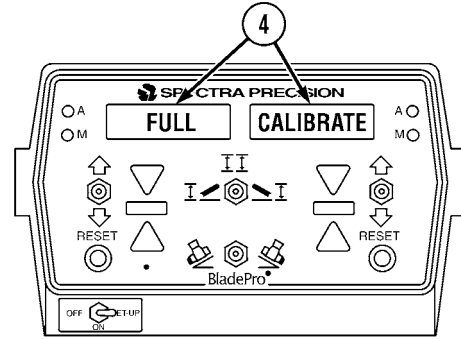
- (1) Position OFF/ON/SET-UP switch (2) in SET-UP position.
- (2) Operate left Increase/Decrease toggle switch (3) down until CALIBRATION appears in the left window (4). Press left RESET button (5) to enter this menu.



LLE00651

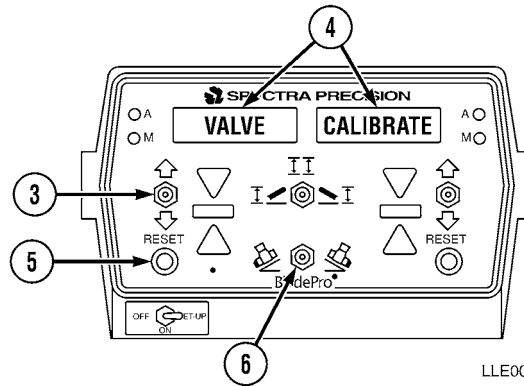
TM 5-6675-348-13&P

- (3) FULL and CALIBRATE will be displayed in the windows (4).



LLE00161

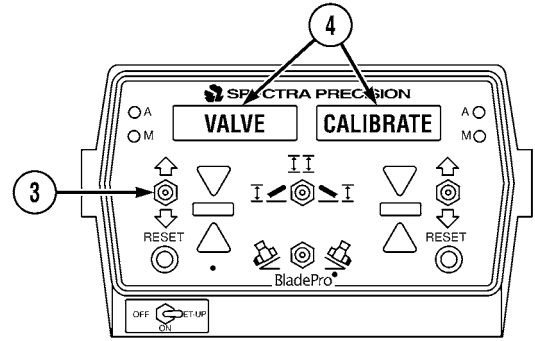
- (4) Operate left Increase/Decrease toggle switch (3) until VALVE CALIBRATE is displayed in windows (4).
- (5) To enter into valve calibration, hold Slope switch (6) to the left and, at the same time, press left RESET button (5). Release both switches at the same time.



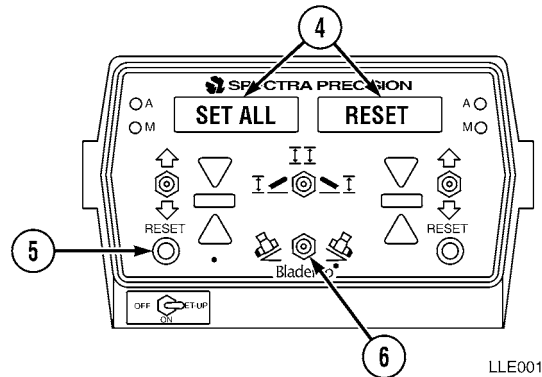
LLE00835

NOTE

- At this point, the blade needs to be set up for calibration. Determine which side (left or right) of blade is going to be calibrated first. Side shift blade to opposite side, then move both cylinders to center of ram.
- If VALVE TEST appears in windows, repeat Step (5).
- VALVE CALIBRATE will flash three times across windows (4) and SET ALL will appear in left window.



LLE00162

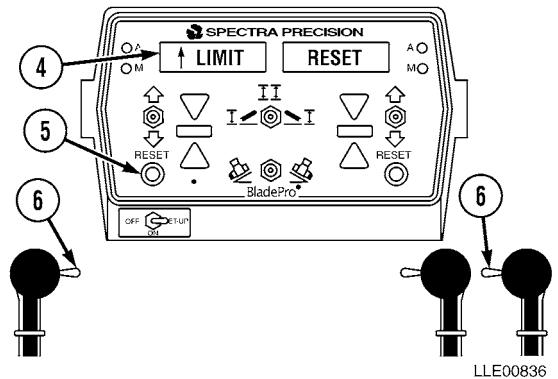


LLE00163

- (6) Select which side control valve will be calibrated first. To enter into this menu, press left or right RESET button (5) for side you want to calibrate.

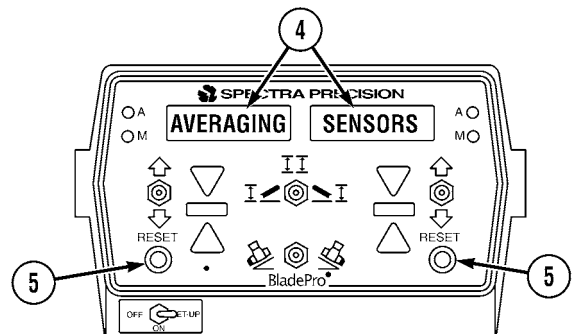
NOTE

- This should be the same side that is side-shifted all the way to one side.
- ↑ LIMIT should be displayed in the left window.



LLE00836

- (7) Set upper limit, using blade's R/L Switch (6), on side to be calibrated, to lift blade until cylinder is almost fully retracted.
- (8) Press RESET button (5) for side to be calibrated. AVERAGING SENSORS will flash across windows (4).



LLE00717

WARNING

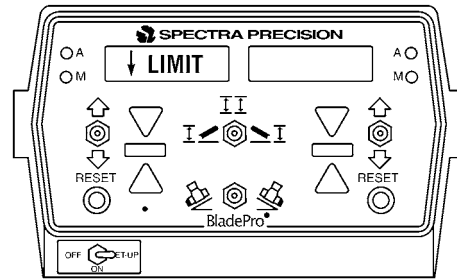
Keep all personnel and equipment away from blade during calibration. Blade may move suddenly, causing injury or death to personnel, or damage to equipment.

CAUTION

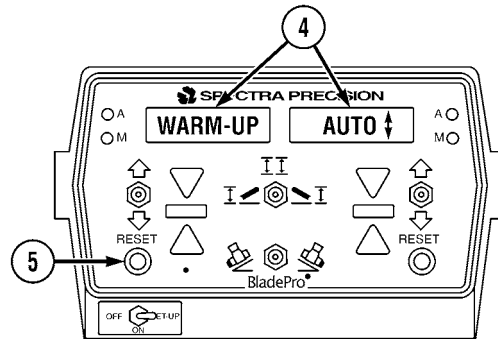
- Do not disturb 130G grader while averaging sensors, or calibration will not be correct.
- Left or right RESET Button must be held in for duration of calibration. Failure to comply could result in improper 130G Grader performance.

NOTE

- The system is requesting that the upper limit be set.
- ↓ LIMIT should be displayed in the left window.
- WARM-UP should be displayed in left window and AUTO in right window.
- System is requesting that lower limit be set. Set lower limit, using blade's manual lever, and lower blade until approximately 1 to 3 in. (2.54 to 7.6 cm) above ground.

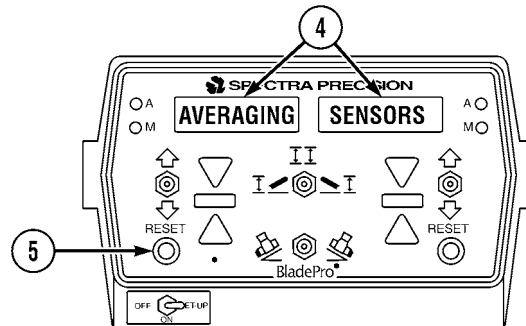


LLE00842



LLE00166

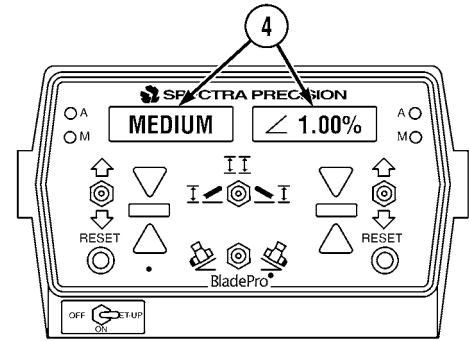
- (9) Press RESET button (5) for side to be calibrated. AVERAGING SENSORS will flash across windows (4).



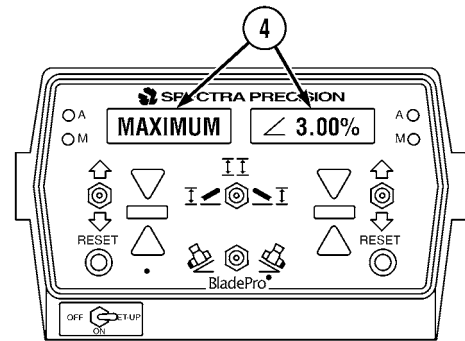
LLE00824

NOTE

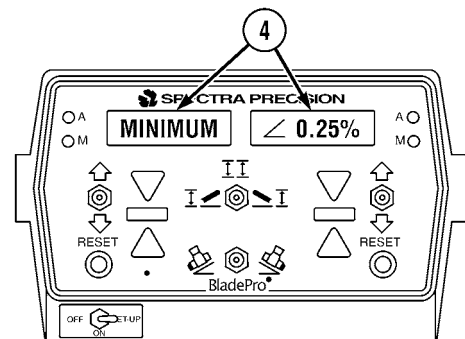
- Start calibrating control valves by pushing left or right RESET Button or by holding the Remote Offset Switch. This switch is located on articulation control lever.
- If the following calibration cannot be performed at any time, contact Trimble Navigation.
- This section of valve calibration is called warm-up period and usually lasts approximately 3 minutes. Numbers will be displayed in the right window during this section and they should range from 0.00% to 3.50%. If after 3 minutes a message appears across both windows indicating VALVE ERROR.
- The next section displayed in the left window after the warm-up section is completed is MAXIMUM.
- The correct number displayed in the right window will be 3.00% \pm 0.10%. If this number is not achieved, the system will not move to the next cycle. Repeat Step (1).
- After MAXIMUM cycle has reached its proper calibration number, the next section displayed in the left window is MEDIUM.
- The correct number for this cycle will be 1.00% \pm 0.01%. If this number is not achieved, the system will not move to the next cycle.
- Next section that will be displayed in the window after MEDIUM has reached its calibration number is MINIMUM. Correct calibration number for this cycle will be 0.25% \pm 0.01%. If this number is not achieved, the system will not move to next cycle.



LLE00168

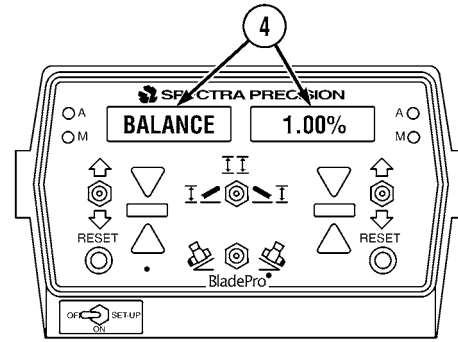


LLE00167



LLE00169

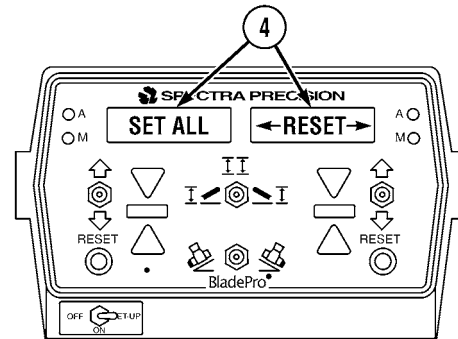
- Final section displayed in window after MINIMUM has reached its proper calibration number is BALANCE. Correct calibration number for this cycle will be 1.00% ±0.01. If this number is not achieved, the system will not finish calibrating.
- Once BALANCE cycle has reached its proper calibration number, SET ALL will again be displayed in window.



LLE00170

(10) At this time, the Remote Offset Switch located on the articulation control lever can be released and valve calibration complete for that side.

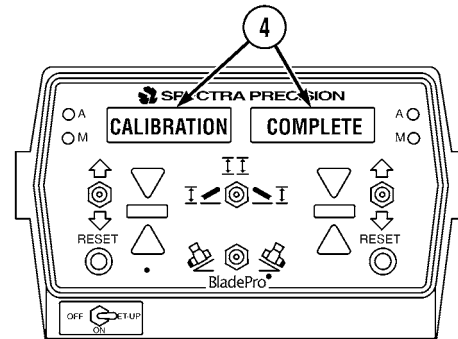
(11) Now it is time to calibrate the other side. Prepare for this by using Blade Side Shift Lever to move blade all the way to the other side of grader. Repeat Steps (7) through (10).



LLE00171

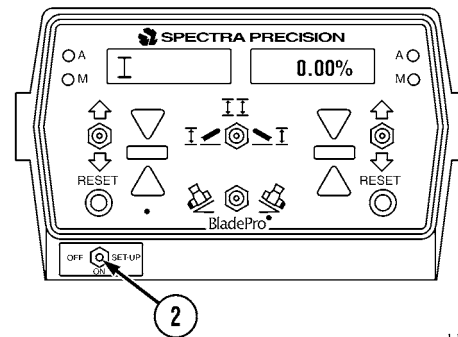
NOTE

When the final cycle of BALANCE has completed, CALIBRATION COMPLETE will display across both windows and valve calibration will be complete.



LLE00172

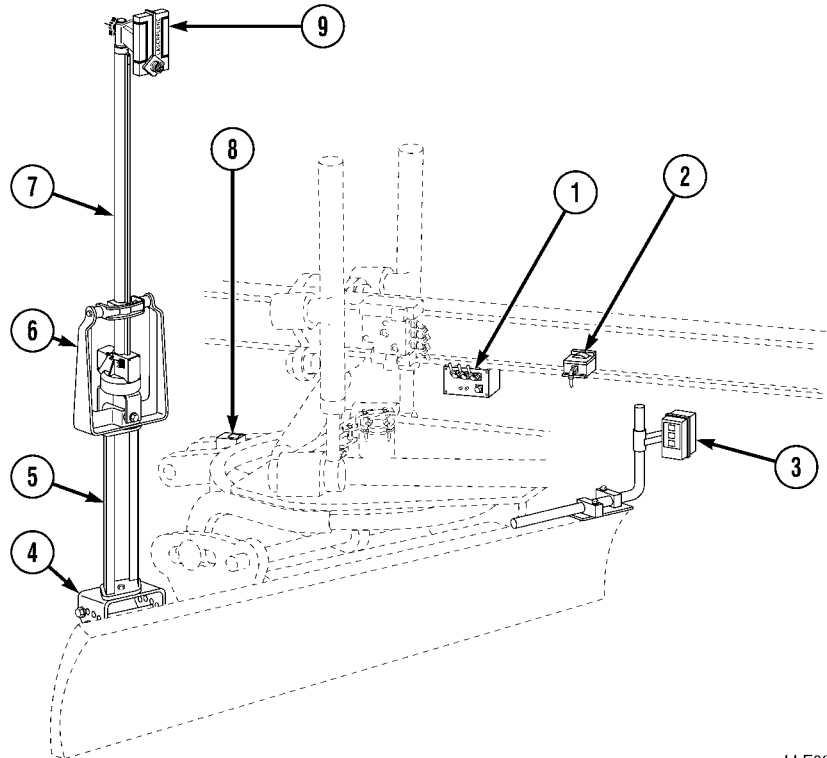
(12) Exit Valve Calibration by positioning OFF/ON/SET-UP switch (2) back to ON, or center position.



LLE00173

3-17. MOVING BLADE PRO[®] MOTOR GRADER CONTROL SYSTEM COMPONENTS FROM GRADER TO GRADER.

a. Blade Pro[®] Motor Grader Control System Components.



LLE00174

- | | |
|---|--------------------------|
| 1. Remote Interface Box | 6. Shock Mount |
| 2. Mainfall Slope Sensor | 7. EM2E-24 Electric Mast |
| 3. Tracer [®] Sonic Grade Controller | 8. Blade Slope Sensor |
| 4. Mast Mount | 9. R2S-S Laser Receiver |
| 5. Mast Riser | |

b. Remove.

WARNING

To avoid injury to personnel, ensure 130G Grader is shut off and blade is on the ground.

NOTE

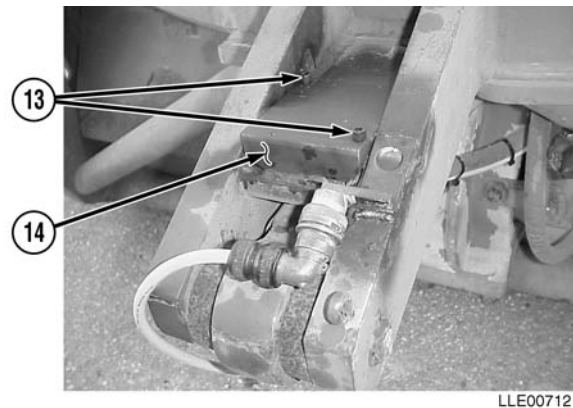
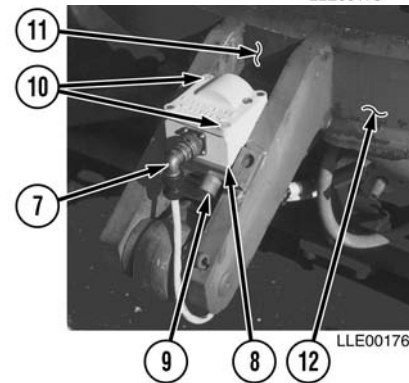
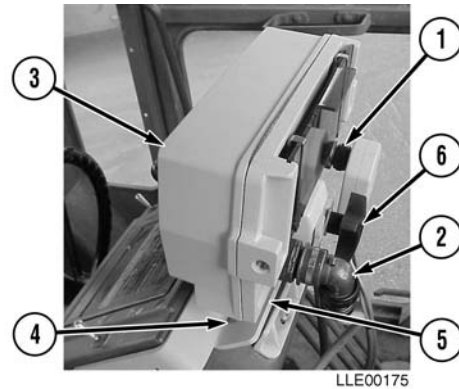
Note location and placement of components prior to removal. This will aid in installation.

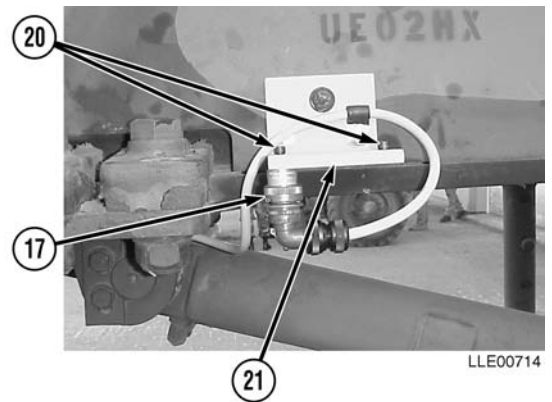
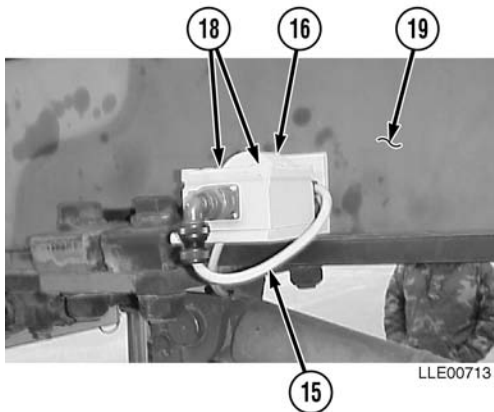
- (1) Remove 6-pin connector (1) and 8-socket connector (2) from Operator Interface Box (3).
- (2) Place 6-pin connector (1) and 8-socket connector (2) onto Connector Holders (4) located on mounting bracket (5).
- (3) Loosen knob (6) on back of Operator Interface Box (3) holding it to mounting bracket (5). Remove Operator Interface Box (3).
- (4) Remove Blade Slope Sensor Cable (7) from Blade Slope Sensor (8) and secure to Connector Holder (9).
- (5) Remove two socket head screws (10) and Blade Slope Sensor (8) located in pocket (11) of 130G Grader's Rotation Circle (12).

NOTE

Socket head screws are used to protect the threads of the Slope Sensor Plate.

- (6) Install two socket head screws (13) in Slope Sensor Plate (14).





- (7) Remove Mainfall Slope Sensor Cable (15) from Mainfall Slope Sensor (16) and secure Mainfall Slope Sensor Cable (15) to Connector Holder (17).
- (8) Remove two socket head screws (18) and Mainfall Sensor (16) located on right side of 130G Grader's gooseneck (19).

NOTE

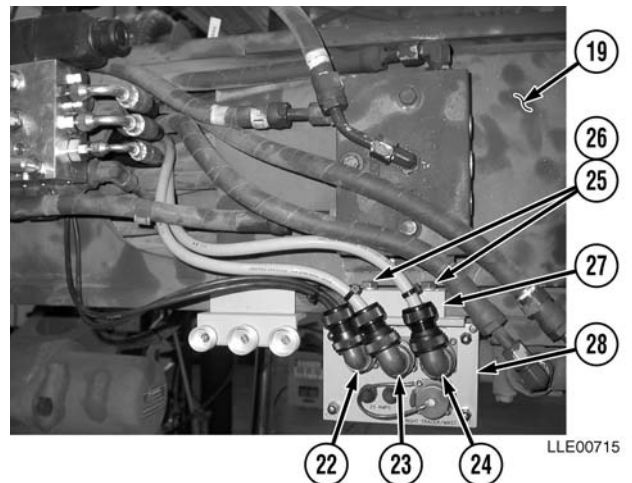
Socket head screws are used to protect the threads of the Mainfall Slope Sensor Mounting Plate.

- (9) Install two socket head screws (20) in Mainfall Slope Sensor Mounting Plate (21).

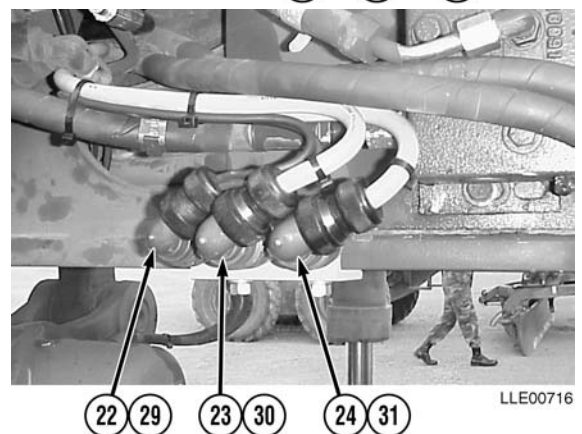
NOTE

- Tag and mark all cables before disconnecting.
- Step (10) applies to both sides of the machine. The right side is shown.

- (10) Remove Connectors (22), (23), and (24), two bolts (25), washers (26), and Remote Box Mounting clamp (27) from Remote Interface Box (28) located under 130G Grader's gooseneck (19).



- (11) Install Connectors (22), (23), and (24) onto Connector Holders (29), (30), and (31).

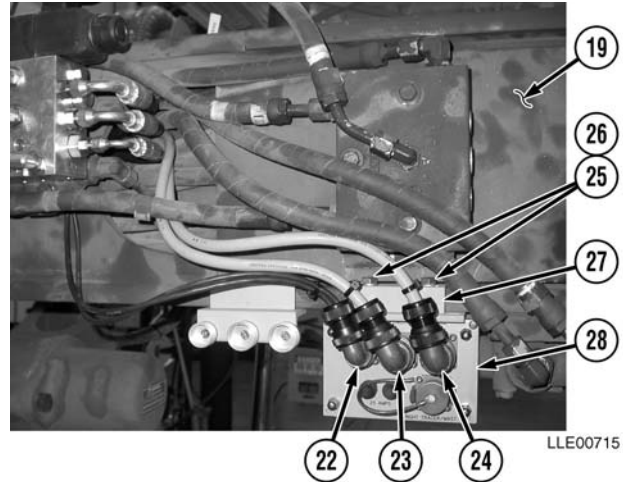


c. Install.

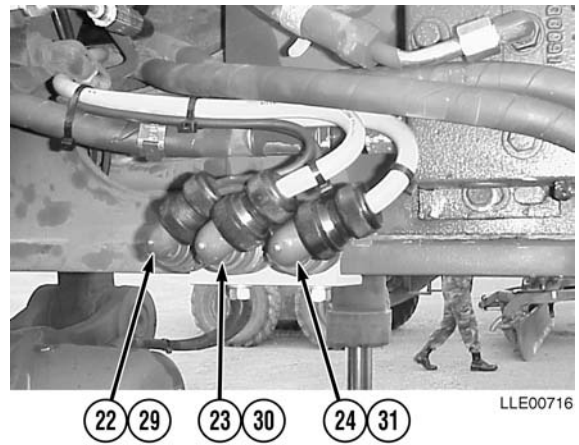
NOTE

Step (1) applies to both sides of the machine. The right side is shown.

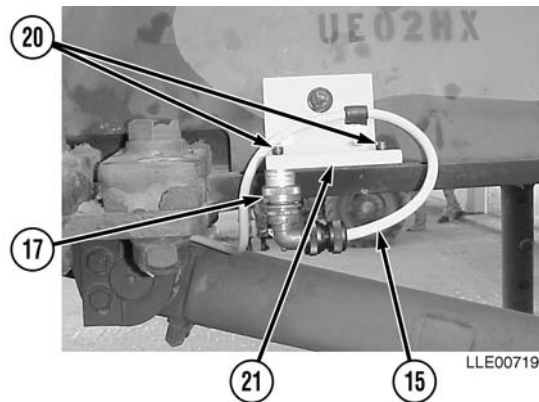
- (1) Install Remote Interface Box (28) under 130G Grader's Gooseneck (19) with two washers (26), bolts (25), and Remote Box Mounting clamp (27).
- (2) Tighten bolts (25).



- (3) Remove Connectors (22), (23), and (24) from Connector Holders (29), (30), and (31).
- (4) Connect Connectors (22), (23), and (24) to Remote Interface Box (28).



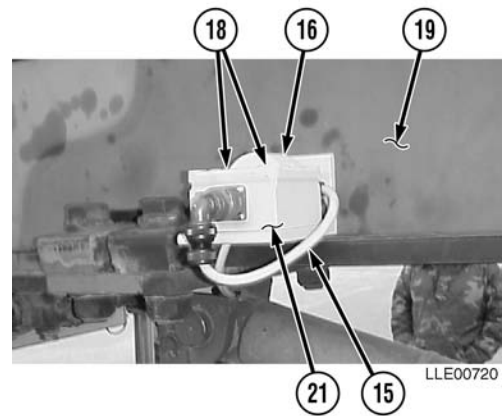
- (5) Remove Mainfall Slope Sensor Cable (15) from Connector Holder (17).
- (6) Remove two socket head screws (20) from Mainfall Slope Sensor Mounting Plate (21).



CAUTION

To ensure proper Blade-Pro[®] Motor Grader Control System operation, ensure all sensor plates are clean and free of debris before bolting any sensors down.

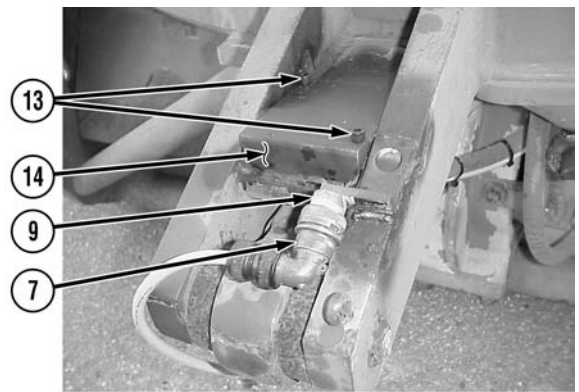
- (7) Install Mainfall Slope Sensor (16), located on right side of the 130G Grader's Gooseneck (19), on Mainfall Slope Sensor Mounting Plate (21) with two socket head screws (18).
- (8) Tighten socket head screws (18).



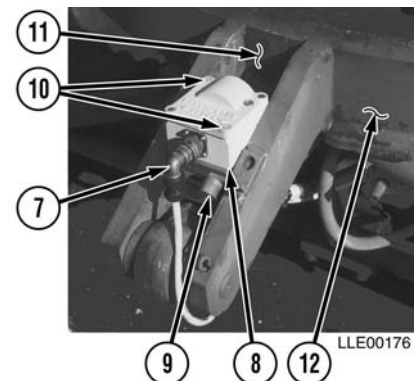
CAUTION

To avoid damage to equipment, ensure cable connector is clean and dry.

- (9) Install Mainfall Slope Sensor Cable (15) on Mainfall Sensor (16).
- (10) Remove Blade Slope Sensor Cable (7) from Connector Holder (9).
- (11) Remove two socket head screws (13) from Slope Sensor Plate (14).



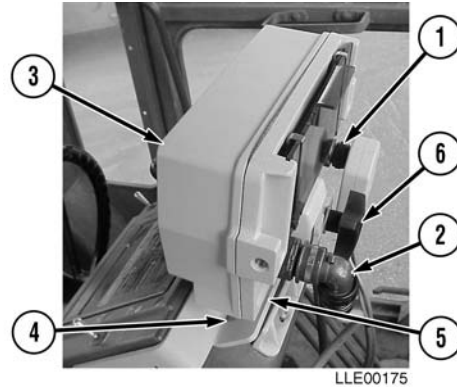
- (12) Install Blade Slope Sensor (8) in pocket (11) of 130G Grader's Rotation Circle (12) with two socket head screws (10).
- (13) Tighten socket head screws (10).
- (14) Install Blade Slope Sensor Cable (7) on Blade Slope Sensor (8).



NOTE

Operator Interface Box mounts on bracket at top of grader console.

- (15) Loosen knob (6) and slide Operator Interface Box (3) into groove on mounting bracket (5). Tighten knob (6) after correct position of Operator Interface Box (3) has been adjusted.
- (16) Remove 6-pin connector (1) and 8-socket connector (2) from Connector Holders (4) located on mounting bracket (5).
- (17) Install 6-pin connector (1) and 8-socket connector (2) on Operator Interface Box (3).
- (18) After all these procedures have been completed, do a final walk around 130G Grader to ensure all connectors are properly tightened and that all bolts are tight.
- (19) Calibrate sensors and valves (refer to Para 3-15 and Para 3-16).

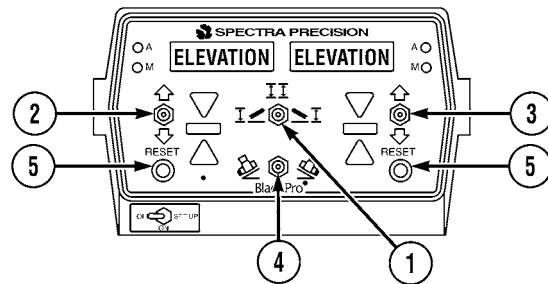


3-18. BLADE PRO[®] MOTOR GRADER CONTROL SYSTEM OPERATION DESCRIPTION.

Operator Interface Box. Puts all control functions within easy reach of the Operator. One Mode Switch is required to select operating configuration.

- (1) Mode switch (1) position and operating configurations available:

Switch Position	Left Side	Right Side
Left Position	Elevation	Cross-Slope
Center Position	Elevation	Elevation
Right Position	Cross-Slope	Elevation



LLE00182

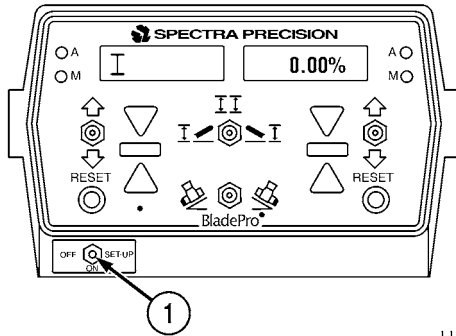
- (2) Selected operating mode is shown in two display windows. The left window is for the 130G Grader's left side and the right window is for the 130G Grader's right side. Left and right Increase/Decrease switches (2) and (3) adjust for elevation and slope values. Change blade slope direction, using bottom center Slope Switch (4). Set Tracer[®] Sonic Grade Controller to a reference surface by pressing RESET button (5) for side controlled by the Tracer[®] Sonic Grade Controller. Two remote switches, located on the left and right manual control levers, provide control of automatic or manual operation for the left and right sides.
- (3) When desired cross-slope is entered into the Operator Interface Box, the Remote Interface Box reads Mainfall Slope Sensor, Blade Slope Sensors, and Circle Rotation Sensor, and calculates cross-slope. Calculated cross-slope is compared to the desired cross-slope. If an error is determined, LED Grade Indicator displays type of correction (i.e., fine, medium, or coarse) and direction (raise or lower) required to reach desired cross-slope. With Blade Pro[®] Motor Grader Control System in automatic operation, the displayed correction is sent to hydraulic valves to reposition the blade to desired slope. This operating speed provides very fast, smooth response to changing grade conditions.

3-19. AUTOMATIC CROSS-SLOPE AND MANUAL ELEVATION.

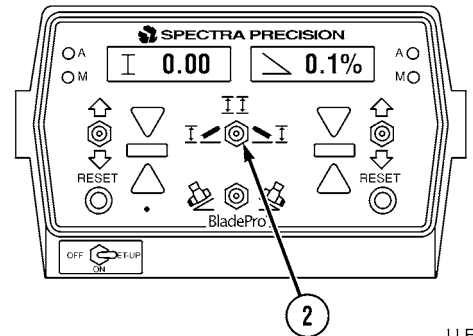
a. General Information.

Automatic Cross-Slope and Manual Elevation allows the Operator to manually control the elevation on the left side of the blade and the cross-slope on the right side of the blade is automatically controlled. Cross-slope and manual elevation setup can be applied on projects that will use existing elevations but require a cross-slope for drainage (e.g., tank trails and dirt road upgrades).

b. Setting Up the Blade Pro[®] Motor Grader Control System.



LLE00831



LLE00185

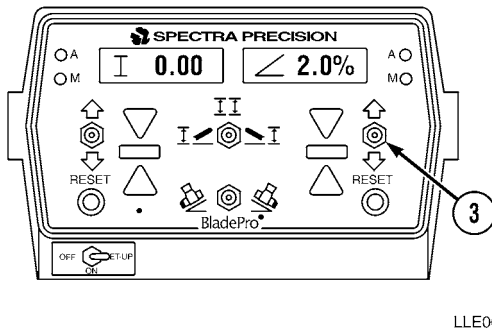
- (1) Set OFF/ON/SET-UP switch (1) to ON position.

NOTE

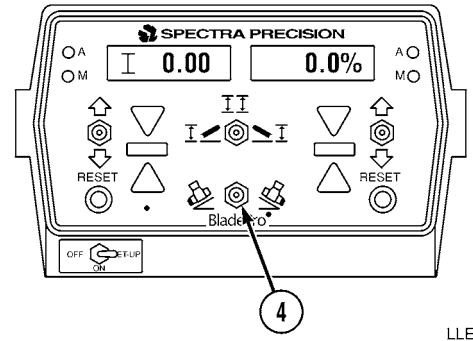
If previous slope was 0.0, no slope symbol (<) will be shown.

- (2) Set Mode switch (2) to left position.

Left Display	Right Display
I 0.00	> 0.1%



LLE00187



LLE00186

- (3) Enter desired cross-slope in right display window by using right Increase/Decrease switch (3).

Left Display	Right Display
I 0.00	< 2.0%

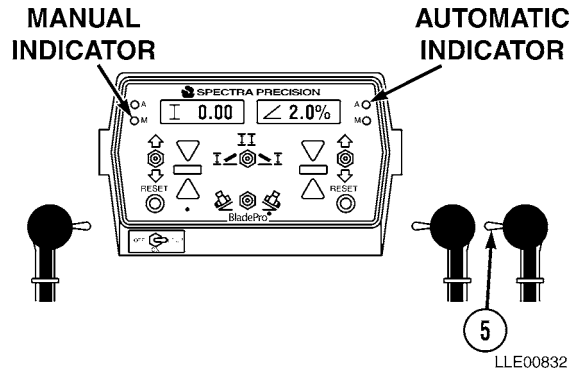
- (4) Change blade slope direction switch (4) to match desired slope, if required.

Left Display	Right Display
I 0.00	< 0.0%

- (5) Toggle right R/L switch (5) forward.

NOTE

- Right green automatic indicator will be illuminated in upper right corner of Operator Interface Box.
- Left red manual indicator should still be illuminated in left-hand corner of Operator Interface Box.
- Automatic operation will now start.
- If return pass is on same side of road crown, toggle Mode switch to right. The cross-slope-controlled side is now left side and blade slope direction is automatically changed.



LLE00832

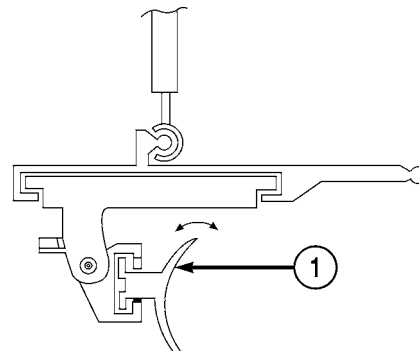
3-20. AUTOMATIC ELEVATION (TRACER[®] SONIC GRADE CONTROLLER) AND CROSS-SLOPE.

a. General Information.

Automatic Elevation and Cross-Slope automatically controls both the elevation on the left side of the blade and the cross-slope on the right side of blade.

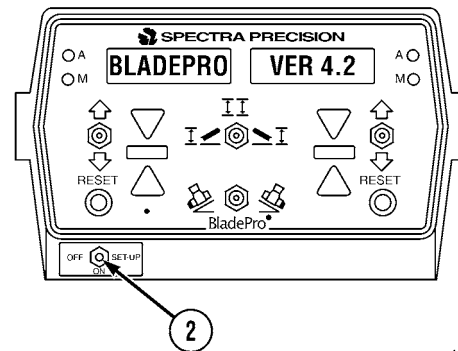
b. Setting Up the Blade Pro[®] Motor Grader Control System.

- (1) Adjust blade (1) to desired roll.



LLE00653

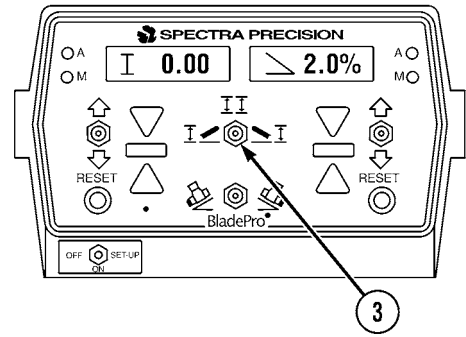
- (2) Set OFF/ON/SET-UP switch (2) to ON position.



LLE00655

- (3) Set Mode switch (3) to left position.

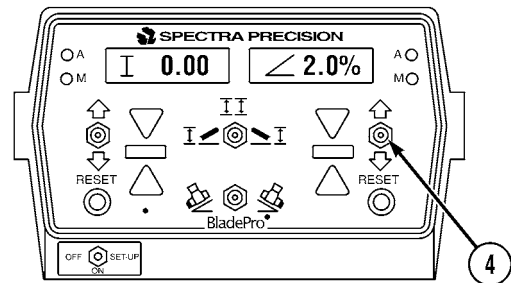
Left Display	Right Display
I 0.00	> 2.0%



LLE00656

- (4) Enter desired cross-slope value into right display window, using right Increase/Decrease switch (4).

Left Display	Right Display
I 0.00	< 2.0%



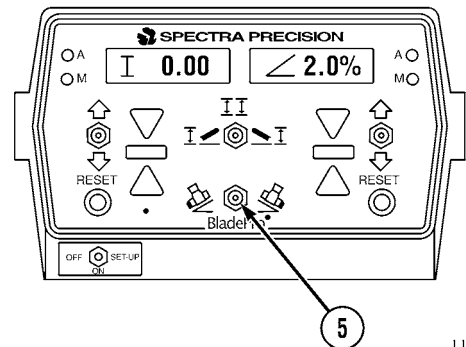
LLE00194

- (5) Change direction of Slope switch (5), if required, to match desired direction of slope.

Left Display	Right Display
I 0.00	< 2.0%

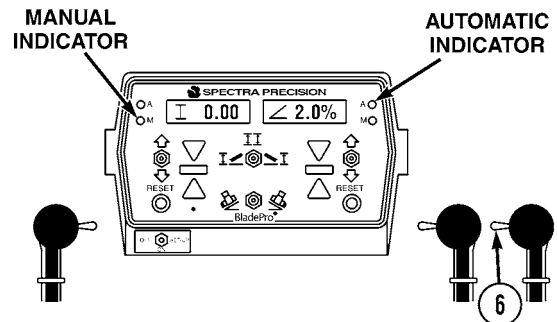
NOTE

- Right green automatic indicator will be illuminated in upper right corner of Operator Interface Box.
- The left red manual indicator should still be illuminated in left-hand corner of Operator Interface Box.



LLE00657

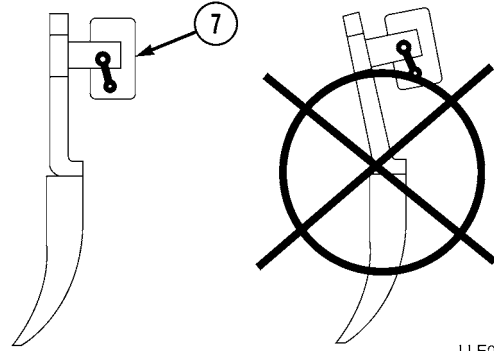
- (6) Toggle right R/L Switch (6) forward.



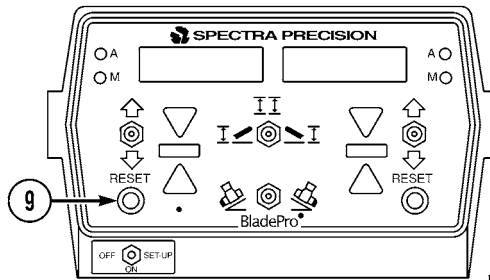
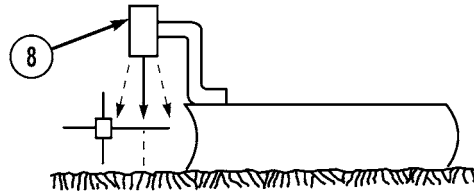
LLE00727

TM 5-6675-348-13&P

- (7) Adjust Tracer[®] Sonic Grade Controller side of blade so that it is 18 to 24 in. (46 to 61.0 cm) above desired elevation.
- (8) Center Tracer[®] Sonic Grade Controller (7) over elevation reference by loosening base tube clamp studs.
- (9) Position tube vertically and center it directly over elevation reference.
- (10) Plumb Tracer[®] Sonic Grade Controller (8) over elevation reference by loosening locking knob on back of mounting arm.
- (11) Vertically align Tracer[®] Sonic Grade Controller (8) for plumb over reference surface.
- (12) Press left RESET button (9) to lock Tracer[®] Sonic Grade Controller (8) onto reference.



LLE00659

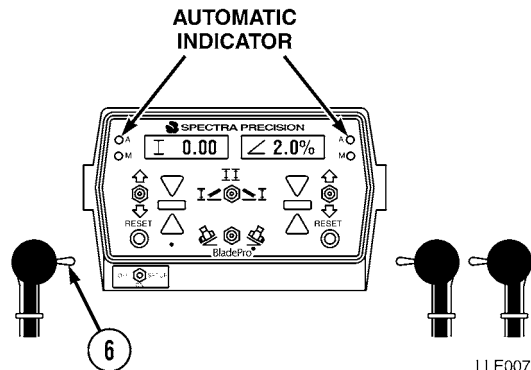


LLE00726

NOTE

- Left green automatic indicator will be illuminated in upper left corner of Operator Interface Box.
- Both right and left green automatic indicators will be illuminated.

- (13) Press left R/L switch (6) forward.

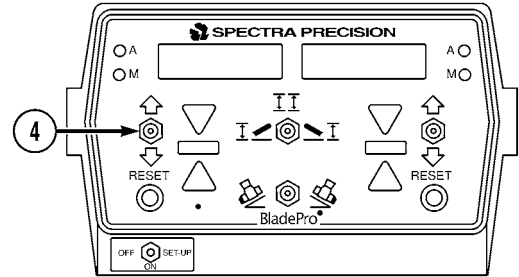


LLE00725

NOTE

- If return pass is to be on same side of crown, position Mode switch to right. The Tracer[®] Sonic Grade Controller now controls right side and cross-slope left.
- Blade's slope direction is changed automatically to match desired slope.
- If the Remote Interface Box right-side Tracer[®] Sonic Grade Controller has not been set to reference elevation, press right RESET button once blade has been set to reference.

(14) The elevation of Tracer[®] Sonic Grade Controller can be changed by using the left Increase/Decrease switch (4) once the cut has been started.



LLE00724

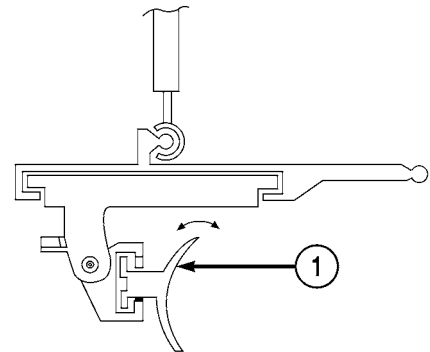
3-21. DUAL AUTOMATIC ELEVATION (TRACER[®] SONIC GRADE CONTROLLER R2S-S LASER RECEIVER WITH EMZE-24 ELECTRIC MAST).

a. General Information.

Dual Automatic Elevation automatically controls elevation on both sides of the blade.

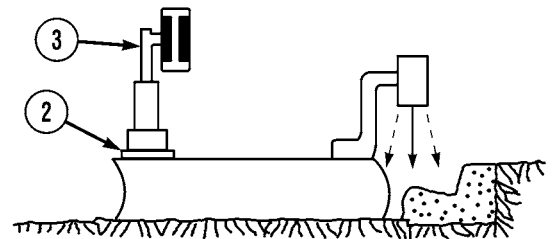
b. Setting up the Blade Pro[®] Motor Grader Control System.

- (1) Start 130G Grader (TM 5-3805-261-10).
- (2) Adjust blade (1) to desired roll.



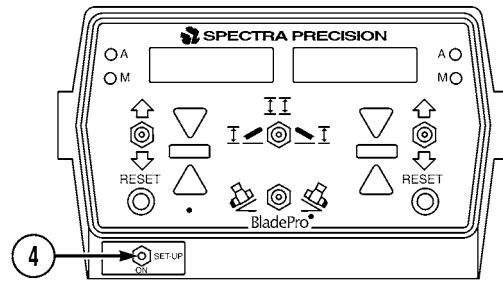
LLE00202

- (3) Adjust mast swivel mount (2) until mast (3) is plumb.



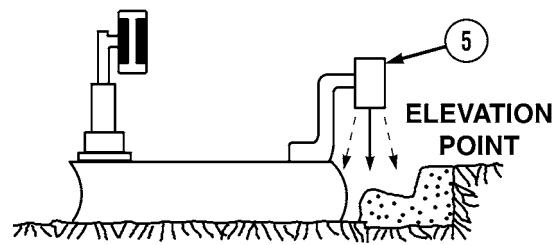
LLE00723

- (4) Set OFF/ON/SET-UP switch (4) to ON position.



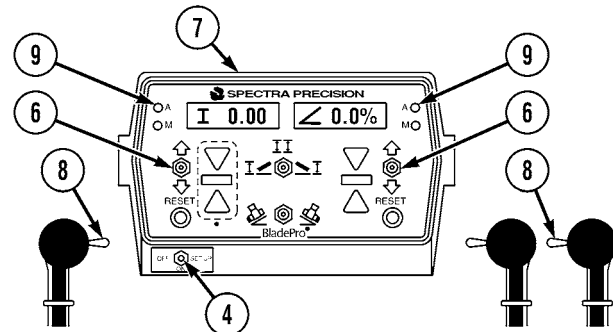
LLE00206

- (5) Position Tracer[®] Sonic Grade Controller (5) on left side of blade over a known elevation point.



LLE00722

- (6) Enter zero cross-slope, using Increase/Decrease switch (6) on right side of Operator Interface Box (7).
- (7) Place R/L Switch (8) on right side in automatic position. Automatic Indicator (9) should be green.
- (8) Adjust Increase/Decrease switch (6) on left side of Operator Interface Box (7) until display is on grade, center green bar only.



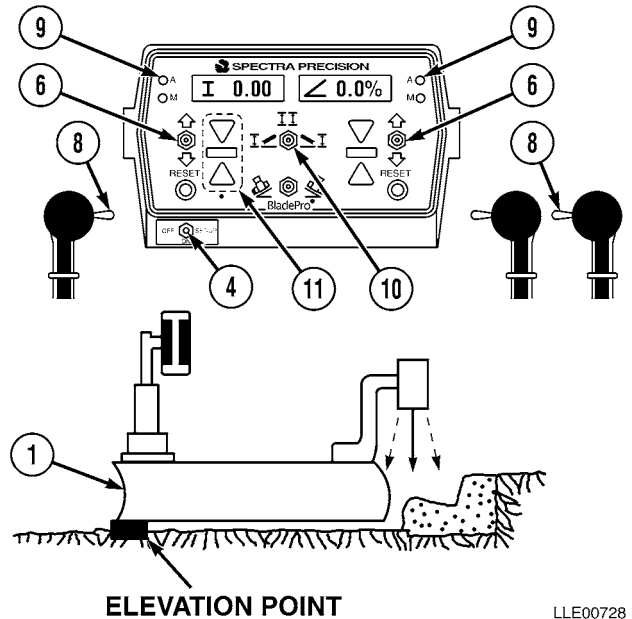
LLE00721

NOTE

Reference will be displayed when OFF/ON/SET-UP switch is placed in SET-UP position.

- (9) Position OFF/ON/SET-UP switch (4) to SET-UP position.
- (10) Use Increase/Decrease switch (6) on right side of Operator Interface Box (7) to enter actual elevation of bottom edge of blade.
- (11) Position OFF/ON/SET-UP switch (4) back to ON position.

- (12) Position Mode switch (10) to far right position.
- (13) Position right side of blade (1) over known elevation point.
- (14) Place R/L switch (8) on left side into automatic mode with zero cross-slope. Automatic Indicator (9) should be green.
- (15) Adjust Increase/Decrease switch (6) on right side of Operator Interface Box (7) until center green bar (11) is illuminated indicating on grade.



LLE00728

NOTE

Reference will be displayed on Operator Interface Box.

- (16) Position OFF/ON/SET-UP switch (4) to SET-UP position.
- (17) Use Increase/Decrease switch (6) on right side of Operator Interface Box (7) to enter actual elevation of bottom edge of blade.
- (18) Place OFF/ON/SET-UP switch (4) back to ON position.
- (19) Position Mode switch (10) to center position.
- (20) Using right and left Increase/Decrease switches (6), raise or lower mast to desired elevation.
- (21) Place right and left Auto/Manual switches (8) to Auto position.
- (22) Begin grading (TM 5-3805-261-10).

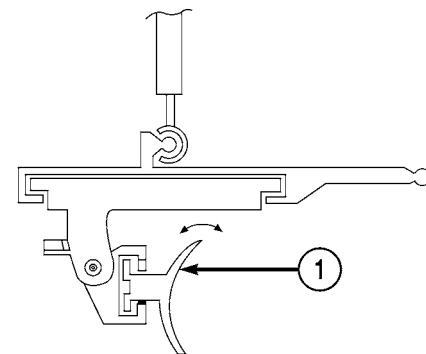
3-22. AUTOMATIC ELEVATION (EM2E-24 ELECTRIC MAST AND R2S-S LASER RECEIVER) AND CROSS-SLOPE.

a. General Information.

Automatic Elevation and Cross-Slope automatically controls elevation on the left and right side of the blade, and positions switch to the far left position.

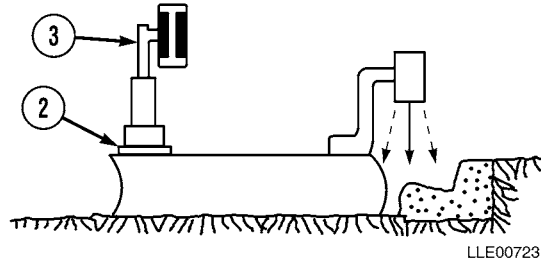
b. Setting up the Blade Pro® Motor Grader Control System.

- (1) Start 130G Grader (TM 5-3805-261-10).
- (2) Adjust blade (1) to desired roll.

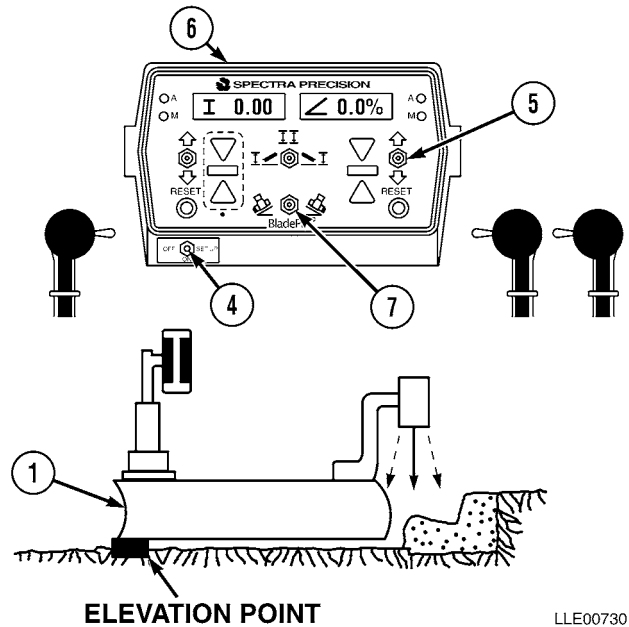


LLE00202

- (3) Adjust mast swivel mount (2) until mast (3) is plumb.
- (4) Set OFF/ON/SET-UP switch (4) to ON position.



- (5) Position left side of blade (1) over known elevation point.
- (6) Enter desired cross-slope, using Increase/Decrease switch (5) on right side of Operator Interface Box (6). Ensure slope direction is correct direction of Slope switch (7).
- (7) Place R/L switch (8) on right side in automatic position. Automatic Indicator (9) should be green.
- (8) Adjust Increase/Decrease switch (5) on left side of Operator Interface Box (6) until center green bar (10) is illuminated, indicating on grade.
- (9) Position OFF/ON/SET-UP switch (4) to SET-UP position.



NOTE

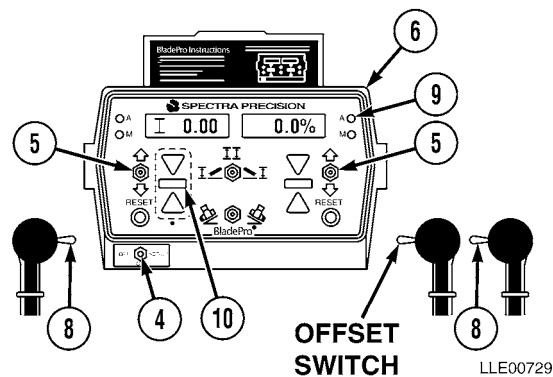
REFERENCE will be displayed on Operator Interface Box.

- (10) Use Increase/Decrease switch (5) on right side of Operator Interface Box (6) to enter actual elevation of bottom edge of blade.
- (11) Place OFF/ON/SET-UP switch (4) back to ON position.

NOTE

Both LEDs should be green.

- (12) Place R/L switch (8) on left side to automatic position, and cycle the switch through MANUAL and back to AUTO.
- (13) Begin grading (TM 5-3805-261-10).



3-23. BLADE PRO[®] MOTOR GRADER CONTROL SYSTEM USER OPTIONS IN SETUP MODE.

- a. **Reference.** Allows a reference elevation (benchmark or sea-level elevation) to be entered into the elevation display window. The reference elevation does not change the elevation of the blade; only the numeric value in the display window is changed.
- b. **Customize.** Allows the Operator to customize certain system functions and features. Functions are OFFSETS, BEEPER ALERTS, and SLOPE DISPLAY. These functions can be turned on or off, or can be changed through the Customize program.
- c. **Remote Switch.** Three functions are available in OFFSET program: **Slope Offset**, **Elevation Offset**, and **Auto Raise/Lower**. Only one OFFSET function can be selected at any given time. Selected OFFSET function is activated by using Remote switch.
 - (1) **Slope Offset** allows Remote switch to function in adjusting desired cross-slope in increments of 0.1% to 19.9%. When Remote switch is toggled forward, programmed offset value is added to displayed cross-slope value. Slope of blade is increased by same value. When Remote switch is toggled toward Operator, programmed offset value is subtracted from displayed cross-slope value and slope of blade is decreased by same value. Slope offset allows cross-slope to be transitioned through zero.
 - (2) **Elevation Offset** allows Remote switch to function in adjusting Tracer[®] Sonic Grade Controller or EMZE-24 Electric Mast elevation from 0.01 to 3.98 ft (0.003 to 1.213 m). When Remote switch is toggled toward Operator, programmed offset value is added to displayed elevation value. The blade's elevation is raised by same value. When Remote switch is toggled forward, programmed offset value is subtracted from displayed elevation value and blade's elevation is lowered by same value.
 - (3) **Auto Raise/Lower** allows Remote switch to automatically raise blade to a selectable relative distance above grade and switches system into inactive automatic operation. Toggling Remote switch in opposite direction automatically lowers blade to a selectable distance and switches system into automatic control. If system does not reach desired elevation range, it will remain in inactive auto mode and blade will have to be manually lowered and switched to automatic operation.
- d. **Beeper.** Beeper is used to alert the Operator that certain events are occurring. These functions can be turned on or off depending on Operator's preference.

Beeper On/Off. With the beeper ON, a single beep is emitted when:

- Remote switch is toggled.
 - A serial communication error is detected.
 - A sensor error is detected.
 - An out-of-range error occurs (See Section V, Blade Pro[®] Motor Grader Control System Troubleshooting Error Messages).
- (1) **Beeper I (Elevation).**
 - (a) Two short beeps are emitted when elevation device is in a fine correction for more than 2 seconds or if a medium or coarse valve correction signal is sent. This alerts the Operator that the cut is not to grade. A second pass or ripping the material may be required.
 - (b) Three short beeps are emitted if Tracer[®] Sonic Grade Controller or Laser Receiver loses its reference. For example, if a string line is used as a grade reference and Tracer[®] Sonic Grade Controller is moved off string line, then three short beeps are emitted to alert Operator.

TM 5-6675-348-13&P

- (2) **Beeper < (Cross-Slope).** Two short beeps are emitted when cross-slope-controlled side of blade remains in a fine correction for more than 2 seconds. If a medium or coarse correction signal is indicated, two short beeps are emitted with no delay. This alerts the Operator that the slope has not been cut correctly. A second pass or ripping the material may be required to cut to grade.
- e. **Slope. % Slope or Rise/Run Display.** Allows the Operator to select how cross-slope is displayed in display window. Options are percent slope (5) or rise/run (e.g., 1/4 in. per foot (6 mm per meter) is displayed as 1/4" in English; 6 mm per meter is displayed as 6 mm/m metric).
- f. **Test.** Activates all LCD segments and LED indicator lights. Visual display shows any missing LCD segments or burned-out LED indicators. The test feature also displays errors that may have occurred.

3-24. PROGRAMMING BLADE PRO[®] MOTOR GRADER CONTROL SYSTEM USER OPTIONS.

a. General Information.

NOTE

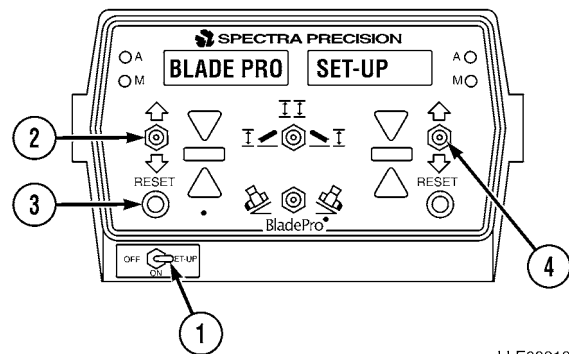
SET-UP can be exited from any point in the SET-UP menu by positioning the OFF/ON/SET-UP switch back to the ON position.

(1) Switches used in SET-UP Mode.

- (a) To enter SET-UP, position the OFF/ON/SET-UP switch (1) to SET-UP position.

NOTE

Left Increase/Decrease switch controls the menu displayed in left display window.



LLE00212

- (b) Toggle left Increase/Decrease switch (2) down to move next item in menu.
- (c) Toggle left Increase/Decrease switch (2) up to move back to last displayed item.
- (d) Use left RESET Button (3) to enter or exit selected menu displayed in left display window.
- (e) Right Increase/Decrease switch (4) changes feature from ON to OFF or value displayed in right window (for example: ON to OFF or 1.25 to 1.26).
- (f) SET-UP can be exited from any point in the SET-UP menu by positioning the OFF/ON/SET-UP switch (1) back to the ON position.

b. Reference Elevation.

Below are instructions for setting a reference elevation into the Operator Interface Box.

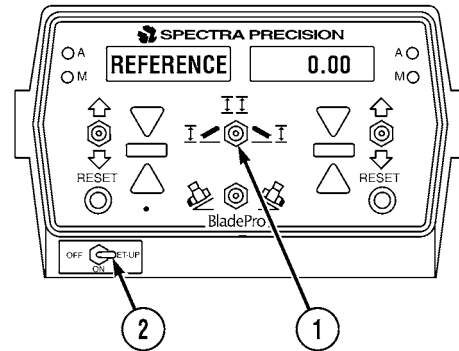
When changing reference elevation in SET-UP, new reference elevation will be displayed only on side of Operator Interface Box in relation to Mode switch (1) position.

To enter a different reference elevation into left side position, move Mode switch (1) to the left.

Left Display	Right Display
+ 0.00	< 2.0%

- (1) Position OFF/ON/SET-UP switch (2) to the right SET-UP position.

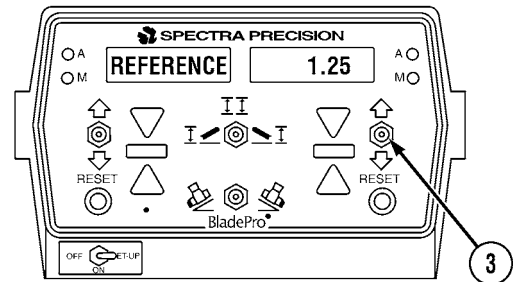
Left Display	Right Display
REFERENCE	0.00



LLE00250

- (2) Use right Increase/Decrease switch (3) to change displayed value until desired value is displayed.

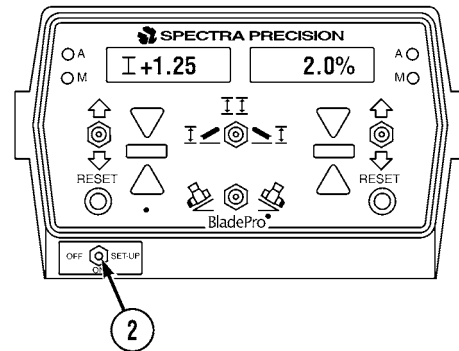
Left Display	Right Display
REFERENCE	1.25



LLE00251

- (3) If no additional changes are required, position OFF/ON/SET-UP switch (2) back to ON position.

Left Display	Right Display
I +1.25	2.0%

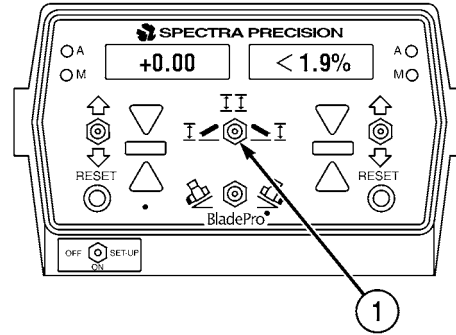


LLE00252

(4) To enter a different reference elevation into both the left and right windows:

(a) Position Mode switch (1) to left position.

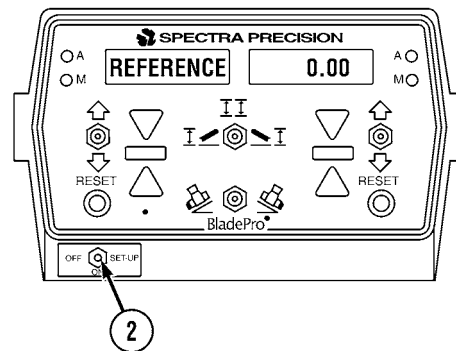
Left Display	Right Display
+ 0.00	< 1.9%



LLE00214

(b) Position OFF/ON/SET-UP switch (2) to SET-UP position.

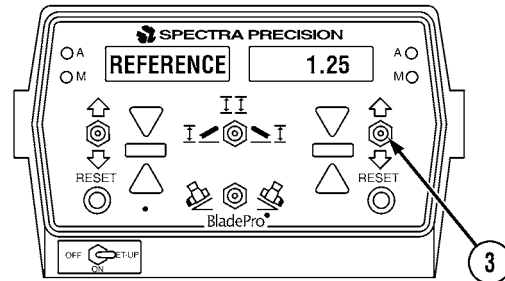
Left Display	Right Display
REFERENCE	0.00



LLE00253

(c) Use right Increase/Decrease switch (3) to change elevation value in right display window for desired reference elevation for left side of blade.

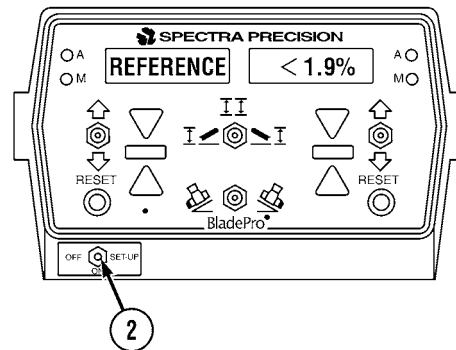
Left Display	Right Display
REFERENCE	1.25



LLE00254

(d) Position OFF/ON/SET-UP switch (2) back to ON position.

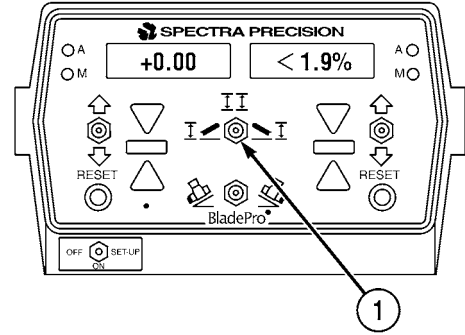
Left Display	Right Display
+ 1.25	< 1.9%



LLE00407

- (e) Position Mode switch (1) to right position.

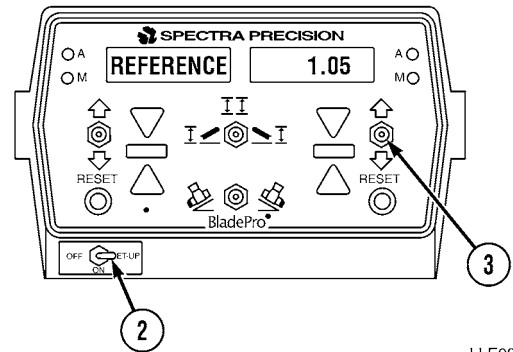
Left Display	Right Display
+ 0.00	<1.9%



LLE00214

- (f) Position OFF/ON/SET-UP switch (2) to SET-UP position.
- (g) Use right Increase/Decrease switch (3) to change value in right display window for desired reference elevation for right side of blade.

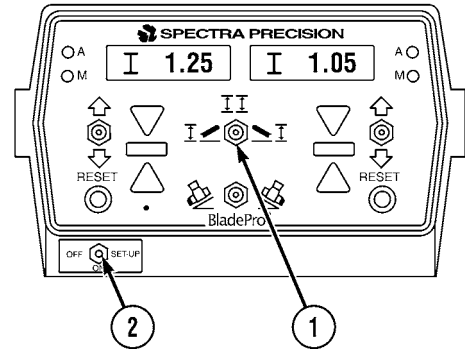
Left Display	Right Display
REFERENCE	1.05



LLE00255

- (h) Position OFF/ON/SET-UP switch (2) back to the ON position.

Left Display	Right Display
I 1.25	I 1.05



LLE00406

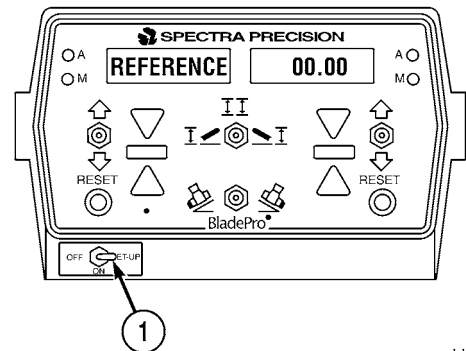
- (i) Position Mode switch (1) to center position.

c. Customize.

To enter **CUSTOMIZE**:

- (1) Position OFF/ON/SET-UP switch (1) to right SET-UP position.

Left Display	Right Display
REFERENCE	00.00

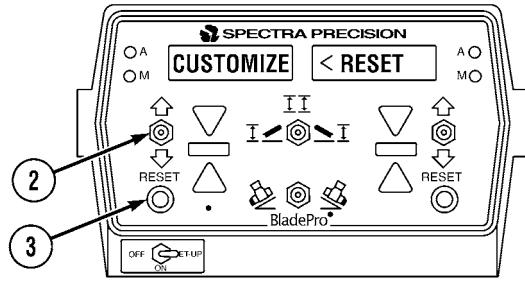


LLE00215

- (2) Toggle left Increase/Decrease switch (2) down until CUSTOMIZE appears.

Left Display	Right Display
CUSTOMIZE	< RESET

- (3) Press left RESET button (3) to enter CUSTOMIZE.



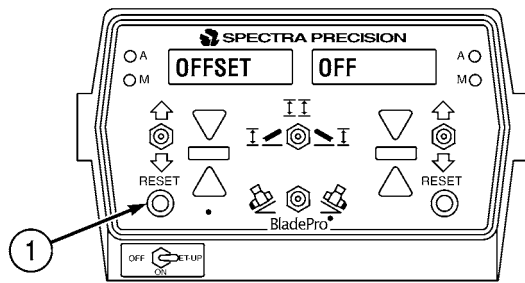
LLE00216

d. Offset.

To enter OFFSET:

- (1) Press left RESET button (1).

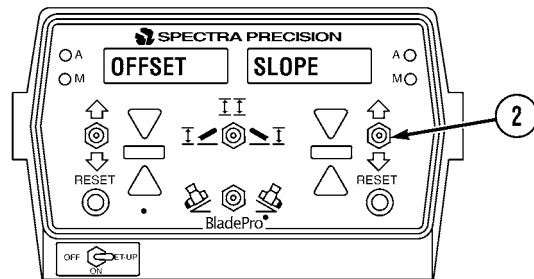
Left Display	Right Display
OFFSET	OFF



LLE00217

- (2) If an OFFSET function was previously selected, then that OFFSET function will be shown.
- (3) Press right Increase/Decrease switch (2) down until desired OFFSET function appears in right window.

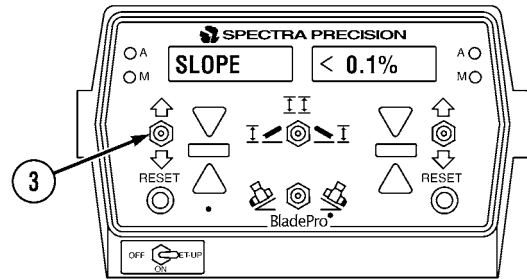
Left Display	Right Display
OFFSET	OFF
OFFSET	AUTO
OFFSET	ELEVATION
OFFSET	SLOPE



LLE00218

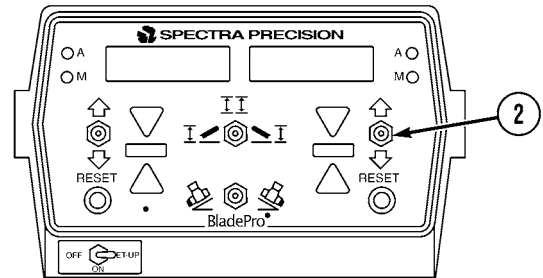
- (4) With desired OFFSET function displayed in right display window, toggle left Increase/Decrease switch (3) down.

Left Display	Right Display
OFFSET (TYPE)	OFFSET (VALUE)
Left Display	Right Display
OFFSETS	NONE
AUTO	>>>
ELEVATION	| + 0.01 (+0.005) Metric
SLOPE	< 0.1%



LLE00219

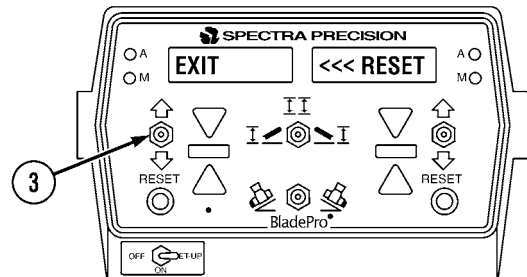
- (5) Toggle right Increase/Decrease switch (2) to select desired OFFSET VALUE. Note that for AUTO RAISE/LOWER, each > equals about 3 seconds of blade travel.



LLE00220

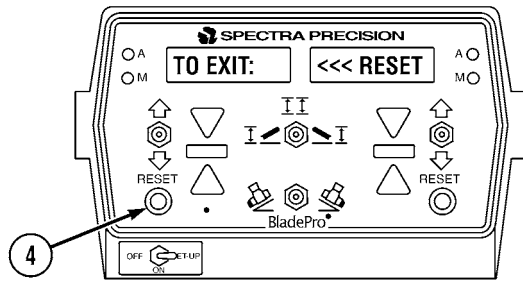
- (6) With desired OFFSET VALUE entered, toggle left Increase/Decrease switch (3) down.

Left Display	Right Display
EXIT	<<< RESET



LLE00221

- (7) Press left RESET button (4) to exit OFFSETS.



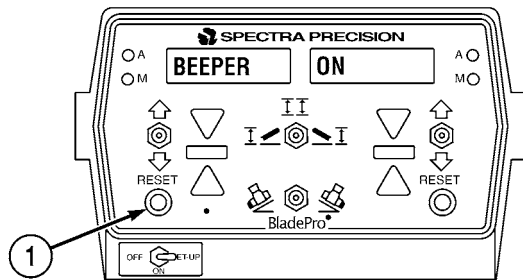
LLE00222

e. Beeper.

To enter **BEEPER**:

- (1) Press left RESET button (1).

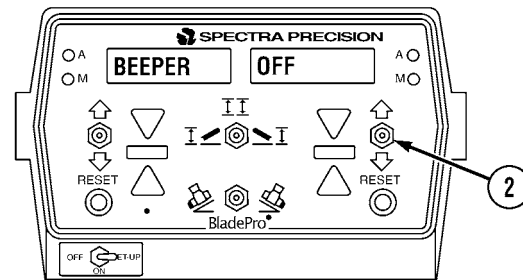
Left Display	Right Display
BEEPER	ON



LLE00223

- (2) To turn beeper OFF, toggle right Increase/Decrease switch (2).

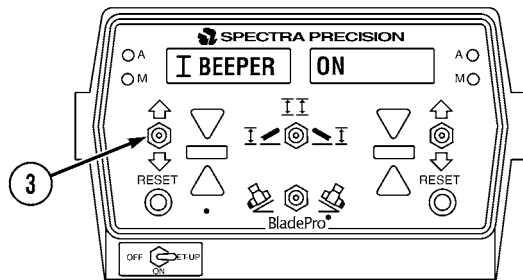
Left Display	Right Display
BEEPER	OFF



LLE00224

- (3) Toggle left Increase/Decrease switch (3) down to enter BEEPER (elevation).

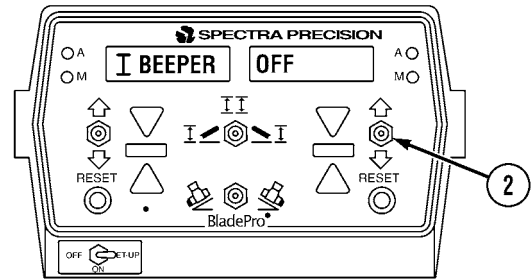
Left Display	Right Display
I BEEPER	ON



LLE00225

- (4) To turn BEEPER OFF, toggle right Increase/Decrease switch (2).

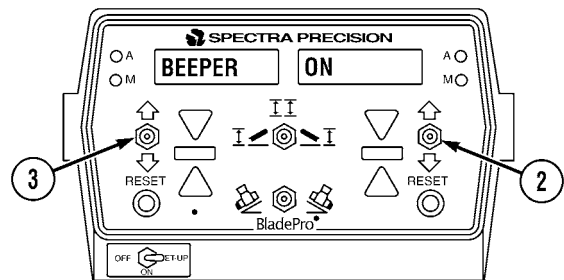
Left Display	Right Display
I BEEPER	OFF



LLE00226

- (5) Toggle left Increase/Decrease switch (3) down to enter BEEPER < (slope).

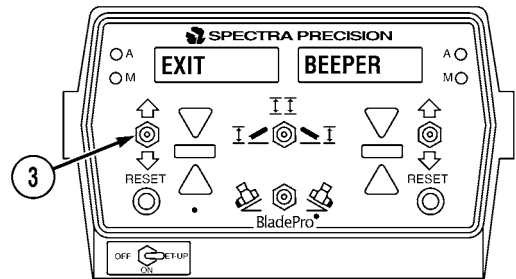
Left Display	Right Display
BEEPER	ON



LLE00227

- (6) To turn BEEPER < OFF, toggle right Increase/Decrease switch (2) down.

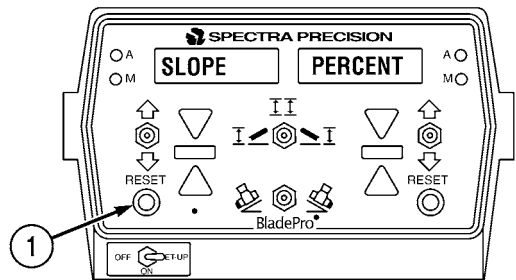
Left Display	Right Display
BEEPER	OFF



LLE00228

- (7) Toggle left Increase/Decrease switch (3) down.

Left Display	Right Display
EXIT	BEEPER



LLE00229

- (8) To exit BEEPER, press left RESET button (1).

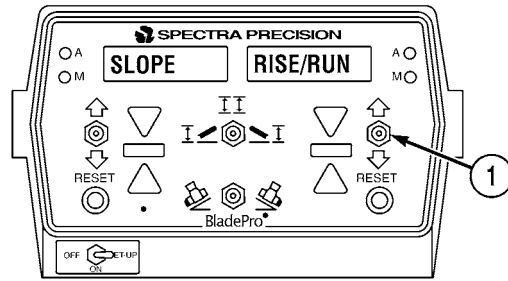
Left Display	Right Display
SLOPE	PERCENT

f. Percent Slope and Rise/Run.

To change the display from PERCENT SLOPE to RISE/RUN:

- (1) Toggle right Increase/Decrease switch (1) down.

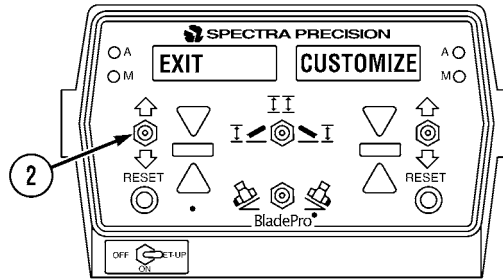
Left Display	Right Display
SLOPE	RISE/RUN



LLE00230

- (2) Toggle left Increase/Decrease switch (2) to exit PERCENT SLOPE RISE/RUN.

Left Display	Right Display
EXIT	CUSTOMIZE

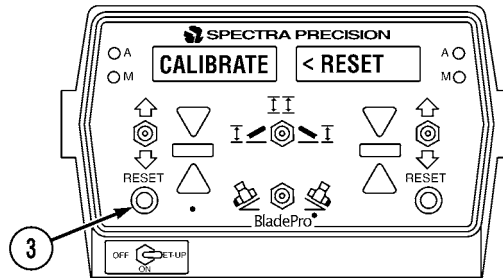


LLE00231

- (3) To exit Customize, press left RESET button (3).

Left Display	Right Display
CALIBRATE	< RESET

- (4) Calibrate Blade Pro[®] Motor Grader Control System (Para 3-15 and Para 3-16) or toggle left Increase/Decrease switch (2) down to enter Test mode.

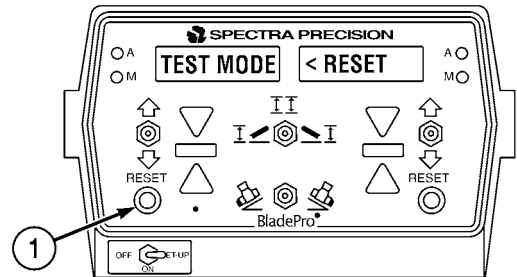


LLE00232

g. Test

- (1) Press and hold left RESET button (1) to enter self-test mode.

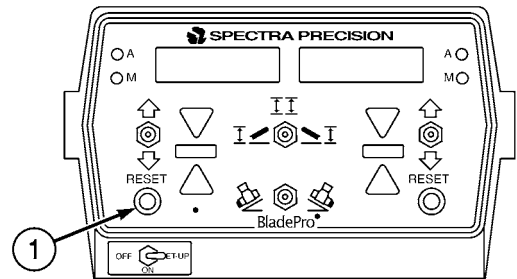
Left Display	Right Display
TEST MODE	<RESET



LLE00233

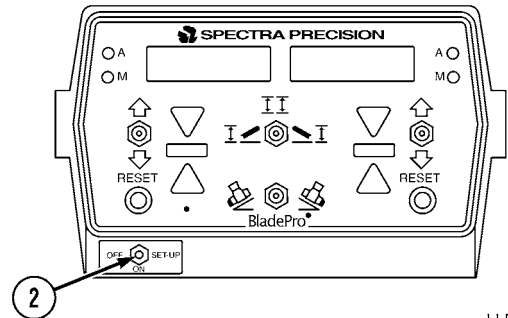
NOTE

- All LED segments will be activated. This checks for inactive segments.
- All LEDs will be illuminated. This checks for burned out LEDs.
- When RESET button is released, Operator Interface Box will show any error codes that have occurred since the last power up. Refer to Blade Pro® Motor Grader Control System Troubleshooting Error Messages in Section V.



LLE00234

- (2) Toggle the OFF/ON/SET-UP switch (2) to ON position to begin normal operation.



LLE00235

SECTION IV. BLADE PRO[®] MOTOR GRADER CONTROL SYSTEM TROUBLESHOOTING

While the Blade Pro[®] Motor Grader Control System is a highly accurate system, you may encounter problems as you work in the field. Use this section to troubleshoot your problems. You may want to have a qualified maintenance person troubleshoot and fix any problems.

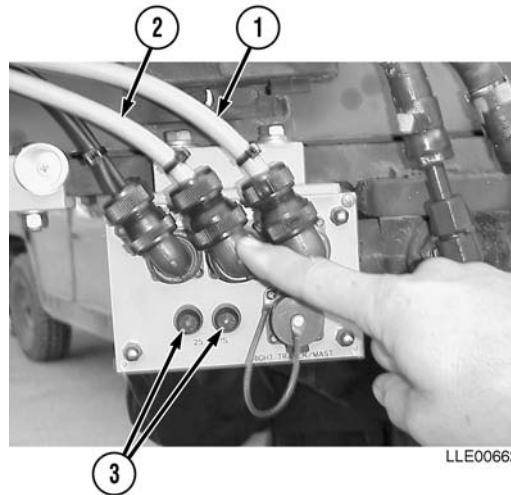
Table 3-6. Blade Pro[®] Motor Grader Control System Fault Index

Fault No.	Description	Page
3-1.	Operator Interface Box Will Not Turn On.....	3-61
3-2.	Auto and Manual LEDs Are Lit on Same Side of Control Box.....	3-62
3-3.	Right/Left Switches in Auto Position, But Automatic Control Is Not Functioning.....	3-63
3-4.	Blade Undercuts or Pulls Into a Cut.....	3-63
3-5.	Tracer [®] Sonic Grade Controller Will Not Reset	3-64
3-6.	Cross-Slope Side Does Not Cut Desired Slope	3-65
3-7.	Tracer [®] Sonic Grade Controller Keeps Losing Reference	3-66
3-8.	Hydraulic Control Valves Do Not Raise or Lower in Automatic Mode, But Blade Operates Manually	3-67
3-9.	Blade Pro [®] Motor Grader Control System Leaves Waves in the Material.....	3-69

Table 3-7. Blade Pro® Motor Grader Control System Troubleshooting

Malfunction	Test or Inspection	Corrective Action
-------------	--------------------	-------------------

FAULT 3-1. OPERATOR INTERFACE BOX WILL NOT TURN ON.



CAUTION

If connections are wet, the Remote Interface Box will be damaged.

Step 1. Check Cable (1) connector from Operator Interface Box to Remote Interface Box for tightness and/or dirt.

Remove and inspect Cable (1) to ensure connector is clean and dry. Securely reconnect Cable.

Step 2. Check Cable (1) from Operator Interface Box to Remote Interface Box for damage.

If Cable (1) is damaged, replace it.

Step 3. Check Power Cable (2) connector.

Remove and inspect Power Cable (2) to ensure connector are clean and dry. Securely reconnect Power Cable (2).

Step 4. Check Power Cable (2) for damage.

If Power Cable (2) is damaged, replace it.

CAUTION

To avoid damage to equipment, fuse must be replaced with a 25-amp fuse.

Step 5. Check for fuses (3) in Remote Interface Box.

Step 6. Inspect fuses (3) on Remote Interface Box. Ensure they have not blown and are securely in place. If fuses (3) are faulty, replace them.

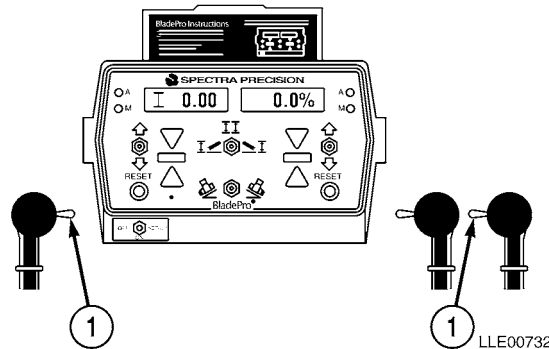
Table 3-7. Blade Pro[®] Motor Grader Control System Troubleshooting (Cont)

Malfunction	Test or Inspection	Corrective Action
FAULT 3-1. OPERATOR INTERFACE BOX WILL NOT TURN ON. (Cont)		
Step 7.	Check for a good ground on pins B and C of Power Cable (2).	If a good ground is not found, replace Power Cable (2).
Step 8.	Check for 22 to 28 Vdc on pins A and D of Power Cable (2).	If 22 to 28 Vdc is not found on pins A and B, check and service batteries, if needed (TM 5-3805-261-20).
		If batteries are serviceable, replace Power Cable (2).
FAULT 3-2. AUTO AND MANUAL LEDs ARE LIT ON SAME SIDE OF CONTROL BOX.		
Step 1.	Check Automatic and Manual LEDs light at same time when Blade Pro [®] Motor Grader Control System is turned on and you cannot grade in Automatic.	Place R/L Switches (1) in Manual position, then place them in Automatic position.

Table 3-7. Blade Pro[®] Motor Grader Control System Troubleshooting (Cont)

Malfunction	Test or Inspection	Corrective Action
-------------	--------------------	-------------------

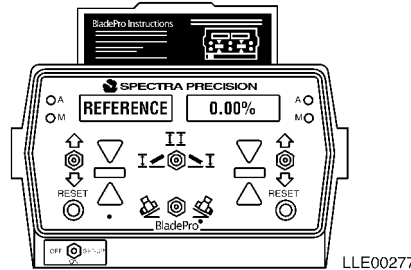
FAULT 3-3. RIGHT/LEFT SWITCHES IN AUTO POSITION, BUT AUTOMATIC CONTROL IS NOT FUNCTIONING.



Step 1. Check Automatic and Manual LEDs light at same time when Blade Pro[®] Motor Grader Control System is turned on and you cannot grade in Automatic.

Place R/L Switches (1) in Manual position, then place them in Automatic position.

FAULT 3-4. BLADE UNDERCUTS OR PULLS INTO A CUT.



Step 1. When cutting variable compacted material, check if blade undercuts material that is less compacted.

Roll blade forward to less aggressive cutting position.

If condition persists, contact Direct Support Maintenance.

Table 3-7. Blade Pro[®] Motor Grader Control System Troubleshooting (Cont)

Malfunction
Test or Inspection
Corrective Action
<p>FAULT 3-5. TRACER[®] SONIC GRADE CONTROLLER WILL NOT RESET.</p>
<p>Step 1. Ensure Tracer[®] Sonic Grade Controller (1) is within its operating range.</p> <p style="padding-left: 40px;">Adjust Tracer[®] Sonic Grade Controller (1) to within 8 to 42 in. (20.3 to 107 cm) of reference surface.</p> <p>Step 2. Ensure Tracer[®] Sonic Grade Controller (1) is directly over reference surface.</p> <p style="padding-left: 40px;">Ensure Tracer[®] Sonic Grade Controller (1) is vertical and plumb over reference surface. Adjust Tracer[®] Sonic Grade Controller (1) over reference surface.</p>
<p>CAUTION</p>
<p>If connections are wet, the Remote Interface Box will be damaged.</p>
<p>Step 3. Check Tracer[®] Sonic Grade Controller (1) cable connectors for looseness and/or moisture.</p> <p style="padding-left: 40px;">Ensure all connectors are clean and dry. Securely reconnect Tracer[®] Sonic Grade Controller (1) cable.</p> <p>Step 4. Check Coil Cable (3) between Tracer[®] Sonic Grade Controller (1) and Remote Interface Box for damage.</p> <p style="padding-left: 40px;">If Coil Cable (3) is damaged, replace it.</p> <p>Step 5. Check Transducer screen (2) on bottom of Tracer[®] Sonic Grade Controller (1) for dirt.</p> <p style="padding-left: 40px;">Clean Transducer screen (2).</p>

Table 3-7. Blade Pro[®] Motor Grader Control System Troubleshooting (Cont)

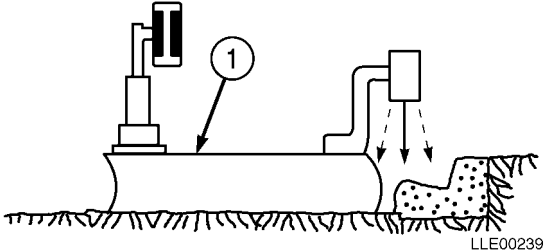
Malfunction	Test or Inspection	Corrective Action
FAULT 3-6. CROSS-SLOPE SIDE DOES NOT CUT DESIRED SLOPE.		
 <p style="text-align: right; font-size: small;">LLE00239</p>		
Step 1.	The 130G Grader (1) may not be able to cut material at the depth you are trying to cut.	Try making several passes to remove material.
Step 2.	The 130G Grader (1) may need to be calibrated.	Perform full calibration (Para 3-15 and Para 3-16).
NOTE		
Excessive 130G Grader mechanical wear can give the Blade Pro [®] Motor Grader Control System false sensor readings.		
Step 3.	Check 130G Grader (1) for excessive mechanical wear.	Inspect 130G Grader (1) for wear (Section VII).

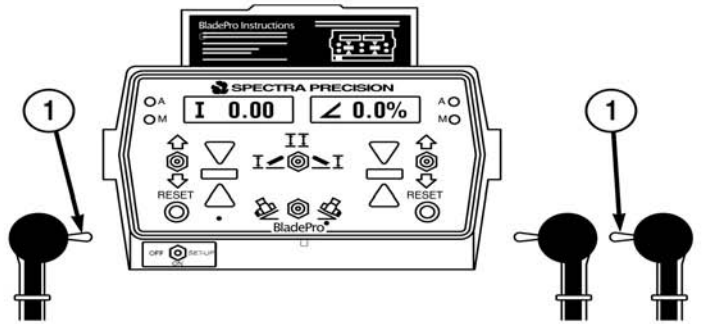
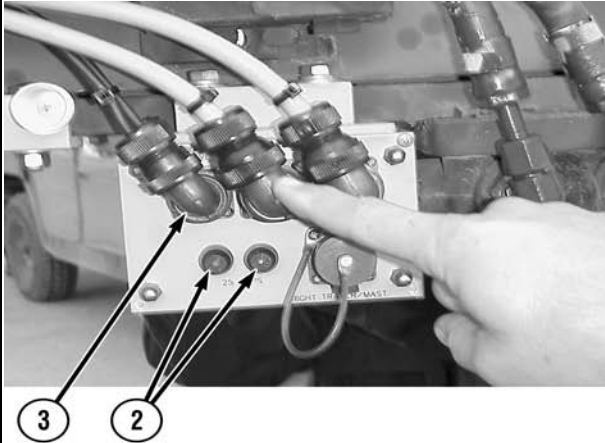
Table 3-7. Blade Pro[®] Motor Grader Control System Troubleshooting (Cont)

Malfunction
Test or Inspection
Corrective Action
<p>FAULT 3-7. TRACER[®] SONIC GRADE CONTROLLER KEEPS LOSING REFERENCE.</p>
<p>Step 1. Ensure Tracer[®] Sonic Grade Controller (1) is within its operating range.</p> <p style="padding-left: 40px;">Adjust Tracer[®] Sonic Grade Controller (1) to within 8 to 42 in. (20 to 107 cm) of reference surface (2).</p> <p>Step 2. Ensure Tracer[®] Sonic Grade Controller (1) is directly over reference surface (2).</p> <p style="padding-left: 40px;">Ensure Tracer[®] Sonic Grade Controller (1) is vertical and plumb over reference surface (2). Adjust Tracer[®] Sonic Grade Controller (1) over reference surface.</p> <p>Step 3. Tracer[®] Sonic Grade Controller (1) is not following string line closely enough.</p> <p style="padding-left: 40px;">Line up Tracer[®] Sonic Grade Controller (1) over reference surface (2).</p> <p style="padding-left: 40px;">If using a string line, tie a brightly colored ribbon onto Tracer[®] Sonic Grade Controller Pole (3), marking your line of sight where pole intersects string line.</p> <p>Step 4. Tracer[®] Sonic Grade Controller (1) is tracing something other than what you thought.</p> <p style="padding-left: 40px;">Carefully align Tracer[®] Sonic Grade Controller (1), then place a pencil between reference and ground. If the Tracer[®] Sonic Grade Controller (1) gives you a correction signal, you are not picking up the correct reference.</p>

Table 3-7. Blade Pro[®] Motor Grader Control System Troubleshooting (Cont)

Malfunction	Test or Inspection	Corrective Action
-------------	--------------------	-------------------

FAULT 3-8. HYDRAULIC CONTROL VALVES DO NOT RAISE OR LOWER IN AUTOMATIC MODE, BUT BLADE OPERATES MANUALLY.



LLE00240

Step 1. Check R/L Switches (1) for proper operation.

Put R/L Switches (1) in Auto position. If green automatic LED does not light, replace R/L Switches (1).

CAUTION

If connectors are wet, the Remote Interface Box will be damaged.

Step 2. Remove Hydraulic Valve Cable connector (3) to ensure it is clean, dry, and free from damage.

If Hydraulic Valve Cable connector (3) is damaged or broken, replace connectors.

Table 3-7. Blade Pro® Motor Grader Control System Troubleshooting (Cont)

Malfunction	Test or Inspection	Corrective Action
<p>FAULT 3-8. HYDRAULIC CONTROL VALVES DO NOT RAISE OR LOWER IN AUTOMATIC MODE, BUT BLADE OPERATES MANUALLY. (Cont)</p>		
<p>CAUTION</p>		
<p>To avoid damage to equipment, fuse must be replaced with a 25-amp fuse.</p>		
Step 3.	Check fuse (2) in Remote Interface Box.	If fuse (2) is faulty, replace.
<p>WARNING</p>		
<p>Do not start or move Blade Pro® Motor Grader Control System while anyone is under the 130G Grader. Failure to comply could result in severe injury or death to personnel</p>		
Step 4.	With 130G Grader running and while clear of moving parts of 130G Grader, press rubber-covered buttons (4) on ends of Valve Spools (5) to ensure Valve Spools (5) are not frozen. Blade should move up and down when each rubber-covered button (4) is pressed.	If Valve Spools are frozen, replace Proportional Valve Assembly (Para 3-35).

Table 3-7. Blade Pro[®] Motor Grader Control System Troubleshooting (Cont)

Malfunction	Test or Inspection	Corrective Action
FAULT 3-9. BLADE PRO[®] MOTOR GRADER CONTROL SYSTEM LEAVES WAVES IN THE MATERIAL.		
Step 1.	Ensure 130G Grader's hydraulic fluid has reached operating temperature.	
Step 2.	Ensure Hydraulic Valves are calibrated properly.	
	Perform Hydraulic Valve calibration (Para 3-16).	
Step 3.	If error is not corrected, contact Trimble Navigation.	

SECTION V. BLADE PRO[®] MOTOR GRADER CONTROL SYSTEM TROUBLESHOOTING ERROR MESSAGES

While the Blade Pro[®] Motor Grader Control System is a highly accurate system, you may see error messages displayed as you work in the field. Use this section to troubleshoot your error messages. You may find you can fix your problem on your own, or call Trimble Navigation.

3-25. TEST/ERROR LOG FEATURE.

Test/Error Log feature activates all LCD and LED lights, so you can see any burned out LCD or LED lights. It also records any errors that may have occurred and gives you a total. This error log will go away when you turn the control box off, so if the Blade Pro[®] Motor Grader Control System has been giving you errors, do not turn Operator Interface Box off until you have resolved the problem or contacted Direct Support Maintenance.

To run Test/Error Log feature:

- (1) Position OFF/ON/SET-UP switch to SET-UP position. Reference and reference number appear in display windows.
- (2) Press left switch down until Test Mode < RESET appears in display windows.
- (3) Press left RESET button. Blade Pro[®] Motor Grader Control System runs self-test. Make note of any lights that have burned out, any error numbers, and total number of error messages.
- (4) Turn OFF/ON/SET-UP switch to ON position.

NOTE

Record Error log number. This will be needed by Direct Support maintenance to troubleshoot your system.

Table 3-8. Error Messages

ERROR MESSAGE	WHAT TO DO ABOUT IT
ART. FAULT	Check articulation sensor to ensure it is firmly in place. Ensure cable is firmly connected and is not cut or broken.
ART. OFF	Call Trimble Navigation.
ART.>>RANGE	130G Grader has been articulated too far. Call your Trimble Navigation.
BLADE FAULT	Check Cross-Slope Sensor to ensure it is firmly in place. Ensure cable is firmly connected and is not cut or broken.
BLADE OFF	Call Blade Pro [®] Motor Grader Control System Authorized Service Center.
BLADE>>RANGE	Check Cross-Slope Sensor to ensure it is firmly in place. Ensure cable is firmly connected and is not cut or broken.
ELEVATION FAULT	Call Trimble Navigation.
ELEVATION >> RANGE	Your Tracer [®] Sonic Grade Controller is too close or far from the reference. Adjust distance, then press RESET button for side Tracer [®] Sonic Grade Controller is on.
HARDWARE FAULT	Call Trimble Navigation.
MAINFALL OFF	Call Trimble Navigation.
MAINFALL FAULT	Check Mainfall Slope Sensor to ensure it is firmly in place. Ensure cable is firmly connected and is not cut.
MAINFALL >> RANGE	130G Grader is on a slope that is too steep for Mainfall Slope Sensor to measure. Move grader to less steep area, then re-evaluate.
ROTATION FAULT	Check Circle Rotation Sensor to ensure it is firmly in place. Ensure cable is firmly connected and is not cut.
ROTATION OFF	Call Trimble Navigation.
ROTATION >> RANGE	Blade has been rotated too far. Carefully rotate blade back to within the 0 to 96° range. If blade has not been rotated too far, your Circle Rotation Sensor may be loose. Ensure Circle Rotation Sensor is firmly attached.
SERIAL ERROR	Call Trimble Navigation.
SYSTEM FAULT	Call Trimble Navigation.
VALVE ERROR	Call Trimble Navigation.
VALVE FAULT	Call Trimble Navigation.
VALVE OFF	Call Trimble Navigation.

SECTION VI. BLADE PRO[®] MOTOR GRADER CONTROL SYSTEM ERROR LOG

3-26. MG2P-35 ERROR LOG.

Table 3-9. Error Log

Level 1 Errors	Display Messages
Blade slope signal detected with sensor OFF.	BLADE OFF
Mainfall signal detected with sensor OFF.	MAINFALL OFF
Rotation angle signal detected with sensor OFF.	ROTATION OFF
Articulation angle signal detected with sensor OFF.	ART. OFF
Level 2 Errors	Display Messages
Valve type not selected.	VALVE OFF
Blade slope signal frequency too low with sensor ON.	BLADE FAULT
Blade slope signal frequency too high with sensor ON.	BLADE FAULT
Blade slope signal value too low with sensor ON.	BLADE» RANGE
Blade slope signal value too high with sensor ON.	BLADE» RANGE
Mainfall signal frequency too low with sensor ON.	MAINFALL FAULT
Mainfall signal frequency too high with sensor ON.	MAINFALL FAULT
Mainfall signal value too low with sensor ON.	MAINFALL» RANGE
Mainfall signal value too high with sensor ON.	MAINFALL» RANGE
Rotation angle signal frequency too low with sensor ON.	ROTATION FAULT
Rotation angle signal frequency too high with sensor ON.	ROTATION FAULT
Rotation angle signal value too low with sensor ON.	ROTATION» RANGE
Rotation angle signal value too high with sensor ON.	ROTATION» RANGE
Articulation angle signal frequency too low with sensor ON.	ART. FAULT
Articulation angle signal frequency too high with sensor ON.	ART. FAULT
Articulation angle signal value too low with sensor ON.	ART.» RANGE
Articulation angle signal value too high with sensor ON.	ART.» RANGE
Level 3 Errors	Display Messages
Operator Interface Box serial transmission check sum fault detected.	SERIAL ERROR
Operator Interface Box serial transmission bad ID number detected.	SERIAL ERROR
Operator Interface Box serial transmission incomplete packet detected.	SERIAL ERROR
Operator Interface Box serial transmission framing fault detected.	SERIAL ERROR
Operator Interface Box serial transmission noise detected.	SERIAL ERROR
Operator Interface Box serial transmission overrun detected.	SERIAL ERROR

Table 3-9. Error Log (Cont)

Level 4 Errors	Display Messages
Left fine lower valve voltage incorrect.	VALVE ERROR
Left medium lower valve voltage incorrect.	VALVE ERROR
Left coarse lower valve voltage incorrect.	VALVE ERROR
Left fine raise valve voltage incorrect.	VALVE ERROR
Left medium raise valve voltage incorrect.	VALVE ERROR
Left coarse raise valve voltage incorrect.	VALVE ERROR
Load sense valve voltage incorrect.	VALVE ERROR
Right fine lower valve voltage incorrect.	VALVE ERROR
Right medium lower valve voltage incorrect.	VALVE ERROR
Right coarse lower valve voltage incorrect.	VALVE ERROR
Right fine raise valve voltage incorrect.	VALVE ERROR
Right medium raise valve voltage incorrect.	VALVE ERROR
Right coarse raise valve voltage incorrect.	VALVE ERROR
Unloading valve voltage incorrect.	VALVE ERROR
Left valve driver overload detected.	VALVE FAULT
Right valve driver overload detected.	VALVE FAULT
Left EM2E-24 Electric Mast motor driver overload detected.	ELEVATION FAULT
Right EM2E-24 Electric Mast motor driver overload detected.	ELEVATION FAULT
Power supply overload detected.	SYSTEM FAULT
Level 5 Errors	Display Messages
Left elevation length increase too slow or stopped.	ELEVATION >> RANGE
Left elevation length decrease too slow or stopped.	ELEVATION >> RANGE
CPU reset during left elevation length change.	ELEVATION FAULT
Right elevation length increase too slow or stopped.	ELEVATION>> RANGE
Right elevation length decrease too slow or stopped.	ELEVATION>> RANGE
CPU reset during right elevation length change.	ELEVATION FAULT
Left driver board type incorrect.	HARDWARE FAULT
Right driver board type incorrect.	HARDWARE FAULT
Left driver board mode incorrect.	HARDWARE FAULT
Right driver board mode incorrect.	HARDWARE FAULT
Remote Interface Box RAM fault detected.	HARDWARE FAULT
Remote Interface Box ROM fault detected.	HARDWARE FAULT
Remote Interface Box EEPROM fault detected.	HARDWARE FAULT

Table 3-10. Error-to-Source Relationships

Level 1 Errors	Abbreviation	Error #
Blade slope signal detected with sensor OFF. User turned OFF Blade Slope Sensor but did not disconnect it. Remote Interface Box CPU board.	Blade On	1
Mainfall signal detected with sensor OFF. User turned OFF Mainfall Slope Sensor but did not disconnect it. Remote Interface Box CPU board.	Mainfall On	2
Rotation angle signal detected with sensor OFF. User turned OFF rotation Angle Sensor but did not disconnect it. Remote Interface Box CPU board.	Rotation On	3
Articulation angle signal detected with sensor OFF. User turned OFF articulation Angle Sensor but did not disconnect it. Remote Interface Box CPU board.	Articulation On	4
Level 2 Errors	Abbreviation	Error #
Valve type not selected. User did not yet select a valve type. Remote Interface Box CPU board.	No Valve Selected	5
Blade slope signal frequency too low or stopped with sensor ON. Blade Slope Sensor or cable. Remote Interface Box CPU board. Remote Interface Box motherboard.	Blade Slow	6
Blade slope signal frequency too high with sensor ON. Blade Slope Sensor or cable. Remote Interface Box CPU board. Remote Interface Box motherboard.	Blade Fast	7
Blade slope signal value too low with sensor ON. Blade Slope Sensor or cable. Remote Interface Box CPU board. Remote Interface Box motherboard.	Blade Low	8
Blade slope signal value too high with sensor ON. Blade Slope Sensor or cable. Remote Interface Box CPU board. Remote Interface Box motherboard.	Blade High	9
Mainfall signal frequency too low or stopped with sensor ON. Mainfall Slope Sensor or cable. Remote Interface Box CPU board. Remote Interface Box motherboard.	Mainfall Slow	10

Table 3-10. Error-to-Source Relationships (Cont)

Level 2 Errors (Cont)	Abbreviation	Error #
Mainfall signal frequency too high with sensor ON. Mainfall Slope Sensor or cable. Remote Interface Box CPU board. Remote Interface Box motherboard.	Mainfall Fast	11
Mainfall signal value too low with sensor ON. Mainfall Slope Sensor or cable. Remote Interface Box CPU board. Remote Interface Box motherboard.	Mainfall Low	12
Mainfall signal value too high with sensor ON. Mainfall Slope Sensor or cable. Remote Interface Box CPU board. Remote Interface Box motherboard.	Mainfall High	13
Rotation angle signal frequency too low or stopped with sensor ON. Rotation Angle Sensor or cable. Remote Interface Box CPU board. Remote Interface Box motherboard.	Rotation Slow	14
Rotation angle signal frequency too high with sensor ON. Rotation Angle Sensor or cable. Remote Interface Box CPU board. Remote Interface Box motherboard.	Rotation Fast	15
Rotation angle signal value too low with sensor ON. Rotation Angle Sensor or cable. Remote Interface Box CPU board. Remote Interface Box motherboard.	Rotation Low	16
Rotation angle signal value too high with sensor ON. Rotation Angle Sensor or cable. Remote Interface Box CPU board. Remote Interface Box motherboard.	Rotation High	17
Articulation angle signal frequency too low or stopped with sensor ON. Articulation Angle Sensor or cable. Remote Interface Box CPU board. Remote Interface Box motherboard.	Articulation Slow	18
Articulation angle signal frequency too high with sensor ON. Articulation Angle Sensor or cable. Remote Interface Box CPU board. Remote Interface Box motherboard.	Articulation Fast	19
Articulation angle signal value too low with sensor ON. Articulation Angle Sensor or cable. Remote Interface Box CPU board. Remote Interface Box motherboard.	Articulation Low	20

Table 3-10. Error-to-Source Relationships (Cont)

Level 3 Errors	Abbreviation	Error #
Articulation angle signal value too high with sensor ON. Articulation Angle Sensor or cable. Remote Interface Box CPU board. Remote Interface Box motherboard.	Articulation High	21
Operator Interface Box serial transmission check sum fault detected. Operator Interface Box. Operator Interface Box cable. Remote Interface Box CPU board. Remote Interface Box motherboard.	Serial Check Sum	22
Operator Interface Box serial transmission ID number out of range detected. Operator Interface Box. Operator Interface Box cable. Remote Interface Box CPU board. Remote Interface Box motherboard.	Serial ID	23
Operator Interface Box serial transmission incomplete packet detected. Operator Interface Box. Operator Interface Box cable. Remote Interface Box CPU board. Remote Interface Box motherboard.	Serial Packet	24
Operator Interface Box serial transmission framing fault detected. Operator Interface Box. Operator Interface Box cable. Remote Interface Box CPU board. Remote Interface Box motherboard.	Serial Frame	25
Operator Interface Box serial transmission noise detected. Operator Interface Box. Operator Interface Box cable. Remote Interface Box CPU board. Remote Interface Box motherboard.	Serial Noise	26
Operator Interface Box serial transmission overrun detected. Remote Interface Box CPU board.	Serial Overrun	27
Level 4 Errors	Abbreviation	Error #
Left fine lower valve voltage incorrect. Remote Interface Box CPU board. Remote Interface Box motherboard. Remote Interface Box left driver board. Left fine lower valve or cable.	Left Lower Fine	28
Left medium lower valve voltage incorrect. Remote Interface Box CPU board. Remote Interface Box motherboard. Remote Interface Box left driver board. Left medium lower valve or cable.	Left Lower Medium	29

Table 3-10. Error-to-Source Relationships (Cont)

Level 4 Errors (Cont)	Abbreviation	Error #
Left coarse lower valve voltage incorrect. Remote Interface Box CPU board. Remote Interface Box motherboard. Remote Interface Box left driver board. Left coarse lower valve or cable.	Left Lower Coarse	30
Left fine raise valve voltage incorrect. Remote Interface Box CPU board. Remote Interface Box motherboard. Remote Interface Box left driver board. Left fine raise valve or cable.	Left Raise Fine	31
Left medium raise valve voltage incorrect. Remote Interface Box CPU board. Remote Interface Box motherboard. Remote Interface Box left driver board. Left medium raise valve or cable.	Left Raise Medium	32
Left coarse raise valve voltage incorrect. Remote Interface Box CPU board. Remote Interface Box motherboard. Remote Interface Box left driver board. Left coarse raise valve or cable.	Left Raise Coarse	33
Load sense valve voltage incorrect. Remote Interface Box CPU board. Remote Interface Box motherboard. Remote Interface Box left driver board. Load sense valve or cable.	Load Sense Valve	34
Right fine lower valve voltage incorrect. Remote Interface Box right driver board fuse. Remote Interface Box CPU board. Remote Interface Box motherboard. Remote Interface Box right driver board. Right fine lower valve or cable.	Right Lower Fine	35
Right medium lower valve voltage incorrect. Remote Interface Box right driver board fuse. Remote Interface Box CPU board. Remote Interface Box motherboard. Remote Interface Box right driver board. Right medium lower valve or cable.	Right Lower Medium	36
Right coarse lower valve voltage incorrect. Remote Interface Box right driver board fuse. Remote Interface Box CPU board. Remote Interface Box motherboard. Remote Interface Box right driver board. Right coarse lower valve or cable.	Right Lower Coarse	37

Table 3-10. Error-to-Source Relationships (Cont)

Level 4 Errors (Cont)	Abbreviation	Error #
Right fine raise valve voltage incorrect. Remote Interface Box right driver board fuse. Remote Interface Box CPU board. Remote Interface Box motherboard. Remote Interface Box right driver board. Right fine raise valve or cable.	Right Raise Fine	38
Right medium raise valve voltage incorrect. Remote Interface Box right driver board fuse. Remote Interface Box CPU board. Remote Interface Box motherboard. Remote Interface Box right driver board. Right medium raise valve or cable.	Right Raise Medium	39
Right coarse raise valve voltage incorrect. Remote Interface Box right driver board fuse. Remote Interface Box CPU board. Remote Interface Box motherboard. Remote Interface Box right driver board. Right coarse raise valve or cable.	Right Raise Coarse	40
Unloading valve voltage incorrect. Remote Interface Box right driver board fuse. Remote Interface Box CPU board. Remote Interface Box motherboard. Remote Interface Box right driver board. Unloading valve or cable.	Unloading Valve	41
Left valve driver overload detected. Remote Interface Box CPU board. Remote Interface Box left driver board. Remote Interface Box motherboard. Left fine raise valve or cable. Left medium raise valve or cable. Left coarse raise valve or cable. Load sense valve or cable.	Left Valve Overload	42
Right valve driver overload detected. Remote Interface Box CPU board. Remote Interface Box right driver board. Remote Interface Box right driver board fuse. Remote Interface Box motherboard. Right fine raise valve or cable. Right medium raise valve or cable. Right coarse raise valve or cable. Unloading valve or cable.	Right Valve Overload	43

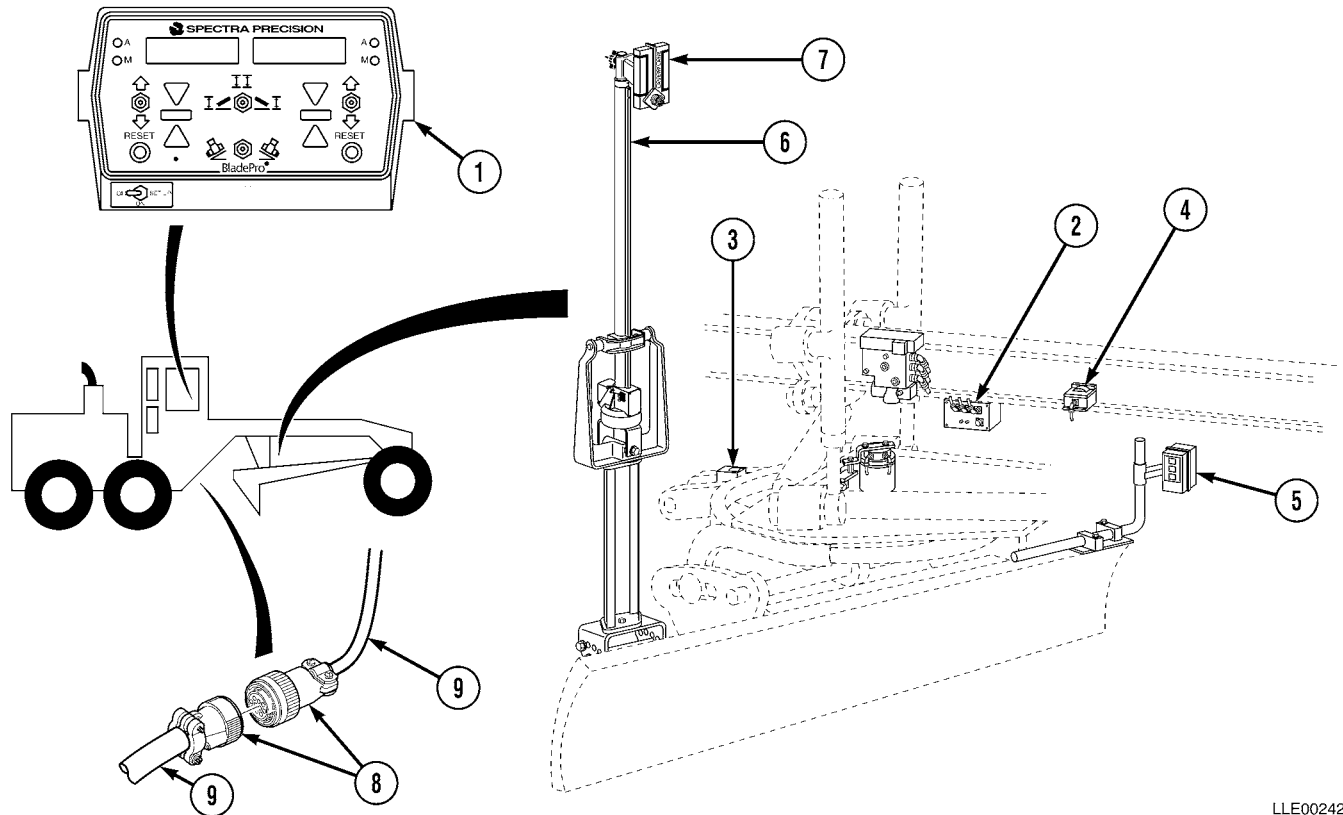
Table 3-10. Error-to-Source Relationships (Cont)

Level 4 Errors (Cont)	Abbreviation	Error #
Left EM2E-24 Electric Mast motor driver overload detected. Remote Interface Box CPU board. Remote Interface Box left driver board. Remote Interface Box motherboard. Left elevation sensor or cable.	Left EM2E-24 Electric Mast Overload	44
Right EM2E-24 Electric Mast motor driver overload detected. Remote Interface Box CPU board. Remote Interface Box right driver board. Remote Interface Box right driver board fuse. Remote Interface Box motherboard. Right elevation sensor or cable.	Right EM2E-24 Electric Mast Overload	45
Power supply overload detected. Operator Interface Box. Operator Interface Box cable. Remote Interface Box CPU board. Remote Interface Box motherboard. Blade Slope Sensor or cable. Mainfall Slope Sensor or cable. Rotation Angle Sensor or cable. Articulation Angle Sensor or cable. Left elevation sensor or cable. Right elevation sensor or cable.	Power Overload	46
Level 5 Errors	Abbreviation	Error #
Left elevation length increase too slow or stopped. Left elevation upper length limit reached. Left elevation sensor or cable. Remote Interface Box CPU board. Remote Interface Box motherboard.	Left Elevation Ceiling	47
Left elevation length decrease too slow or stopped. Left elevation lower length limit reached. Left elevation sensor or cable. Remote Interface Box CPU board. Remote Interface Box motherboard.	Left Elevation Floor	48
CPU reset during left elevation length change. User turned off system before left elevation sensor stopped. Left elevation sensor or cable. Remote Interface Box CPU board. Remote Interface Box motherboard.	Left Elevation Miscount	49

Table 3-10. Error-to-Source Relationships (Cont)

Level 5 Errors (Cont)	Abbreviation	Error #
Right elevation length increase too slow or stopped. Right elevation upper length limit reached. Right elevation sensor or cable. Remote Interface Box right driver board fuse. Remote Interface Box CPU board. Remote Interface Box motherboard.	Right Elevation Ceiling	50
Right elevation length decrease too slow or stopped. Right elevation lower length limit reached. Right elevation sensor or cable. Remote Interface Box right driver board fuse. Remote Interface Box CPU board. Remote Interface Box motherboard.	Right Elevation Floor	51
CPU reset during right elevation length change. User turned off system before right elevation sensor stopped. Right elevation sensor or cable. Remote Interface Box CPU board. Remote Interface Box motherboard.	Right Elevation Miscount	52
Remote Interface Box left driver board type incorrect. Remote Interface Box left driver board. Remote Interface Box CPU board.	Wrong Left Board	53
Remote Interface Box right driver board type incorrect. Remote Interface Box right driver board. Remote Interface Box CPU board.	Wrong Right Board	54
Remote Interface Box left driver board mode incorrect. Remote Interface Box left driver board. Remote Interface Box CPU board.	Wrong Left Driver	55
Remote Interface Box right driver board mode incorrect. Remote Interface Box right driver board. Remote Interface Box CPU board.	Wrong Right Driver	56
Remote Interface Box CPU RAM fault detected. Remote Interface Box CPU board.	RAM Fault	57
Remote Interface Box CPU ROM fault detected. Remote Interface Box CPU board.	ROM Fault	58
Remote Interface Box CPU EEPROM fault detected. Remote Interface Box CPU board.	EEPROM Fault	59

3-27. CONFIGURE FOR TRANSPORT.



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a. Before Transport.



Blade Pro[®] Motor Grader Control System components are not designed to be air dropped. Failure to comply may result in damage to equipment.

When transporting your 130G Grader(s) with Blade Pro[®] Motor Grader Control System by ship, train, air, or truck, perform the following procedure:

NOTE

Perform Step (1) if you have an Airborne or Air Mobile grader.

- (1) Disconnect the Main Power Cable (9) before sectionalizing your 130G Grader for transportation.
- (2) Remove all components listed below, except Circle Rotation Sensor, and store in their carrying cases during shipment and transportation:

- | | |
|---------------------------|---|
| 1. Operator Interface Box | 5. Tracer [®] Sonic Grade Controller |
| 2. Remote Interface Box | 6. EM2E-24 Electric Mast |
| 3. Blade Slope Sensor | 7. R2S-S Laser Receiver |
| 4. Mainfall Slope Sensor | |

b. After Transport.

- (1) Install all components removed and do a complete calibration of components (1) through (4), (Para 3-15 and Para 3-16).

SECTION VII. BLADE PRO[®] MOTOR GRADER CONTROL SYSTEM MAINTENANCE

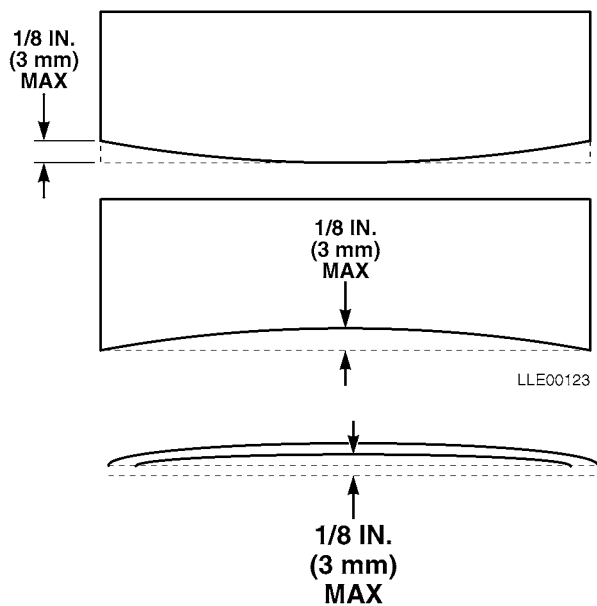
NOTE

The following section deals with critical wear and maintenance areas of your 130G Grader and Blade Pro[®] Motor Grader Control System.

Consistent accuracy of your Blade Pro[®] Motor Grader Control System is largely dependent on the 130G Grader's condition. 130G Grader wear varies with job conditions, Operator skills, and materials. The 130G Grader wear points should be inspected on a regular basis.

3-28. BLADE CUTTING EDGE INSPECTION.

- a. **Blade Wear Inspection.** Uneven blade wear occurs mainly in three locations: on the cutting edge, arcing from edges to center creating an upward bow, and from center wearing to either end. Blade wear can be checked by placing the cutting edge on or slightly above a flat surface, such as concrete or pavement, and comparing cutting edge to that surface. Maximum deviation from even wear should be less than 1/8 in. (3 mm) if accuracy within 1/100 ft (0.003 m) is desired (TM 5-3805-261-10).
- b. **Blade Curvature Inspection.** Curvature is a bowing effect from edges to center, arcing toward the rear of the machine. Check blade curvature by placing a straightedge or string across the corners of the blade and measuring maximum deviation at center, 1/8 in. (3 mm) maximum (TM 5-3805-261-10).

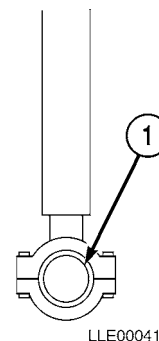


TOP VIEW

3-29. BLADE LIFT CYLINDER SOCKETS INSPECTION.

Check socket (1) wear by lowering moldboard to hard surface until ball seats firmly in upper half of socket. Raise moldboard and measure distance until ball seats in lower half of socket.

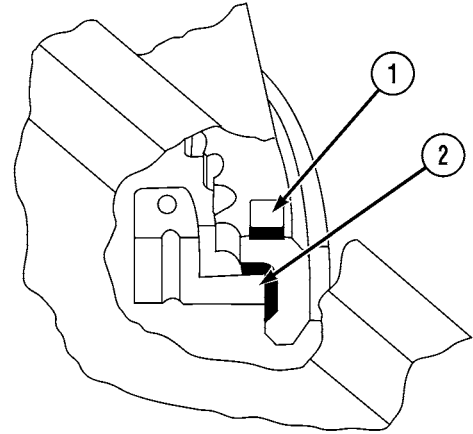
Maximum measured clearance should be less than 0.040 in. (0.10 cm). Shim replacement or removal may be necessary (TM 5-3805-261-20).



3-30. WEAR STRIPS (CIRCLE TOP) INSPECTION.

Wear strips between circle top surface (1) and drawbar can be checked in a similar manner as that of checking cylinder sockets. Lower moldboard to hard surface until blade is loaded with downward pressure.

- (1) Measure distance between circle top (2) and drawbar. Raise moldboard off ground and measure distance again. Difference between two measurements should be no more than 0.02 in. (0.05 cm).

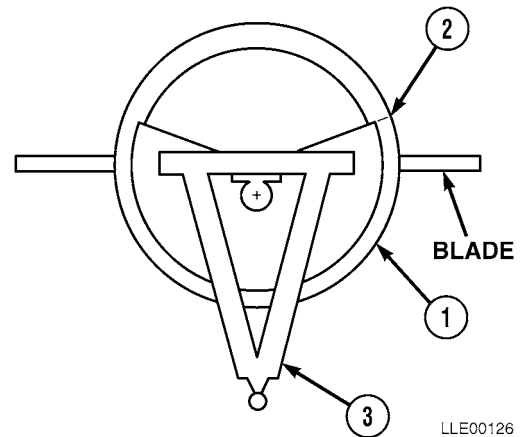


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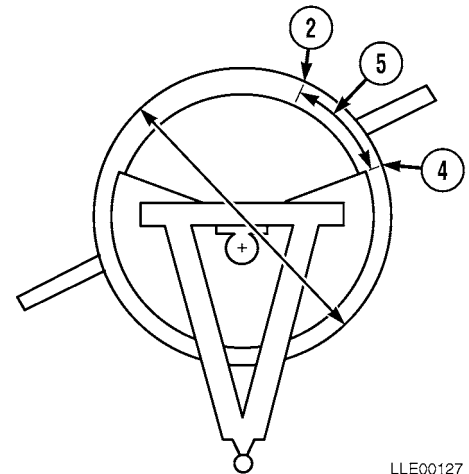
3-31. HOSE TRAY BACKLASH ADJUSTMENT.

a. Measure.

- (1) Rotate circle (1) clockwise 10 degrees and mark first mark (2) on circle relative to A-frame (3).
- (2) Rotate circle (1) counterclockwise slowly. Stop when top plate of hydraulic swivel begins turning. Place second mark (4) on circle.
- (3) Measure distance (5) between mark (2) and mark (4). Distance should be less than 1/2 in. (1.3 cm). Refer to Step b. to adjust.



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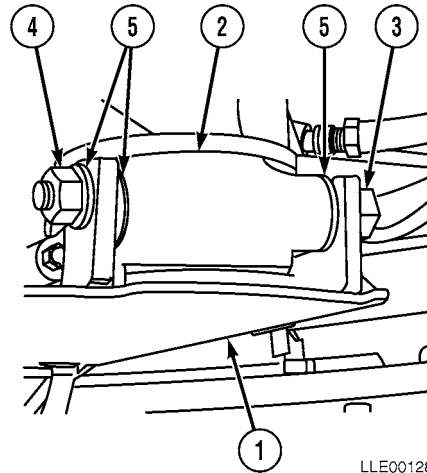
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b. Adjust.

NOTE

Rotational backlash is recommended to be less than 1/2 in. (1.3 cm).

- (1) If greater than 1/2 in. (1.3 cm), two joints between Circle Rotation Sensor and circle can be tightened.
- (2) First joint is between hose tray (1) and hydraulic swivel (2).
- (3) Remove existing pin connecting hose tray to swivel.
- (4) Replace pin with 8-in. (20.3 cm) long, 3/4-10, grade 5 bolt (3) and nut (4).
- (5) Use 3/4 in. flat washers (5) to remove slack between two parts.



3-32. CIRCLE SLIDE SHOE INSPECTION.

Circle Slide Shoes should also be checked for proper adjustment. Consult your 130G Grader Technical Manual for this procedure (TM 5-3805-261-10).

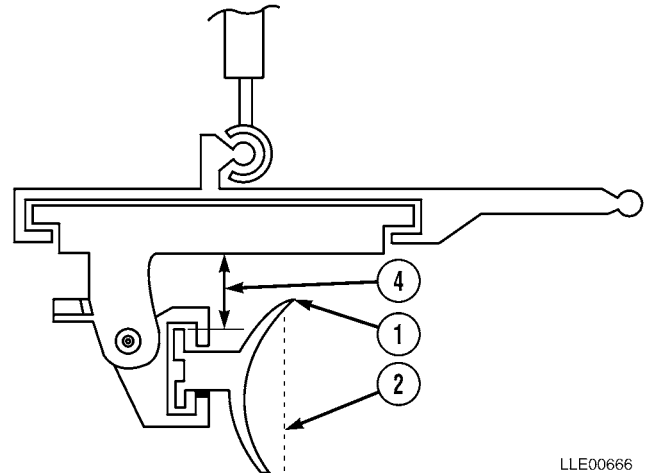
3-33. BLADE BACKLASH ADJUSTMENT.

a. Measure.

- (1) Roll blade (1) to vertical position (2) and sideshift blade to area of greatest wear on slide rails (3).
- (2) Let right side blade (1) hang in air while left side blade (1) is placed firmly on ground.

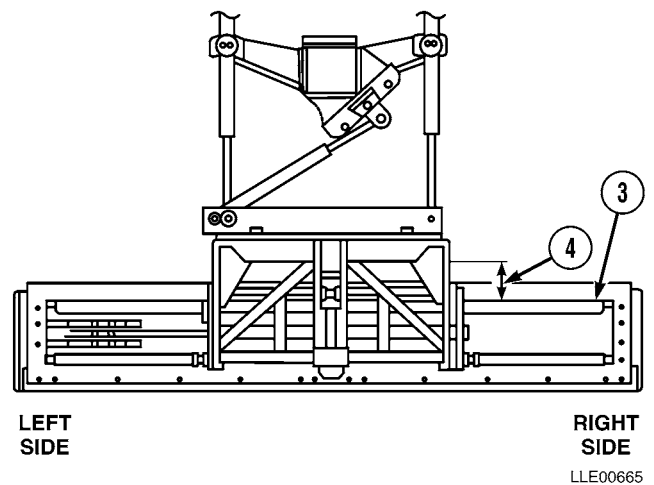
NOTE

- When taking vertical distance measurement, ensure blade roll backlash does not cause errors in your reading.
- During grading, blade roll backlash is usually loaded one way and does not have much effect on cross-slope accuracy. It will, however, affect elevation accuracy.



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- (3) Using a straightedge, measure vertical distance (4) from bottom of circle to top of slide rail (3) on right side.
- (4) Place right side blade (1) firmly on ground while left side blade (1) hangs in air and repeat vertical distance measurements on right side.
- (5) Difference between two measurements is backlash [Step (3) - Step (4) = backlash].
- (6) Repeat Steps (2) through (5) on left side.
- (7) Side shift blade (1) to area of least wear on slide rails (3) and repeat Steps (2) through (6) above.
- (8) If vertical distance measurements taken in Steps (5) for either left or right side are over 1/8 in. (0.32 mm) greater than vertical distance measurements from Step (7), slide rails (3) should be repaired or replaced. Notify Direct Support Maintenance.



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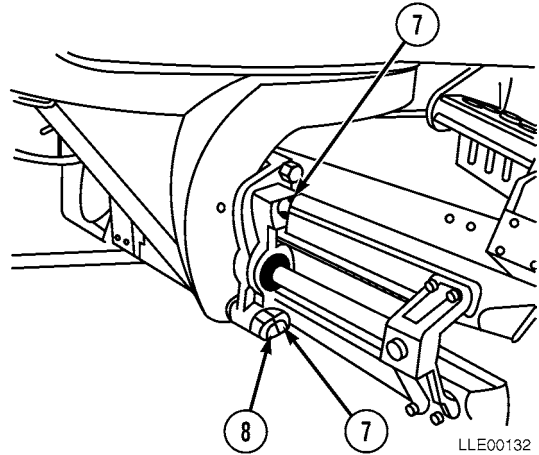
b. Adjust.

- (1) Largest backlash is recommended to be less than 1/8 in. (0.32 cm). If backlash is greater than 1/8 in. (0.32 cm), two joints (7) between circle and blade can be tightened.

NOTE

More probable points to inspect are wear strips between blade slide rails and blade brackets.

- (2) Tighten joints after replacing wear strips and shims.
- (3) Tighten blade roll backlash at this time.
- (4) After this side has been side shifted to its minimum clearance position, (see Para 3-34), wear strips can be formed to provide clearance of 0.005 to 0.035 in. (0.013 to 0.089 cm) between sides of rails and wear strips.
- (5) Second joint to inspect is blade pivot pin (8). If movement at pin is 1/32 in. (0.079 cm) or more, notify Direct Support Maintenance.

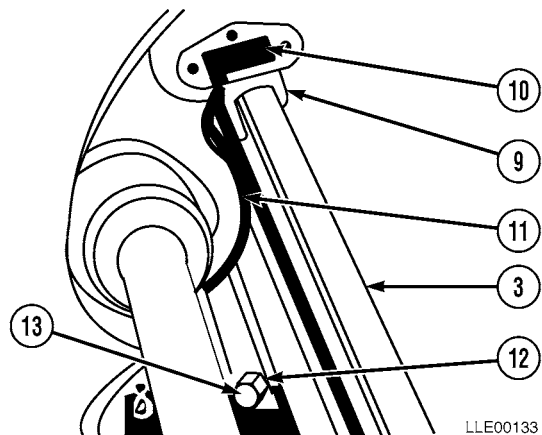


3-34. WEAR STRIP AND SHIM REPLACEMENT.

NOTE

- Sensor calibration is required after these procedures (see Para 3-15).
- Use shims as required to obtain 0.005- to 0.035-in. (0.013 to 0.089 cm) clearance between rails and wear strips at minimum clearance position found by sideshifting moldboard through full range with shims divided as equally as possible between top and bottom wear strips.

- (1) Install wear strip (9) and shims (10) on the slide rail (3) and in bracket (11).
- (2) Position blocks (12) and install bolts (13).



3-35. BLADE PRO® MOTOR GRADER CONTROL SYSTEM INSTALLATION.

This Task Covers:

- a. Installation.
- b. Follow-On Maintenance.

INITIAL SETUP

Model

130G Grader (TM 5-3805-261-Series)

Tools and Special Tools

Tool Kit, Automotive Maintenance, Common No. 2, Item 2, Appendix B
 Tool Kit, Electric, Item 3, Appendix B
 Tool Kit, Welders, Item 4, Appendix B

Materials and Parts

Cloth, Lint-Free, Item 3, Appendix F
 Gloves, Chemical Oil Protective, Item 4, Appendix F
 Paint, Spray, Black, Item 8, Appendix F
 Rags, Wiping, Item 9, Appendix F
 Tags, Identification, Item 13, Appendix F
 Ties, Cable, Item 15, Appendix F

Materials and Parts (Cont.)

Base Mounting Block, Item 1, Appendix K
 Label, Caution, Rotational Sensor, Item 3, Appendix K
 Label, Chart, Conversion, Item 4, Appendix K
 Label, Warning, Welding/Jump Starting, Item 5, Appendix K
 Plate, Tracer Mast Mount, Item 6, Appendix K

Personnel Required

MOS 62B
 MOS 44B

Equipment Condition

Engine OFF (TM 5-3805-261-10).
 Wheels chocked (TM 5-3805-261-10).
 130G Grader setup para (3-15).

a. Installation.

WARNING

- Ensure 130G Grader is on level ground, all hydraulic implements are lowered to the ground, transmission control is moved to Neutral, and the lock and emergency brake are engaged. Failure to comply could result in serious injury to personnel.
- Do not work on hydraulic oil while oil is hot. Failure to comply could result in severe injury to personnel.
- Prolonged contact with lubricating oil, MIL-L-2105, may cause a skin rash. Skin and clothing that come in contact with lubricating oil should be thoroughly washed immediately. Saturated clothing should be removed immediately. Areas in which lubricating oil is used should be well ventilated to keep fumes to a minimum.
- Hydraulic oil is slippery and can cause falls. To avoid injury, wipe up all spilled hydraulic oil with rags.
- Remove hydraulic fill cap to vent pressure from hydraulic tank.
- Use Operator's controls to lower all components and relieve hydraulic system pressure. Failure to comply may result in serious injury or death to personnel.

NOTE

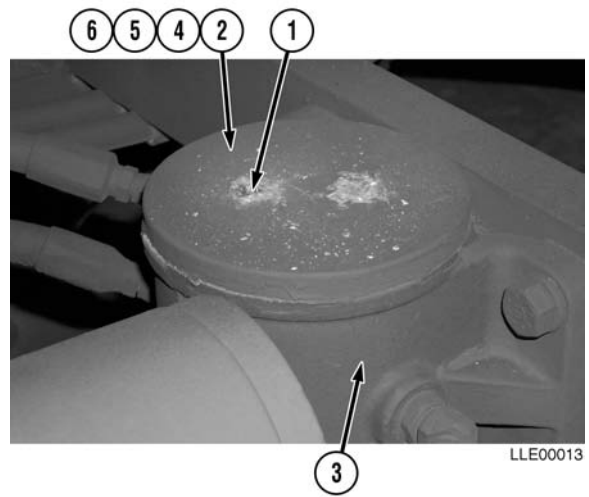
Retain all items (except bench stock items) removed from 130G Grader for future use.

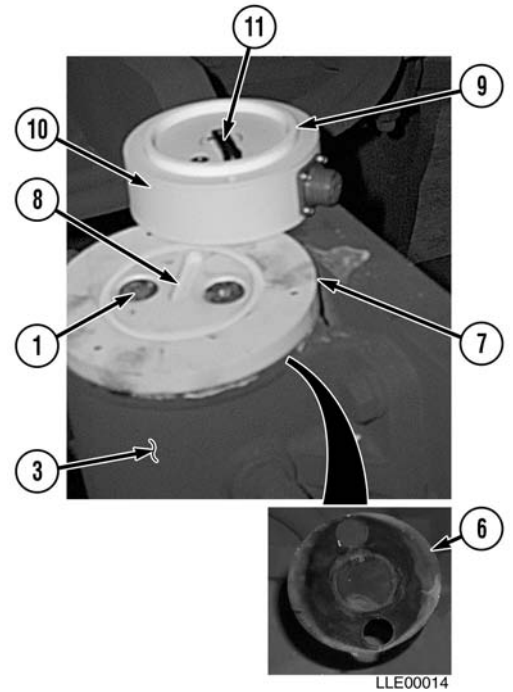
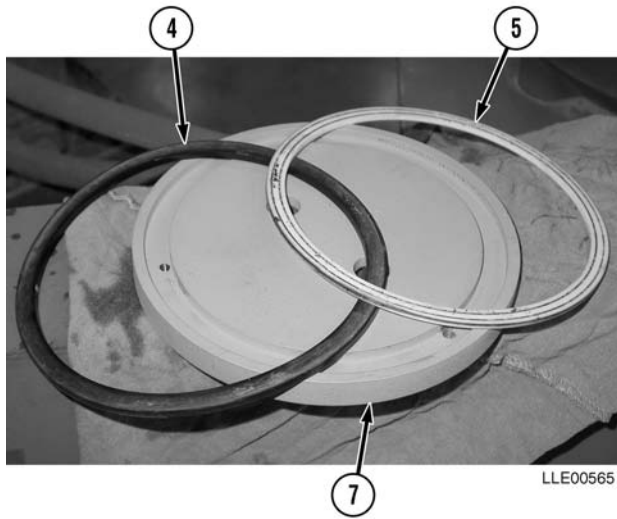
- (1) Remove hydraulic tank fill cap to vent pressure from hydraulic tank (TM 5-3805-261-10).
- (2) Install hydraulic tank fill cap.
- (3) Remove two screws (1) and Hydraswivel plate (2) from Hydraswivel (3).

CAUTION

Install Hydraswivel Gaskets and Hydraswivel Shims in same manner as removed or damage to equipment could result.

- (4) Remove two Hydraswivel Gaskets (4) and (5) from Hydraswivel plate (2).
- (5) Inspect Hydraswivel Gaskets (4) and (5) and Hydraswivel Shims (6). If damaged, replace.





CAUTION

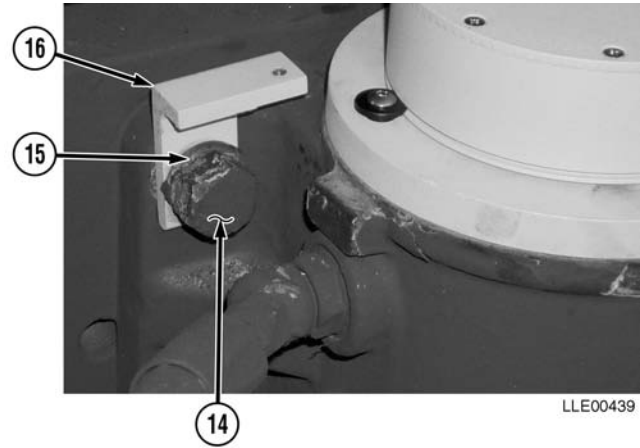
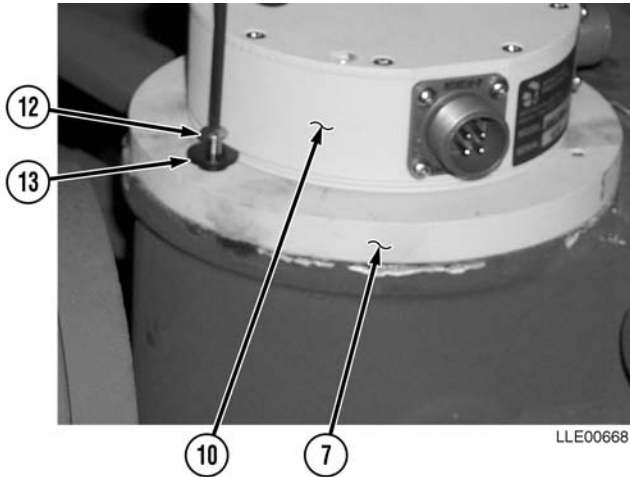
Failure to replace Hydraswivel Gaskets and Hydraswivel Shims in original positions may cause leakage or damage to equipment.

- (6) Install Hydraswivel Gaskets (4) and (5) into Orientation Disc (7).
- (7) Install Hydraswivel Shims (6) under Orientation Disc (7).
- (8) Install Orientation Disc (7) to Hydraswivel (3) with Milled Slot (8) positioned toward rear of 130G Grader.
- (9) Install two screws (1) in Orientation Disc (7).
- (10) Tighten screws (1).
- (11) Install Teflon Ring (9) on Circle Rotation Sensor (10).
- (12) Line up Dog Bone (11) with Milled Slot (8) in Orientation Disc (7).

NOTE

For ease of calibration, place 2-pin female connector of Circle Rotation Sensor toward rear of 130G Grader.

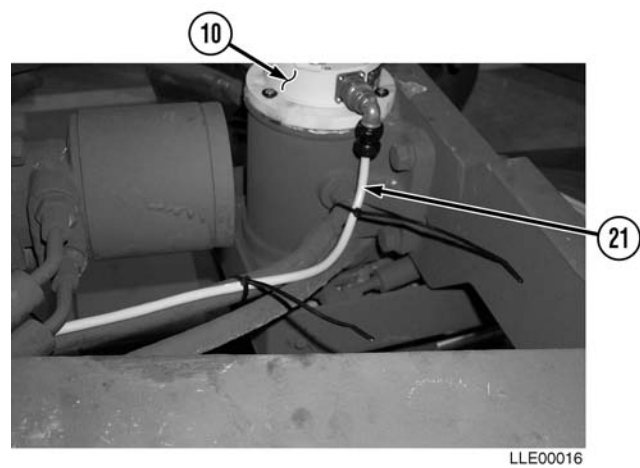
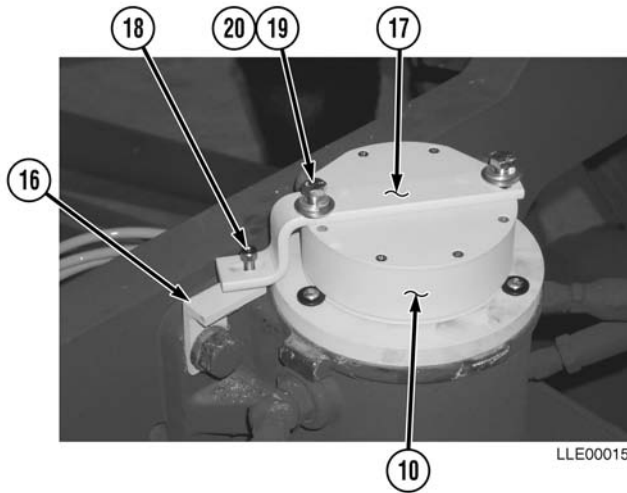
- (13) Install Circle Rotation Sensor (10) onto Orientation Disc (7).



CAUTION

To prevent damage to equipment, lip on bushing must be in slot of Circle Rotation Sensor.

- (14) Install three screws (12) and bushings (13) in Circle Rotation Sensor (10) and Orientation Disc (7).
- (15) Remove bolt (14) and lockwasher (15). Discard lockwasher (15).
- (16) Install Circle Rotation Sensor Arm Mounting Bracket (16), new lockwasher (15), and bolt (14).
- (17) Level Circle Rotation Sensor Arm Mounting Bracket (16). Tighten bolt (14).



- (18) Align Circle Rotation Sensor Arm (17) on Circle Rotation Sensor (10).
- (19) Install screw (18) on Circle Rotation Sensor Arm Mounting Bracket (16).
- (20) Tighten screw (18).
- (21) Install Circle Rotation Sensor Arm (17), two washers (19), and bolts (20) on Circle Rotation Sensor (10).
- (22) Tighten bolts (20).
- (23) Install Circle Rotation Sensor Cable (21) on Circle Rotation Sensor (10).

CAUTION

To prevent damage to equipment, the Circle Rotation Sensor Cable must be secured to hydraulic lines with cable ties approximately every 6 in. (15.2 cm).

NOTE

Leave approximately 2 in. (5.1 cm) of slack in Rotation Sensor Cable for calibration.

- (24) Route Circle Rotation Sensor Cable (21) with existing hydraulic lines to front of 130G Grader.

NOTE

Gooseneck Panels for both sides of the 130G Grader are removed the same. The left side is shown.

- (25) Remove eight bolts (22) and washers (23).
- (26) Remove Gooseneck Panels (24) and (25) and Float Valve (26) from Gooseneck (27).
- (27) Route Circle Rotation Sensor Cable (21) under Gooseneck Panel (28).

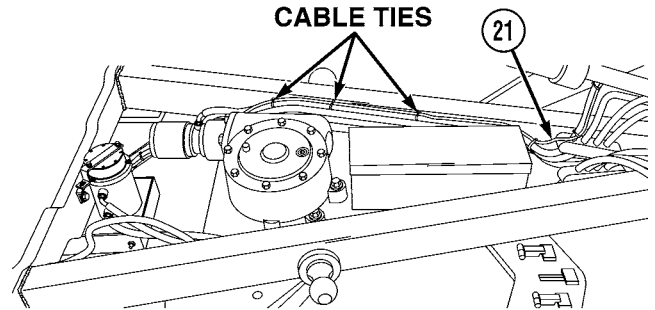
CAUTION

Do not cable tie Circle Rotation Sensor Cable Service Loop inside the Gooseneck. Failure to comply could result in damage to 130G Grader.

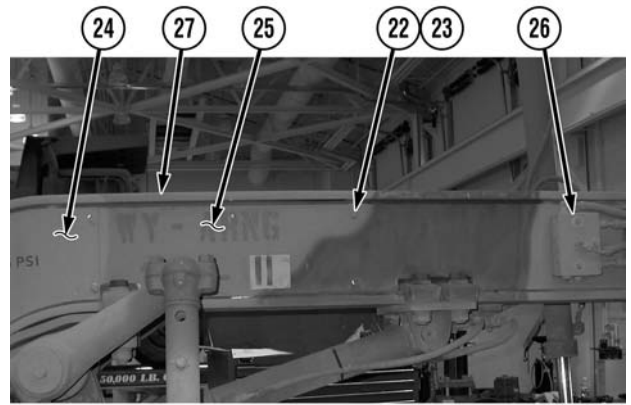
NOTE

Leave approximately 18 in. (46 cm) hanging past 130G Grader's Gooseneck Panel's rear mounting location.

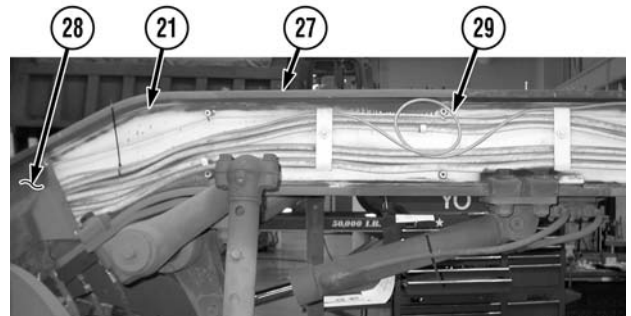
- (28) Create a Service Loop (29) of the extra Circle Rotation Sensor Cable (21) inside the Gooseneck (27).
- (29) Route Circle Rotation Sensor Cable (21) with existing hydraulic lines in Gooseneck (27).



LLE00441



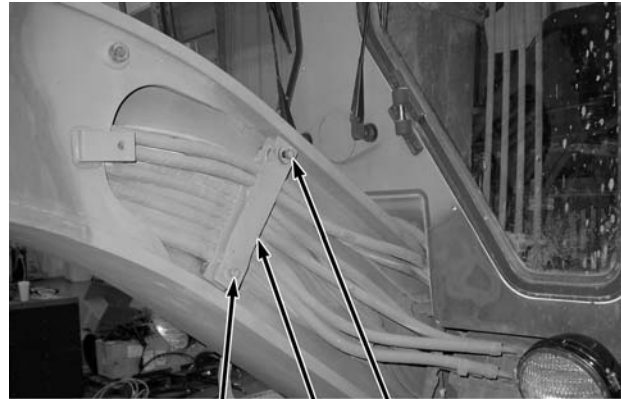
LLE00570



LLE00571

TM 5-6675-348-13&P

- (30) Loosen lower Gooseneck retainer bolt (30).
- (31) Remove upper retainer bolt (31), washer (32), and spacer (33).
- (32) Rotate Gooseneck Retainer (34) 90 degrees.
- (33) Tighten lower Gooseneck retainer bolt (30).
- (34) Repeat Steps (30) through (33) on right side of 130G Grader.



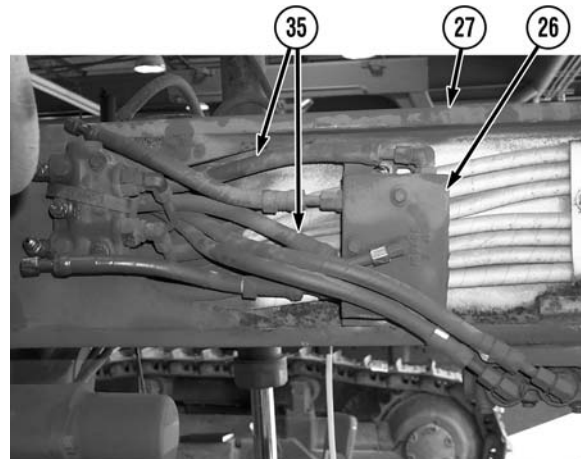
LLE00572

WARNING

- Hydraulic oil is slippery and can cause falls. To avoid injury, wipe up all spilled hydraulic oil with rags.
- Float valve is held in position only by lines. Use care during line removal to prevent damage to equipment or injury to personnel.

NOTE

- Inspect all hoses, lines, and fittings for cracks, bends, nicks, dents, stripped threads, and cuts. Replace all damaged parts.
 - Perform Steps (35) and (36) on right side of 130G Grader only.
 - Tag and mark all hoses prior to removal.
 - Plug holes and cap fittings to prevent spilling oil.
 - Cable tie as needed.
- (35) Disconnect two Float Valve Lines (35) from Float Valve (26).
 - (36) Pull two Float Valve lines (35) out of Gooseneck (27).
 - (37) Temporarily position two Float Valve Lines (35) over Gooseneck (27).

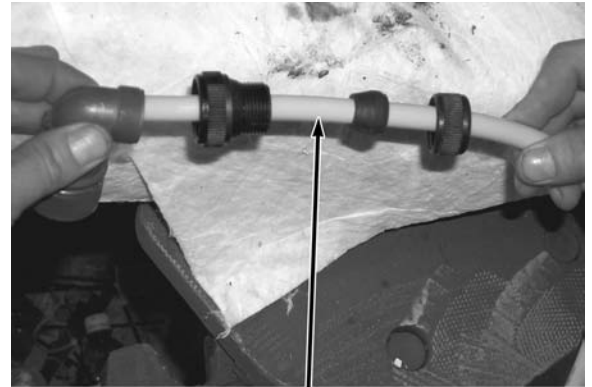


LLE00445

- (38) Disassemble female end of Operator Cable (36).

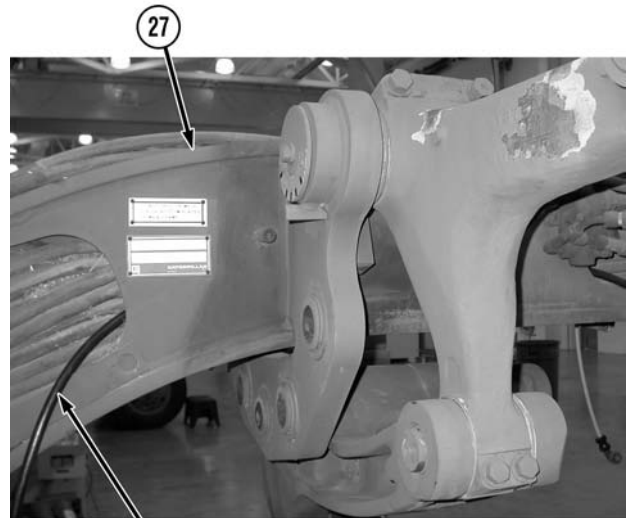
NOTE

- Hydraulic hoses for both sides of 130G Grader install the same. The right side is shown.
- Mark return line short hose before installation.
- For ease of installation, hold hydraulic lines toward top of 130G Grader's Gooseneck while installing. If hydraulic lines hit an obstruction during installation, twist and push lines at the same time.
- Route straight end of hydraulic lines through Gooseneck from front of 130G Grader to back.
- Steps (40) through (45) require the aid of an assistant.

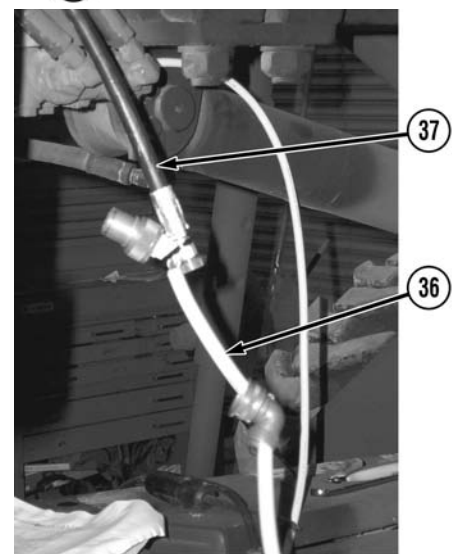


LLE00025

- (39) Locate Load Sense Line (37).
- (40) Push straight end of Load Sense Line (37) through Gooseneck (27), starting from the rear and pushing toward the front of the Gooseneck (27).
- (41) Cable tie female end of Operator Cable (36) to Load Sense Line (37) on straight end of Load Sense Line (37).
- (42) With the aid of an assistant, pull Load Sense Line (37) until female end of Operator Cable (36) exits through rear side of Gooseneck (27).
- (43) Remove Load Sense Line (37).



LLE00573



LLE00027

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- (44) Cable tie Main Power Cable (38) to Operator Cable (36).7

NOTE

Leave approximately 18 in. (46 cm) of both cables outside front of Gooseneck.

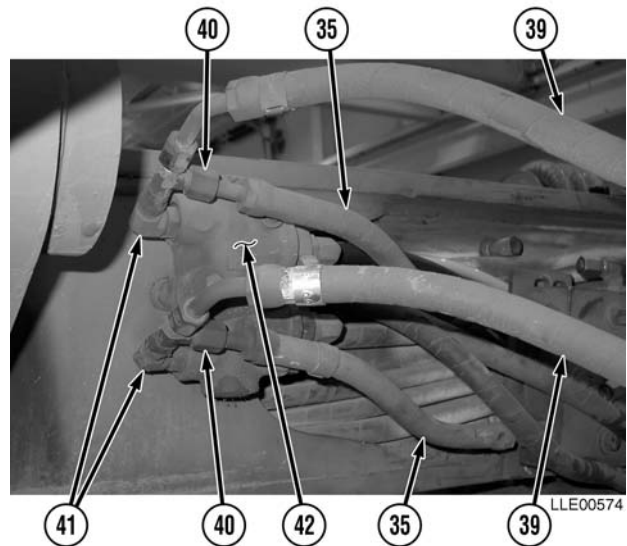
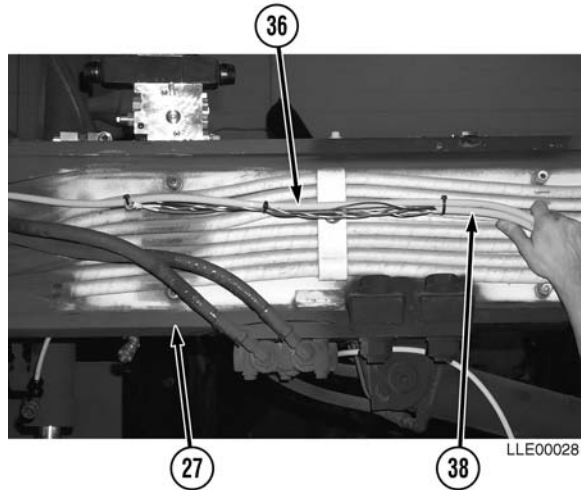
- (45) With the aid of an assistant, pull Operator Cable (36) until both Main Power Cable (38) and Operator Cable (36) are hanging through front and rear of Gooseneck (27).

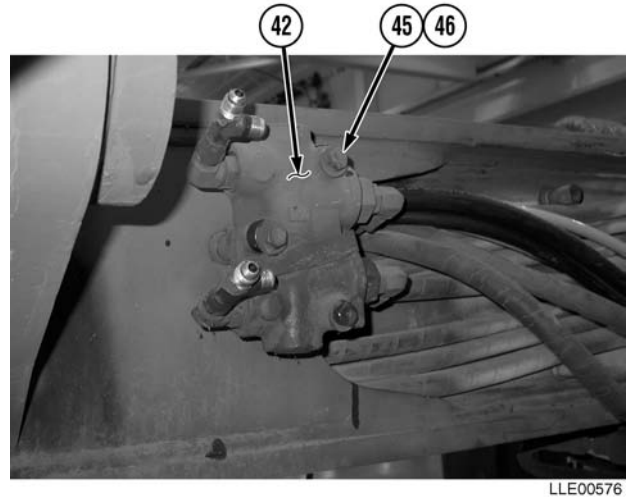
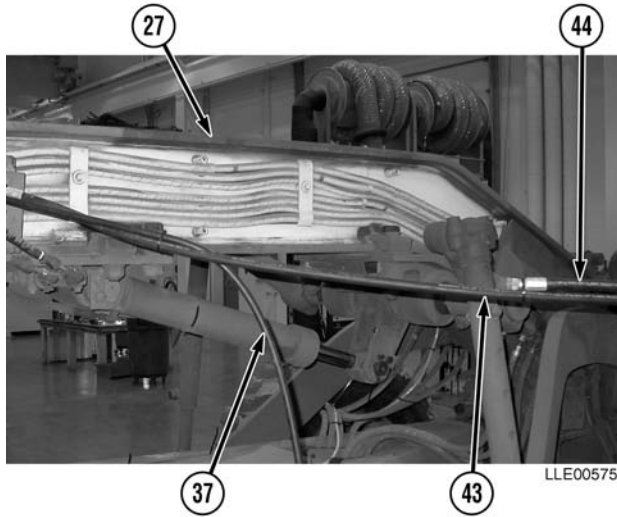
WARNING

Hydraulic oil is slippery and can cause falls. To avoid injury, wipe up all spilled hydraulic oil with rags.

NOTE

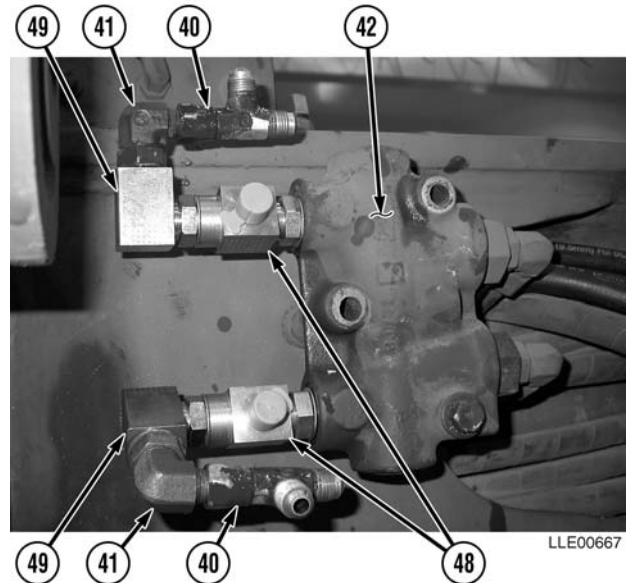
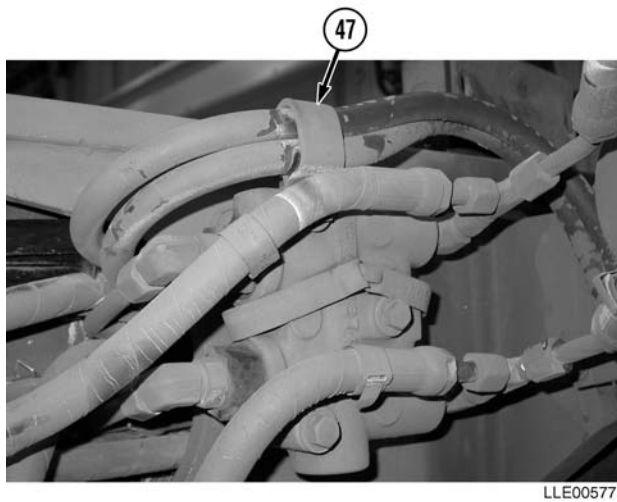
- Inspect all hoses, lines, and fittings for cracks, bends, nicks, dents, stripped threads, and cuts. Replace all damaged parts.
 - Tag and mark all existing lines prior to removal.
 - Plug holes and cap fittings to prevent oil spills.
 - Retain 90-degree fittings and T-fittings for installation of Proportional Valve.
- (46) Remove two Float Valve Lines (35), Cylinder Lines (39), T-fittings (40), and 90-degree fittings (41) from left Lift and Articulation Check Valve (LACV) (42).





(47) Route Load Sense Line (37), Return Line (43), and Pressure Line (44) through Gooseneck (27).

(48) Remove two bolts (45) and flat washers (46) from LACV (42).



NOTE

- Step (49) applies to left side of 130G Grader only.
- Retain Loop Clamp for installation of Proportional Valve.

(49) Remove Loop Clamp (47).

NOTE

Do not tighten LACV fittings until all fittings are installed.

(50) Install two T-fittings (48) in LACV (42).

(51) Install two 90-degree block fittings (49) in T-fittings (48).

(52) Install two retained 90-degree fittings (41) in block 90-degree fittings (49).

(53) Install two retained T-fittings (40) in 90-degree fittings (41).

NOTE

Proportional Valve Assembly can be used on either side of 130G Grader.

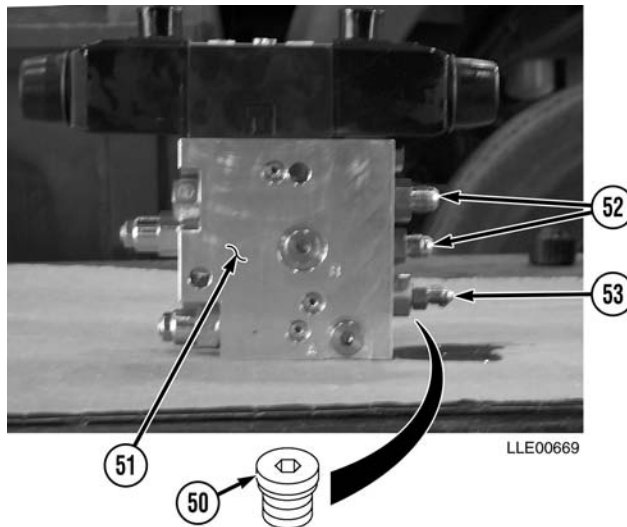
- (54) Remove three dust plugs (50) from side of Proportional Valve (51).

WARNING

Hydraulic oil is slippery and can cause falls. To avoid injury, wipe up all spilled hydraulic oil with rags.

CAUTION

To prevent fittings breaking off in block, do not overtighten fittings.



NOTE

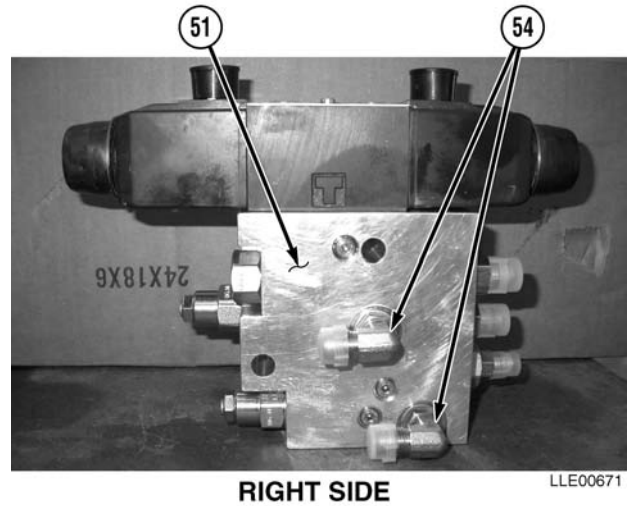
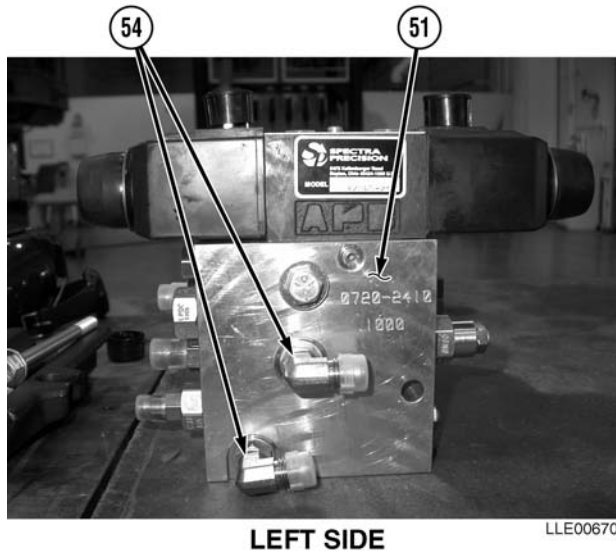
- Lubricate O-rings on O-ring seals to JIC/SAE fittings with clean hydraulic fluid before installation.
- All other dust fittings should be tightened.

- (55) Install two #6 ORS to JIC/SAE fittings (52) on Proportional Valve (51).

- (56) Tighten #6 ORS to JIC/SAE fittings (52).

- (57) Install #4 ORS to JIC/SAE fitting (53) on Proportional Valve (51).

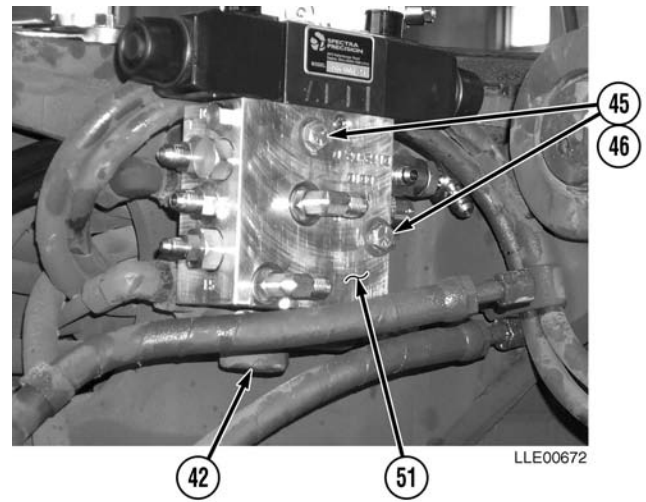
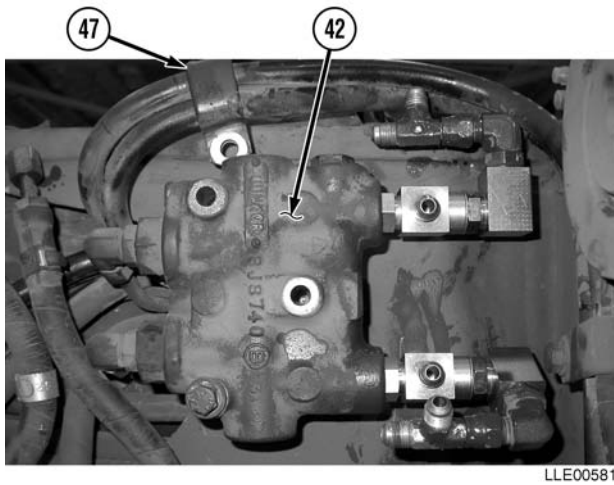
- (58) Tighten #4 ORS to JIC/SAE fitting (53).



NOTE

For ease of installation, do not tighten 90-degree fittings.

(59) Install two 90-degree fittings (54) on Proportional Valve Assembly (51).



CAUTION

To prevent leaks and damage to equipment, ensure all plugs on back side of Proportional Valve Assembly are tight before installation.

NOTE

- Loop Clamp is installed on back side of LACV on left side only.
 - Rotate Loop Clamp 180 degrees before installation.
- (60) Install Loop Clamp (47) and Proportional Valve Assembly (51) with two bolts (45) and flat washers (46) on LACV (42).
- (61) Tighten bolts (45).

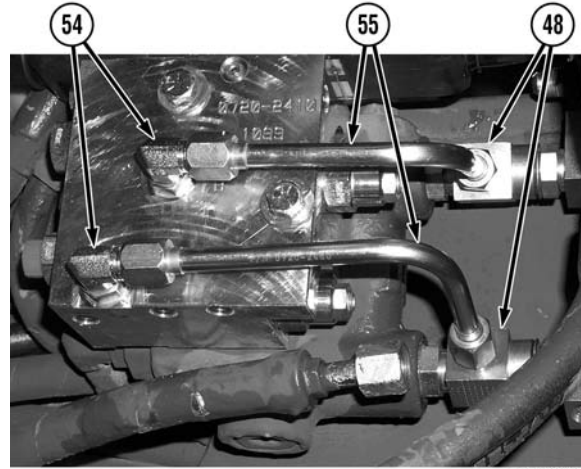
CAUTION

To prevent damage to equipment, do not bend or force steel tubes to fit.

(62) Install steel tubes (55) on 90-degree fittings (54) and T-fittings (48).

(63) Level steel tubes (55).

(64) Tighten 90-degree fittings (54) and T-fittings (48).



LLE00673

(65) Install Load Sense Line (37) on #4 JIC/SAE fitting (53).

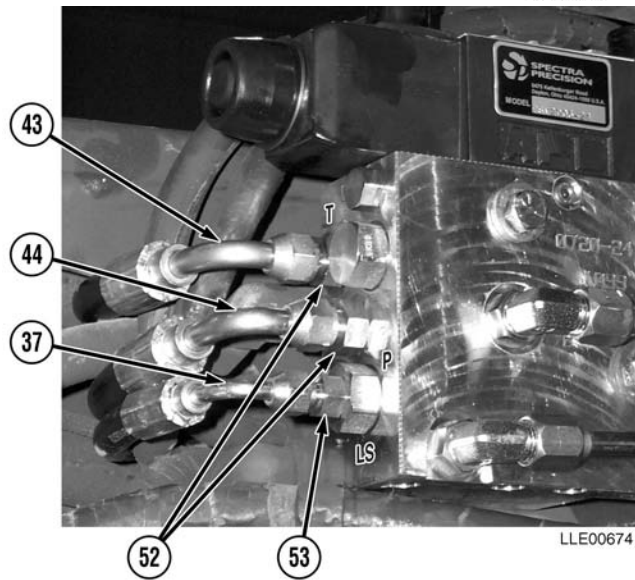
(66) Tighten Load Sense Line (37).

(67) Install Pressure Line (44) on lower #6 JIC/SAE fitting (52).

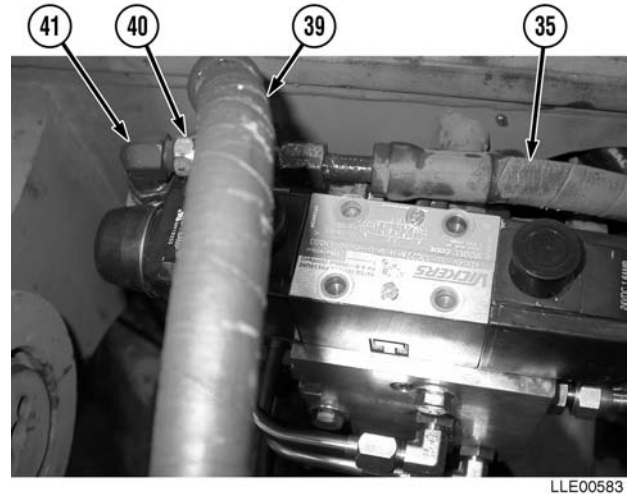
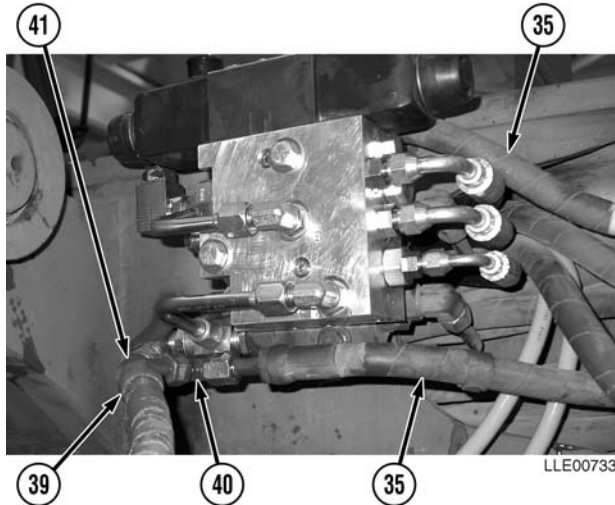
(68) Tighten Pressure Line (44).

(69) Install Return Line (43) on upper #6 JIC/SAE fitting (52).

(70) Tighten Return Line (43).



LLE00674



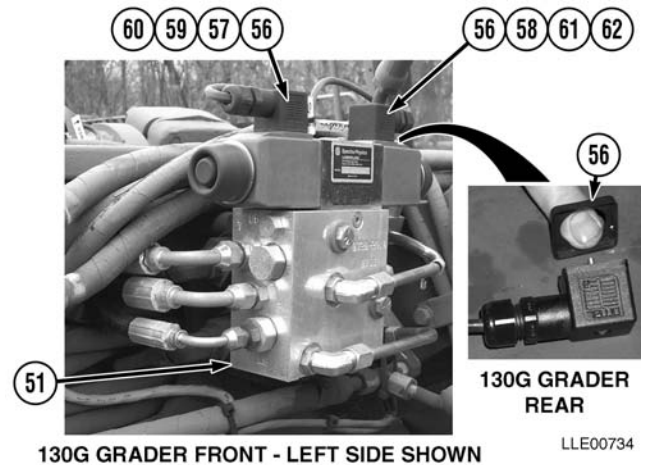
- (71) Install two Cylinder Lines (39) and two Float Valve Lines (35) to T-fittings (40).
- (72) Tighten two Cylinder Lines (39) and Float Valve Lines (35) to T-fittings (40).
- (73) Tighten 90-degree fittings (41) and T-fittings (40).
- (74) Install gaskets (56) on Hydraulic Valve Cables marked RAISE (57) and LOWER (58).

CAUTION

Hydraulic Valve Cables are marked RAISE and LOWER. Failure to install Hydraulic Valve Cables in the correct positions may cause damage to equipment.

NOTE

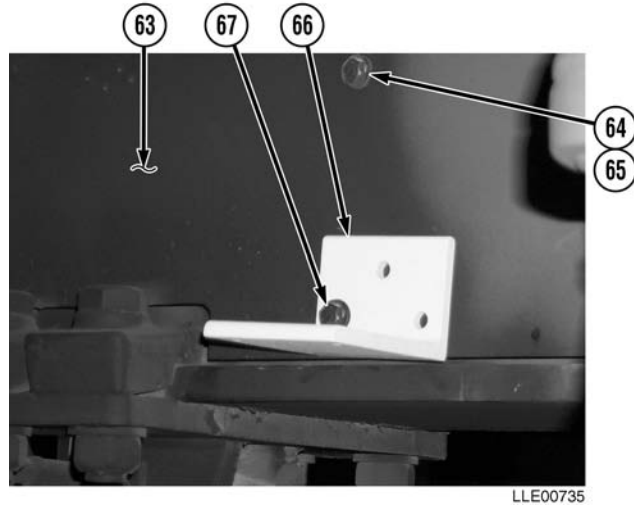
Remove protective caps from Proportional Valve Assembly electrical terminals before installing Hydraulic Valve Cables.



- (75) Install Hydraulic Valve Cable (RAISE) (57) on Proportional Valve Assembly Terminal (59).
- (76) Secure Hydraulic Valve Cable (RAISE) (57) to Proportional Valve Assembly Terminal (59) with screw (60).
- (77) Tighten screw (60).
- (78) Install Hydraulic Valve Cable (LOWER) (58) on Proportional Valve Assembly Terminal (61).
- (79) Secure Hydraulic Valve Cable (LOWER) (58) to Proportional Valve Assembly Terminal (61) with screw (62).
- (80) Tighten screw (62).
- (81) Route Hydraulic Valve Cables (57) and (58) behind Proportional Valve Assembly (51).
- (82) Cable tie Hydraulic Valve Cables (57) and (58) together as needed.

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- (83) Repeat Steps (46) through (81) for right-side installation.
- (84) Temporarily install right-side Gooseneck Panel (63), six washers (64), and six bolts (65).
- (85) Temporarily install Mainfall Slope Sensor Bracket (66) to right-side Gooseneck Panel (63), using existing bolt (67).
- (86) Level, mark, and center punch Mainfall Slope Sensor Bracket (66) mounting holes.
- (87) Remove bolt (67), Mainfall Slope Sensor Bracket (66), six bolts (65), six washers (64), and right-side Gooseneck Panel (63).
- (88) Drill two 1/2-in. (13 mm) holes at punch marks.
- (89) Align Mainfall Slope Sensor Bracket (66) to bottom of right-side Gooseneck Panel (63).
- (90) Install with two bolts (67), lockwashers (68), and nuts (69).
- (91) Tighten nuts (69).

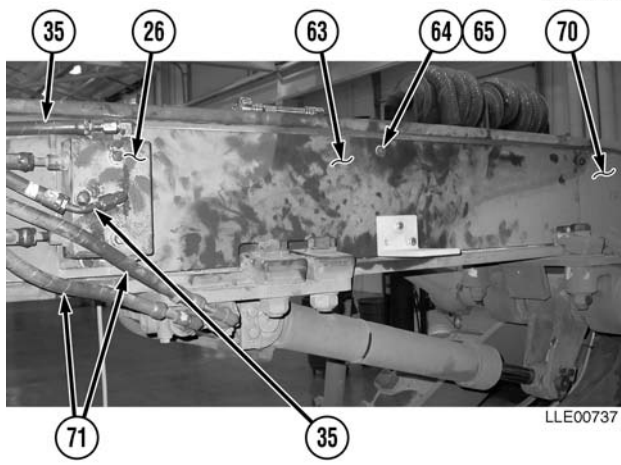
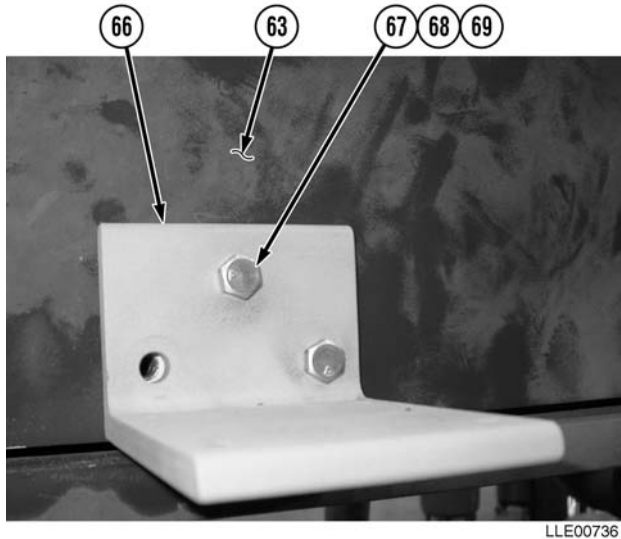


- (92) Install both right-side Gooseneck Panels (63) and (70) and Float Valve (26) with eight washers (64) and bolts (65).
- (93) Install two Float Valve lines (35) to Float Valve (26).

NOTE

Position Scarifier Hydraulic Lines clockwise as far as possible to allow clearance for the Remote Interface Box.

- (94) Reposition Scarifier Hydraulic Lines (71) clockwise as far as possible.



NOTE

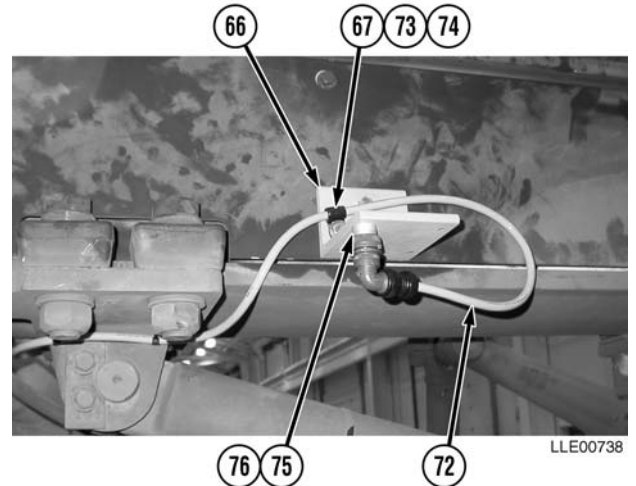
Leave approximately 16 in. (40.6 cm) of Mainfall Slope Sensor Cable on female end, for storage, as shown.

- (95) Install Mainfall Slope Sensor Cable (72), Loop Clamp (73), washer (74), bolt (67) to Mainfall Slope Sensor Bracket (66).

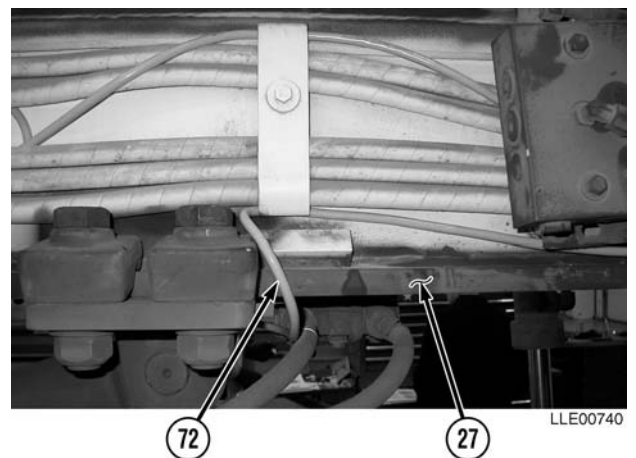
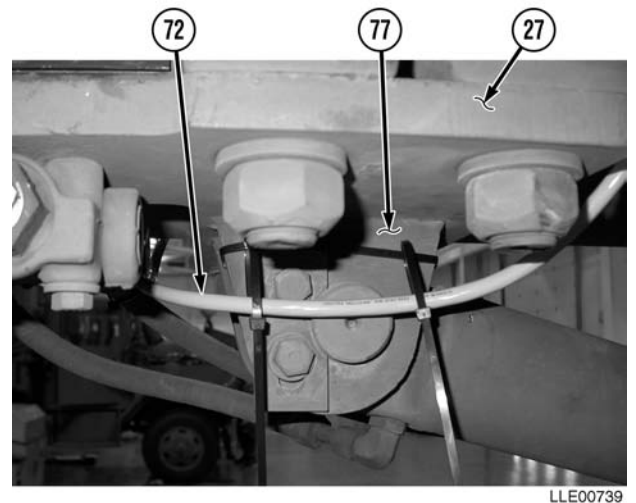
NOTE

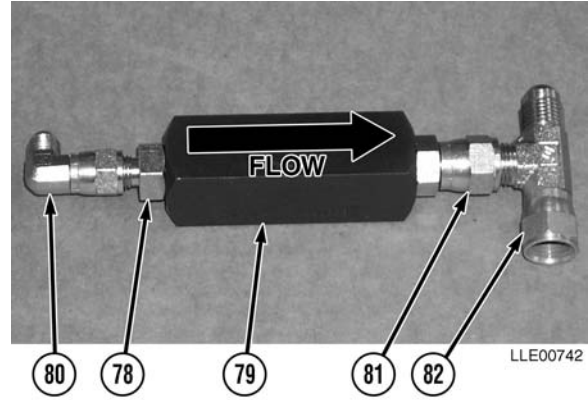
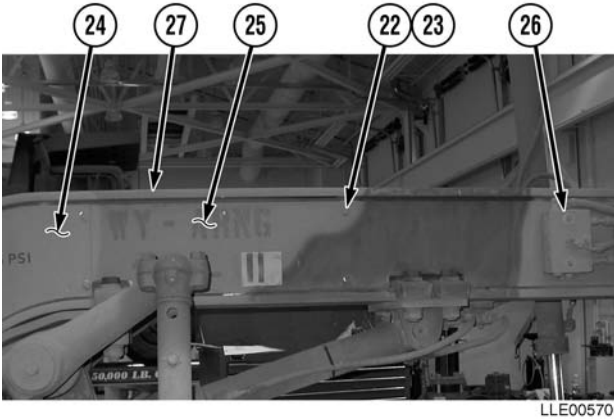
Connector holder mounting screw is larger than hole in dust cap.

- (96) Ream connector holder (75) mounting hole with rat-tail file.
- (97) Install screw (76) and connector holder (75) to outer rear hole of Mainfall Slope Sensor Bracket (66).



- (98) Install two cable ties around Rotating Eye Bracket (77).
- (99) Route Mainfall Slope Sensor Cable (72) under Gooseneck (27).
- (100) Attach Mainfall Slope Sensor Cable (72) with two ties secured by cable ties installed in Step (98).
- (101) Route Mainfall Slope Sensor Cable (72) under left-side Gooseneck (27) toward rear of 130G Grader.





(102) Install both left-side Gooseneck Panels (24) and (25) and Float Valve (26), using eight flat washers (23) and bolts (22).

NOTE

- Both sides of 130G Grader are installed the same.
- Lubricate O-rings on ORS to JIC/SAE fittings with clean hydraulic fluid before installation.
- Note inlet and outlet side of Check Valve before installation.

(103) Install #4 ORS to JIC/SAE fittings (78) on inlet side of Check Valve (79).

(104) Tighten #4 ORS to JIC/SAE fittings (78).

(105) Install 90-degree fitting (80) on #4 ORS to JIC/SAE fitting (78).

(106) Install #6 ORS to JIC/SAE fitting (81) on outlet side of Check Valve (79).

(107) Tighten #6 ORS to JIC/SAE fitting (81).

(108) Install T-fitting (82) on #6 ORS to JIC/SAE fitting (81).

WARNING

Hydraulic oil is slippery and can cause falls. To avoid injury, wipe up all spilled hydraulic oil with rags.

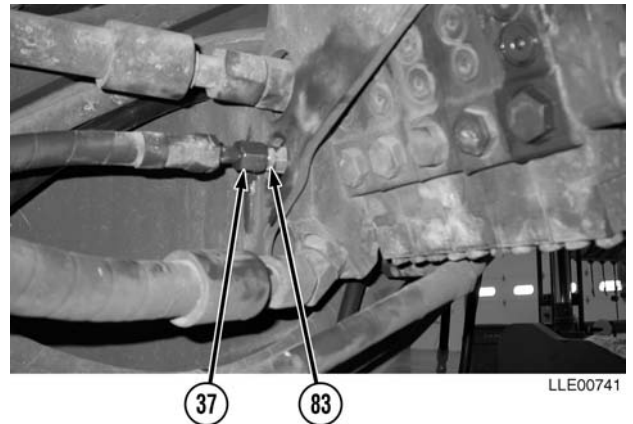
CAUTION

Inspect all hoses, lines, and fittings for cracks, bends, nicks, dents, stripped threads, and cuts. Replace all damaged parts.

NOTE

- Tag and mark all hoses prior to removal.
- Plug holes and cap fittings to prevent oil spills.
- Cable tie as needed.
- Do not tighten 90-degree fitting or T-fitting on Check Valve until all lines are installed.

(109) Remove Load Sense Line (37) from fitting (83).



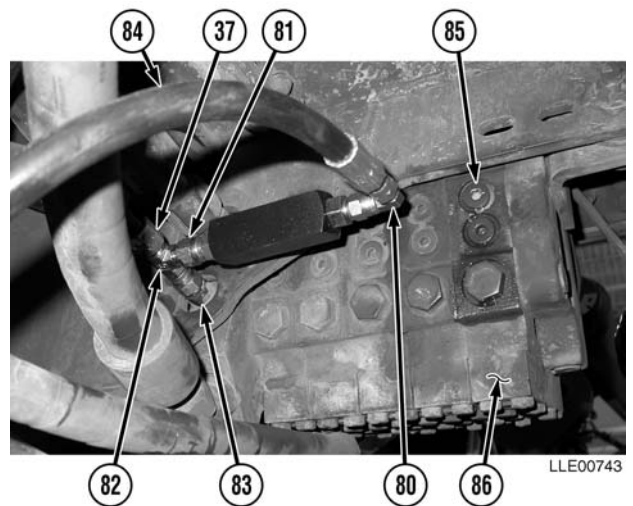
(110) Install T-fitting (82) to fitting (83).

(111) Install original Load Sense Line (37) to T-fitting (82).

(112) Install new Load Sense Line (84) to 90-degree fitting (80).

(113) Tighten #6 ORS to JIC/SAE fitting (81) T-fitting (82). Tighten T-fitting (82) to fitting (83). Tighten original Load Sense Line (37) to T-fitting (82). Tighten new Load Sense Line (84) to 90-degree fitting (80).

(114) Remove plug (85) from Stack Valve (86). Retain plug (85) for future use.



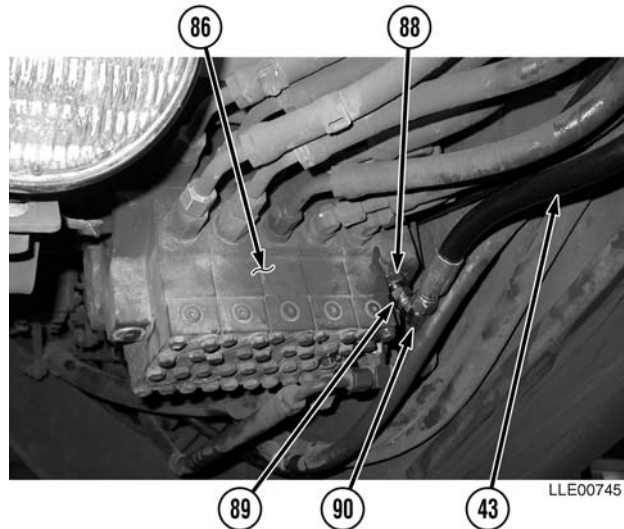
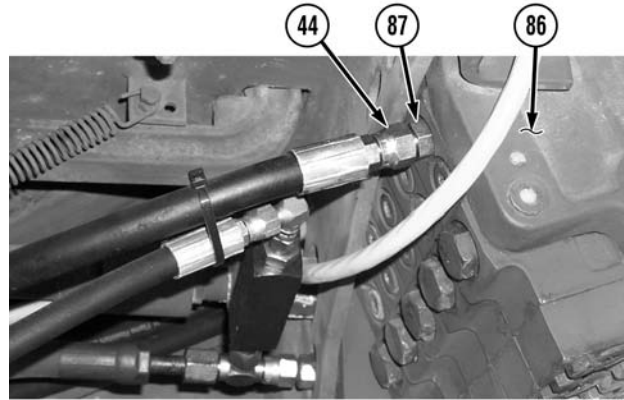
TM 5-6675-348-13&P

- (115) Install #6 JIC/SAE fitting (87) on Stack Valve (86).
- (116) Tighten #6 JIC/SAE fitting (87).
- (117) Install Pressure Line (44) on #6 JIC/SAE fitting (87).
- (118) Tighten Pressure Line (44) to #6 JIC/SAE fitting (87).

WARNING

Hydraulic oil is slippery and can cause falls. To avoid injury, wipe up all spilled hydraulic oil with rags.

- (119) Remove plug (88) from Stack Valve (86). Retain plug (88) for future use.
- (120) Install fitting (89) on Stack Valve (86).
- (121) Tighten fitting (89).
- (122) Install 90-degree fitting (90) on fitting (89).
- (123) Tighten 90-degree fitting (90).
- (124) Install Return line (43) on 90-degree fitting (90).
- (125) Repeat Steps (103) through (124) for other side of 130G Grader.

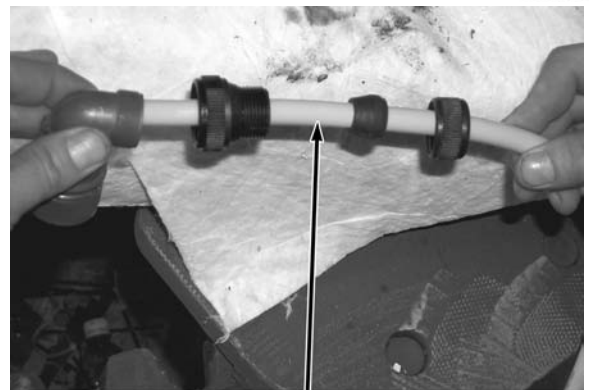


- (126) Loosen Gooseneck lower retainer bolt (30).
- (127) Reposition lower Gooseneck Retainer (34).
- (128) Tighten bolt (30).
- (129) Install Gooseneck upper retainer bolt (31), washer (32), and spacer (33).
- (130) Tighten upper retainer bolt (31).

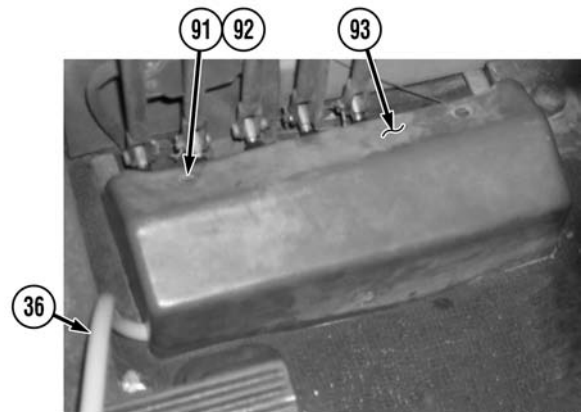


30 34 31 32 33 LLE00746

- (131) Assemble female end of Operator Cable (36).
- (132) Remove three screws (91), washers (92), and right side Stack Valve Cover (93).



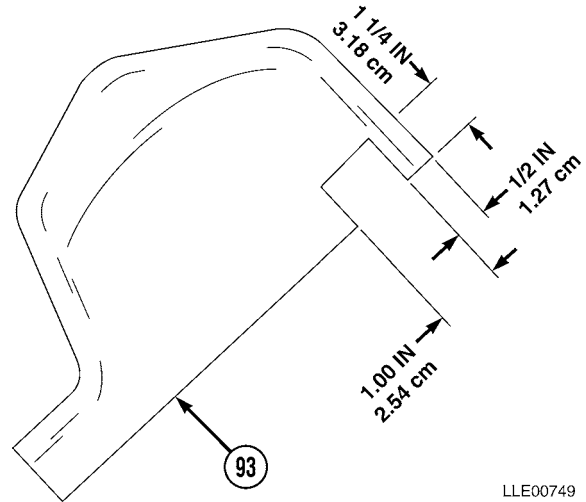
36 LLE00747



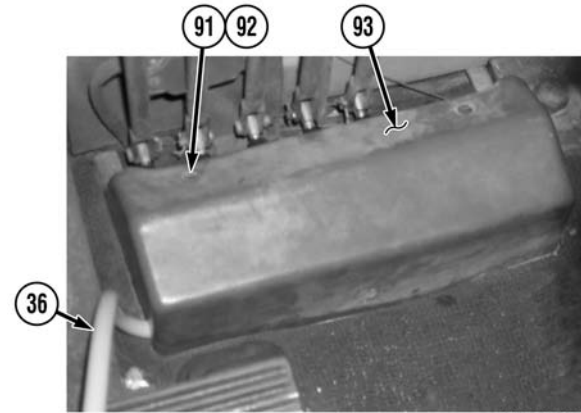
LLE00748

TM 5-6675-348-13&P

- (133) Cut approximately 1 1/4-in. (3.2 cm) slot, 1 in. (2.54 cm) wide and 1/2 in. (1.3 cm) deep, in left side of Stack Valve Cover (93).
- (134) From under cab, route Operator Cable (36) over hydraulic lines, under floorboard, and into cab.
- (135) Install right side of Stack Valve Cover (93), three washers (92), and screws (91) over Operator Cable (36).



LLE00749

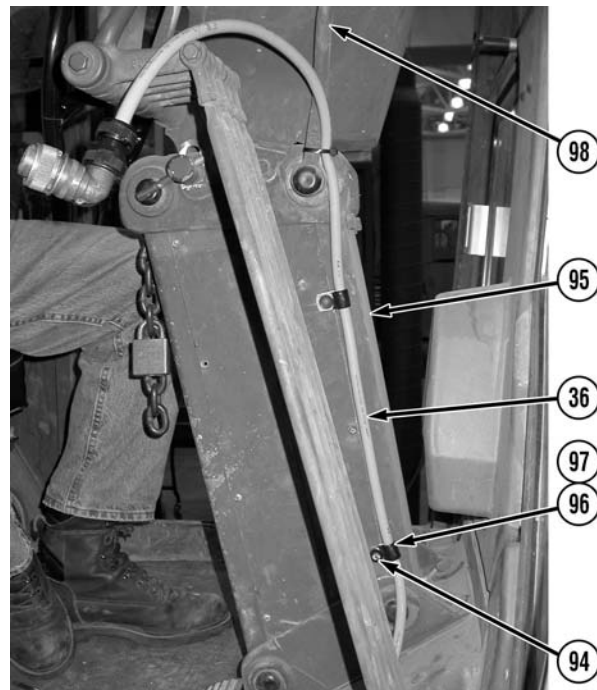


LLE00748

NOTE

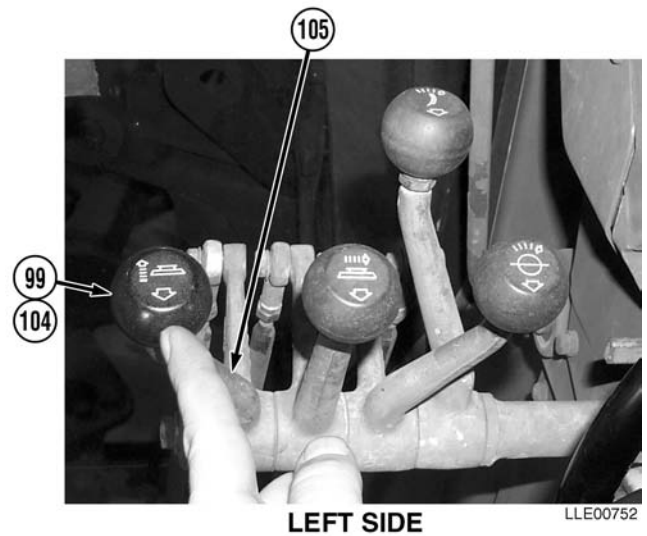
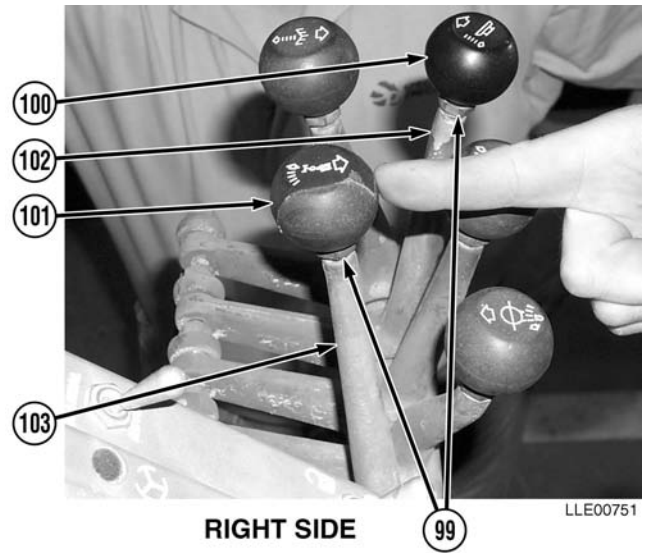
For ease of installation, remove only one screw in column at a time. Work from floorboard up column.

- (136) Remove screws (94) from column (95).
- (137) Install Operator Cable (36), Loop Clamps (96), and bushings (97) on column (95) with screws (94).
- (138) Cable tie Operator Cable (36) to Steering Column Release Lever (98).



LLE00750

- (139) Loosen jam nuts (99) on right-side RAISE/LOWER Knob (100) and Articulation Knob (101).
- (140) Remove right-side RAISE/LOWER Knob (100) from right-side RAISE/LOWER Lever (102).
- (141) Remove Articulation Knob (101) from Articulation Lever (103).
- (142) Loosen jam nut (99) on left-side RAISE/LOWER Knob (104).
- (143) Remove left-side RAISE/LOWER Knob (104) from left-side RAISE/LOWER Lever (105).

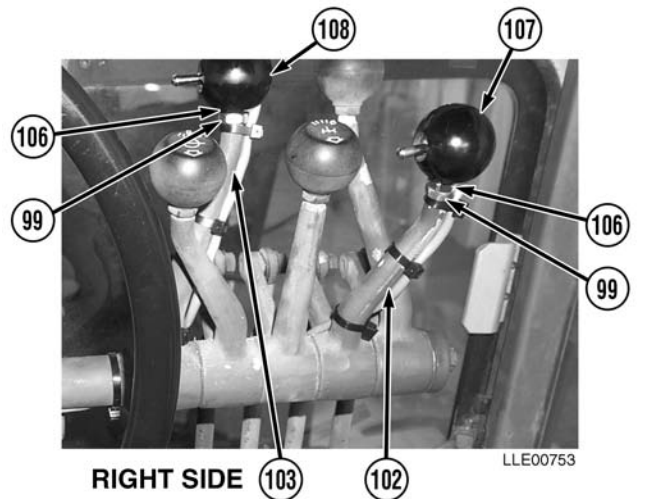


- (144) Install second jam nuts (106) on RAISE/LOWER Control Levers (102), (103), and (105).

NOTE

R/L Switches are the same and can be installed on either RAISE/LOWER Lever.

- (145) Install R/L Switch (107) on RAISE/LOWER Lever (102).
- (146) Install Remote Switch (108) on Articulation Lever (103).
- (147) Tighten jam nuts (106) and (99).

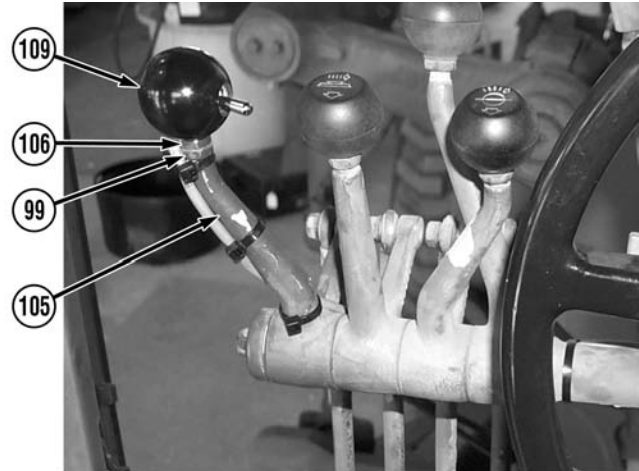


TM 5-6675-348-13&P

- (148) Install R/L Switch (109) on left-side RAISE/LOWER Lever (105).
- (149) Tighten jam nuts (106) and (99).

NOTE

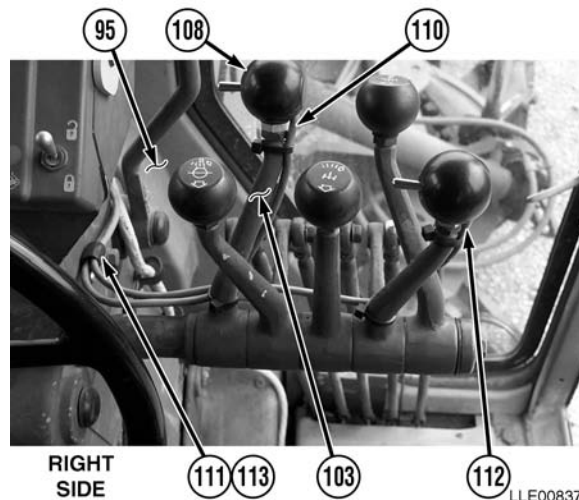
- Install cable ties as required.
- The Power Cables for all switches are routed the same. The Remote Switch on the Articulation Lever is shown.
- Steps (150) through (153) apply to both sides.



LEFT SIDE

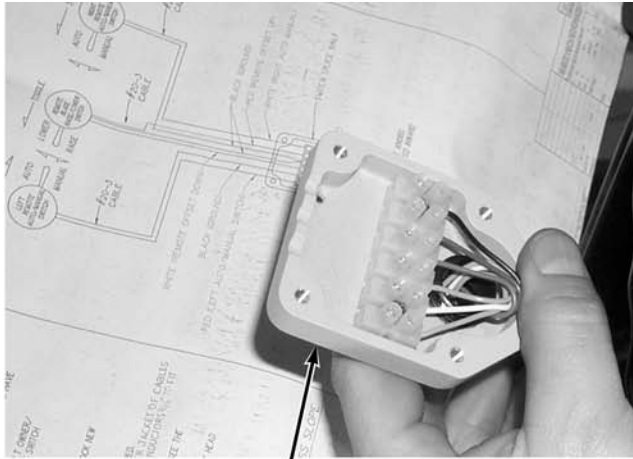
LLE00784

- (150) Route Remote Switch Cable (110) from Remote Switch (108), down Articulation Lever (103), and across to column (95).
- (151) Remove screw (111) from column (95).
- (152) Install Remote Switch Cable (110), R/L Switch Cable (112), Loop Clamp (113), and screw (111) on steering column (95).
- (153) Cut Remote Switch Cable (110) and R/L Switch Cable (112) to 26 in. (66 cm), as measured from Loop Clamp (113).

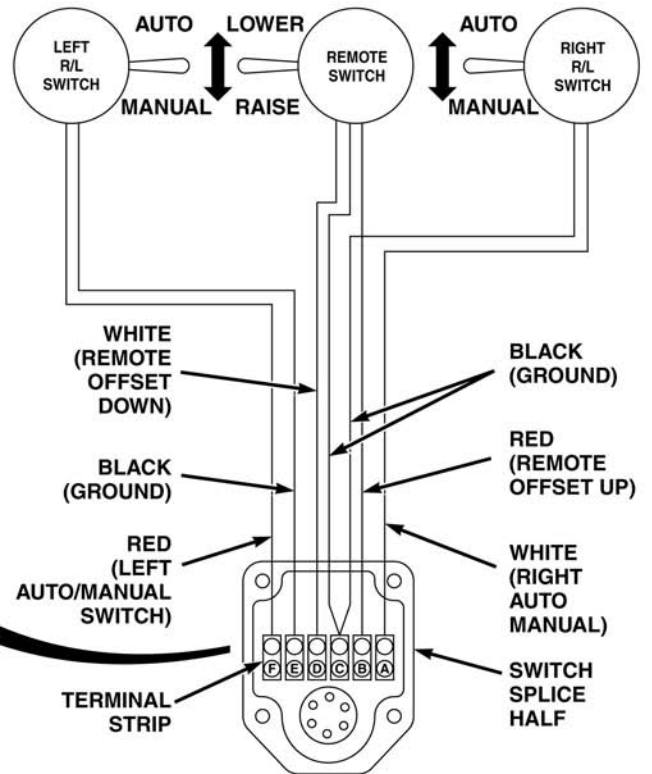


RIGHT SIDE

LLE00837



114



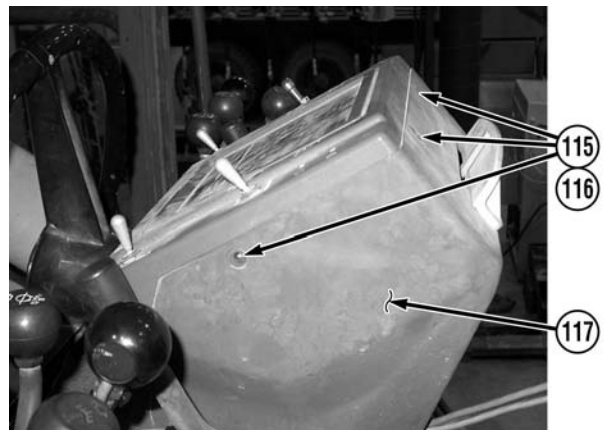
LLE00756

(154) Attach wires to Remote Splice Assembly (114), using wiring schematics.

NOTE

One screw is located on left side of Operator Control Box.

(155) Remove four screws (115) and washers (116) from Monitoring System Control Panel (117).



LLE00757

TM 5-6675-348-13&P

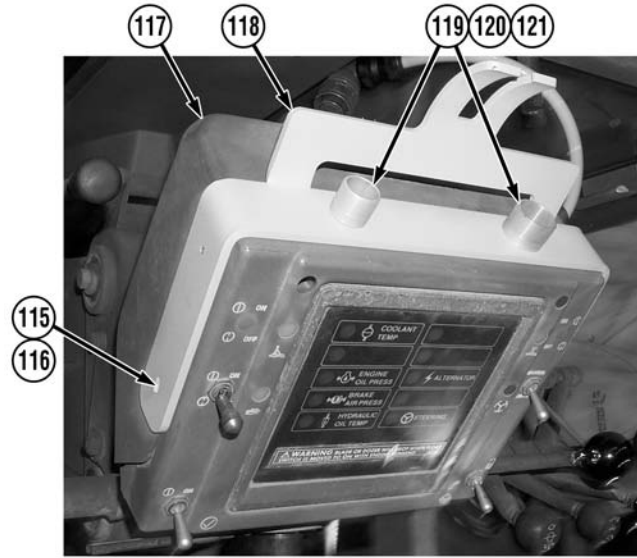
(156) Install Control Box Mounting Bracket (118) on Monitoring System Control Panel (117) with two screws (115) and washers (116).

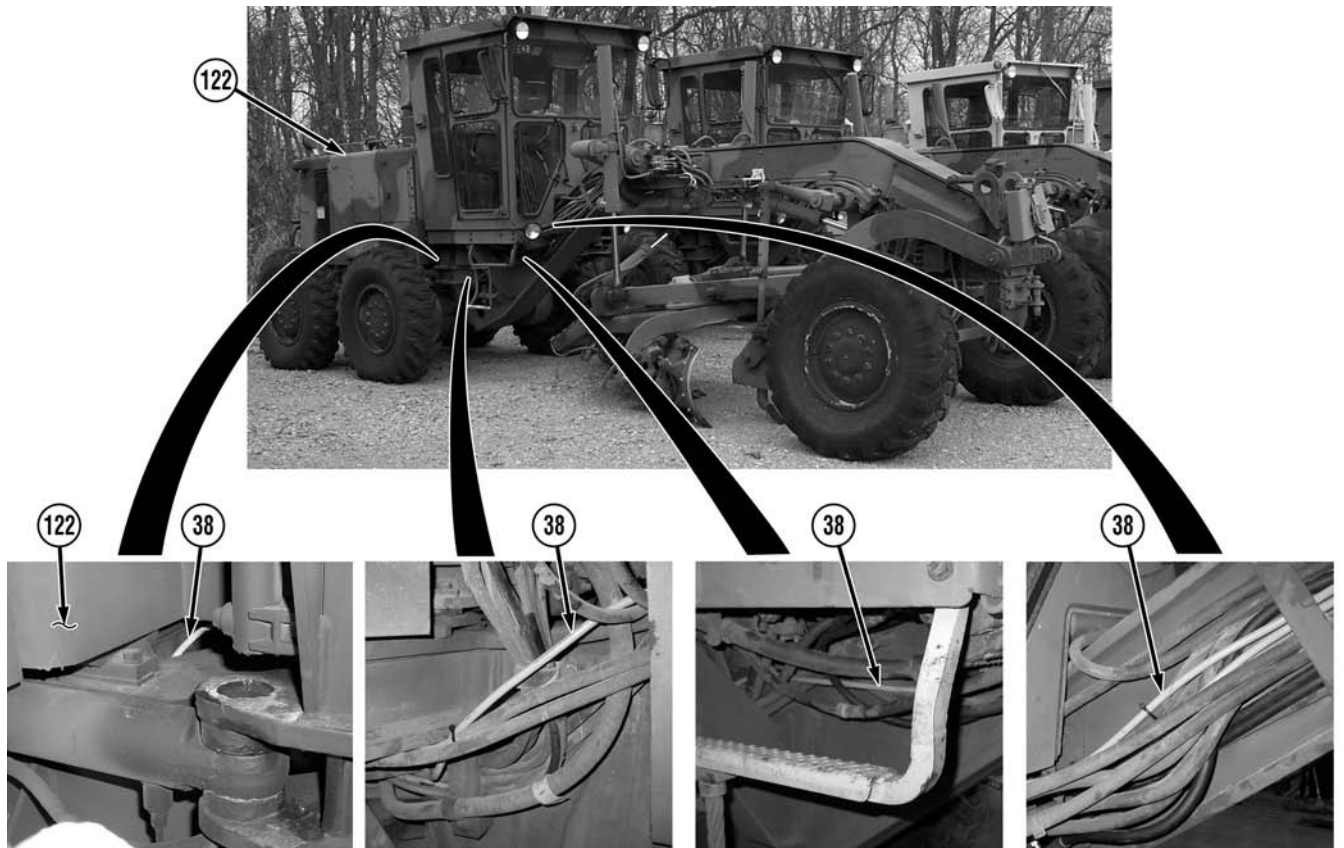
(157) Tighten screws (115).

NOTE

Connector holders are different sizes. The small Connector Holder is installed on the left and the large Connector Holder is installed on the right.

(158) Install two Connector Holders (119) on Control Box Mounting Bracket (118) with two washers (120) and screws (121).





LLE00759

WARNING

- Remove all jewelry, such as rings, dog tags, bracelets, etc. If jewelry contacts Battery Terminal, a direct short may result in instant heating of tools, damage to equipment, and injury or death to personnel.
- Exercise extreme caution when working under tilt platform. Falling platform could result in serious injury or death to personnel.
- Turn battery disconnect switch OFF prior to performing maintenance in immediate battery area or working on electrical system. Failure to comply can result in electrical shock to personnel or damage to equipment.

CAUTION

To avoid damage to Power Cable, it must be routed through Articulation Joint (following existing electrical cables and hoses).

NOTE

Cable tie as needed.

- (159) Route Main Power Cable (38) under cab, through Articulation Joint, and up through hole under Engine Compartment (122).

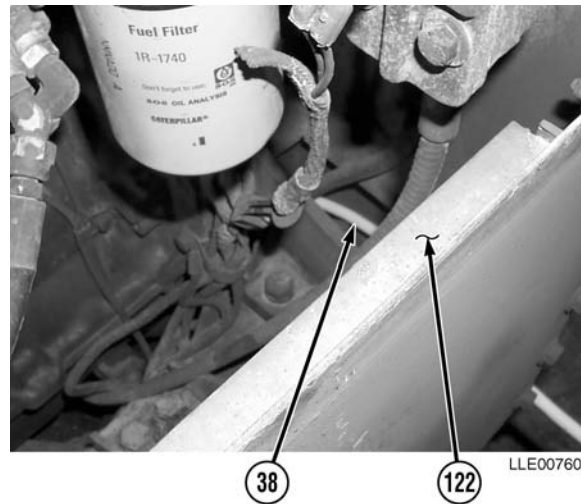
WARNING

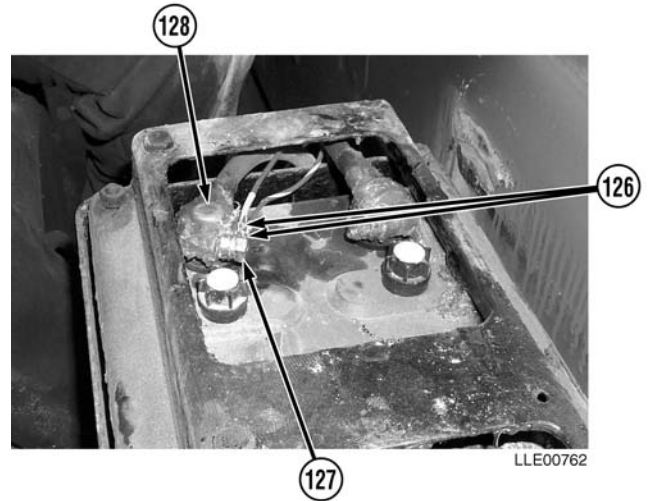
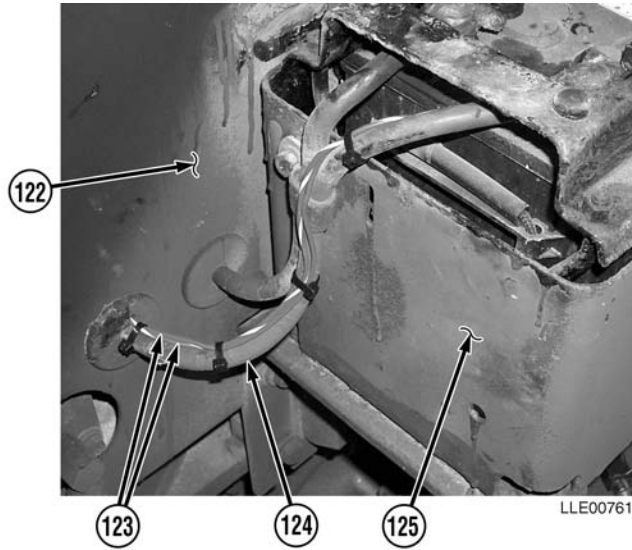
- Battery acid (electrolyte) is extremely harmful. Always wear safety goggles and rubber gloves, and do not smoke when performing maintenance on batteries. Injury will result if acid contacts skin or eyes. Wear rubber apron to prevent damage to clothing.
- Remove all jewelry, such as rings, dog tags, bracelets, etc. If jewelry contacts Battery Terminal, a direct short may result in instant heating of tools, damage to equipment, and injury or death to personnel.
- Exercise extreme caution when working under tilt platform. Falling platform could result in serious injury or death to personnel.
- Turn battery disconnect switch OFF prior to performing maintenance in immediate battery area or working on electrical system. Failure to comply can result in electrical shock to personnel or damage to equipment.
- Always disconnect the negative (-) battery cable before servicing the battery or positive (+) battery cable. Failure to comply can result in electrical shock to personnel or damage to electrical system.
- Do not allow battery cable ends to contact each other or the machine. Failure to comply can result in damage to battery or electrical system.

NOTE

Cable tie as required.

- (160) Route Main Power Cable (38) into Engine Compartment (122).

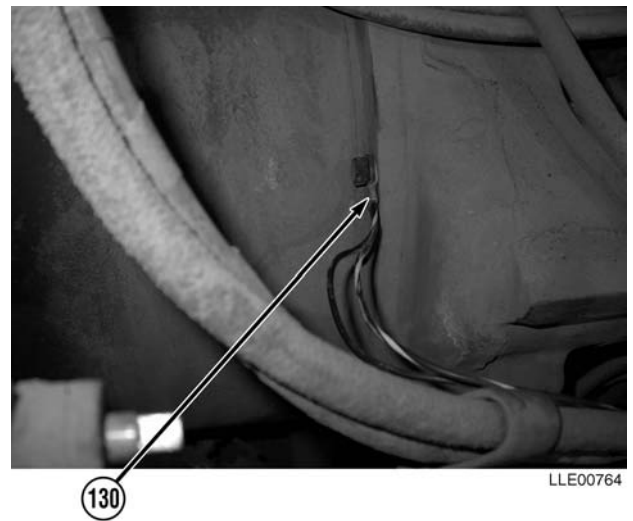




NOTE

Cable tie as required.

- (161) Route two Red Wires (123) through Engine Compartment (122), following path of right-side Battery Cable (124), to right side of Battery Box (125).
- (162) Install two connectors (126) and nut (127) on positive Battery Terminal (128).
- (163) Tighten nut (127).



- (164) Remove bell housing bolt (129).

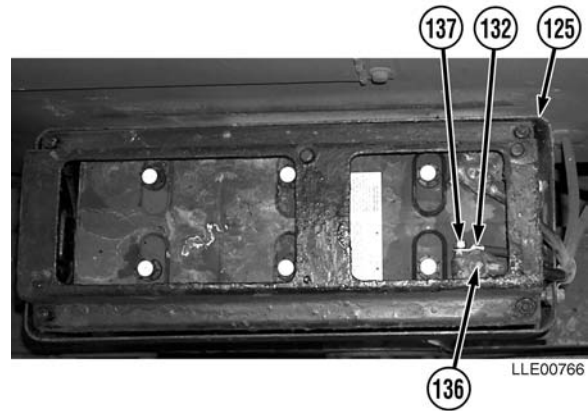
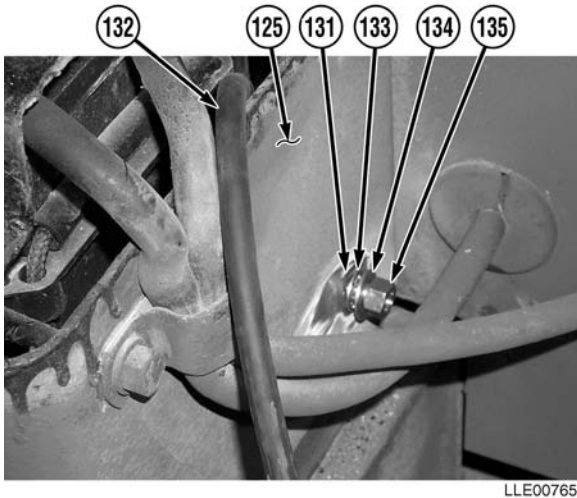
NOTE

For proper operation, a good ground is essential.

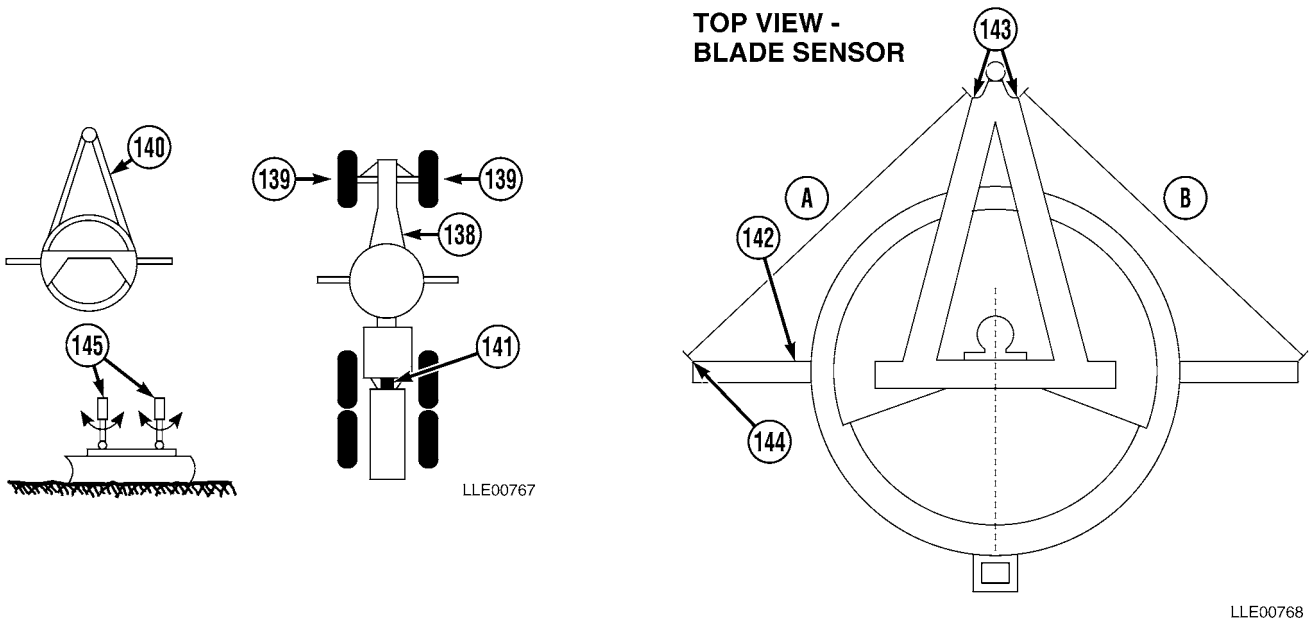
- (165) Install bell housing bolt (129) and Black Wire connectors (130).
- (166) Tighten bell housing bolt (129).

WARNING

- CARC paint contains isocyanate (HDI), which is highly irritating to skin and respiratory system. High concentrations of HDI can produce symptoms of itching and reddening of skin, a burning sensation in throat and nose, and watering of the eyes. In extreme concentrations, HDI can cause cough, shortness of breath, pain during respiration, increased sputum production, and chest tightness. The following precautions must be taken whenever using CARC paint:
- ALWAYS use air line respirators when using CARC paint, unless air sampling shows exposure to be below standards. Use chemical cartridge respirator if air sampling is below standards.
- DO NOT let skin or eyes come in contact with CARC paint. Always wear protective equipment (gloves, ventilation mask, safety goggles, etc.).
- DO NOT use CARC paint without adequate ventilation.
- NEVER weld or cut CARC-coated materials.
- DO NOT grind or sand painted equipment without high-efficiency air purifying respirators in use.
- BE AWARE of CARC paint exposure symptoms; symptoms can occur a few days after initial exposure. Seek medical help immediately if symptoms are detected.



- (167) Remove paint from hole (131) at rear of left side of Battery Box (125).
- (168) Install Voltage Protection Cable (132), internal star-washer (133), flat washer (134), and nut (135) through hole (131) in Battery Box (125).
- (169) Tighten nut (135).
- (170) Apply black spray paint to Diode connection (132).
- (171) Install Voltage Protection Cable (132) on negative Battery Terminal (136) with nut (137).
- (172) Loop all excess Voltage Protection Cable (132) in Battery Box (125).



- (173) Start 130G Grader (138) (TM 5-3805-261-10).
- (174) Park 130G Grader (138) on solid material, such as concrete, asphalt, or compacted soil.
- (175) Align front tires (139) vertically and position A-frame draw bar (140) directly centered under main frame of 130G Grader (138).
- (176) Align 130G Grader (138) so that holes in articulation area (141) are aligned.

NOTE

To simplify the welding procedure, roll blade fully forward.

- (177) Adjust blade (142) and measure distance from front A-frame (143) to outside corners of Moldboard (144). Dimensions (A) and (B) should be the same.
- (178) Float blade until cylinder knuckles (145) are not supporting any weight. Cylinder knuckles (145) should rotate freely.
- (179) Shut OFF 130G Grader (138) (TM 5-3805-261-10).

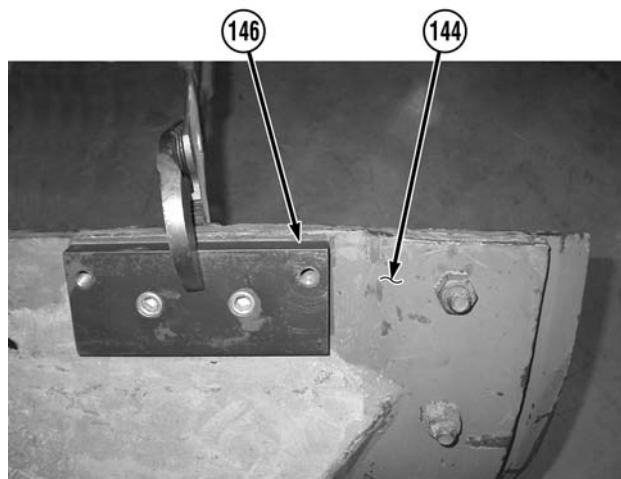
WARNING

- Unsafe welding practices can cause serious injury from fire, explosions, or harmful agents. Allow only authorized personnel to weld or cut metals, and follow safety precautions in TC 9-237. Protective clothing and goggles must be worn, adequate protective equipment must be used, a suitable fire extinguisher must be kept nearby, and requirements of TC 9-237 must be strictly followed. Failure to comply may result in serious injury or death to personnel.
- CARC paint contains isocyanate (HDI), which is highly irritating to skin and respiratory system. High concentrations of HDI can produce symptoms of itching and reddening of skin, a burning sensation in throat and nose, and watering of the eyes. In extreme concentrations, HDI can cause cough, shortness of breath, pain during respiration, increased sputum production, and chest tightness. The following precautions must be taken whenever using CARC paint:
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 - DO NOT use CARC paint without adequate ventilation.
 - NEVER weld or cut CARC-coated materials.
 - DO NOT grind or sand painted equipment without high-efficiency air purifying respirators in use.
 - BE AWARE of CARC paint exposure symptoms; symptoms can occur a few days after initial exposure. Seek medical help immediately if symptoms are detected.

NOTE

Position Tracer[®]/Mast Mounting Plate so threaded holes in Tracer[®]/Mast Mounting Plate face front of Moldboard and setscrews face up.

- (180) Remove paint from area to be welded.
- (181) Weld Tracer[®]/Mast Mounting Plate (146) on both sides of Moldboard (144), approximately 5 3/4 in. (14.60 cm) from end of Moldboard (144) and approximately 1/4 in. (0.64 cm) from top edge of Moldboard (144).
- (182) Remove paint from area to be welded.

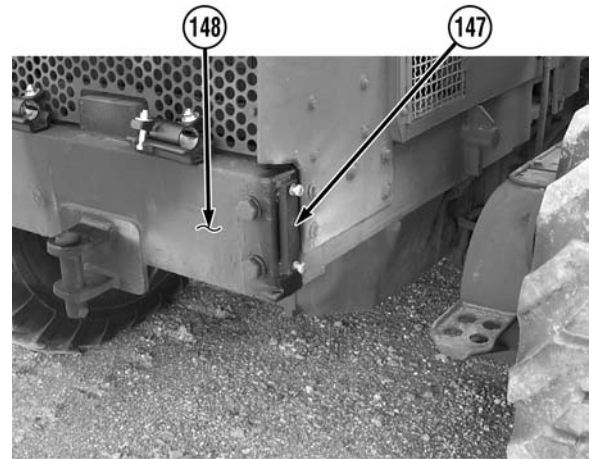


LLE00769

WARNING

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 - DO NOT let skin or eyes come in contact with CARC paint. Always wear protective equipment (gloves, ventilation mask, safety goggles, etc.).
 - DO NOT use CARC paint without adequate ventilation.
 - NEVER weld or cut CARC-coated materials.
 - DO NOT grind or sand painted equipment without high-efficiency air purifying respirators in use.
 - BE AWARE of CARC paint exposure symptoms; symptoms can occur a few days after initial exposure. Seek medical help immediately if symptoms are detected.

- (183) Weld Tracer[®] Mounting Block (147) approximately 1/2 in. (1.3 cm) down and approximately 1/2 in. (1.3 cm) in from rear frame crossmember (148) end.



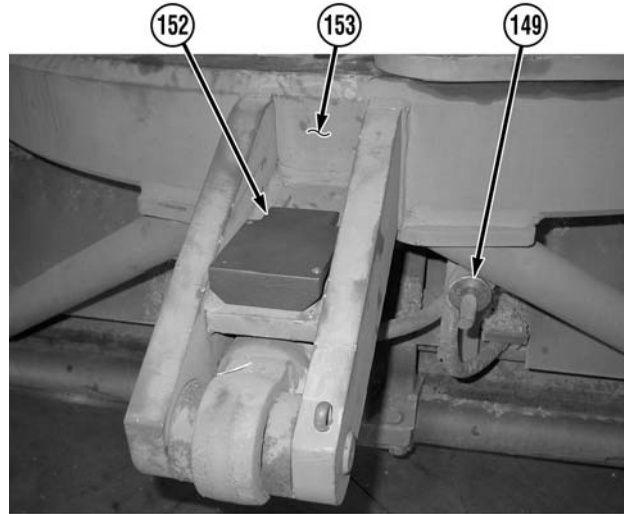
LLE00770

TM 5-6675-348-13&P

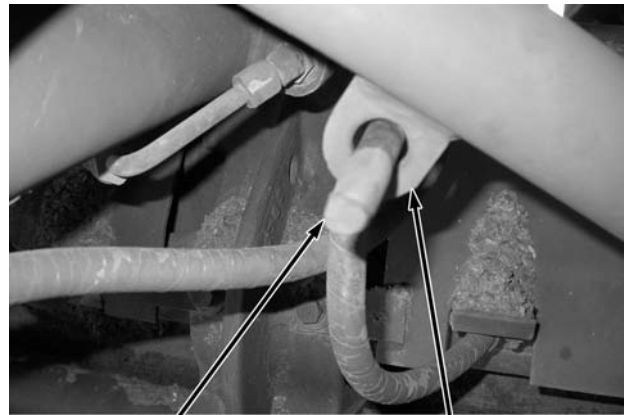
NOTE

Steps (184) through (186) apply to both sides.

- (184) Remove paint from area to be welded.
- (185) Before tack welding washer (149), center rod (150) in existing Hose Tray Rod Bracket (151).
- (186) Weld washer (149) to Hose Tray Rod Bracket (151).

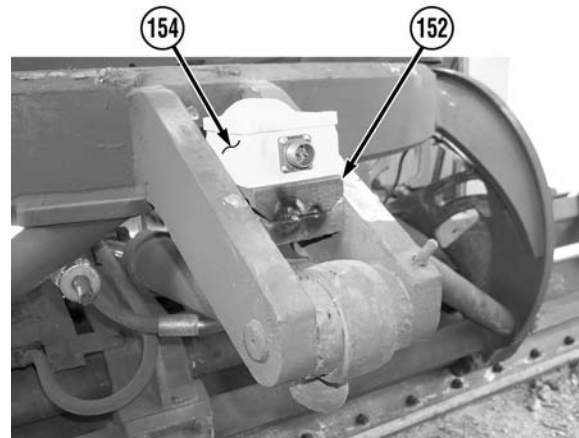


LLE00772



LLE00771

- (187) Install Slope Sensor Mounting Plate (152) approximately 1/4 in. (0.64 cm) from front edge of Frame Pocket (153).
- (188) Remove paint from area to be welded.
- (189) Tack weld rear of Slope Sensor Mounting Plate (152) in frame pocket (153).
- (190) Temporarily install Slope Sensor (154) to Slope Sensor Mounting Plate (152).

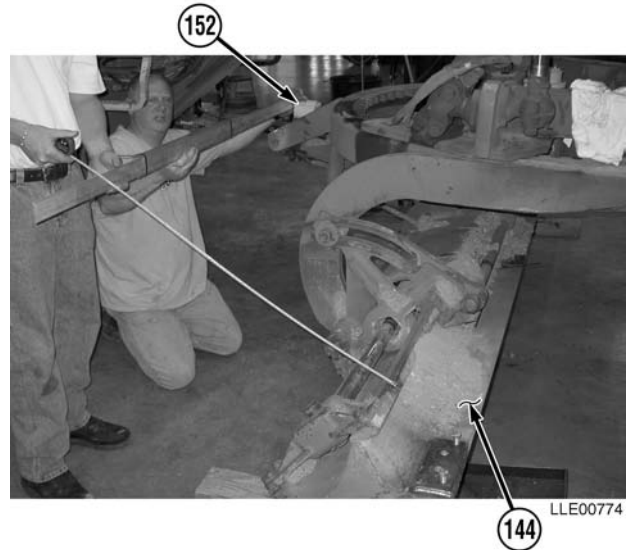


LLE00773

NOTE

- The aid of an assistant is required for Step (191).
- Measurement is adjusted by movement of Slope Sensor Mounting Plate.

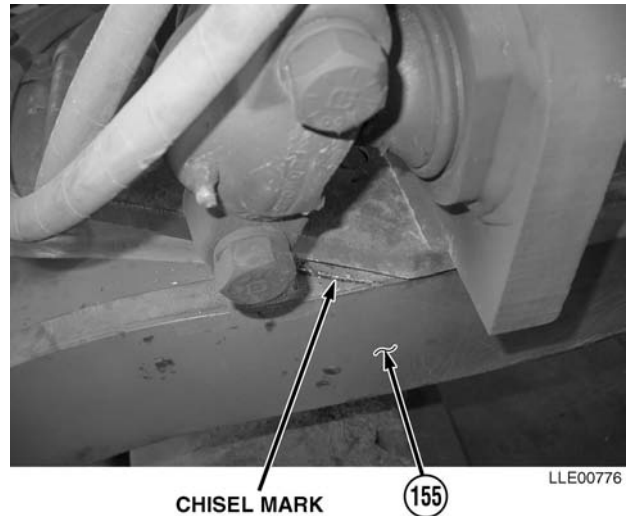
(191) With the aid of an assistant, square Slope Sensor Mounting Plate (152) to Moldboard (144) using straightedge, level, and measuring tape until distance between straightedge and Moldboard (144) is equal within 1/4 in. (0.64 cm) on both sides.



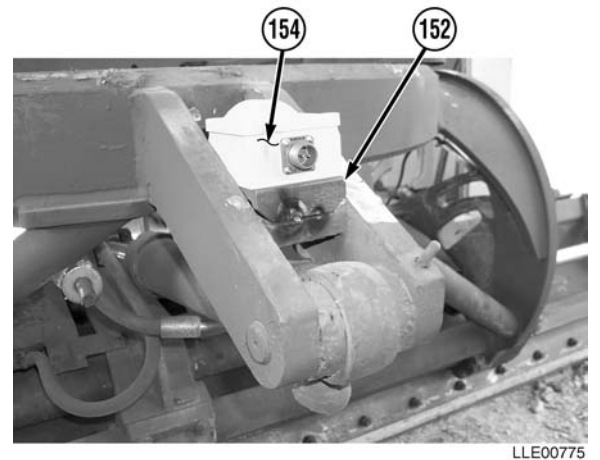
NOTE

Step (192) applies to both sides of vehicle.

(192) Chisel mark on 130G Grader's Rotation Circle (155).



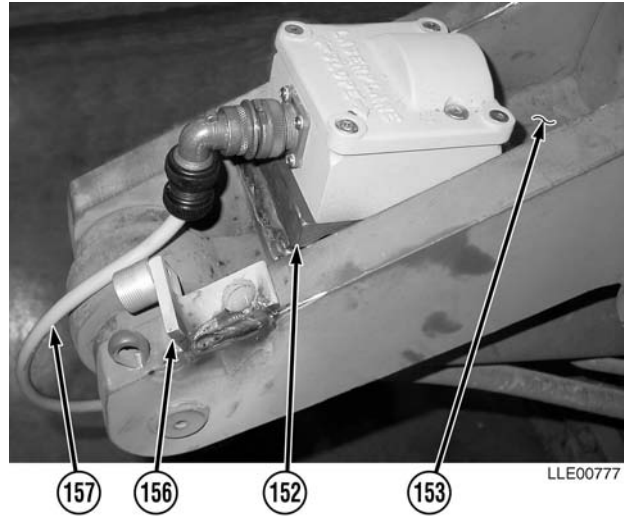
(193) Remove Slope Sensor (154) from Slope Sensor Mounting Plate (152).



WARNING

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- (194) Weld front and back of Slope Sensor Mounting Plate (152) to Frame Pocket (153).
- (195) Position and weld Connector Holder (156) to Frame Pocket (153).



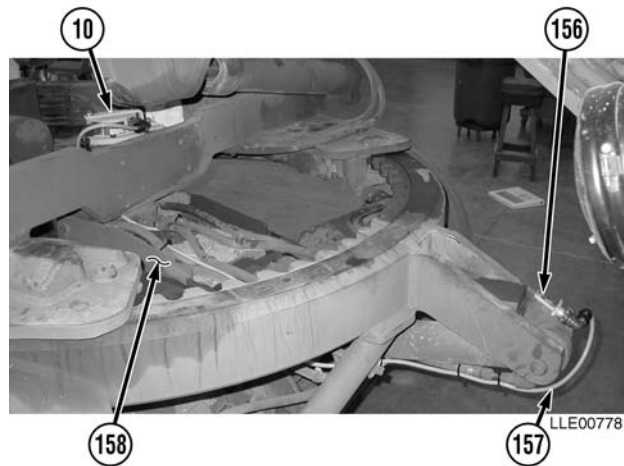
CAUTION

To prevent damage to the Slope Sensor Cable, allow enough slack in Slope Sensor Cable at Circle Rotation Sensor connection to permit circle movement.

NOTE

Allow enough slack at Slope Sensor Connector to reach Blade Slope Sensor.

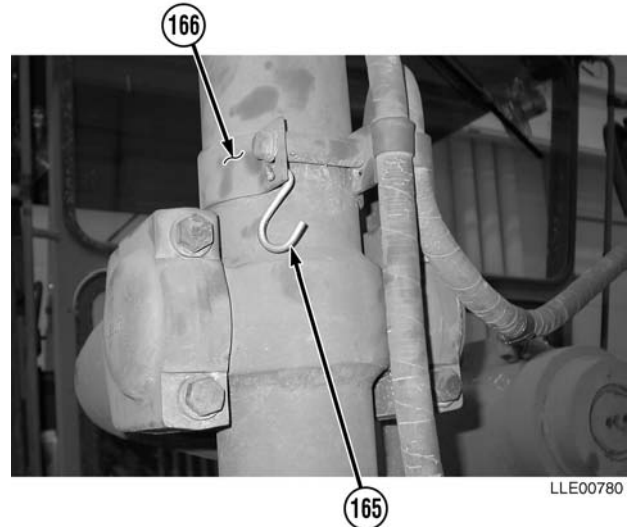
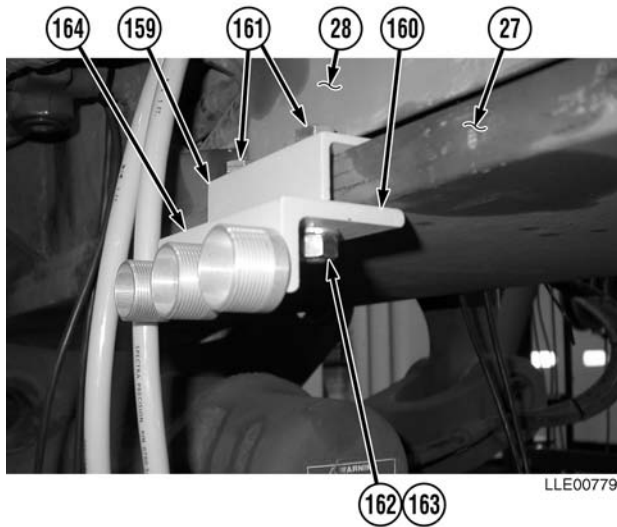
- (196) Install Slope Sensor Cable (157) to Connector Holder (156).



NOTE

Allow enough slack in the Slope Sensor Cable to allow for rotation of the Circle Frame.

- (197) Route Slope Sensor Cable (157) along hydraulic lines on top of Hose Tray (158), to Circle Rotation Sensor (10).
- (198) Connect Slope Sensor Cable (157) to Circle Rotation Sensor (10).
- (199) Cable tie as needed.



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- DO NOT use CARC paint without adequate ventilation.
- NEVER weld or cut CARC-coated materials.
- DO NOT grind or sand painted equipment without high-efficiency air purifying respirators in use.
- BE AWARE of CARC paint exposure symptoms; symptoms can occur a few days after initial exposure. Seek medical help immediately if symptoms are detected.

(200) Prime all new welds with black spray paint.

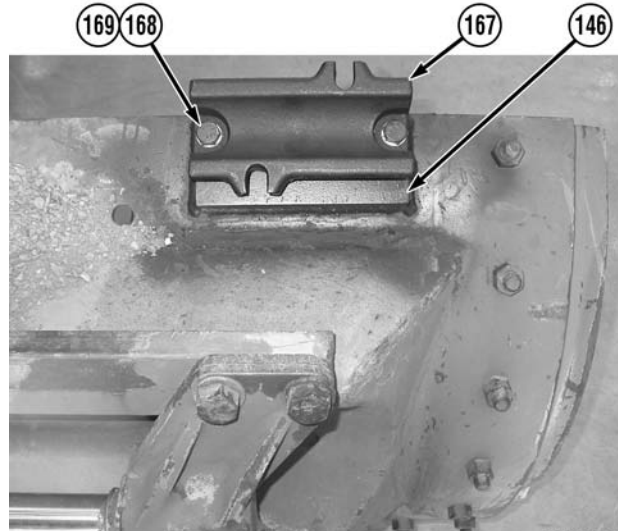
NOTE

Steps (201) through (207) apply to both sides of the 130G Grader. The right side is shown.

- (201) Assemble Remote Box Mounting Clamp (159) to Cable Bracket (160), using two capscrews (161), lockwashers (162), and hex nuts (163).
- (202) Install Connector Holder Assembly (164) on Gooseneck (27) frame. Align with back side of Gooseneck Panel (28).
- (203) Install S-Hook (165) on Blade Lift Hydraulic Cylinder Bracket (166).

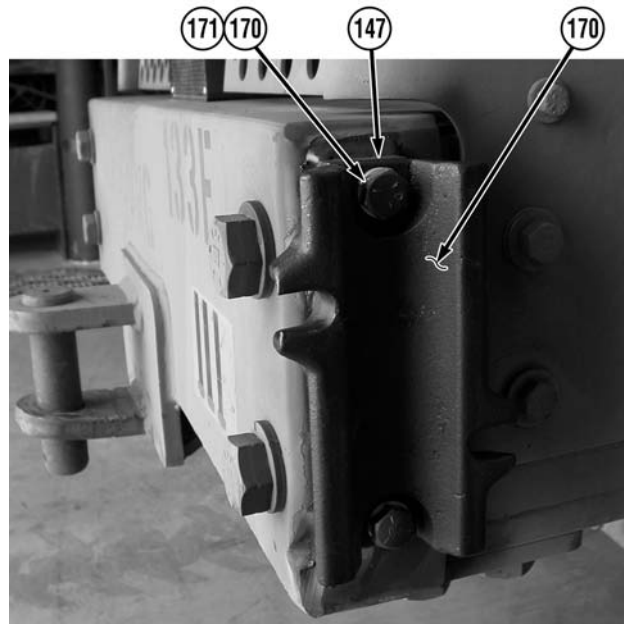
TM 5-6675-348-13&P

- (204) Install Cast Clamp (167) to Tracer[®]/Mast Mounting Plate (146) with two lockwashers (168) and screws (169).



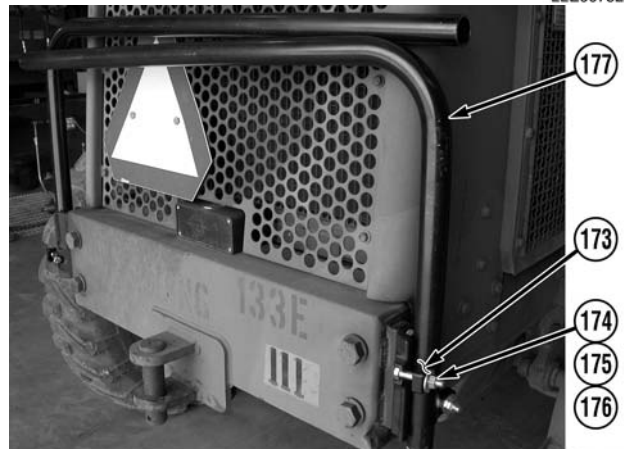
LLE00781

- (205) Install Cast Clamp (170) to Tracer[®]/Mast Mounting Block (147) with two lockwashers (171) and bolts (172).



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- (206) Install Base Clamp (173) to Cast Clamp (170) with two flat washers (174), bolts (175), and nuts (176). Do not tighten.
- (207) Install Tracer[®] Tube (177) to Base Clamp (173).
- (208) Place Tracer[®] Tube (177) in stow position.
- (209) Tighten nuts (176).



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b. Follow-On Maintenance.

- (1) Start Engine (TM 5-3805-261-Series).
- (2) Check for leaks (TM 5-3805-261-10).
- (3) Remove Chocks (TM 5-3805-261-10).
- (4) Calibrate (Para 3-15 and Para 3-16).

END OF TASK

CHAPTER 4

BUCKET-PRO™ SYSTEM (HYEX)

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SECTION I. BUCKET-PRO™ SYSTEM INTRODUCTION



Before operating a HYEX equipped with the Bucket-Pro™ System, be fully aware of machine and job site safety. Refer to appropriate sections of manufacturer's Operating Manual for the HYEX (TM 5-3805-280-10). Read this chapter thoroughly.

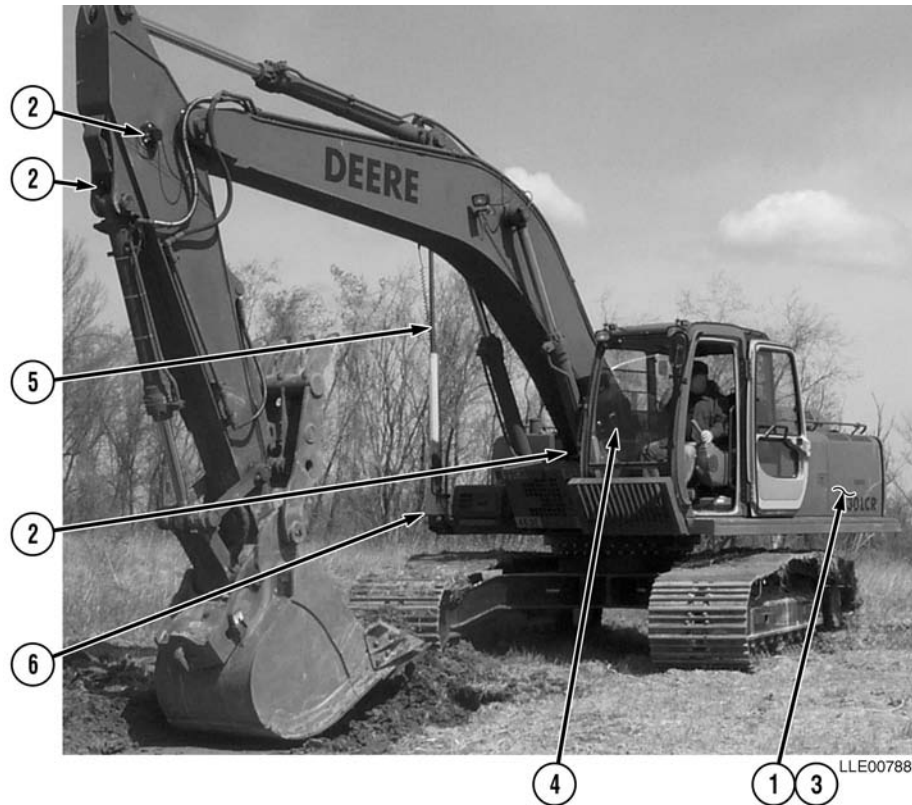
4-1. SCOPE.

This chapter is used for operation, maintenance, and installation of the Bucket-Pro™ System used on the HYEX.

4-2. BUCKET-PRO™ SYSTEM EQUIPMENT CHARACTERISTICS, CAPABILITIES, AND FEATURES.

- a. **Characteristics.** The Bucket-Pro™ System is a depth-of-cut and grade display system used on the HYEX.
- b. **Capabilities.** Installation and calibration on a typical midsized HYEX takes approximately 1 day. The Bucket-Pro™ System is an electromechanical system, so tampering with the hydraulic system of the HYEX is not required.
- c. **Features.** Standard features include a Dual-Axis Tilt Sensor that constantly compensates for frame pitch and roll; Angle Sensors that measure boom, stick, and bucket position; Gravity Sensors that are used on the boom and stick; and an Encoder that measures the bucket angle. A microprocessor control box and a monochrome LCD, for real-time monitoring of bucket teeth, are also featured. The display mounts in the cab and provides graphic information on elevation, depth of cut, percent of grade, and reach. Five push buttons control all modes of operation. A picture of the bucket and stick's position is in front of the Operator at all times. Also shown on the display are numerical values, HI/LO/On-Grade three-light display, and selectable on-grade detector audible tone.

4-3. LOCATION AND DESCRIPTION OF MAJOR COMPONENTS.



NOTE

Bucket-Pro™ System is equipped with a Dual-Axis Tilt Sensor to compensate for frame pitching and rolling during operation. Dual-Axis Tilt Sensor must be allowed to reach operating temperature to function accurately. Warm-up for Dual-Axis Tilt Sensor takes approximately 10 minutes after Bucket-Pro™ System is powered up.

- (1) **REMOTE CONTROL BOX.** Remote Control Box contains microprocessors and software of your Bucket-Pro™ System.
- (2) **ANGLE SENSORS.** Three Angle Sensors measure boom, stick, and bucket angles, and feed data to Remote Control Box.
- (3) **DUAL-AXIS TILT SENSOR.** Dual-Axis Tilt Sensor constantly compensates for movements so that displayed elevation and grade references remain set up as entered. Dual-Axis Tilt Sensor constantly compensates for the EM2E-24 Electric Mast rocking out of plumb as the HYEX pitches and rolls during digging cycle.
- (4) **GRAPHIC DISPLAY.** Graphic LCD display with five buttons interfaces with all Bucket-Pro™ System features and functions.
- (5) **EM2E-24 ELECTRIC MAST.** The EM2E-24 Electric Mast is a telescoping receiver mount driven by an electric motor.
- (6) **SHOCK MOUNT.** Attaches to the Bucket-Pro™ System and protects from vibration.
- (7) **1145-2 TRANSMITTER LASER REFERENCE SYSTEM.** (Not Shown) Bucket-Pro™ System Laser Reference System allows trenching over long distances without having to benchmark Bucket-Pro™ System each time HYEX is moved.

SECTION II. BUCKET-PRO™ SYSTEM PMCS

4-4. PMCS INTRODUCTION.

Preventive Maintenance Checks and Services (PMCS) means systematic caring, inspecting, and servicing equipment to keep it in good condition and to prevent breakdowns. As a Bucket-Pro™ System Operator, your mission is to:

- a. Be sure to perform your PMCS each time you operate the Bucket-Pro™ System. Always do your PMCS in the same order so it becomes a habit. Once you've had some practice, you'll quickly spot anything wrong.
- b. Do your Before PMCS just before you operate the Bucket-Pro™ System. Pay attention to WARNINGS, CAUTIONS, and NOTES.
- c. Do your During PMCS while you operate Bucket-Pro™ System. Pay attention to WARNINGS, CAUTIONS, and NOTES.
- d. Do your After PMCS right after operating Bucket-Pro™ System. Pay attention to WARNINGS, CAUTIONS, and NOTES.
- e. Do your Weekly PMCS once a week.
- f. Use DA Form 2404 or DA Form 5988-E (Equipment Inspection and Maintenance Worksheet) to record any faults that you don't immediately fix.

4-5. PMCS PROCEDURES.

- a. PMCS Table (Table 4-1.) lists inspections and care required to keep your Bucket-Pro™ System in good operating condition. This table is set up so you can do Before and After PMCS while walking around the Bucket-Pro™ System.
- b. The "Interval" column tells you when to do a certain check or service.
- c. The "Procedure" column tells you how to do required checks and services. Carefully follow these instructions.
- d. The "Not Fully Mission Capable If" column tells you when your Bucket-Pro™ System is nonmission capable and why the Bucket-Pro™ System cannot be used.
- e. When something looks wrong that you cannot fix, write down the problem on your DA Form 2404 or DA Form 5988-E. Immediately report the problem to your Supervisor.

- f. When you do your PMCS, you will always need a rag or two. Following are checks that are common to the entire Bucket-Pro™ System.

WARNING

- Degreasing Solvent (MIL-PRF-680, Type II) is toxic and flammable. Keep away from heat or flame. Never smoke when using solvent. The flashpoint for Type II Degreasing Solvent is 141 °F (61 °C). Wear protective goggles, face shield, and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Failure to comply may result in injury or death to personnel.
 - If personnel become dizzy while using cleaning solvent, immediately get fresh air and medical help. If solvent contacts skin or clothes, flush with cold water. If solvent contacts eyes, immediately flush eyes with water and get immediate medical attention. Do not use diesel fuel, gasoline, or benzene (benzol) for cleaning.
 - Adhesives, solvents, and sealing compounds burn easily and give off vapors that are harmful to the skin and clothing. To avoid injury or death, keep away from open fire when using these materials, and use only in well-ventilated areas. If adhesives, solvents, or sealing compounds contact the skin or clothing, wash immediately with soap and water, and rinse thoroughly. Failure to comply may result in injury or death to personnel.
- (1) **Keep It Clean.** Dirt, grease, oil, and debris only get in the way and may cover up a serious problem. Clean as you work. Use Degreasing Solvent (MIL-PRF-680, Type II) on all metal surfaces. Use soap and water when you clean rubber or plastic material.
 - (2) **Rust and Corrosion.** Check Bucket-Pro™ System for rust and corrosion. When any bare metal or corrosion exists, clean surface and apply a coat of paint. Report bare metal or corrosion to your supervisor.
 - (3) **Bolts, Nuts, and Screws.** Check all bolts, nuts, and screws for obvious looseness, missing, bent, or broken condition. You can't check them all with a tool, but look for chipped paint, bare metal, or rust around bolt heads. When you find a bolt, nut, or screw you think is loose, tighten it or report it to your supervisor.
 - (4) **Welds.** Look for loose or chipped paint, rust, or gaps where parts are welded together. When you find a bad weld, report it to your supervisor.
 - (5) **Electric Wires and Connectors.** Look for cracked, frayed, or broken insulation, bare wires, and loose or broken connectors. Tighten loose connectors. Report any damaged wires to your supervisor.
 - (6) When you check operating conditions, check to see if component is serviceable.

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4-6. SHORTENED MAINTENANCE INSTRUCTIONS.

Local conditions of extreme heat, dust, cold, or wetness dictate that service intervals shall be shortened.

4-7. ADDITIONAL MAINTENANCE INSPECTIONS.

Additional maintenance inspections are required for the following reasons:

- a. Prolonged storage. Inspect Bucket-Pro™ System components that have been stored for a period of 3 months or more.
- b. Initial preparation upon receipt.
- c. Preparation for storage.

4-8. PMCS COLUMN ENTRY EXPLANATION.

- a. **Item No. Column.** The checks and services are numbered in interval order showing a walk-around sequence around the Bucket-Pro™ System. Use these numbers in the "Item No." column on DA Form 2404 or DA Form 5988-E when recording faults that you don't immediately fix.
- b. **Interval Column.** This column indicates when the lubrication, check, and/or service should be performed.
- c. **Location, Item to Check/Service Column.** The underlined items listed in this column are divided into groups indicating the portion of the equipment of which they are a part (e.g., brakes, fuel, engine). Under these groupings, a few common words are used to identify the specific item being checked.
- d. **Procedure Column.** This column contains procedures required to perform the checks and services.
- e. **Not Fully Mission Capable If Column.** This column contains the criteria that cause the equipment to be classified as NOT READY/AVAILABLE because of an inability to perform its primary mission. An entry in this column will:
 - (1) Identify conditions that make the equipment not available for readiness reporting purposes.
 - (2) Deny use of the equipment until corrective maintenance has been performed.

4-9. BUCKET-PRO™ SYSTEM OPERATOR'S PMCS TABLE.

Table 4-1. Bucket-Pro™ System Operator's PMCS (Before/After)

Item No.	Interval	Location	Procedure	Not Fully Mission Capable If:
		Item to Check/Service		
1.	Before/After	Electrical Cables	Check all electrical cables and wires to ensure none are frayed, cracked, or exposed.	Frayed, cracked, or exposed wires are evident.
2.	Before/After	Flat Belt Assembly	Check for any dirt, debris, or damage. Clean dirt and debris before operating. Repair damage before operating.	Damaged, broken, or does not move freely.

Table 4-1. Bucket-Pro™ System Operator's PMCS (Before/After) (Cont)

Item No.	Interval	Location	Procedure	Not Fully Mission Capable If:
		Item to Check/Service		
3.	Before/After	Exit Clamp Assembly	Check for any dirt, debris, or damage.	Damaged.
4.	Before/After	Pulley Assembly	Check for any dirt, debris, or damage. Check for tightness. Clean dirt and debris before operating. Repair damage before operating.	Damaged.
5.	Before/After	Cable Encoder Sensor	Check for dirt, debris, or damage. Check for frayed cable.	Damaged. Cable is frayed.
6.	Before/After	Voltage Protection Cable	Ensure cable is not frayed, cracked, or exposed.	Frayed, cracked, or exposed wires are evident.
7.	Before/After	EM2E-24 Electric Mast Assembly	Check for any dirt, debris, or damage. Clean dirt and debris before operating. Repair damage before operating.	Damaged.
8.	Before/After	Graphic Display	Check for any dirt, debris, or damage. Clean dirt and debris before operating. Repair damage before operating.	Damaged.
9.	Before/After	Remote Interface Box	Check for any dirt, debris, or damage. Clean dirt and debris before operating. Repair damage before operating.	Damaged.
10.	Before/After	Arm Pendulous Angle Sensors	Check for any dirt, debris, or damage. Clean dirt and debris before operating. Repair damage before operating.	Damaged.

SECTION III. BUCKET-PRO™ SYSTEM OPERATION

4-10. BUTTON OPERATION.

Five buttons are on the front panel of the Graphic Display. The bottom button (1) turns the system ON/OFF.

Four buttons access Bucket-Pro™ System's operation and setup/calibration functions. Operation modes (2) and calibration are accessed using a sequence of menus. Setup and calibration menus are pass-code protected to guard against system setup tampering.

NOTE

All numerical entry modes have preprogrammed minimum/maximum values that cannot be exceeded.

Menu options are selected by pointing to the entry you want using Up and Down (↑↓) buttons (3), then pressing ENTER button (4). Numerical entries, when required, are also made using Up and Down (↑↓) buttons and are confirmed by pressing ENTER button (4).

4-11. GRAPHIC DISPLAY FEATURES.

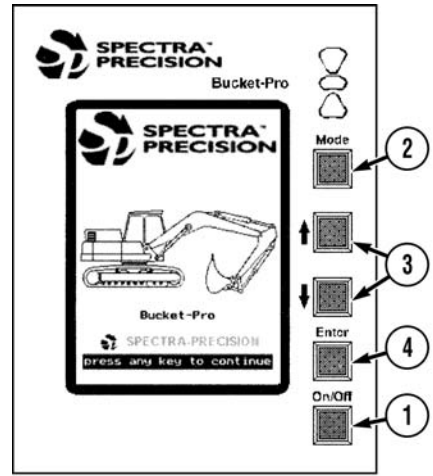
NOTE

Optional features are enabled at installation or by the Operator.

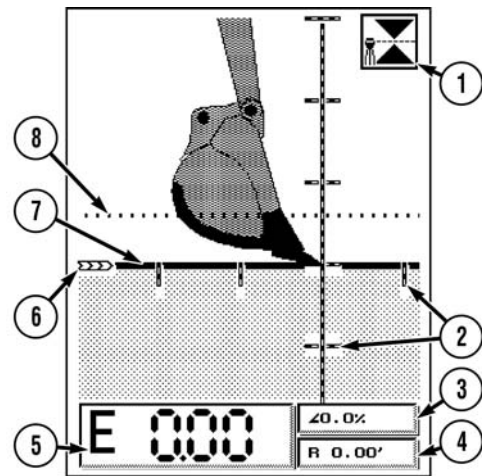
The Graphic Display shows informational data depending on which features and functions are enabled.

Commonly used features include:

- (1) Laser/Mast Indicator
- (2) Distance Markers
- (3) Slope Display
- (4) Reach Display
- (5) Elevation Display
- (6) Grade Reference Indicator
- (7) Main Grade Line
- (8) Cut/Fill Line



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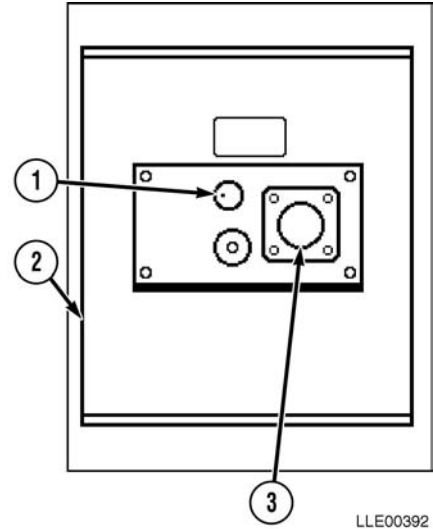
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4-12. GRAPHIC DISPLAY CONTRAST.

NOTE

During very cold weather, the display needs a few minutes to warm up before a viewable contrast level is obtained.

Turning the knob (1) on the back of the Graphic Display (2), next to the electrical connector (3), adjusts the Graphic Display contrast level (brightness) for ambient light conditions and viewing angle.



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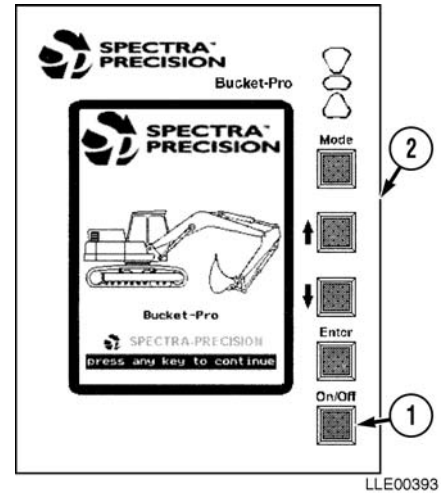
4-13. BUCKET-PRO™ SYSTEM INITIALIZATION.

- (1) Press ON/OFF button (1) on front panel of Graphic Display (2) to power up Bucket-Pro™ System.

NOTE

- Before the Bucket-Pro™ System operates correctly, all Angle Sensors should be referenced for accuracy. The Bucket Sensor reference window appears on the screen.
- Follow instructions in window and fully retract bucket cylinder (TM 5-3805-280-10).

- (2) Press ENTER button to confirm selection.

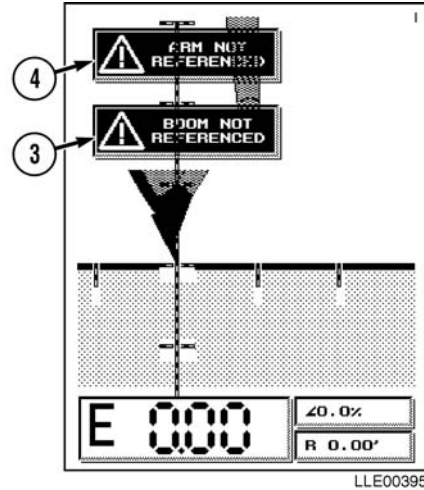


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NOTE

ARM NOT REFERENCED and BOOM NOT REFERENCED flags must be removed or Bucket-Pro™ System will not know where it is in regards to boom and arm sensors. Main operating display appears with two more referencing flags.

- (3) Move boom through reference point (approximately 30 degrees above horizontal) until BOOM NOT REFERENCED flag (3) disappears.
- (4) Move arm through reference point (approximately ± 5 degrees from vertical in each direction) until ARM NOT REFERENCED flag (4) disappears.



4-14. OPERATION EXAMPLES.

The following examples help you understand basic daily setup for frequently used applications, including basic trench/basement excavation and slope excavation. Although many more ways to use the system exist, these examples show how to use the Bucket-Pro™ System.

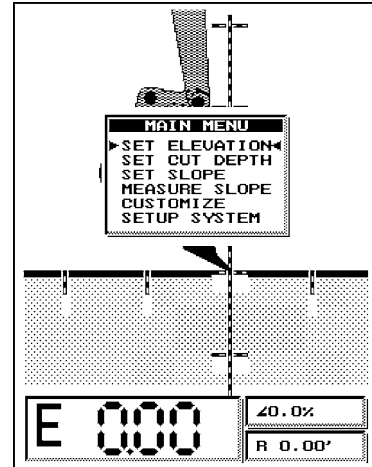
The basis for operating the Bucket-Pro™ System revolves around three well-understood job site principles:

- Reference (Benchmark) Elevation
- Cut Depth
- Percent Slope

4-15. REFERENCE (BENCHMARK) ELEVATION.

Reference (Benchmark) Elevation is a known elevation on a job site. This elevation may be a survey benchmark, sea-level benchmark, or elevation of an existing structure. One of these must be available prior to excavating. A good idea is to check elevation setting whenever possible to ensure accuracy and maintain overall job quality. In absence of a reference benchmark on a job site, Bucket-Pro™ System can be used in an absolute mode by putting bucket's cutting edge on ground and setting a Bench Elevation of 0.00 ft as an artificial reference.

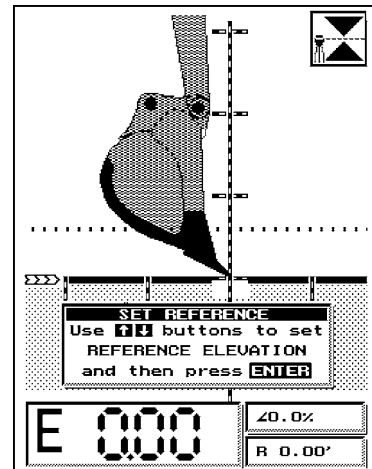
- (1) Press MODE button to access MAIN MENU.
- (2) Point menu arrows to SET ELEVATION mode using Up and Down (↑↓) buttons.
- (3) Press ENTER button to confirm selection.



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NOTE

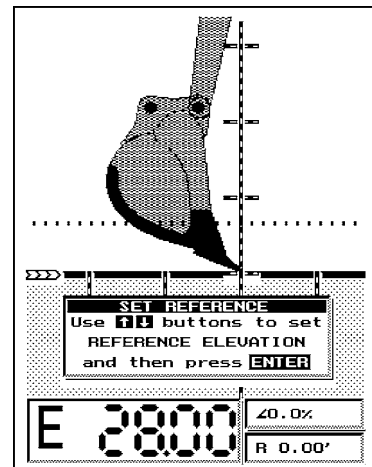
- Current BENCHMARK ELEVATION appears in main elevation window in right corner of display. Instruction menu SET REFERENCE appears in center of screen.
 - Most elevations are staked out by surveyors prior to the start of the job. Stakes have a known elevation or BENCHMARK ELEVATION marked on them.
- (4) Adjust elevation value shown beside “E” to required BENCHMARK ELEVATION using Up and Down (↑↓) buttons.



LLE00281

NOTE

- If bench elevations are not known, perform Step (5).
- (5) Adjust elevation value shown beside “E” to elevation value of 0.00 ft using Up and Down (↑↓) buttons.
 - (6) Press ENTER button to confirm selection.



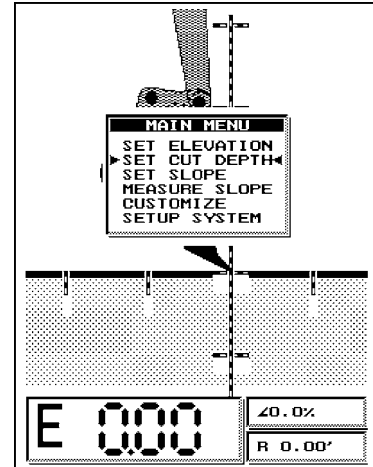
LLE00282

4-16. SET CUT DEPTH.

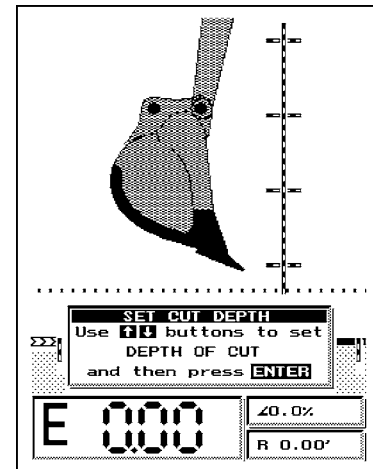
NOTE

- A cut depth (or depth of excavation) is the distance between bench elevation and target grade line (solid line) on Graphic Display.
- Positive depth cuts are above reference elevation and negative depth cuts are below reference elevation.
- Majority of normal excavating uses negative depth cuts.

- (1) Press MODE button to access MAIN MENU.
- (2) Point menu arrows to SET CUT DEPTH mode using Up and Down (↑↓) buttons.
- (3) Press ENTER button to confirm selection.
- (4) Current CUT DEPTH appears in lower left corner of screen after "E." An instruction window SET CUT DEPTH appears in the center of the screen.



LLE00283

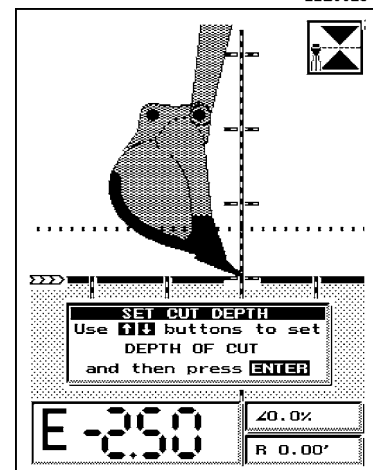


LLE00284

NOTE

- Cut depth value is the vertical distance from benchmark elevation to bottom of trench or basement.
- To restore default cut depth of 0.00 ft, simultaneously press Up and Down (↑↓) buttons.

- (5) Adjust displayed elevation value to correct DEPTH OF CUT using Up and Down (↑↓) buttons.
- (6) Press ENTER button to confirm selected DEPTH OF CUT value. Normal Operating Screen returns.



LLE00285

4-17. SETTING SLOPE EXCAVATION.

Three separate slopes can be programmed into the Bucket-Pro™ System with the press of a button. The slope you select can be changed easily to permit fast multiple-slope excavations during a single setup. Benchmark elevations and cut depths apply to slope excavation the same as to level excavation.

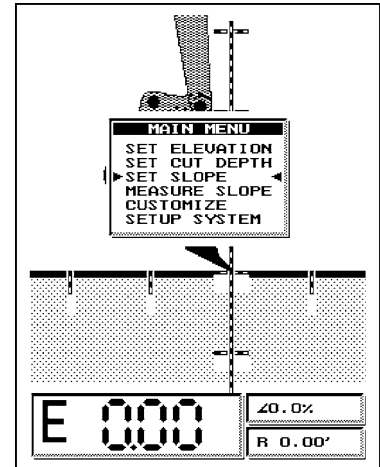
- (1) Press MODE button to access MAIN MENU.
- (2) Point menu arrows to SET SLOPE mode using Up and Down (↑↓) buttons.
- (3) Press ENTER button to confirm selection.

NOTE

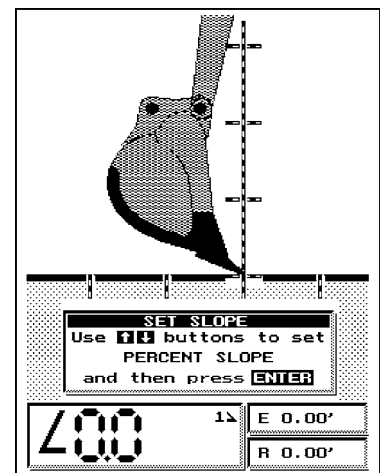
- Slope display < indicates slope is away from HYEX.
 - Slope display > indicates slope is towards HYEX.
- (4) Observe current SLOPE in main elevation window in lower left corner of display.
 - (5) Review SET SLOPE instructions window on main display.

NOTE

- To set positive SLOPE (up and away from HYEX), use Up button. To set negative SLOPE (down and away from HYEX), use Down button.
 - SLOPE being set can be one of three values stored in Bucket-Pro™ System's memory to alternate among them.
 - Active slope is the slope numbered on the Graphic Display that matches the finished grade line.
- (6) Adjust desired percent of grade value (+66% in this example, or <66.0 as it appears on the display) for SLOPE #1 using Up and Down (↑↓) buttons.
 - (7) Press ENTER button to confirm selection and to return to Normal Operating Screen.



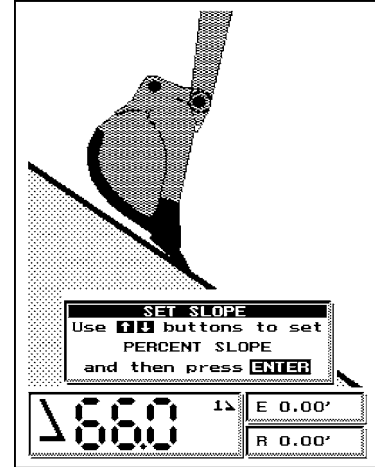
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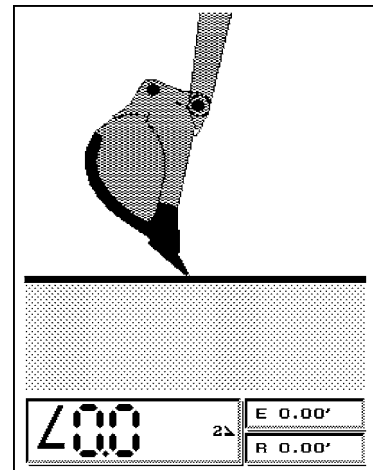
LLE00287

NOTE

- To restore default cut slope of 0.00%, simultaneously press Up and Down (↑↓) buttons.
 - Slope #1 has now been set and Bucket-Pro™ System is under normal operation. If only one slope is needed, which is the case for most trench work, begin excavating.
 - If you are doing multiple slopes, as in canal work, and want to enter the other two slopes in memory, press Down button to set SLOPE #2.
 - Screen changes and a sign appears in main elevation window at current 2> grade setting.
- (8) Repeat Steps (2) through (7), but set SLOPE #2 (-66% in this example, or >66.0 as it appears on display) in lower left corner window. Repeat Steps (2) through (7) to enter a value for SLOPE #3.
- (9) Under normal SLOPE operation, change between SLOPE #1, SLOPE #2, and SLOPE #3 by pressing Up and Down (↑↓) buttons.
- (10) Position bucket's teeth on canal BENCHMARK stake.
- (11) Press ENTER button to select SYSTEM REFERENCING.



LLE00288



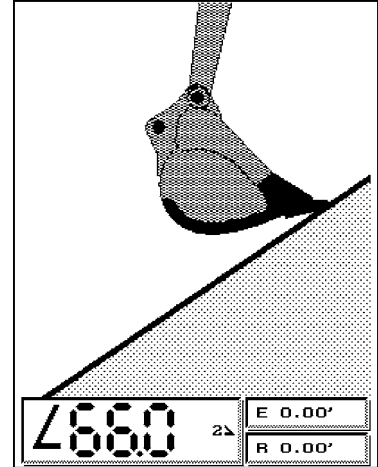
LLE00289

- (12) Select YES, using Up and Down (↑↓) buttons, when “Ref. at initial bench elevation” window appears.

NOTE

Bucket-Pro™ System is now referenced for a canal excavation with +66% on one bank and -66% on the other bank.

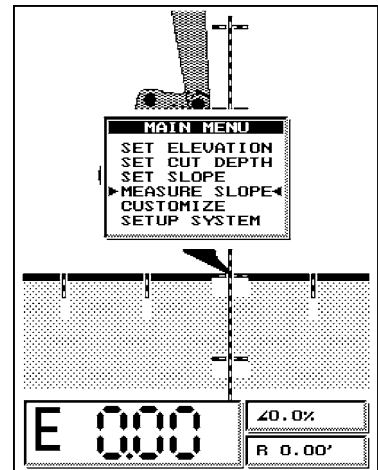
- (13) Press ENTER button to confirm selection.



LLE00290

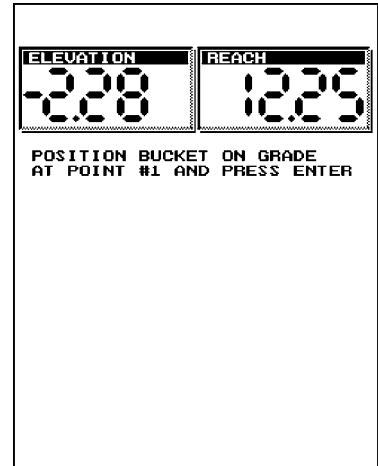
4-18. MEASURE SLOPE.

- (1) Use MEASURE SLOPE to locate unknown grade between two points within reach of HYEX.
- (2) Press MODE button to access MAIN MENU.
- (3) Point menu arrows to MEASURE SLOPE mode using Up and Down (↑↓) buttons.
- (4) Press ENTER button to confirm selection.



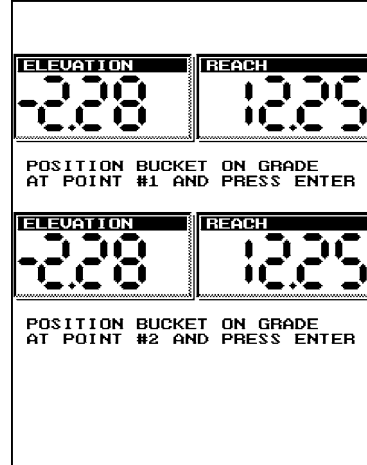
LLE00291

- (5) Position bucket's teeth on any part of slope to be measured.
- (6) Press ENTER button.



LLE00292

- (7) Position bucket's teeth on a second point on slope and press ENTER button.

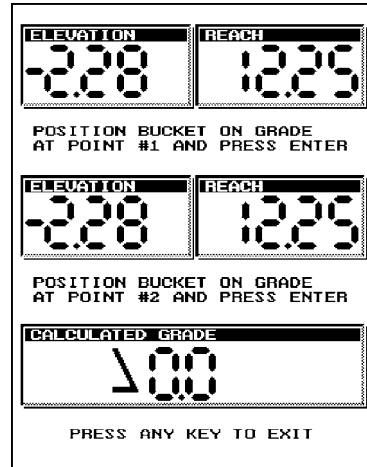


LLE00293

NOTE

CALCULATED GRADE appears in a window at bottom of screen. A 100% slope equals 45 degrees.

- (8) Press any button to exit.

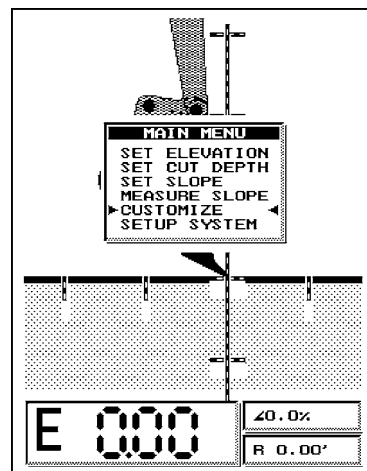


LLE00294

4-19. CUSTOMIZE.

For special applications, CUSTOMIZE menu option in MAIN MENU allows special features and system adjustments to be made. In CUSTOMIZE, you can manually reference nonindexed Bucket-Pro™ system sensors. Use the following procedure to access all CUSTOMIZED mode options.

- (1) Press MODE button to access MAIN MENU.
- (2) Point menu arrows to desired option, in this case CUSTOMIZE, using Up and Down (↑↓) buttons.
- (3) Press ENTER button to confirm selection.



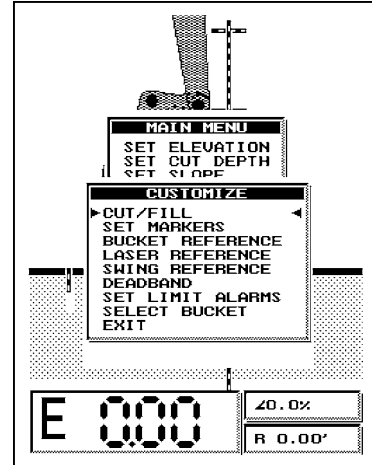
LLE00295

NOTE

- CUSTOMIZE menu appears on Graphic Display.
 - CUSTOMIZE menu contains eight options.
- (4) Point menu arrows to option that you want using Up and Down (↑↓) buttons.

NOTE

To exit CUSTOMIZE menu, scroll down to EXIT, or simply press MODE button. Normal operation resumes with any additional feature you select from CUSTOMIZE.



- (5) Press ENTER button to confirm selection.

4-20. CUSTOMIZE MENU SUMMARY.

NOTE

The following pages provide a detailed description of each selection in CUSTOMIZE menu.

Table 4-2. CUSTOMIZE Menu Options

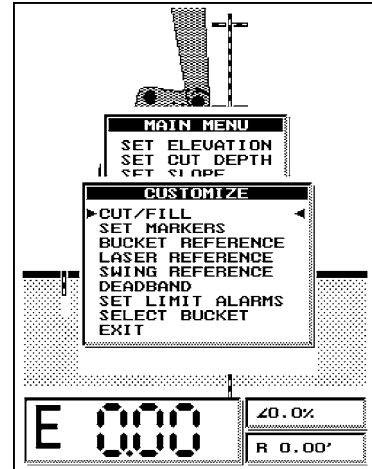
OPTION	DESCRIPTION
Cut/Fill:	Adds additional CUT or FILL line to standard finished-grade line.
Set Markers:	Add user-defined horizontal and vertical distance marker lines on Graphic Display.
Bucket Reference:	Allows manual referencing of Bucket Sensor without going into SETUP mode.
Laser Reference:	Allows manual search for laser beam if it is blocked longer than preset time.
Swing Reference:	Allows manual referencing of swing sensor 0° position, when enabled.*
DEADBAND:	Sets system DEADBAND tolerance and selects audible tone detector style.
Set Limit Alarms:	Set/select height operation limit alarms.
Select Bucket:	Allows selection, addition, deletion, or editing of buckets loaded in memory.
Exit:	Stores selections in memory and returns you to main operating screen.
* This feature is not available.	

4-21. CUT/FILL.

NOTE

CUT/FILL option allows the setup on Graphic Display a secondary dotted grade line above or below main solid finished-grade line. CUT/FILL line can be used to control bedding-layer thickness, top-of-pipe location, or a stepped trench for a catch basin. Use the following steps to set CUT/FILL line:

- (1) Press MODE button to access MAIN MENU.
- (2) Point menu arrows to CUSTOMIZE menu, using Up and Down (↑↓) buttons.
- (3) Press ENTER button to confirm selection.

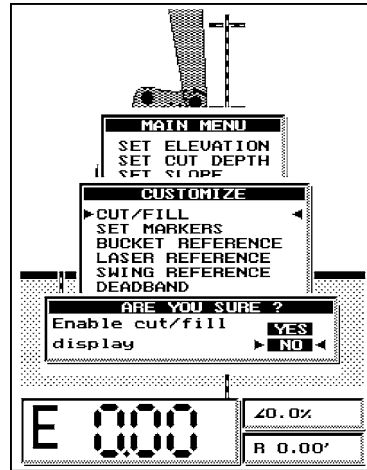


LEE00297

NOTE

ARE YOU SURE? window appears on Graphic Display.

- (4) Using Up and Down (↑↓) buttons, select NO if you want to disable CUT/FILL and return to CUSTOMIZE menu, or select YES to continue.

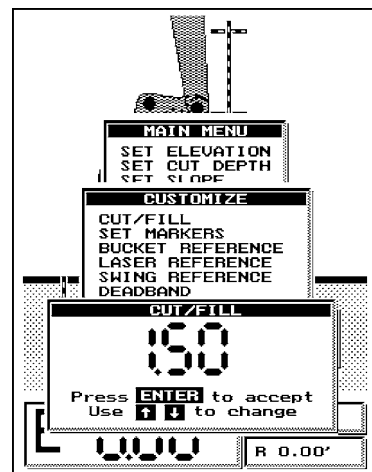


LEE00298

NOTE

- If you chose CUT/FILL, a CUT/FILL dimension window appears.
- A positive CUT/FILL value generates a dotted line above solid finished-grade line.
- A negative CUT/FILL value generates a dotted line below solid finished-grade line.
- To protect against overcut in areas having a lot of underground facilities, a negative CUT/FILL layer can be used in conjunction with overcut alarm (refer to DEADBAND) as a maximum allowable over-dig line.

- (5) Enter layer thickness you want, using Up and Down (↑↓) buttons.
- (6) After selecting value wanted, press ENTER button to return to CUSTOMIZE menu.
- (7) To exit menu, press Up and Down (↑↓) buttons to highlight EXIT and press ENTER button, or press MODE button.

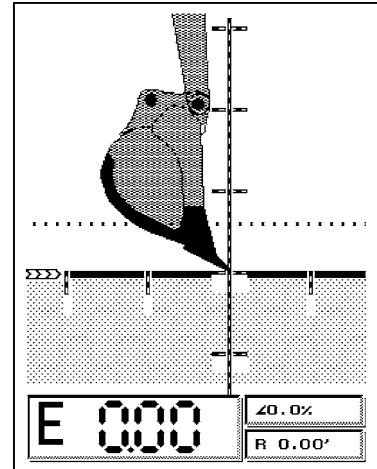


LEE00299

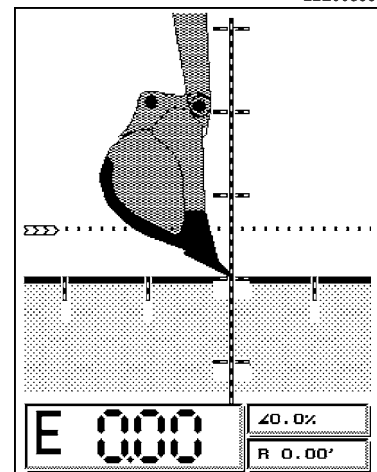
4-22. SWITCHING GRADES LINES.

- (1) If CUT/FILL mode is being used, DEADBAND alarm and HI/LO/On-Grade LED cluster (in upper right corner of display) can be connected to solid finished-grade line or dotted bedding-layer line. Symbol shown indicates which grade line is operating. Use Up and Down (↑↓) buttons to change operating indicator arrow from one grade line to other.

- (2) Elevation and reach values shown on Graphic Display always indicate bucket's cutting edge elevation, regardless of which grade line is selected. Bucket's cutting edge is always referenced to solid finished-grade line at start of operation. If bucket's cutting edge is moved to dotted bedding-layer line and referenced, grade and reach values change to bedding-layer line with respect to same BENCHMARK elevation.



LLE00300

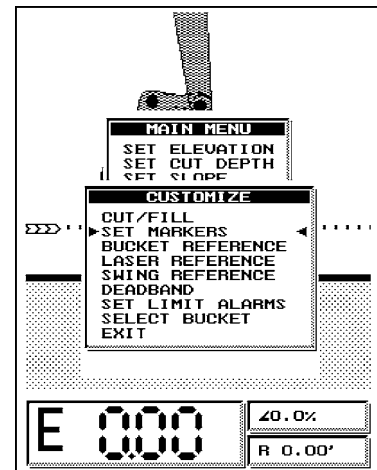


LLE00301

4-23. SET MARKERS.

Distance markers can be set so you can rough-measure distance horizontally or vertically in an excavation. Undercutting required for a pipe bell is an example of a job where rough measuring is helpful. If pipe joint is approximately 6 ft (1.8 m) long and bell protrudes approximately 8 in. (20.3 cm) below finished grade, markers should be spaced approximately 6 ft (1.8 m) apart. These markers show that each time bucket's cutting edge comes to a marker, it is time to undercut for pipe bell. These markers also provide a visual view measurement instead of numbers in lower corner of Graphic Display.

- (1) Press MODE button to access MAIN MENU.
- (2) Point menu arrows to CUSTOMIZE menu using Up and Down (↑↓) buttons.
- (3) Press ENTER button to confirm selection.
- (4) Point menu arrows to SET MARKERS using Up and Down (↑↓) buttons.
- (5) Press ENTER button to confirm selection.



LLE00302

NOTE

ARE YOU SURE? window appears on Graphic Display.

- (6) Select NO if you want to disable SET MARKERS and return to CUSTOMIZE menu, or select YES to continue.

NOTE

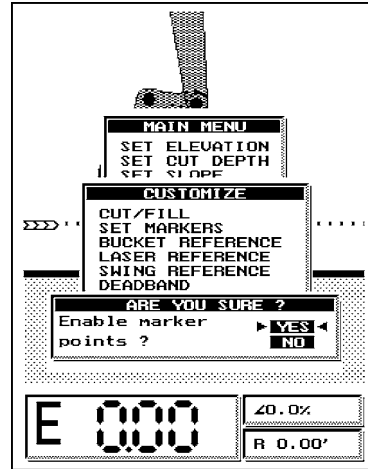
If you chose SET MARKERS, a dimension window labeled MARKER DISTANCE appears.

- (7) Enter MARKER DISTANCE spacing that you want, using Up and Down (↑↓) buttons (2.50 is displayed here).

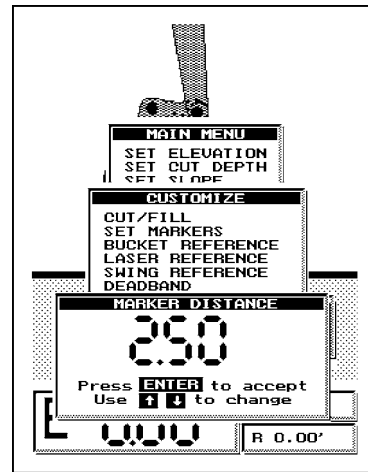
NOTE

Maximum MARKER DISTANCE spacing is 20 ft (6.10 m), minimum MARKER DISTANCE spacing is 1 ft (30.5 cm). All images displayed during normal operation are scaled to bucket size. This length includes viewed distance between markers lines. If buckets are changed, viewed distance between marker lines also changes. Overall grade and reach accuracy is not affected.

- (8) Press ENTER button to select value and return to CUSTOMIZE menu.
- (9) To exit menu, press Up and Down (↑↓) buttons to highlight EXIT and press ENTER button, or press MODE button.



LLE00303

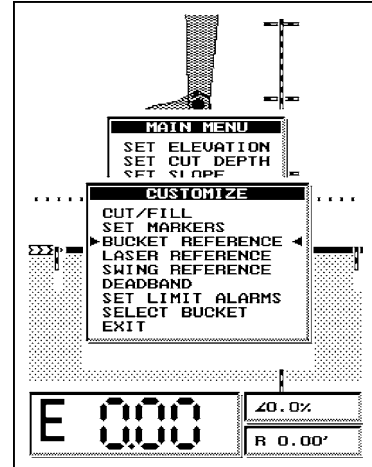


LLE00304

4-24. BUCKET REFERENCE.

BUCKET REFERENCE is used if Encoder wire comes loose. This allows for BUCKET REFERENCE without turning Bucket-Pro™ System Off and On and performing complete Setup procedure.

- (1) Press MODE button to access MAIN MENU.
- (2) Point menu arrows to CUSTOMIZE menu using Up and Down (↑↓) buttons.
- (3) Press ENTER button to confirm selection.
- (4) Point menu arrows to BUCKET REFERENCE using Up and Down (↑↓) buttons.
- (5) Press ENTER button to confirm selection.



LLE00305

NOTE

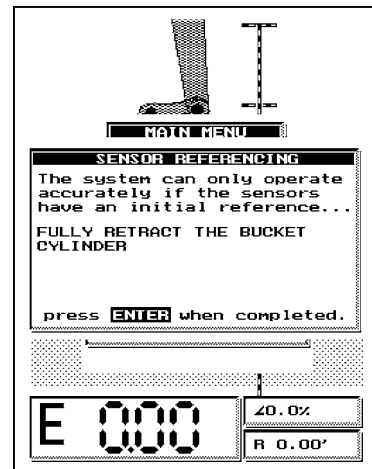
SENSOR REFERENCING window appears.

- (6) Follow instructions in window. Fully retract bucket cylinder, then press ENTER button.

NOTE

After bucket cylinder is referenced, Graphic Display reverts to the MAIN MENU.

- (7) To exit MAIN MENU, press Up and Down (↑↓) buttons to highlight EXIT and press ENTER button, or press MODE button.



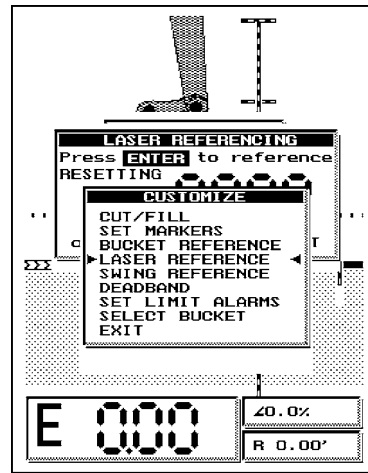
LLE00306

4-25. LASER REFERENCE.

NOTE

LASER REFERENCE provides a means of starting a search for laser. Procedure is used if laser reference at power up was bypassed and Operator needs to use laser at another time during excavation.

- (1) Select LASER REFERENCE from menu.
- (2) Press ENTER button.

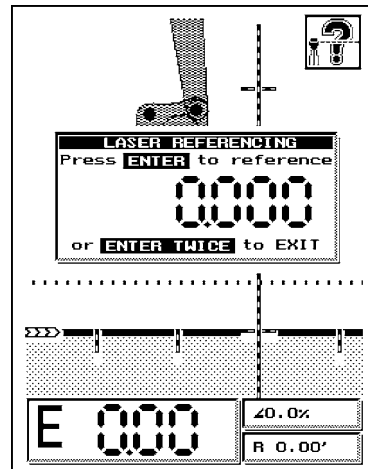


LLE00311

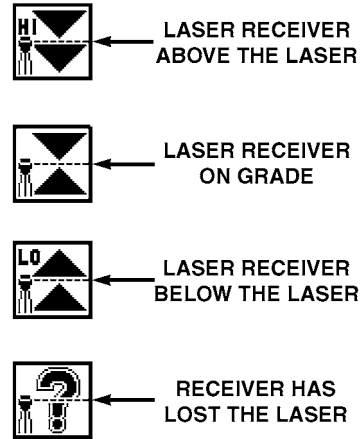
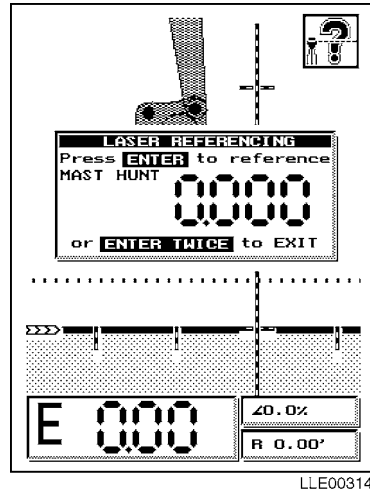
NOTE

LASER REFERENCING will appear. Perform Step (3) to start laser search, or Step (4) to disable laser search.

- (3) Press ENTER button one time to start laser search.
- (4) Press ENTER button two times to disable laser search.



LLE00312



LLE00315

- (5) Observe MAST HUNT in window of Graphic Display.
- (6) Observe mast extension value when laser has been found. Once on-grade is found, the system reverts to MAIN MENU.

NOTE

After LASER REFERENCING has been used, perform all benchmark elevation setting procedures.

- (7) Exit CUSTOMIZE menu when finished with all selections.

NOTE

- When laser lock has taken place, a number appears in LASER REFERENCING window. This value is the amount of mast extension in meters. The value is for installers and has no significance in determining Bucket-Pro™ grade calculations.
- When laser lock-on has taken place, laser beam indicator appears in upper right corner of Graphic Display, and shows status of Laser Reference System at any given time during operation. It has nothing to do with elevation or finished grade indication.

- (8) Check mast movement in upper right corner of display.

NOTE

During each digging cycle, HYEX boom or dipper stick can momentarily block laser beam. When blockage occurs, a question mark (?) appears on Graphic Display. If laser beam is blocked for more than a preset amount of time (default setting is 60 seconds), LASER REFERENCING screen automatically appears and gives instructions for achieving new laser lock-on. Please follow these instructions.

- (9) Observe symbols as EM2E-24 Electric Mast movement proceeds.

NOTE

Work can be done with Laser Reference System in 4 ft (1.22 m) extension range of EM2E-24 Electric Mast before having to rereference. Steeper slopes require shorter distance traveled before reference must be performed again.

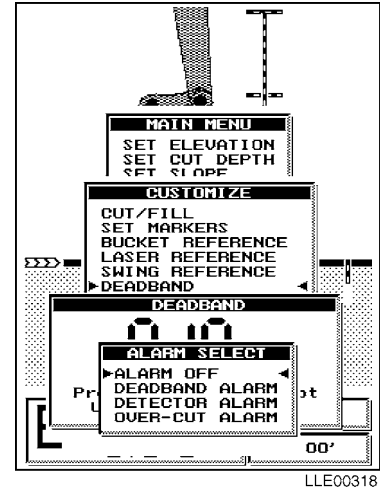
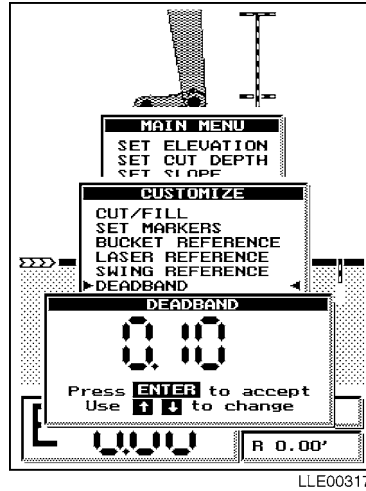
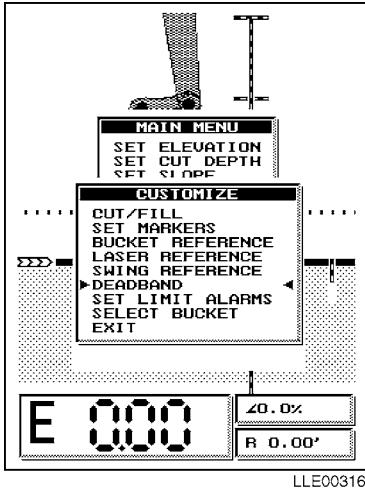
- (10) Perform all Benchmark Elevation procedures (Para 4-15).

4-26. SWING REFERENCE.

This feature is not available.

4-27. DEADBAND.

DEADBAND is the tolerance spread for ON-GRADE indication on the Graphic Display. For close-tolerance work, a smaller DEADBAND is required; for rough excavation, use a wider DEADBAND. While in DEADBAND mode, three types of detector-alarm modes are also selectable.



- (1) Press MODE button to access MAIN MENU.
- (2) Point menu arrows to CUSTOMIZE using Up and Down (↑↓) buttons.
- (3) Press ENTER button to confirm selection.
- (4) Point menu arrows to DEADBAND using Up and Down (↑↓) buttons.
- (5) Press ENTER button to confirm selection.
- (6) Observe that DEADBAND window appears on screen.
- (7) Set DEADBAND using Up and Down (↑↓) buttons.
- (8) Press ENTER button to select that value.
- (9) Observe that window showing alarms appears on screen.

NOTE

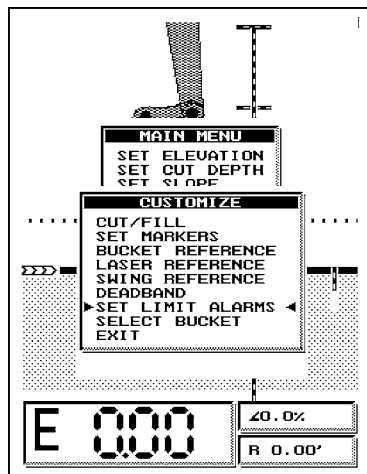
After selecting DEADBAND value, ALARM SELECT window with four choices appears.

- (10) Point menu arrows to choice you want using Up and Down (↑↓) buttons.
- (11) Press ENTER button to confirm selection.
- (12) To exit MAIN MENU, press Up and Down (↑↓) buttons to highlight EXIT and press ENTER button, or press MODE button.

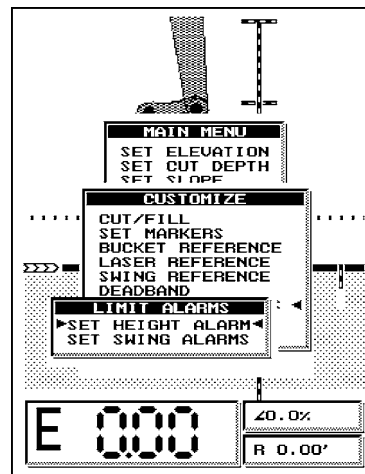
Table 4-3. System Alarms

ALARM	DESCRIPTION
ALARM OFF	Internal audible alarm is turned off.
DEADBAND ALARM	Audible alarm sounds steady tone as long as bucket's cutting edge is in DEADBAND and green on-grade LED lights.
DETECTOR ALARM	Audible tone sounds fast pulsing tone (10 cps) when above DEADBAND. Audible tone sounds a slower pulsing tone (5 cps) when below DEADBAND. Audible tone sounds steadily while within DEADBAND. Actual ON-GRADE indication is + and - setting in DEADBAND menu box. Minimum HI and LOW width is 0.33 ft. (4 in.). Width increases proportionally when DEADBAND is set to over 0.16 ft. (2 in.).
OVER-CUT ALARM	Audible tone sounds steadily when bucket's cutting edge goes below DEADBAND bottom limit.

4-28. SET LIMIT ALARMS.



LLE00319



LLE00320

LIMIT ALARMS warns when close to height or right-of-way obstruction. Limits can be preset based on knowledge of job conditions.

NOTE

If audible height alarm sounds at startup of HYEX with bucket on ground, perform Steps (1) through (6). Otherwise skip to Step (7).

- (1) Press MODE button twice to access MAIN MENU.
- (2) Point menu arrows to CUSTOMIZE, using Up and Down (↑↓) buttons.
- (3) Press ENTER button to confirm selection.
- (4) Point menu arrows to SET LIMIT ALARMS, using Up and Down (↑↓) buttons.
- (5) Press ENTER button to confirm selection.

NOTE

When SET HEIGHT ALARM is selected, ARE YOU SURE? window appears. Selecting NO disables HEIGHT ALARM and Bucket-Pro™ System returns to CUSTOMIZE. Selecting YES allows setting new HEIGHT ALARM.

- (6) Press ENTER button to confirm selection.
- (7) Press MODE button to access MAIN MENU.
- (8) Point menu arrows to CUSTOMIZE using Up and Down (↑↓) buttons.
- (9) Press ENTER button to confirm selection.
- (10) Point menu arrows to SET LIMIT ALARMS, using Up and Down (↑↓) buttons.

NOTE

- SET LIMIT ALARMS window appears.
- LIMIT ALARMS window gives only choice of SET HEIGHT ALARM.

- (11) Press ENTER button to confirm selection.

NOTE

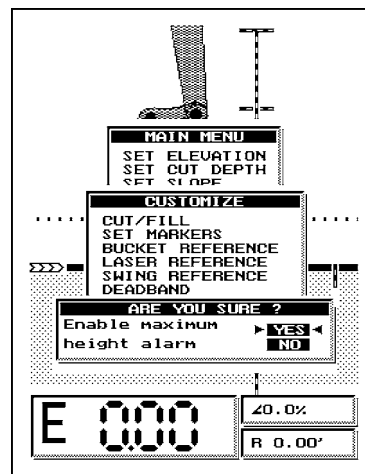
When SET HEIGHT ALARM is selected, ARE YOU SURE? window appears. Selecting NO disables HEIGHT ALARM and Bucket-Pro™ System returns to CUSTOMIZE. Selecting YES allows setting new HEIGHT ALARM.

- (12) Press ENTER button to confirm selection.

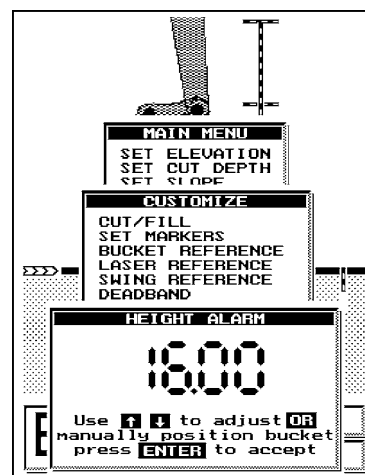
NOTE

HEIGHT ALARM can be set two ways. If HYEX is moved before setting a number, Bucket-Pro™ System uses current real-time data from the Angle Sensors to set the alarm height. The height displayed is either the bucket height or the dipper stick pivot-pin height, whichever is highest. If a button is pressed before any HYEX movement is detected by the Angle Sensors, Bucket-Pro™ System assumes the manual HEIGHT ALARM value is going to be entered and ignores Angle Sensors inputs.

- (13) Manually select height value you want using Up and Down (↑↓) buttons.
- (14) Press ENTER button to confirm selection.
- (15) To exit the menu, press Up and Down (↑↓) buttons to highlight EXIT and press ENTER button, or press MODE button.



LLE00321

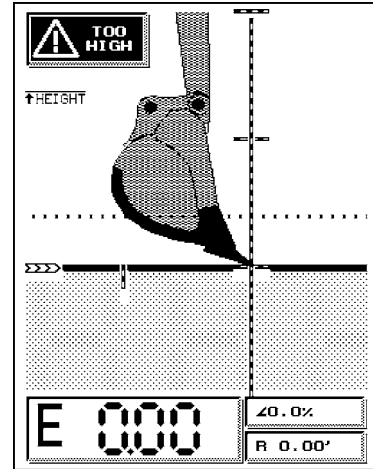


LLE00322

NOTE

When HEIGHT ALARM is selected, a height marker is shown on left side of Graphic Display when HYEX approaches set height limit.

- (16) Observe TOO HIGH window and audible alarm sound when height limit has been reached or exceeded.

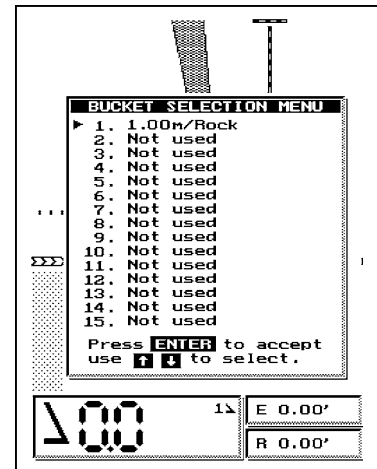


LLE00323

4-29. SELECT BUCKET.

Because ground conditions vary, changing buckets may be needed. Bucket-Pro™ System lets you store up to 15 different bucket sizes in Bucket-Pro™ System memory. Use the following steps when you have to quick-change a bucket:

- (1) Press MODE button to access MAIN MENU.
- (2) Point menu arrows to CUSTOMIZE using Up and Down (↑↓) buttons.
- (3) Press ENTER button to confirm selection.
- (4) Point menu arrows to SELECT BUCKET using Up and Down (↑↓) buttons.
- (5) Press ENTER button to confirm selection.



LLE00324

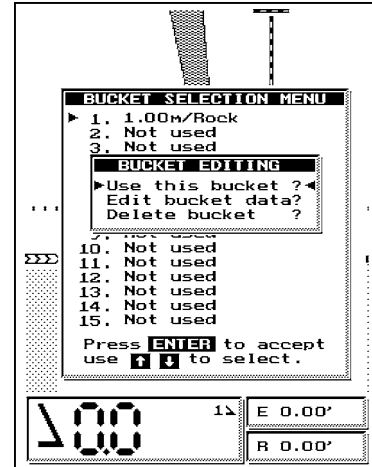
NOTE

BUCKET SELECTION MENU appears, showing all stored bucket sizes. Menu allows you to choose up to 15 different buckets.

- (6) Observe BUCKET SELECTION MENU.
- (7) Point menu arrows to bucket you want using, Up and Down (↑↓) buttons.
- (8) Press ENTER button to confirm selection.

NOTE

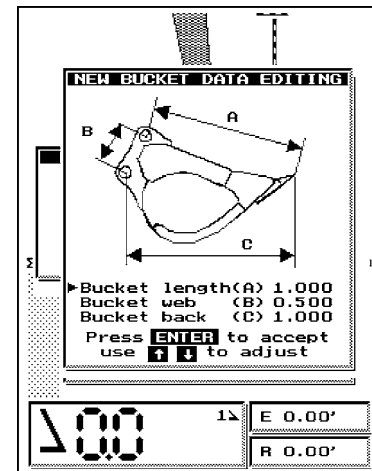
- If bucket selection has a valid bucket entry in it, BUCKET EDITING window appears with three options.
 - Menu lets you select whether bucket listed on menu is used in its current form, edited by changing its dimensions, or deleted to create space on menu.
- (9) Select your choice of bucket editing using Up and Down ($\uparrow\downarrow$) buttons.
 - (10) Press ENTER button to confirm selection.



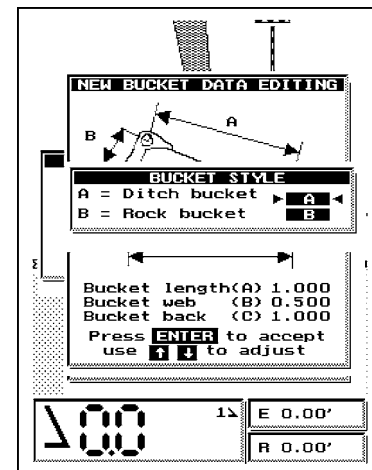
LLE00325

NOTE

- If DELETE BUCKET is chosen, you are returned to Step (9).
 - If EDIT BUCKET DATA is chosen, NEW BUCKET DATA EDITING menu appears on Graphic Display. EDIT BUCKET DATA is used to adjust for tooth wear.
 - If a bucket size on the menu shows NOT USED, add a new bucket at this time.
 - When NOT USED is selected, or EDIT BUCKET DATA selection above, NEW BUCKET DATA EDITING menu appears on Graphic Display.
 - A bucket has three dimensions required in calculating the bucket's cutting-edge elevation. Dimensions are shown as A, B, and C in the NEW BUCKET DATA EDITING window.
- (11) Point menu arrows to dimension you want to add/change using Up and Down ($\uparrow\downarrow$) buttons.
 - (12) Press ENTER button to confirm selection.
 - (13) Enter dimension value using Up and Down ($\uparrow\downarrow$) buttons.
 - (14) Press ENTER button to confirm selection.



LLE00326



LLE00327

NOTE

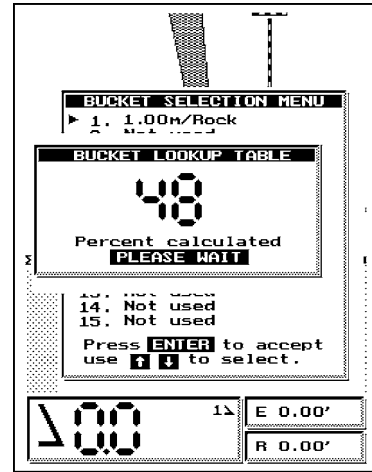
After bucket data has been entered, the BUCKET STYLE window appears, giving a choice of bucket types.

- (15) Point menu arrows to either A, DITCH BUCKET, or B, ROCK BUCKET, using Up and Down (↑↓) buttons.

NOTE

- This selection determines the look of the bucket graphic on the Graphic Display.
- When all bucket data has been entered and the bucket style has been selected, the BUCKET LOOKUP TABLE window, with numbers counting from 0 to 100%, appears.
- Counting can take between 10 to 30 seconds. All switches are deactivated, except the ON/OFF switch, until the window disappears.
- When the counting stops, the Bucket-Pro™ System returns to CUSTOMIZE.

- (16) To exit menu, press Up and Down (↑↓) buttons to highlight EXIT and press ENTER button, or press MODE button.



LLE00328

SECTION IV. BUCKET-PRO™ SYSTEM TROUBLESHOOTING

While Bucket-Pro™ System is a highly accurate system, you may encounter problems as you work in the field. Use this section to troubleshoot your problems. You may want to have a qualified maintenance person troubleshoot and fix any problems.

Table 4-4. Bucket-Pro™ System Fault Index

Fault No.	Description	Page
4-1.	Bucket-Pro™ System/Graphic Display Does Not Turn On.....	4-31
4-2.	Sensors Do Not Work	4-32
4-3.	EM2E-24 Electric Mast Does Not Work.....	4-33
4-4.	Graphic Display Not Responding Properly (Direction, Speed, Location with Respect to Grade)	4-34
4-5.	Graphic Display Does Not Match Machine Geometry (Bucket and/or Arm Not in Correct Position).....	4-35
4-6.	Elevation Value Does Not Match Desired Value	4-36

Table 4-5. Bucket-Pro™ System Troubleshooting

Malfunction	Test or Inspection	Corrective Action
FAULT 4-1. BUCKET-PRO™ SYSTEM/GRAPHIC DISPLAY DOES NOT TURN ON.		
Step 1.	Ensure Power Cable (1) is connected.	Connect Power Cable (1).
Step 2.	Inspect Power Cable (1) for damage.	If Power Cable (1) is damaged, replace Power Cable (1).
Step 3.	Ensure Graphic Display Cable (2) is connected.	Connect Graphic Display Cable (2).
Step 4.	Check Fuse (3) at Remote Interface Box (4).	If Remote Interface Box (4) Fuse (3) is faulty, replace Fuse (3).
Step 5.	Check for 22 to 28 Vdc at Battery Connection (5).	If 22 to 28 Vdc is not found, service Battery.

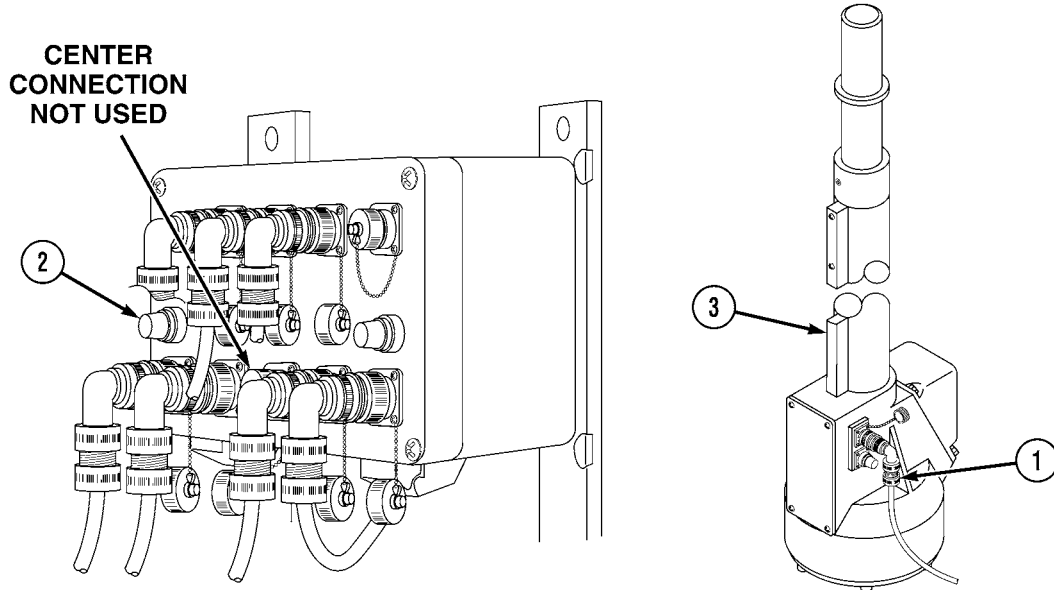
Table 4-5. Bucket-Pro™ System Troubleshooting (Cont)

Malfunction	Test or Inspection	Corrective Action
FAULT 4-2. SENSORS DO NOT WORK.		
<p style="text-align: right;">LLE00685</p>		
Step 1.	Ensure Sensor Cables (1) are connected to proper Connector on Remote Interface Box (2).	Install Sensor Cables (1) on proper Remote Interface Box (2) Connector.
Step 2.	Ensure all Sensor Cables (1) are connected to Sensors (3).	Inspect Sensor Cable (1). Reconnect if disconnected, or replace if damaged.
Step 3.	Sensor(s) (3) are damaged.	Inspect Sensor(s) (3). If damaged, replace Sensor(s) (3).
Step 4.	Ensure Voltage Protection Cable is functioning.	Replace Voltage Protection Cable.
Step 5.	Check Averaging or Normal/Reversed Setup in View Sensor Menu.	Perform Setup Averaging again (Para 4-32).
Step 6.	Dual-Axis Tilt Sensor is not enabled in Setup Parameters in Setup menu (Dual-Axis Tilt Sensor failure only).	Enable-Dual Axis Tilt Sensor (Para 4-32).

Table 4-5. Bucket-Pro™ System Troubleshooting (Cont)

Malfunction	Test or Inspection	Corrective Action
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FAULT 4-3. EM2E-24 ELECTRIC MAST DOES NOT WORK.



- Step 1. Ensure correct model Electric Mast (EM2E-24) is installed.
If wrong Electric Mast is installed, replace with EM2E-24 Electric Mast.
- Step 2. Check Mast Cable (1).
If Mast Cable (1) is disconnected, reconnect Mast Cable (1).
If Mast Cable (1) is defective, replace Mast Cable (1) (Para 4-31).
- Step 3. Check Remote Interface Box Mast Fuse (2).
If Remote Interface Box Mast Fuse (2) is defective, replace Remote Interface Box Mast Fuse (2).
- Step 4. Ensure EM2E-24 Electric Mast (3) is enabled in Setup Parameters.
Perform System Calibration (Para 4-32).

Table 4-5. Bucket-Pro™ System Troubleshooting (Cont)

Malfunction	Test or Inspection	Corrective Action
FAULT 4-4. GRAPHIC DISPLAY NOT RESPONDING PROPERLY (DIRECTION, SPEED, LOCATION WITH RESPECT TO GRADE).		
LLE00687		
Step 1.	Ensure Sensor(s) (1) are attached to correct Connector (2) on Remote Interface Box (3).	If incorrect, connect Sensor(s) (1) to proper location.
Step 2.	Sensor(s) (1) damaged.	Inspect Sensor(s) (1). If damaged, replace Sensor(s) (1).
Step 3.	Check Sensor(s) (1) calibration.	If calibration is incorrect, perform System Calibration (Para 4-32).
Step 4.	Check Bucket-Pro™ System benchmark reference.	Set Benchmark Elevation (Para 4-15).
Step 5.	Check Averaging or Normal/Reversed Setup in View Sensor menu.	Perform System Calibration (Para 4-32).

Table 4-5. Bucket-Pro™ System Troubleshooting (Cont)

Malfunction	Test or Inspection	Corrective Action
FAULT 4-5. GRAPHIC DISPLAY DOES NOT MATCH MACHINE GEOMETRY (BUCKET AND/OR ARM NOT IN CORRECT POSITION).		
LLE00688		
Step 1.	Ensure correct bucket is selected in Setup menu.	Select correct bucket.
Step 2.	Ensure Sensor(s) (1) are connected to correct Connector (2) on Remote Interface Box (3).	If incorrect, connect Sensor(s) (1) to proper location.
Step 3.	Sensor(s) (1) damaged.	Inspect Sensor(s) (1). If damaged, replace Sensor(s) (1).
Step 4.	Check Sensor(s) (1) calibration.	If calibration is incorrect, recalibrate (Para 4-32).
Step 5.	Check Encoder Web belt for damage.	If damaged, replace Encoder Web belt.
Step 6.	Check averaging or NORMAL/REVERSED setup in View Sensor menu.	Perform System Calibration (Para 4-32).

Table 4-5. Bucket-Pro™ System Troubleshooting (Cont)

Malfunction	Test or Inspection	Corrective Action
FAULT 4-6. ELEVATION VALUE DOES NOT MATCH DESIRED VALUE.		
Step 1.	Ensure correct bucket is selected in Setup menu.	Select correct bucket.
Step 2.	Check Laser setup.	Perform LASER REFERENCING setup (Chapter 5).
Step 3.	Check Mast mm/count setup in Edit Machine Dimensions setup menu.	If incorrect, reset measurements.
Step 4.	Sensor(s) (1) damaged.	Inspect Sensor(s) (1). If damaged, replace Sensor(s) (1).
Step 5.	Check Sensor(s) (1) calibration.	If calibration is incorrect, recalibrate (Para 4-32).
Step 6.	Check averaging or NORMAL/REVERSED setup in View Sensor menu.	Perform System Calibration (Para 4-32).

SECTION V. BUCKET-PRO™ SYSTEM MAINTENANCE

4-30. BELLY PLATE REMOVAL AND INSTALLATION.

This Task Covers:

a. Remove.

b. Install.

c. Follow-On Maintenance.

INITIAL SETUP

Models

JD 230 LC HYEX

Materials and Parts

None

Tools and Special Tools

Tool Kit, Automotive Maintenance: Common
No. 2, Item 2, Appendix B

Personnel Required

One

Equipment Condition

Engine OFF (TM 5-3805-280-10).
Track chocked (TM 5-3805-280-10).
Batteries disconnected (TM 5-3805-280-10).

a. Remove.

NOTE

All four belly plates are removed the same way. The procedure for one belly plate is shown.

Remove six bolts (1), lockwashers (2), flat washers (3), and belly plate (4).

b. Install.

NOTE

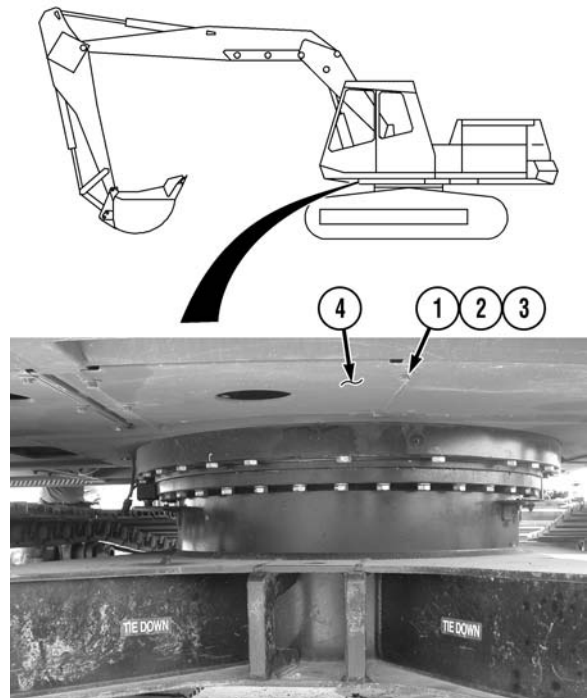
All four belly plates are installed the same way. Procedure for one belly plate is shown.

Install belly plate (4) with six flat washers (3), new lockwashers (2), and bolts (1).

c. Follow-On Maintenance.

- (1) Connect Batteries (TM 5-3805-280-10).
- (2) Remove Chocks (TM 5-3805-280-10).

END OF TASK



LLE00625

4-31. BUCKET-PRO™ SYSTEM INSTALLATION.

This Task Covers:

- a. Arm Sensor.
- b. Boom Sensor.
- c. Tool Box.
- d. Follow-On Maintenance.

INITIAL SETUP

Models

JD 230 LC HYEX

Tools and Special Tools

Tool Kit, Automotive Maintenance, Common No. 2, Item 2, Appendix B
 Tool Kit, Welders, Item 4, Appendix B

Materials and Parts

Gloves, Chemical Oil Protective, Item 4, Appendix F
 Goggles, Industrial, Item 5, Appendix F
 Hook, Pile, Item 6, Appendix F
 Non-Electrical, Safety Wire, Item 7, Appendix F
 Paint, Spray, Black, Item 8, Appendix F
 Ties, Cable, Item 15, Appendix F

Materials and Parts (Cont.)

Label, Warning, Welding/Jump Starting, Item 2, Appendix K
 Ring, Arm Sensor Mounting, (2), Item 2, Appendix K
 Ring, Boom Sensor Mounting, Item 3, Appendix K

Personnel Required

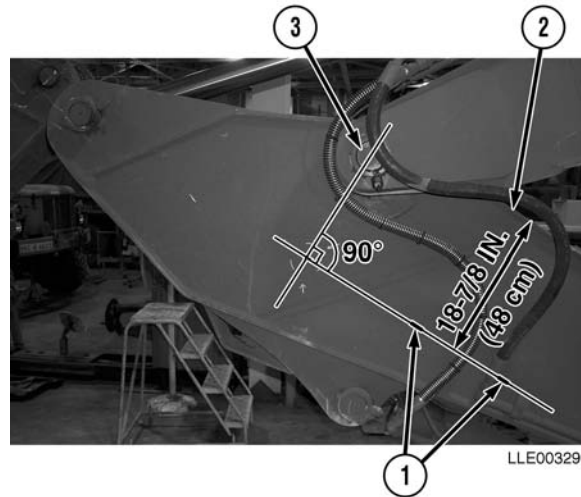
MOS 62B
 MOS 44B

Equipment Condition

Engine OFF (TM 5-3805-280-10).
 Track chocked (TM 5-3805-280-10).
 Batteries disconnected (TM 5-3805-280-10).
 Belly Plates removed as required (Para 4-30).

a. Arm Sensor.

- (1) Measure and mark two points (1) 18-7/8 in. (47.9 cm) from top of Arm (2).
- (2) Using a straightedge, draw a line under Arm Pin (3) using marks made in Step (1).
- (3) Draw a line 90 degrees to the line drawn in Step (2), at center of Arm Pin (3).



NOTE

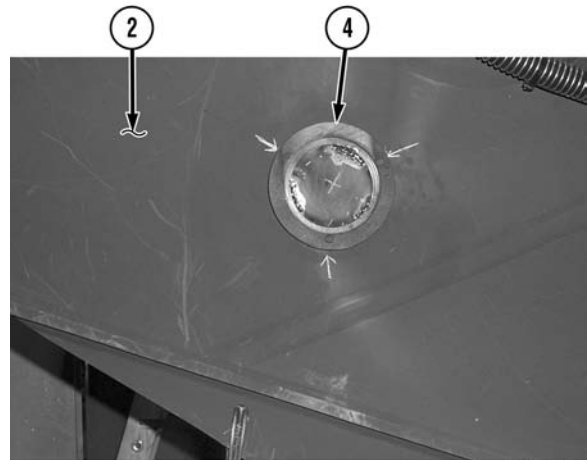
To properly position Arm Sensor for calibration, index one arm sensor mount hole in the 9 o'clock position on the horizontal line drawn in Step (2).

- (4) Center Arm Sensor Mounting Ring (4) on center point of lines drawn in Steps (2) and (3).
- (5) Trace center of Arm Sensor Mounting Ring (4) on Arm (2).

CAUTION

Do not weld on the Arm Sensor Mounting Ring directly under arm sensor mounting holes. Welding under the arm sensor mounting holes may damage the threads.

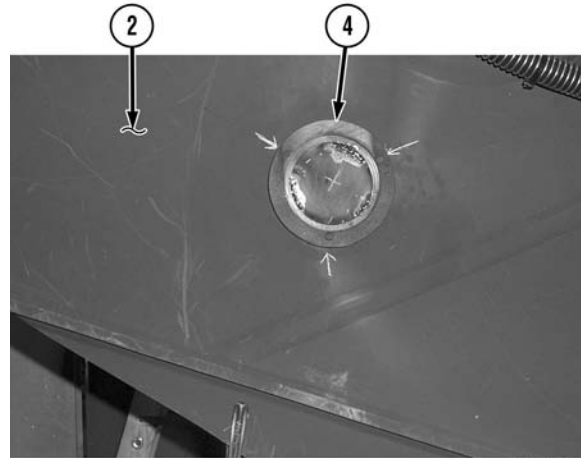
- (6) Mark location of Arm Sensor mounting holes and welding locations on Arm (2).



WARNING

- CARC paint contains isocyanate (HDI), which is highly irritating to skin and respiratory system. High concentrations of HDI can produce symptoms of itching and reddening of skin, a burning sensation in throat and nose, and watering of the eyes. In extreme concentrations, HDI can cause cough, shortness of breath, pain during respiration, increased sputum production, and chest tightness. The following precautions must be taken whenever using CARC paint:
- ALWAYS use air line respirators when using CARC paint, unless air sampling shows exposure to be below standards. Use chemical cartridge respirator if air sampling is below standards.
- DO NOT let skin or eyes come in contact with CARC paint. Always wear protective equipment (gloves, ventilation mask, safety goggles, etc.).
- DO NOT use CARC paint without adequate ventilation.
- NEVER weld or cut CARC-coated materials.
- DO NOT grind or sand painted equipment without high-efficiency air purifying respirators in use.
- BE AWARE of CARC paint exposure symptoms; symptoms can occur a few days after initial exposure. Seek medical help immediately if symptoms are detected.

- (7) Remove paint from area where Arm Sensor Mounting Ring (4) will be welded on Arm (2).



WARNING

Unsafe welding practices can cause serious injury from fire, explosions, or harmful agents. Allow only authorized personnel to weld or cut metals, and follow safety precautions in TC 9-237. Protective clothing and goggles must be worn, adequate protective equipment must be used, a suitable fire extinguisher must be kept nearby, and requirements of TC 9-237 must be strictly followed. Failure to comply may result in serious injury or death to personnel.

NOTE

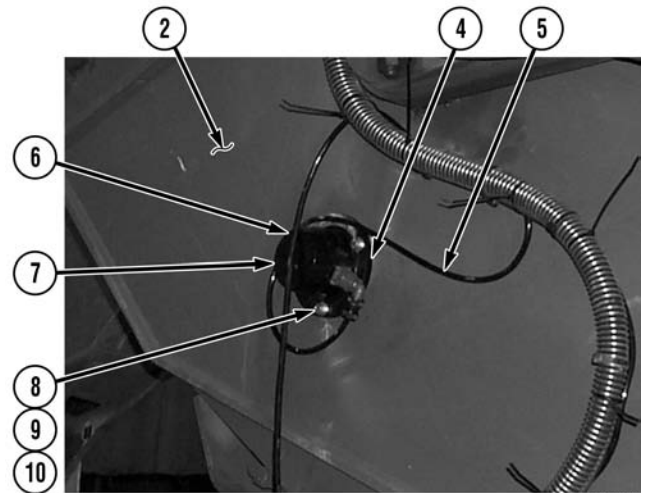
For proper arm sensor calibration, weld within the lower lip of the Arm Sensor Mounting Ring.

- (8) Weld Arm Sensor Mounting Ring (4) to Arm (2).
- (9) Paint Arm Sensor Mounting Ring (4) with black spray paint.
- (10) Connect 40-ft Arm Sensor Cable (5) to Arm Sensor (6).
- (11) Install loop clamp (7) on 40-ft Arm Sensor Cable (5).

NOTE

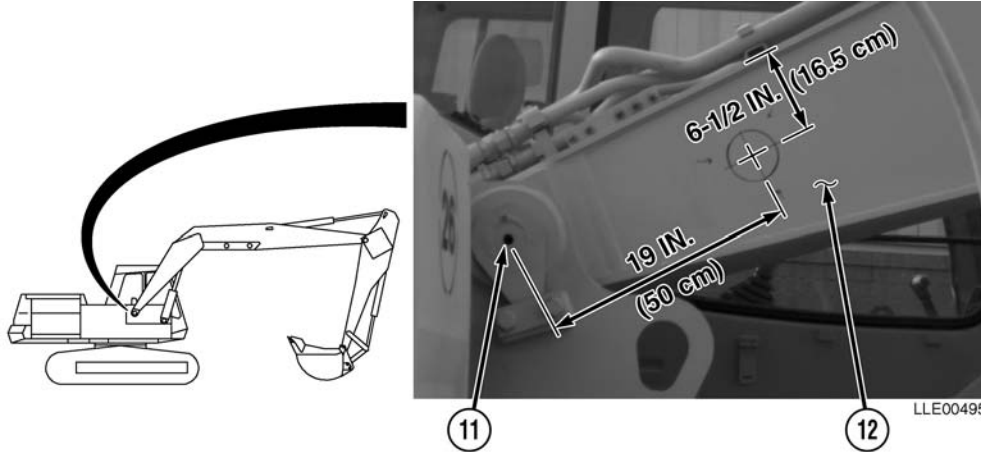
- The Front Arm Sensor mount bolt is also used to attach the loop clamp.
- The flat washer is not installed with the loop clamp.

- (12) Install Arm Sensor (6) to Arm Sensor Mounting Ring (4) with three bolts (8), lockwashers (9), two flat washers (10), and one loop clamp (7).



LLE00343

b. Boom Sensor.

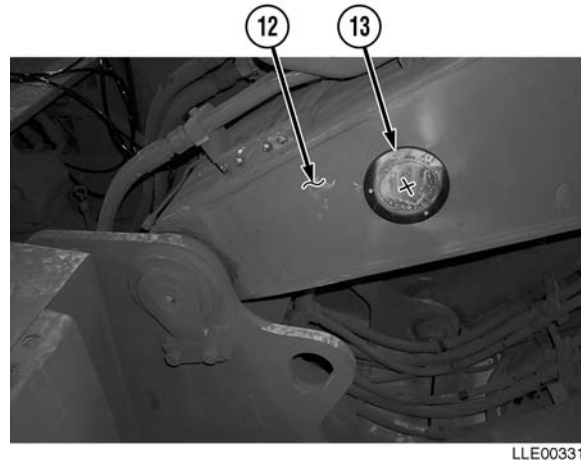


- (1) Measure and mark a point approximately 19 in. (48 cm) from center of Boom Pivot Pin (11) toward front of vehicle.
- (2) Measure and mark two points approximately 6 1/2 in. (16.5 cm) from top of Boom (12).
- (3) Using a straightedge, draw a line using marks made in Step (2).

NOTE

To properly position the Boom Sensor for calibration, index one Boom Sensor Mount Hole in the 9 o'clock position on the horizontal lines drawn in Steps (1) and (2).

- (4) Center Boom Sensor Mounting Ring (13) on marks made in Steps (1) and (2).
- (5) Trace center of Boom Sensor Mounting Ring (13) on Boom (12).
- (6) Mark Boom Sensor Mounting Holes and welding locations on Boom (12).



WARNING

- CARC paint contains isocyanate (HDI), which is highly irritating to skin and respiratory system. High concentrations of HDI can produce symptoms of itching and reddening of skin, a burning sensation in throat and nose, and watering of the eyes. In extreme concentrations, HDI can cause cough, shortness of breath, pain during respiration, increased sputum production, and chest tightness. The following precautions must be taken whenever using CARC paint:
 - ALWAYS use air line respirators when using CARC paint, unless air sampling shows exposure to be below standards. Use chemical cartridge respirator if air sampling is below standards.
 - DO NOT let skin or eyes come in contact with CARC paint. Always wear protective equipment (gloves, ventilation mask, safety goggles, etc.).
 - DO NOT use CARC paint without adequate ventilation.
 - NEVER weld or cut CARC-coated materials.
 - DO NOT grind or sand painted equipment without high-efficiency air purifying respirators in use.
 - BE AWARE of CARC paint exposure symptoms; symptoms can occur a few days after initial exposure. Seek medical help immediately if symptoms are detected.
- (7) Remove paint from area to be welded.

WARNING

Unsafe welding practices can cause serious injury from fire, explosions, or harmful agents. Allow only authorized personnel to weld or cut metals, and follow safety precautions in TC 9-237. Protective clothing and goggles must be worn, adequate protective equipment must be used, a suitable fire extinguisher must be kept nearby, and requirements of TC 9-237 must be strictly followed. Failure to comply may result in serious injury or death to personnel.

CAUTION

Do not weld on the Boom Sensor Mounting Ring directly under Boom Sensor Mounting Holes. Welding on the boom sensor mounting holes may damage the threads.

NOTE

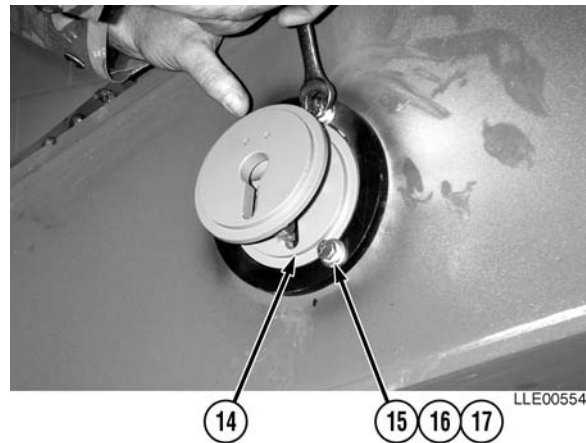
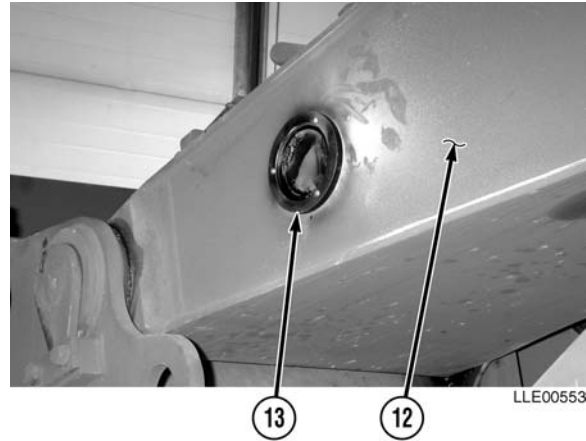
For proper Boom Sensor calibration, weld within the lower lip of the Boom Sensor Mounting Ring.

- (8) Weld Boom Sensor Mounting Ring (13) onto Boom (12).
- (9) Paint Boom Sensor Mounting Ring (13) with black spray paint.

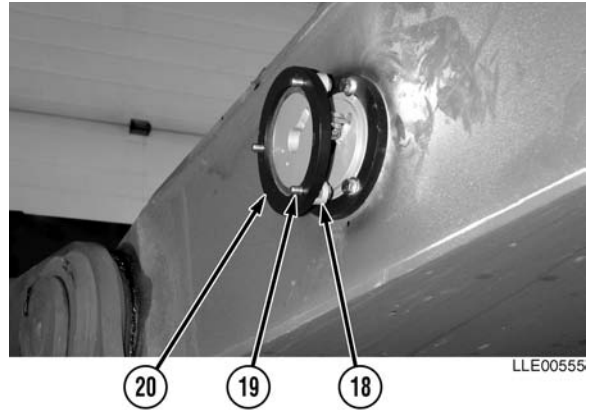
NOTE

To properly position the Boom Sensor for calibration, locate the Boom Sensor swivel mount parallel with the center line of the boom before tightening.

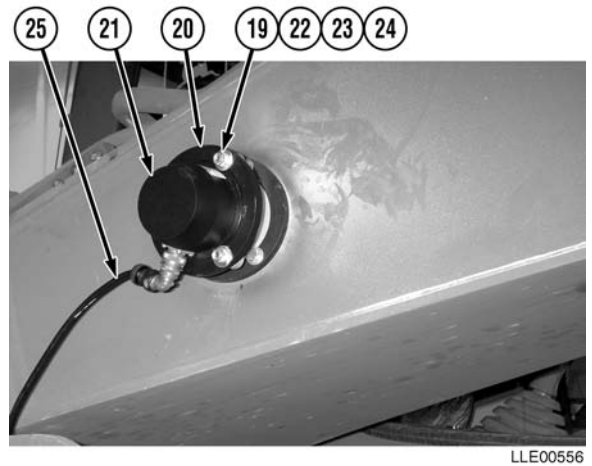
- (10) Install Boom Sensor Swivel Mount (14) with three bolts (15), flat washers (16), and lockwashers (17).
- (11) Tighten bolts (15).



- (12) Install three spacers (18) and bolts (19) on Boom Sensor Mounting Ring (20).



- (13) Install Boom Sensor (21) on Boom Sensor Mounting Ring (20), with three flat washers (22), lockwashers (23), and nuts (24).



- (14) Tighten nuts (24).

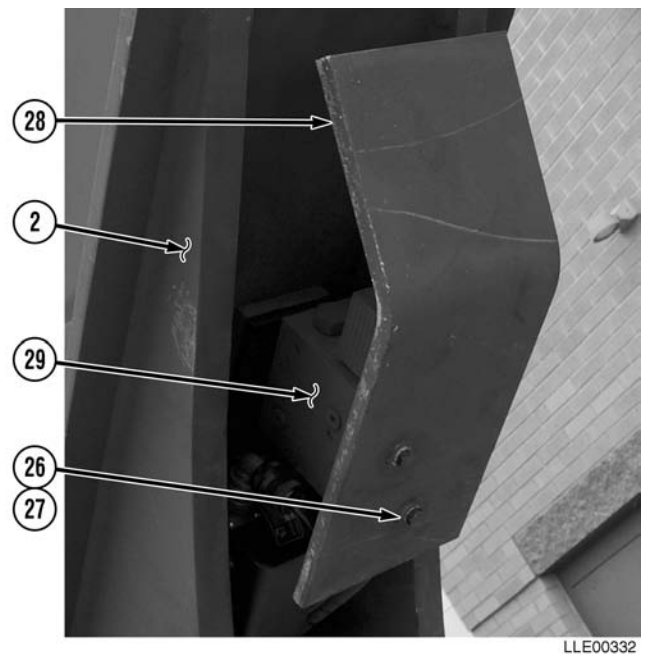
- (15) Install Boom Sensor Cable (25) on Boom Sensor (21).

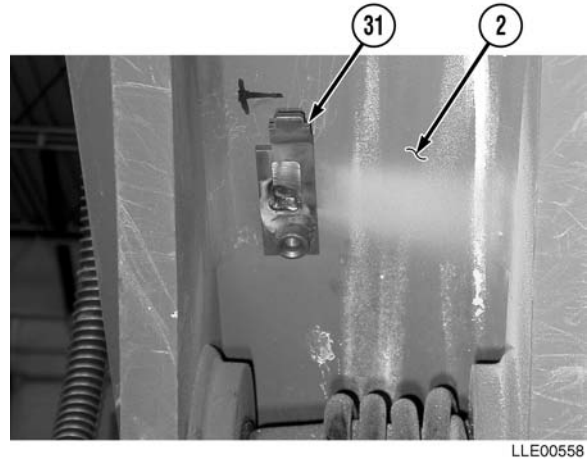
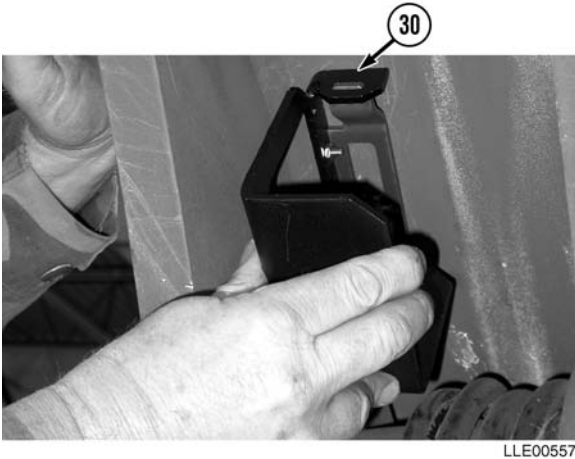
- (16) Remove two bolts (26), flat washers (27), and Skid Plate (28) from Arm (2); allow Hydraulic Valve (29) to hang.

NOTE

Raise Boom for welding.

- (17) Connect Battery and raise Boom (TM 5-3805-280-10).





NOTE

For proper fitting and calibration, place Encoder Mounting Bracket's welded bracket tightly against the factory weld inside the Arm.

- (18) Using the Encoder Mounting Bracket (30), mark position of Encoder Mounting Bracket's welded bracket (31), 2 in. (5.1 cm) down from Bucket Valve Adapter Plates and 0.75 in. (2 cm) in from left side rail.

WARNING

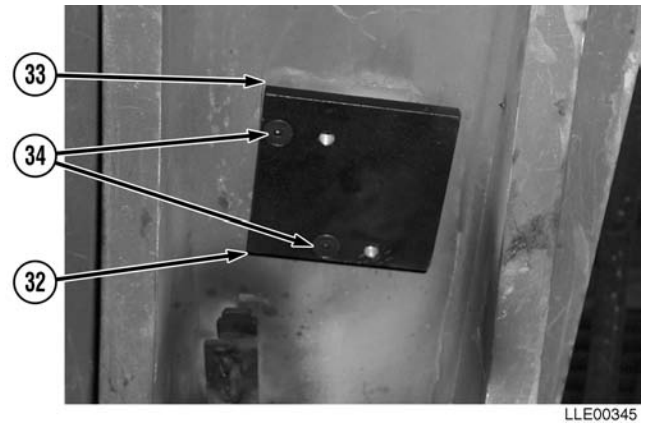
Unsafe welding practices can cause serious injury from fire, explosions, or harmful agents. Allow only authorized personnel to weld or cut metals, and follow safety precautions in TC 9-237. Protective clothing and goggles must be worn, adequate protective equipment must be used, a suitable fire extinguisher must be kept nearby, and requirements of TC 9-237 must be strictly followed. Failure to comply may result in serious injury or death to personnel.

CAUTION

Do not weld across Arm. All welds must run parallel with the Arm. Failure to comply can cause damage to the Arm.

- (19) Weld Encoder Mounting Bracket's welded bracket (31) to Arm (2).

- (20) Install Bucket Valve Adapter Plate (32) to existing Bucket Valve Mount Plate (33) with two Allen screws (34).



LLE00345

- (21) Install Poly Tube Adapter (35) onto Poly Tube (36).
 (22) Tighten Poly Tube Adapter (35).

NOTE

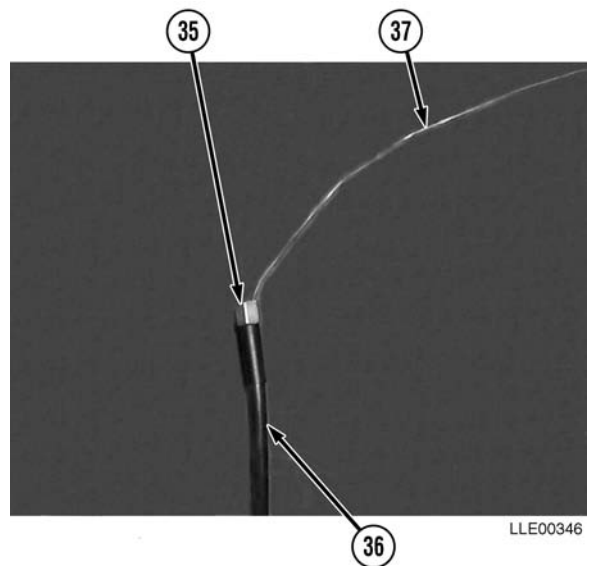
Bending the end of the Lacing Wire in a loop will ease the installation process.

- (23) Feed Lacing Wire (37) through Poly Tube (36).

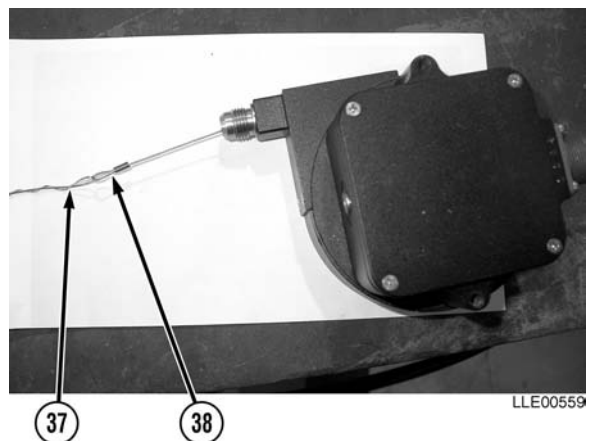
NOTE

Securely attach Encoder Wire to lacing wire to prevent Encoder Wire from retracting back through Poly Tube Adapter.

- (24) Attach Encoder Wire (38) to Lacing Wire (37).
 (25) Pull Lacing Wire (37) and Encoder Wire (38) through Poly Tube (36) until Encoder Wire (38) exits Poly Tube (36).



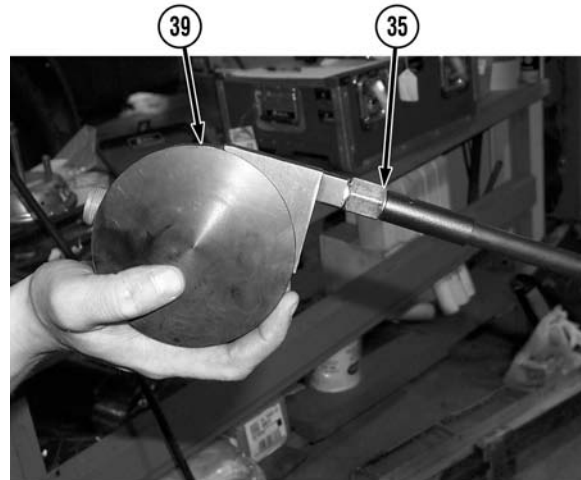
LLE00346



LLE00559

TM 5-6675-348-13&P

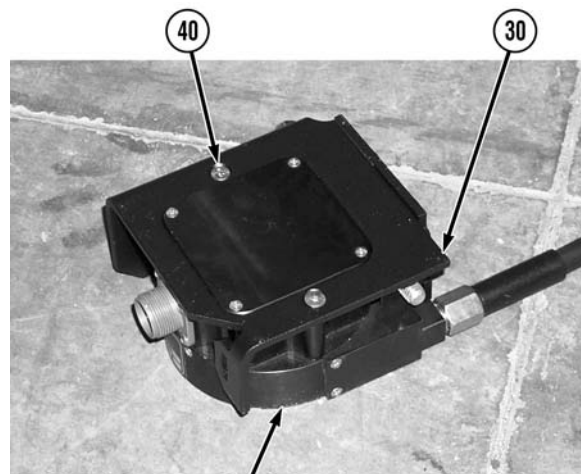
- (26) Tighten Poly Tube Adapter (35) onto Encoder (39).



LLE00833

- (27) Install Encoder (39) into Encoder Mounting Bracket (30) with two screws (40).

- (28) Tighten screws (40).



LLE00693

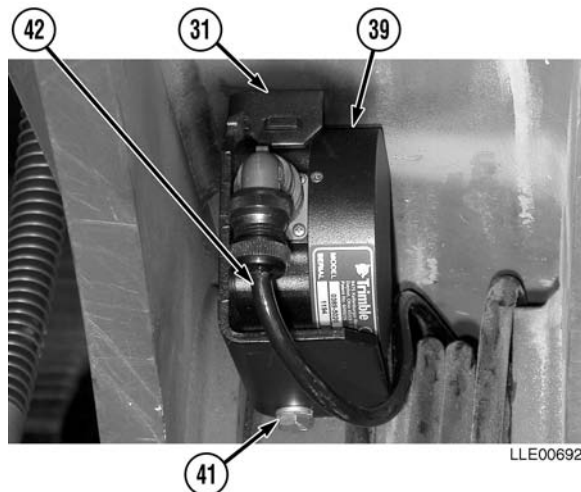
- (29) Install Encoder Mounting Bracket (30) onto Encoder Mounting Bracket's welded bracket (31) with bolt (41).

- (30) Tighten bolt (41).

NOTE

Encoder Cable and Arm Sensor Cable are both routed on the left side of the Boom.

- (31) Install Encoder Cable (42) to Encoder (39).



LLE00692

(32) Install Hydraulic Valve (29), Skid Plate (28), two flat washers (27), and bolts (26) to Bucket Valve Adapter Plate (32).

(33) Tighten bolts (26).

NOTE

- Place bottom of the Mast Mounting Bracket even with the lowest point and right side on the catwalk.
- The aid of an assistant is required for Step (34).

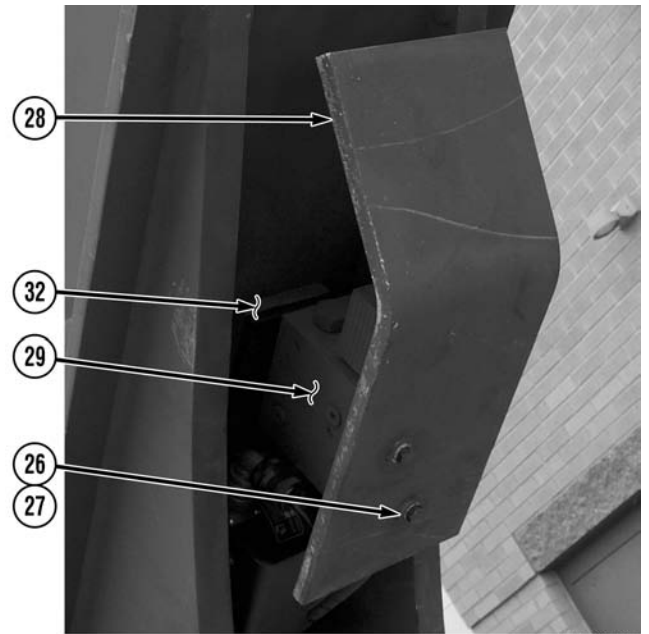
(34) Using Mast Mounting Bracket (43), mark location of mast mount three bolt holes (44) and (45).

NOTE

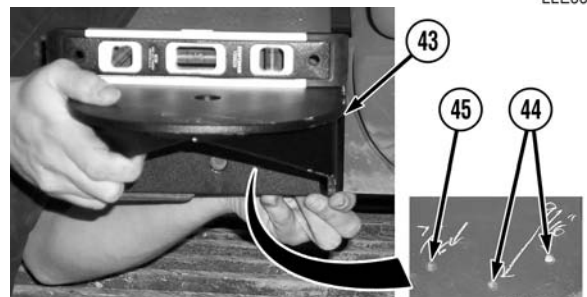
For ease of installation, start with a 7/16-in. (11 mm) drill bit and progress up to 9/16-in. (14 mm) drill bit.

(35) Drill two 9/16-in. (14 mm) holes (44) and drill one 7/16-in. (11 mm) hole (45).

(36) Using a 1/2-13NC tap, tap 7/16-in. (11 mm) hole (45).



LLE00795



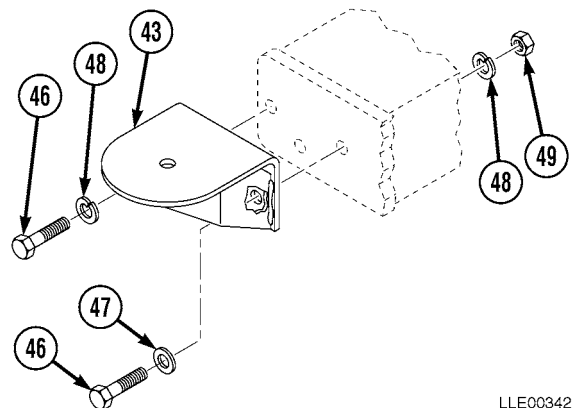
LLE00335

CAUTION

Mast Mount must be level side to side and front to rear. Failure to comply may result in damage to equipment.

(37) Install Mast Mounting Bracket (43), three bolts (46), flat washer (47), three lockwashers (48), and two nuts (49).

(38) Tighten nuts (49) and bolt (46).

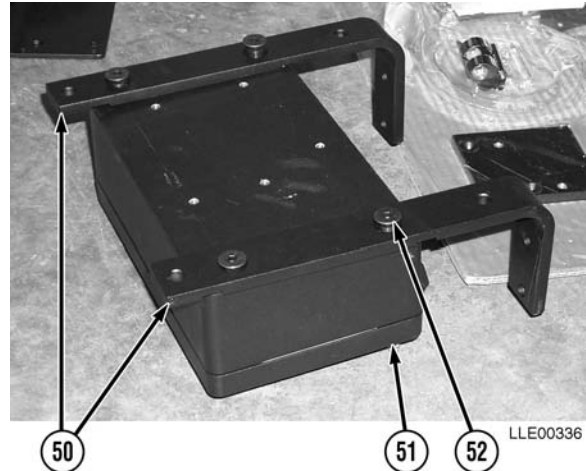


LLE00342

TM 5-6675-348-13&P

(39) Install two Remote Interface Box Mounting Brackets (50) onto Remote Interface Box (51) with four screws (52).

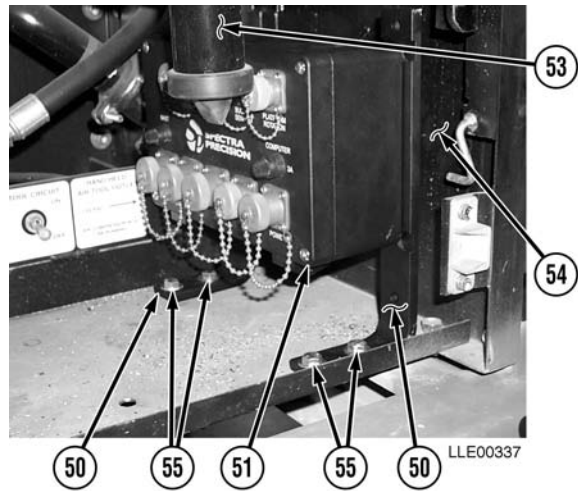
(40) Tighten screws (52).



(41) Position Remote Interface Box (51), with Remote Interface Box Mounting Brackets (50), under Dust Collector (53) and 6 1/2 in. (16.5 cm) from Bulkhead (54).

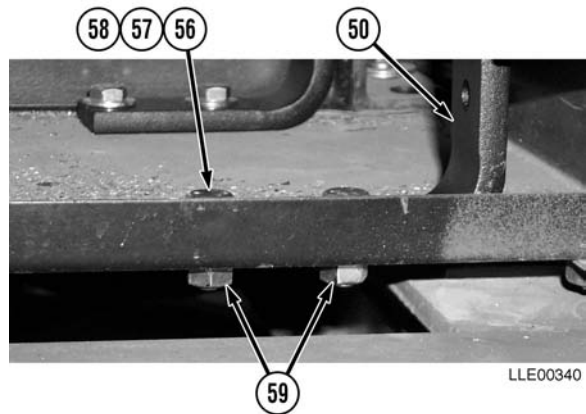
(42) Mark location for mounting holes.

(43) Drill four 1/2-in. (13 mm) holes (55).

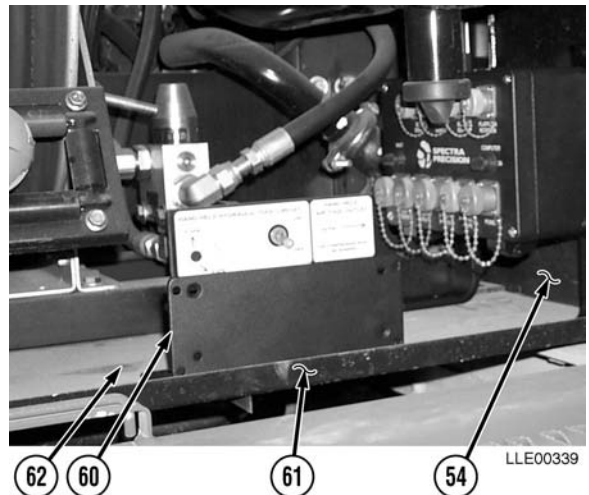


(44) Install Remote Interface Box Mounting Brackets (50) with four bolts (56), flat washers (57), lockwashers (58), and nuts (59).

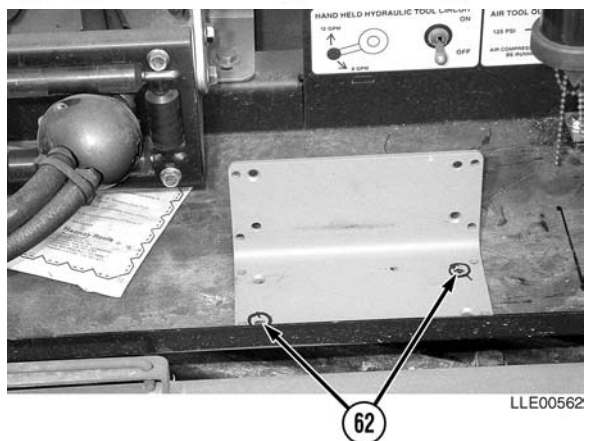
(45) Tighten nuts (59).



- (46) Position Dual-Axis Tilt Sensor Mounting Bracket (60) 10-1/2 in. (26.7 cm) from Bulkhead (54) and 1/4 in. (0.64 cm) from edge of platform (61).



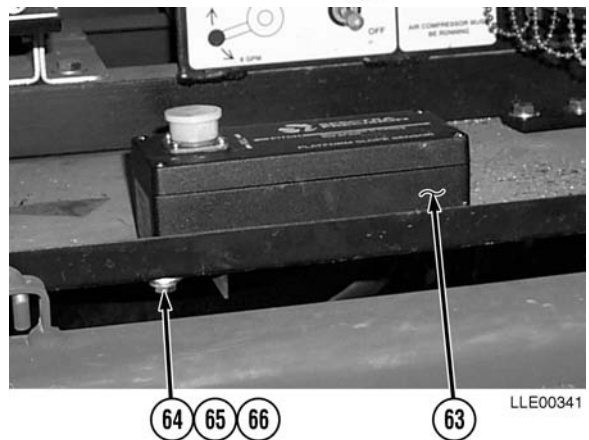
- (47) Mark location for mounting holes (62).
- (48) Drill two 5/16-in. (8 mm) holes (62).
- (49) Discard Slope Sensor Mounting Bracket (60).



NOTE

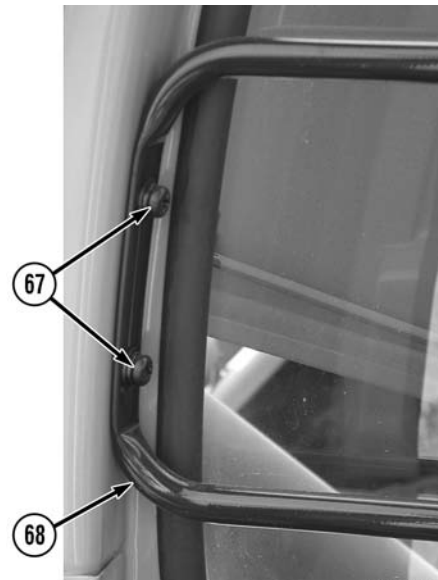
Place Electrical Connector toward cab when Dual-Axis Tilt Sensor is installed.

- (50) Install Dual-Axis Tilt Sensor (63) with two bolts (64), lockwashers (65), and flat washers (66).
- (51) Tighten bolts (64).



TM 5-6675-348-13&P

- (52) Remove two screws (67) from lower Side Window Guard (68). Discard screws (67).



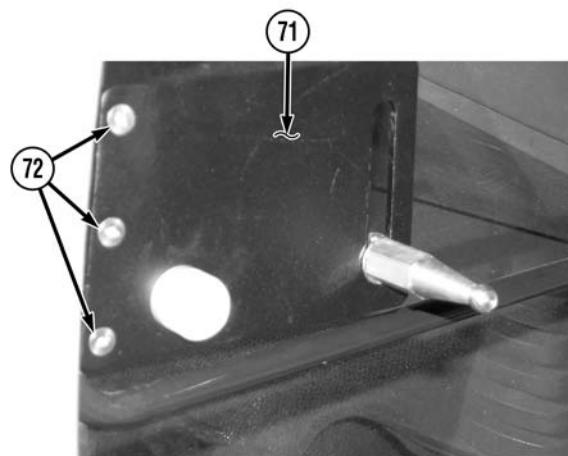
LLE00563

- (53) Install Graphic Display Mounting Block (69) to lower Side Window Guard (68) with two screws (70).



LLE00350

- (54) Install Graphic Display Mounting Plate (71) on Graphic Display Mounting Block (69) with three screws (72).

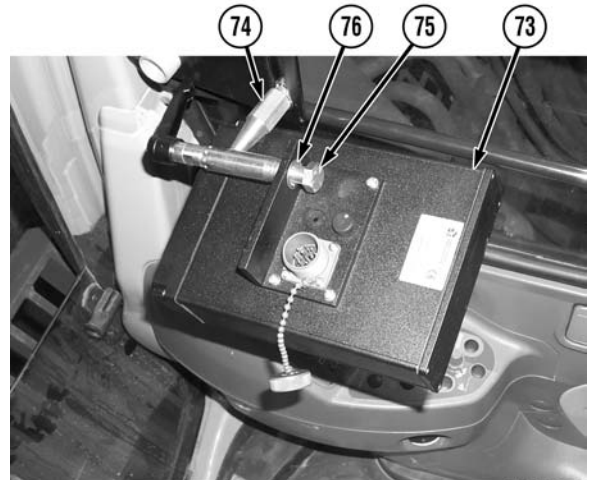


LLE00351

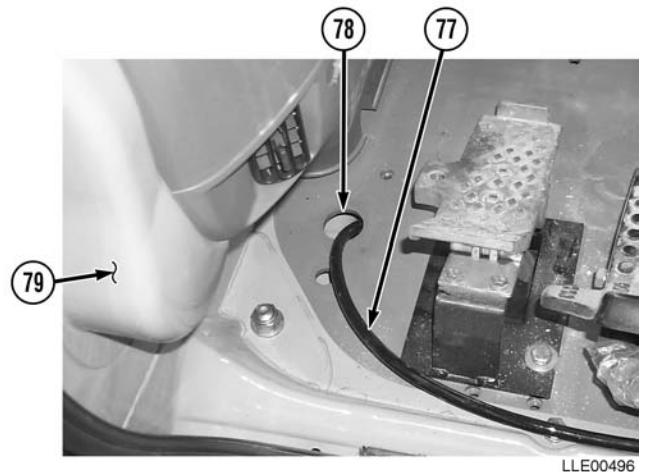
- (55) Install Graphic Display (73) onto Graphic Display Mounting Pin (74) with screw (75) and washer (76).

NOTE

Before routing Display Cable, pull back front, right corner of rubber floor mat.

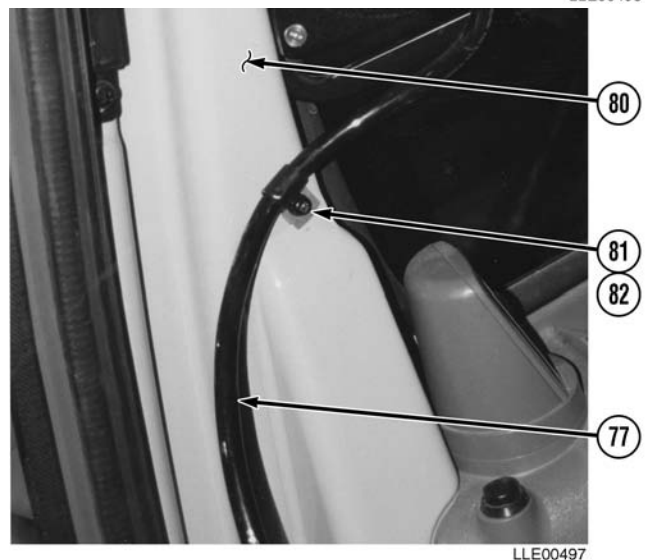


- (56) Route Display Cable (77) through cab floor (78) and along lower cab wall (79).



- (57) Install Display Cable (77) on upper cab wall (80) with Loop Clamp (81) and screw (82).

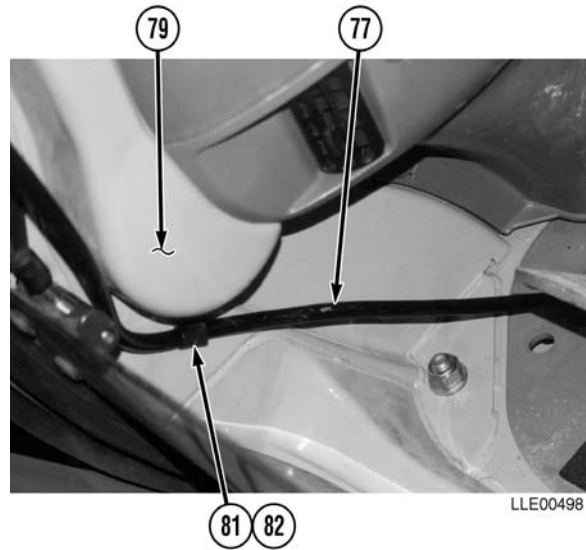
- (58) Tighten screw (82).



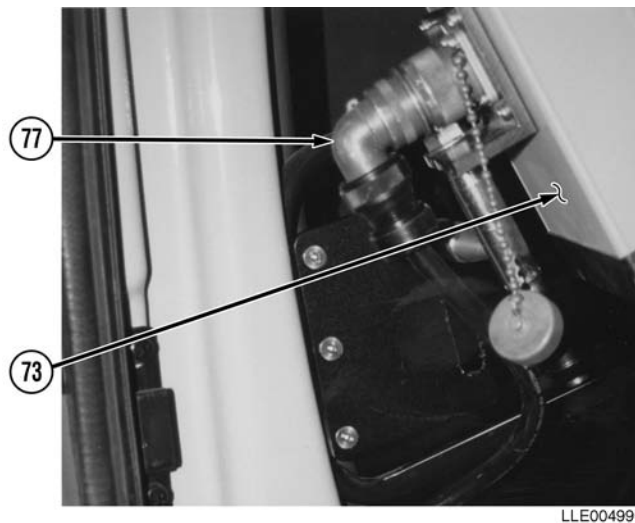
TM 5-6675-348-13&P

(59) Install Display Cable (77) on lower cab wall (79) with Loop Clamp (81) and screw (82).

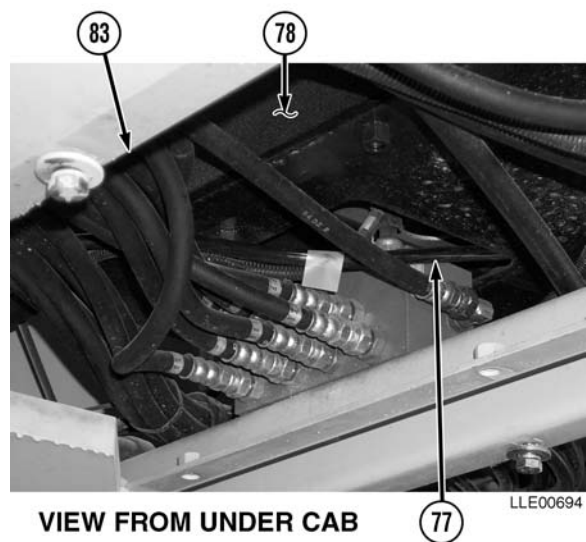
(60) Tighten screw (82).

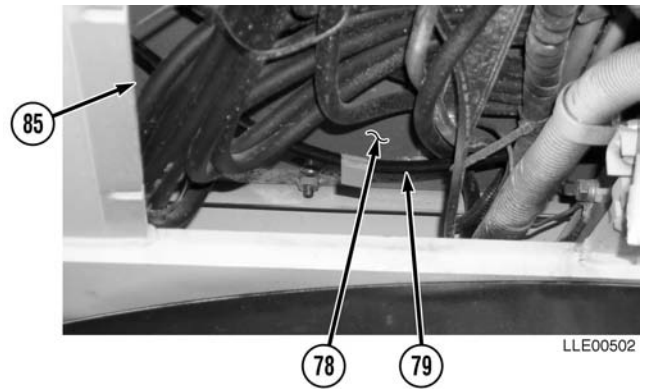
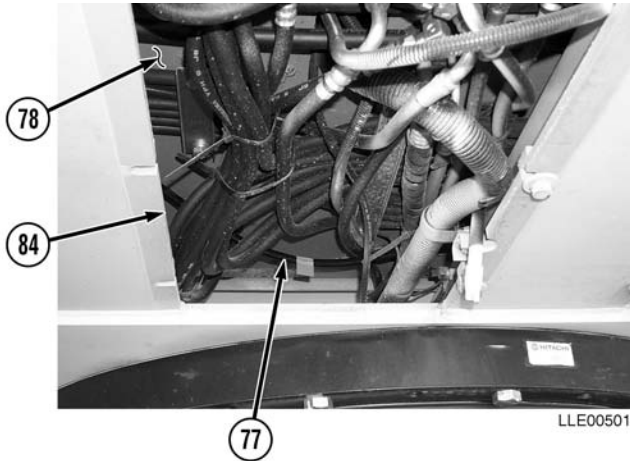


(61) Install Display Cable (77) on Graphic Display (73).



(62) Route Display Cable (77) under cab floor (78) through front floor compartment (83).



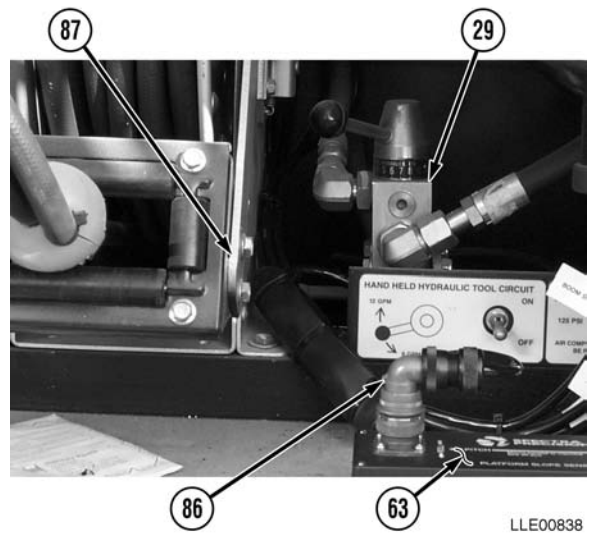


(63) Route Display Cable (77) under cab floor (78) through front center compartment (84).

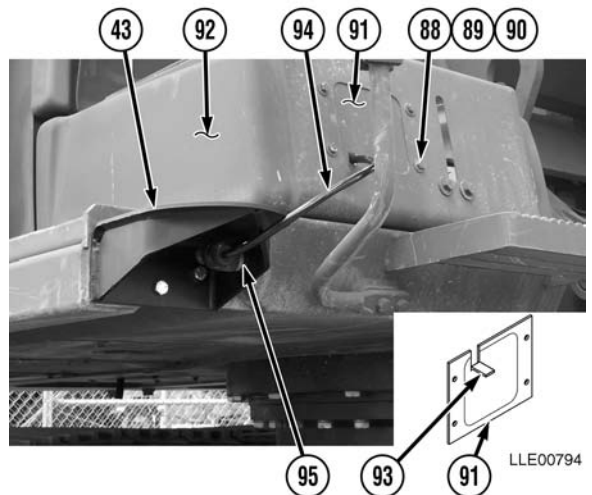
(64) Route Display Cable (77) under cab floor (78) through rear floor compartment (85).

(65) Route Dual-Axis Tilt Sensor Cable (86) from rear floor compartment (85) up through Hydraulic compartment between Hose Reel (87) and Hydraulic Valve (29).

(66) Install Dual-Axis Tilt Sensor Cable (86) onto Dual-Axis Tilt Sensor (63).

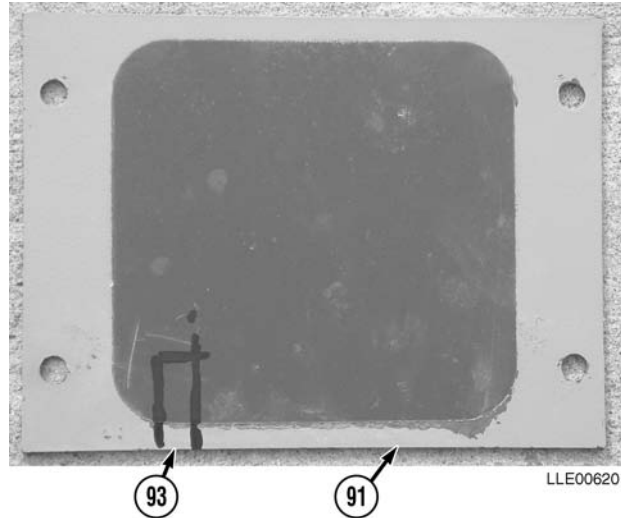


(67) Remove four locknuts (88), eight washers (89), four screws (90), and plate (91) from Stowage Box (92). Discard locknuts (88).

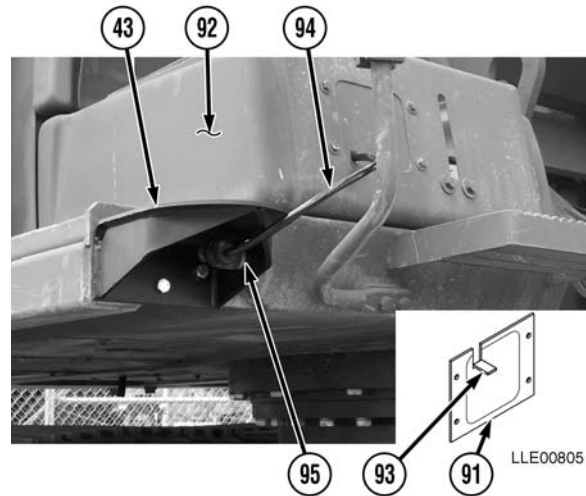


TM 5-6675-348-13&P

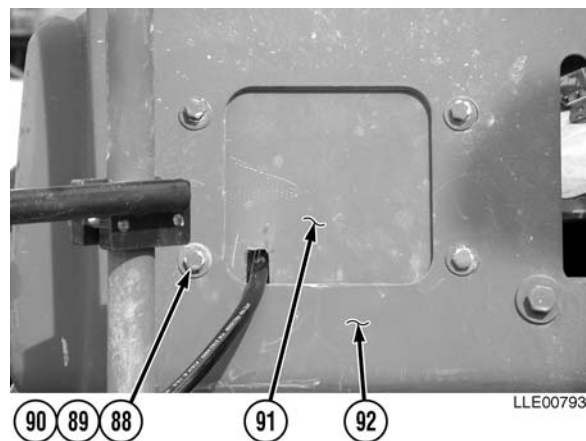
- (68) Mark Plate (91) approximately 1 in. (2.54 cm) upward and approximately 1 in. (2.54 cm) over from lower left corner.
- (69) Cut and bend 1/2-in. (1.3 cm) tab (93) on bottom of Plate (91).



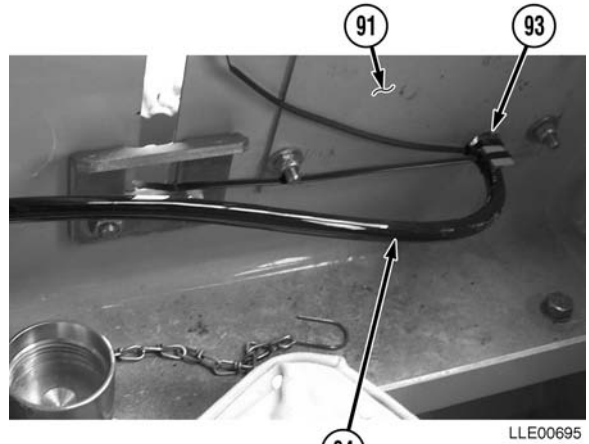
- (70) Install Mast Cable (94) on Stowage Bracket (95) of Mast Mounting Bracket (43).
- (71) Route Mast Cable (94) into Stowage Box (92).



- (72) Install Plate (91) on Stowage Box (92) with four screws (90), eight washers (89), and four locknuts (88).
- (73) Tighten locknuts (88).

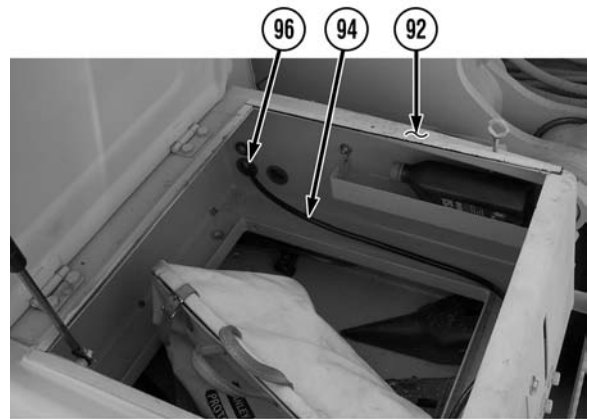


- (74) Cable tie Mast Cable (94) to the tab (93) on bottom of plate (91).



LLE00695

- (75) Route Mast Cable (94) around inside lower edge of Stowage Box (92).
- (76) Remove dust plug (96) from left rear side of Stowage Box (92).



LLE00792

NOTE

Cut cross-cut slit large enough to allow Mast Cable to be routed through dust plug.

- (77) Cut cross-cut slit in center of dust plug (96).
- (78) Route Mast Cable (94) through dust plug (96) hole.
- (79) Install dust plug (96) with Mast Cable (94) in left rear side of Stowage Box (92).

- (80) Route Arm Sensor Cable (5) and Encoder Cable (42) alongside left-hand Bucket Cylinder Hydraulic Hose (97) to base of Boom (12).



- (81) Secure Arm Sensor Cable (5) and Encoder Cable (42) to Bucket Cylinder Hydraulic Hose (97) with tie wraps every 6 to 8 in. (15.2 to 20.3 cm).
- (82) Route Mast Cable (94) to join Arm Sensor Cable (5) and Encoder Cable (42) at base of Boom (12).
- (83) From end of cables, measure approximately 6 ft (1.9 m) of Arm Sensor Cable (5), Boom Sensor Cable (25), and Encoder Cable (42) Loop cables from 6 ft (1.9 m) mark to base of Boom (12) to create a service loop.



LLE00696

TM 5-6675-348-13&P

- (84) Install cable ties 180 degrees apart on service loop.
- (85) Using cable ties, secure service loop to existing John Deere service loop.

CAUTION

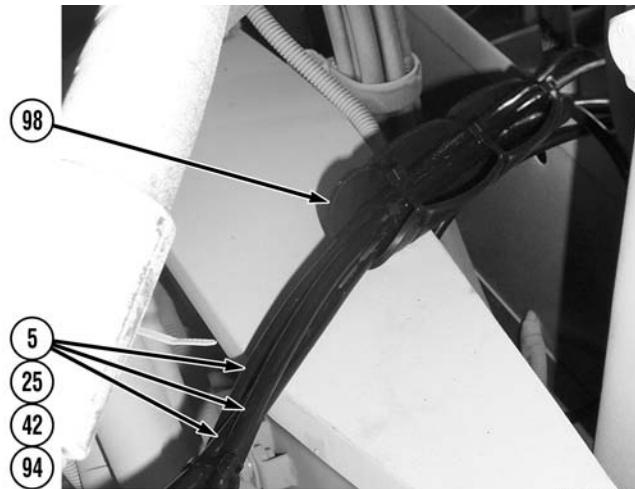
Cables must be placed in cable guide or damage to cables may result.

- (86) Install Boom Sensor Cable (25), Arm Sensor Cable (5), Encoder Cable (42), and Mast Cable (94) in Cable Guide (98).
- (87) Close Cable Guide (98) with three cable ties.

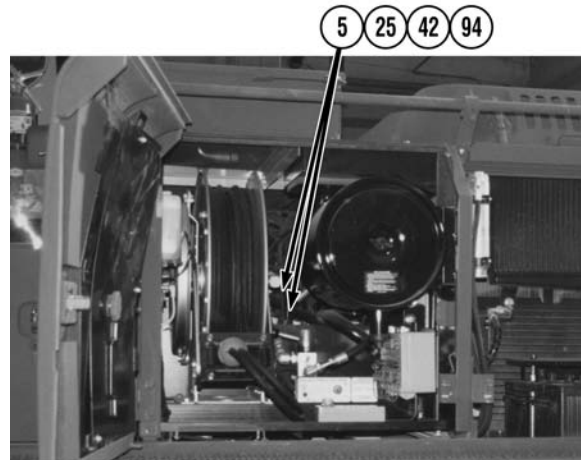
CAUTION

To prevent damage to cables, ensure cables are routed clear of hose reel.

- (88) Route Boom Sensor Cable (25), Arm Sensor Cable (5), Encoder Cable (42), and Mast Cable (94) through frame to Hydraulic Compartment.



LLE00791

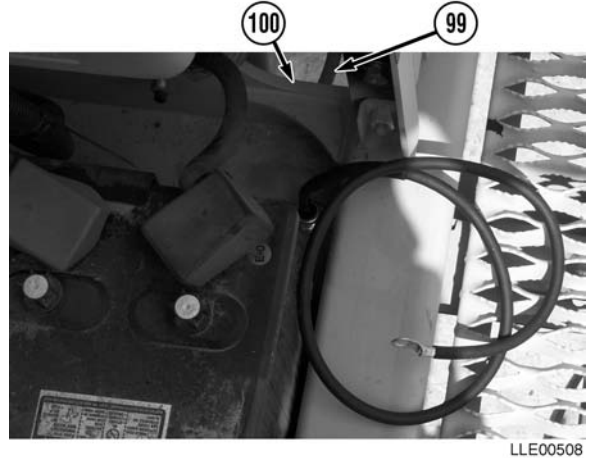


LLE00790

- (89) Relocate radiator over flow tube (99) to other side of Bracket (100).

WARNING

- CARC paint contains isocyanate (HDI), which is highly irritating to skin and respiratory system. High concentrations of HDI can produce symptoms of itching and reddening of skin, a burning sensation in throat and nose, and watering of the eyes. In extreme concentrations, HDI can cause cough, shortness of breath, pain during respiration, increased sputum production, and chest tightness. The following precautions must be taken whenever using CARC paint:
 - ALWAYS use air line respirators when using CARC paint, unless air sampling shows exposure to be below standards. Use chemical cartridge respirator if air sampling is below standards.
 - DO NOT let skin or eyes come in contact with CARC paint. Always wear protective equipment (gloves, ventilation mask, safety goggles, etc.).
 - DO NOT use CARC paint without adequate ventilation.
 - NEVER weld or cut CARC-coated materials.
 - DO NOT grind or sand painted equipment without high-efficiency air purifying respirators in use.
 - BE AWARE of CARC paint exposure symptoms; symptoms can occur a few days after initial exposure. Seek medical help immediately if symptoms are detected.



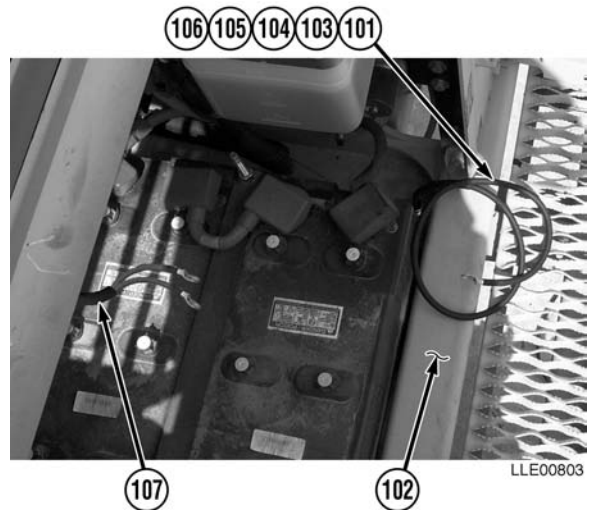
- (90) Clean paint and material from hole (101) in Battery Box (102) using wire brush.

- (91) Install Voltage Protection Cable (103) in hole (101) with lockwasher (104), washer (105), and nut (106).

- (92) Tighten nut (106).

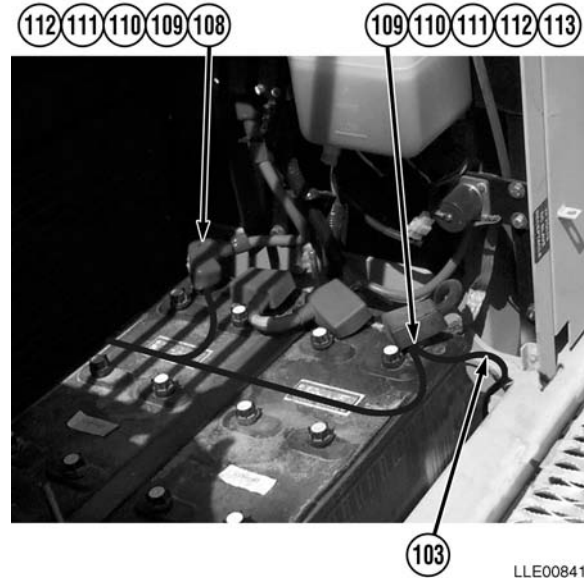
- (93) Paint hole (101) with black spray paint.

- (94) Route Power Cable (107) to Battery Box (102).

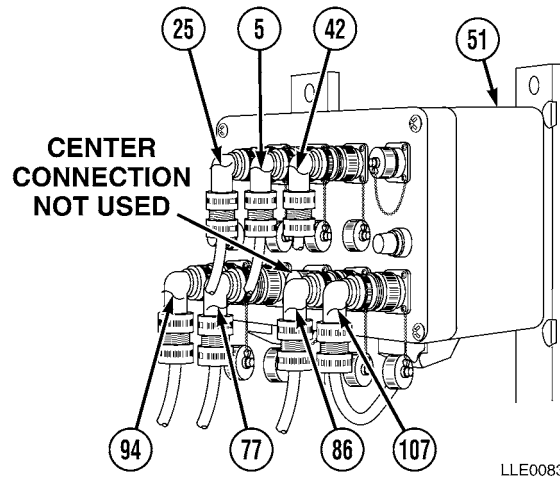


TM 5-6675-348-13&P

- (95) Install Power Cable's positive (red) wire (108) on positive Battery Terminal Clamp (109) with washer (110), lockwasher (111), and nut (112).
- (96) Tighten nut (112).
- (97) Coil excess Voltage Protection Cable (103) in Battery Box (102).
- (98) Install Power Cable's negative (black) wire (113) and Voltage Protection Cable (103) on negative Battery Terminal Clamp (109) with washer (110), lockwasher (111), and nut (112).
- (99) Tighten nut (112).
- (100) Coil excess Voltage Protection Cable (103) in Battery Box (102).
- (101) Install Power Cable (107), Boom Sensor Cable (25), Arm Sensor Cable (5), Encoder Cable (42), Mast Cable (94), Display Cable (77), and Dual-Axis Tilt Sensor Cable (86), on Remote Interface Box (51).



LLE00841



LLE00834

- (102) Measure and cut Guide Rod (114) to 3-1/4-inch (8.25 cm) length on short side and 10-inch (25.4 cm) length on long side.

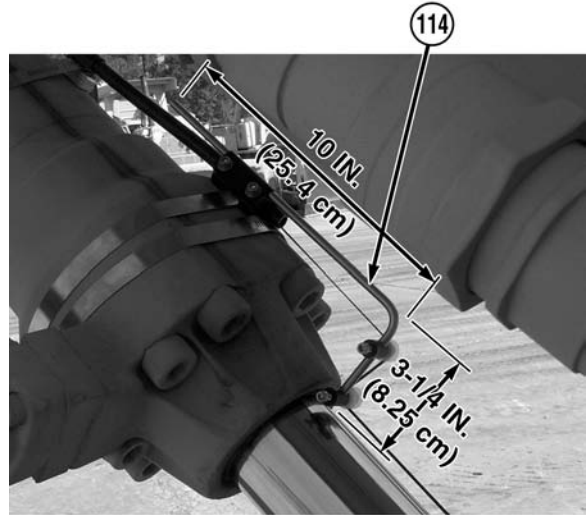
CAUTION

Properly position Poly Tube and Guide Rod for calibration. Align the Poly Tube and Guide Rod Bracket straight on the Bucket Cylinder or damage to equipment may result.

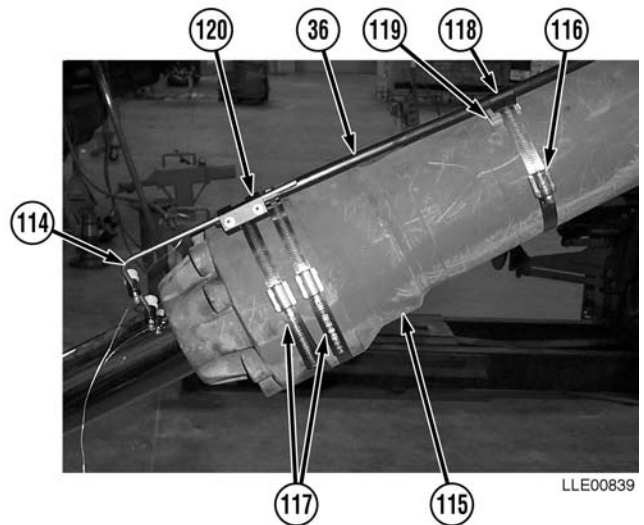
NOTE

- Wedges are used under the Poly Tube clips and hose clamps to keep the Poly Tube straight.
- Guide Rod Bracket is installed as close as possible to the bottom edge of the Bucket Cylinder.
- When installed properly, with the Guide Rod Bracket, the Poly Tube will appear straight in line with Encoder and offset from centerline on Bucket Cylinder.
- A combination of large and small wedges are used to level the Poly Tube to the Bucket Cylinder.

- (103) Install Poly Tube (36) on Bucket Cylinder (115) with five Hose Clamps (116), two Hose Clamps (117), four Poly Tube Clips (118), wedges (119), and Guide Rod Bracket (120).



LLE00797



LLE00839

NOTE

Wedges are tapered. Adjust wedges by positioning smaller end to match wider end.

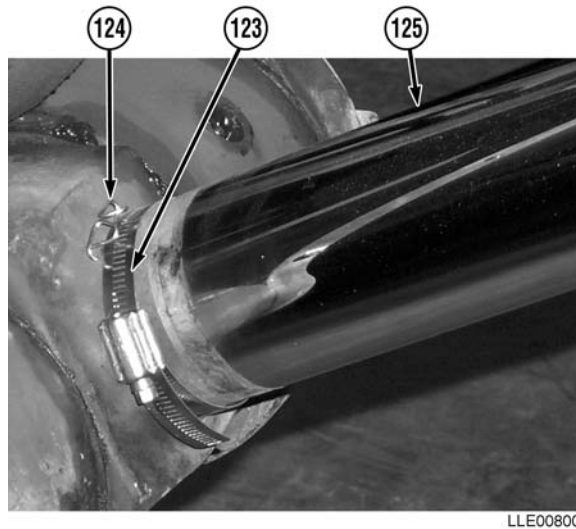
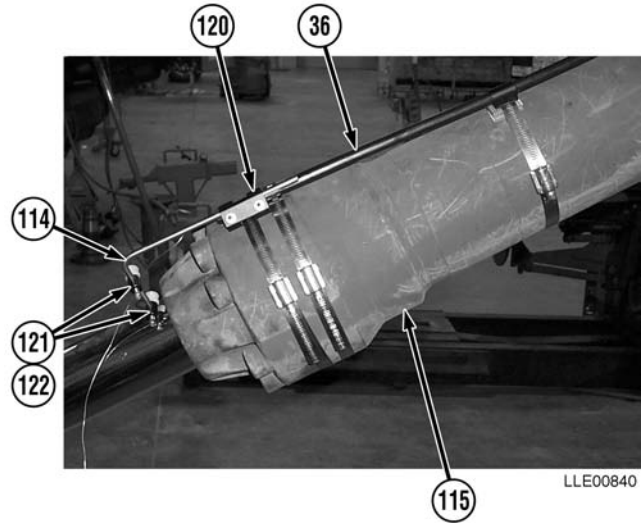
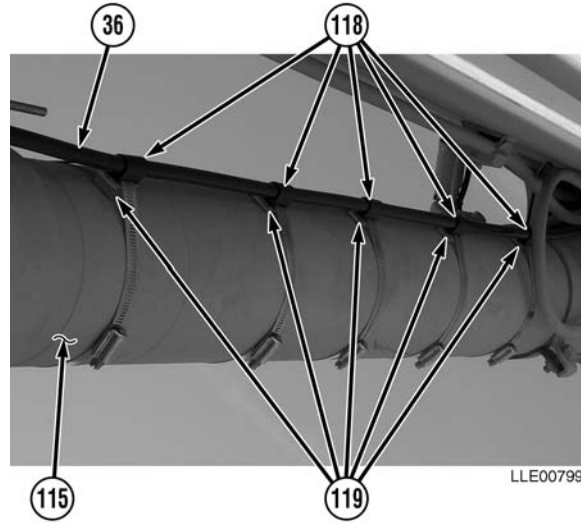
- (104) Adjust wedges (119) as needed, under Poly Tube Clips (118) and on Bucket Cylinder (115) until Poly Tube (36) is level.
- (105) Install two Runners (121) on Guide Rod (114) with two screws (122).
- (106) Tighten screws (122).

NOTE

Poly Tube should appear relatively straight when functioning properly.

- (107) Install Guide Rod (114) in Guide Rod Bracket (120) with Runners (121) aligned with Poly Tube (36).

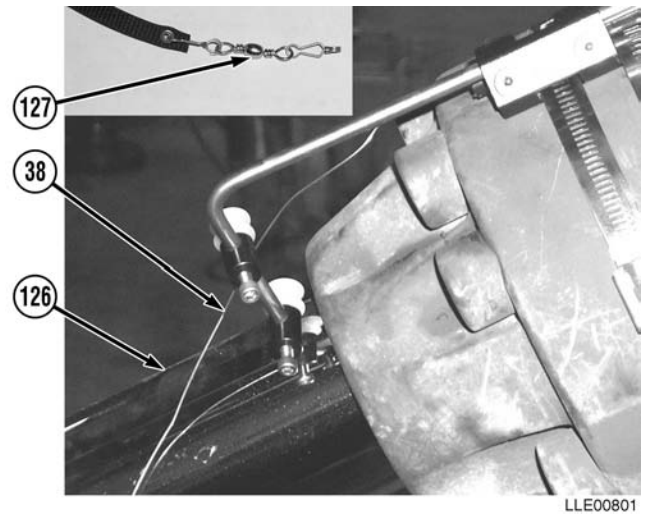
- (108) Attach Hose Clamp (123) and Belt Clip (124) to end of Bucket Cylinder Ram (125).



NOTE

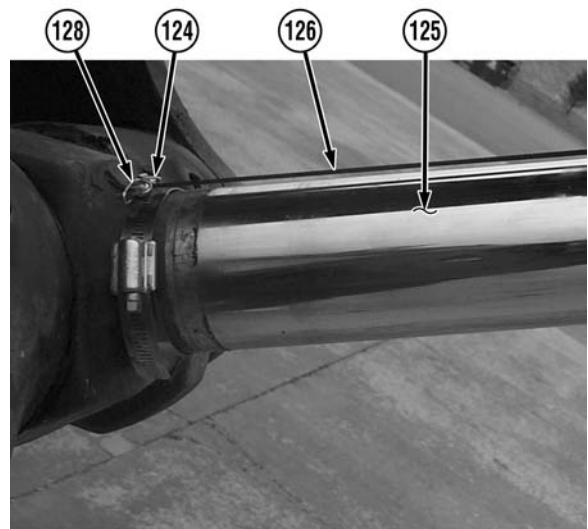
- If Encoder Wire is released before Encoder Web Belt is installed, Steps (23) through (26) and Steps (103) through (108) will need to be repeated.
- Install Encoder Web Belt rough side out.

(109) Attach Encoder Web Belt (126) to Encoder Wire (38) using three-link chain (127).



LLE00801

(110) Attach Rivet end (128) of Web Belt (126) to Belt Clip (124) at end of Bucket Cylinder Ram (125).



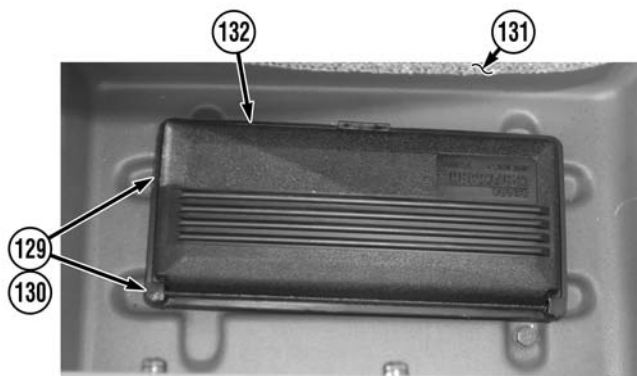
LLE00802

c. Tool Box.

- (1) Measure and cut two hook and pile strips (129) and apply to stowage point (130) behind Operator's seat (131).
- (2) Remove protective paper from two hook and pile strips (129) and install tool box (132).

d. Follow-On Maintenance.

- (1) Install Belly Plates (Para 4-30) as required.
- (2) Connect Batteries (TM 5-3805-280-10).
- (3) Remove Chocks (TM 5-3805-280-10).
- (4) Perform Bucket-Pro™ System Calibration (Para 4-32).



LLE00493

END OF TASK

4-32. BUCKET-PRO™ SYSTEM CALIBRATION.

This task covers:

- | | | |
|-----------------------------|----------------------------|---------------------------------|
| a. Clear Memory. | b. System Setup. | c. Edit Data. |
| d. Boom Angle Calibration. | e. Arm Angle Calibration. | f. Bucket Cylinder Calibration. |
| g. Pitch Angle Calibration. | h. Roll Angle Calibration. | i. Follow-On Maintenance. |

INITIAL SETUP

Models

Bucket-Pro™ System

Personnel Required

MOS 62B
MOS 44B

Special Tools

ANSI

Equipment Condition

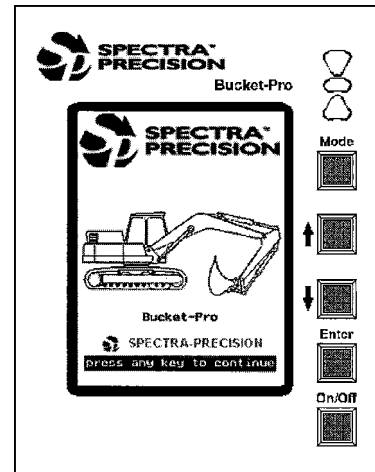
Engine running (TM 5-3805-280-10).
Tracks chocked (TM 5-3805-280-10).



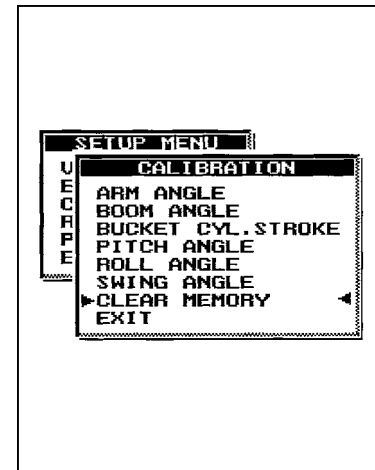
Memory must be cleared before machine is calibrated. Failure to comply could result in incorrect calibration.

a. Clear Memory.

- (1) Turn on Graphic Display.
- (2) Press Down (↓) button twice.
- (3) Point menu arrows to SETUP SYSTEM mode, using Down (↓) button.
- (4) Press ENTER button.
- (5) To bypass the entry code, press and hold Up and Down (↑↓) buttons at the same time, while pressing ENTER button.
- (6) In SETUP menu, select CALIBRATION.
- (7) Press ENTER button.
- (8) In CALIBRATION menu, select CLEAR MEMORY.
- (9) Press ENTER button.
- (10) In the ARE YOU SURE? dialog box, select YES.
- (11) Press ENTER button. Bucket-Pro™ System memory is now clear.
- (12) Turn off Graphic Display.
- (13) To access SETUP MENU and re-enter data, repeat Steps (1) through (5).



LLE00362



LLE00806

b. System Setup.

Calibration allows the initial setting of all sensors. The calibration settings are then constants in the Remote Interface Box's nonvolatile memory. After the initial calibration, the boom and arm sensors self-align (reset) to a zero reference mark each time the boom and arm are moved through their normal operating cycle.

- (1) Press MODE button to access MAIN MENU.
- (2) Point menu arrows to SETUP SYSTEM mode using Up and Down (↑↓) buttons.
- (3) Press ENTER button to confirm selection.
- (4) To bypass the entry code, press and hold Up and Down (↑↓) buttons at the same time, while pressing ENTER button.

NOTE

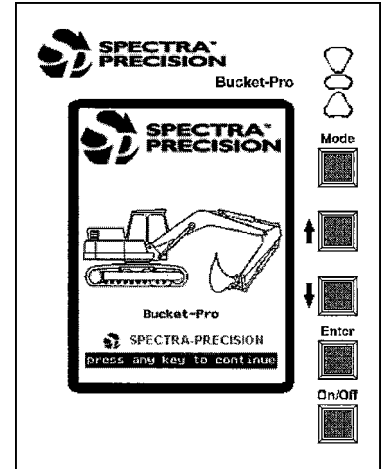
- VIEW SENSORS allow the raw data values from the sensors and same angle or position of the sensors to be displayed on the screen.
- These values determine proper orientation and operation of the sensors during installation and troubleshooting.

- (5) Using the Up and Down (↑↓) buttons, select VIEW SENSORS.
- (6) Press ENTER button.
- (7) Ensure arm and boom averaging are set to 5 and count is reversed.
- (8) Ensure arm angle increases as arm is moved away from machine frame.

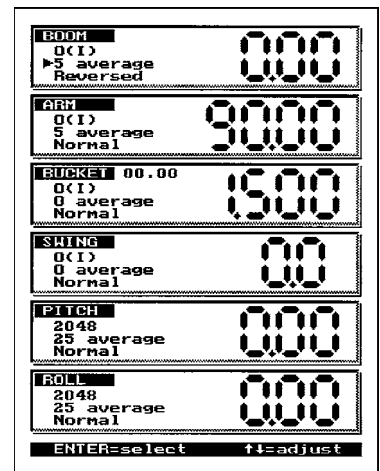


The machine measurements must be entered before calibrating the system. Failure to enter the machine measurement before calibration will cause an incorrect calibration

- (9) Ensure boom angle increases as boom is raised.
- (10) Ensure bucket counts properly.
- (11) Ensure pitch and roll averaging are set to 25 and Normal for starting point.
- (12) Ensure Arm and Boom Sensors locate reference mark (I) when machine is operated manually.
- (13) Press ENTER button until SETUP menu is displayed.



LLE00362



LLE00363

c. **Edit Data.** This allows the Operator to set up the system and input dimensions of the machine.

- (1) Enable Dual-Axis.

Selects whether the platform tilt sensor is turned ON or OFF. If the sensor is off, the mast-extension elevation to the bucket-teeth elevation is not compensated as the machine is pitched or rolled.

- (2) Disable Swing Sensor.

This feature is not available.

- (3) Enable Laser Mast.

Turns on the mast search and laser receiver function.

- (4) Units.

This feature is for selecting metric (meters/mm) or U.S. (feet/decimal or feet/inches) display readouts. The selections are M, F/D, or F/I.

- (5) Language.

This feature is not available.

- (6) Keypress Beep.

Keypress Beep turns the audible tone feature ON/OFF. Select YES to turn on the audible tone feedback each time a button is pressed.

- (7) Enable Light Bar.

This feature is not available.

- (8) Serial Baud Rate.

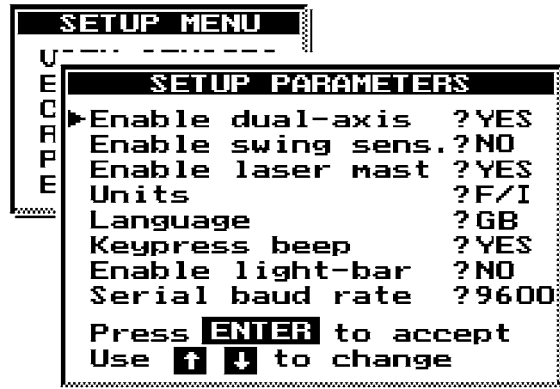
This feature is not available.



LL E00527



LL E00528

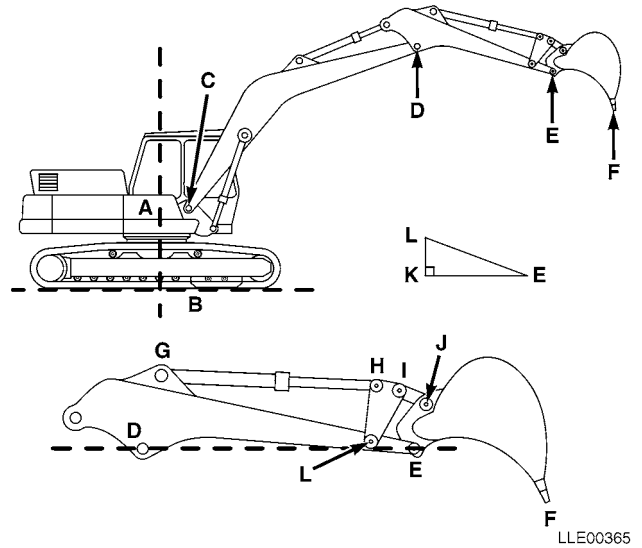


LL E00807

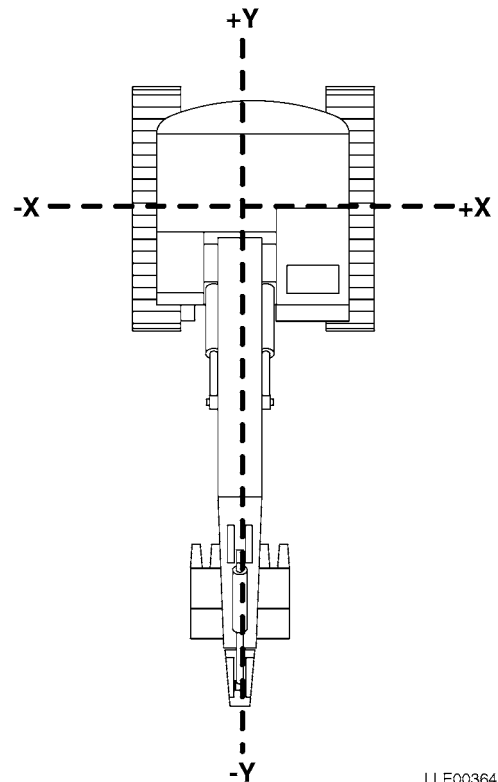
(9) Edit Machine Dimensions.

NOTE

- All dimensions are in meters (m).
- Cylinder Minimum-Maximum difference cannot exceed 2,000 m.
- Under standard mast placement on military machine (at front of right-side catwalk), Mast Bases X, Y, and Z will always be negative.
- Boom pivot X and Y will always be positive.
- Bucket dimensions may be different depending on tooth wear. Reference John Deere manual.



Boom Length:	C-D	6.007
Arm Length:	D-E	2.963
Boom Pivot X:	A-C	0.195
Boom Pivot Y:	B-C	1.887
Control Length 1:	L-H	0.618
Control Length 2:	H-I	0.000
Control Length 3:	I-L	0.618
Link Length:	I-J	0.579
Rock Bucket		
Bucket Length:	E-F	1.675
Bucket Web:	E-J	0.474
Bucket Back:	J-F	1.840
Cylinder Position 1:	G-E	2.661
Cylinder Position 2:	G-J	2.213
Control X:	K-E	0.457
Control Y:	K-L	0.039
Cylinder Min:	G-H (Min)	1.664
Cylinder Max:	G-H (Max)	2.736
Mast Base X:		-1.473
Mast Base Y:		-0.662
Mast Base Z:		-0.739
Mast Height:		1.665
Mast mm/Pulse:		0.762
Mast Average:		0
Mast Timeout:		60
Ditch Bucket		
Bucket Length:		1.238
Bucket Web:		0.475
Bucket Back:		1.437

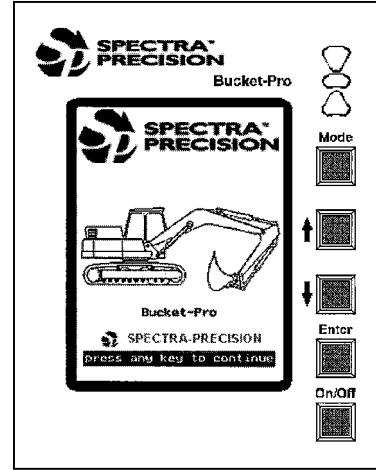


d. Boom Angle Calibration.

NOTE

Before performing boom angle calibration, ensure that system setup has been completed.

- (1) In SETUP menu, select CALIBRATION, using Up and Down (↑↓) buttons.
- (2) Press ENTER button.
- (3) In CALIBRATION menu, select BOOM ANGLE, using Up and Down (↑↓) buttons.

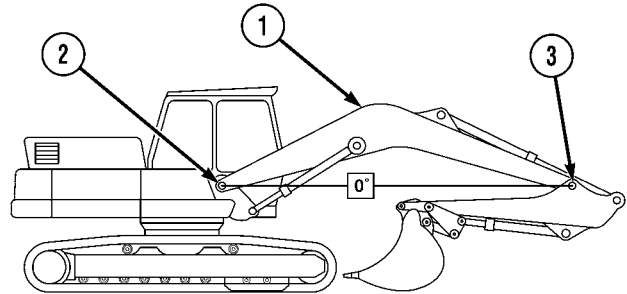


LLE00362

NOTE

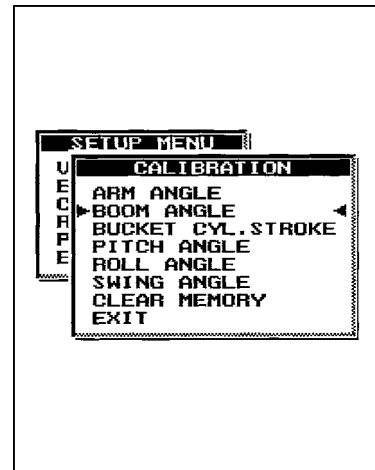
Boom sensor is correctly indexed when sensors index mark (?) changes to sensor index mark (I) on Graphic Display.

- (4) Move boom (1) through a range of motion to ensure boom sensor is indexed.
- (5) Using an Automated Integrated Survey Instrument (AISI), position boom pivot pin (2) horizontally level with arm pivot pin (3).



LLE00808

- (6) Press ENTER button.

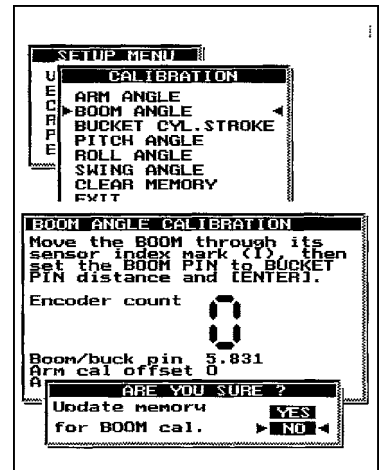


LLE00372

NOTE

The BOOM ANGLE number is used during troubleshooting.

- (7) Record BOOM ANGLE number.
- (8) In the ARE YOU SURE? dialog box, select YES, using the Up and Down (↑↓) buttons, and update data.



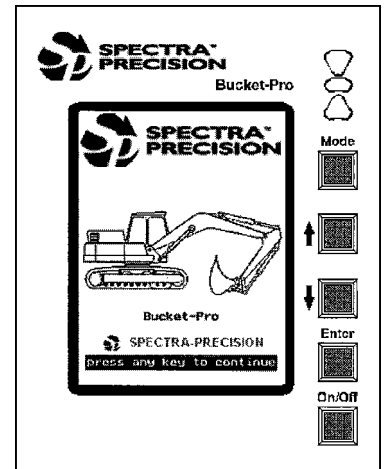
LLE00376

e. Arm Angle Calibration.

NOTE

Before performing arm angle calibration, ensure that system setup has been completed.

- (1) In SETUP menu, select CALIBRATION using the Up and Down (↑↓) buttons.
- (2) Press ENTER button.
- (3) In CALIBRATION menu, select ARM ANGLE, using the Up and Down (↑↓) buttons.

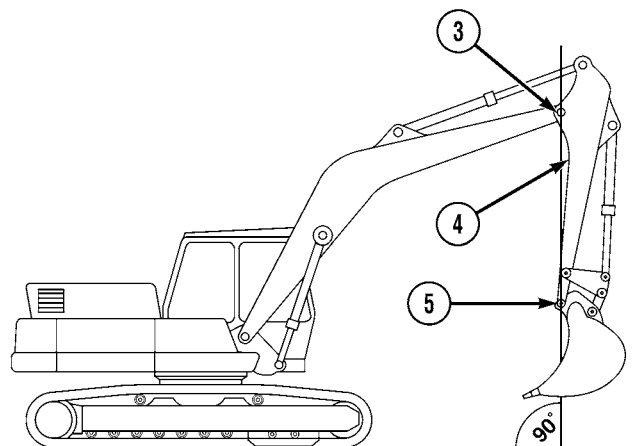


LLE00362

NOTE

Arm sensor is correctly indexed when sensor index mark (?) changes to sensor index mark (I) on Graphic Display.

- (4) Move arm (4) through a range of motion to ensure arm sensor is indexed.
- (5) Using an AISI, position arm pivot pin (3) directly vertical over bucket pivot pin (5).



LLE00809

- (6) Press ENTER button.

NOTE

The ARM ANGLE number is used during troubleshooting.

- (7) Record ARM ANGLE number.
- (8) In the ARE YOU SURE? dialog box, select YES, using the Up and Down (↑↓) buttons, and update data.

f. Bucket Cylinder Calibration.

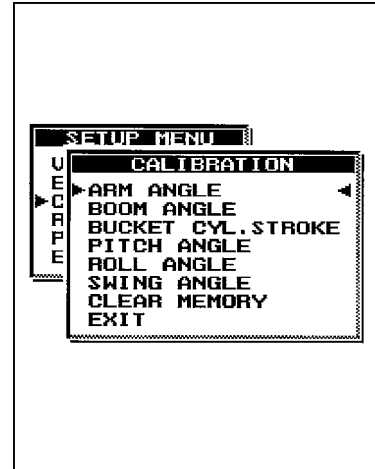


Do not strike cylinder against end stops when retracting and extending, or damage to equipment may result.

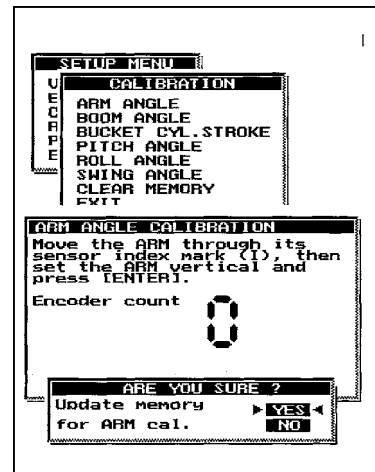
NOTE

Bucket cylinder calibration divides bucket cylinder length into increments and linkage measurements to calculate rotated position of bucket teeth.

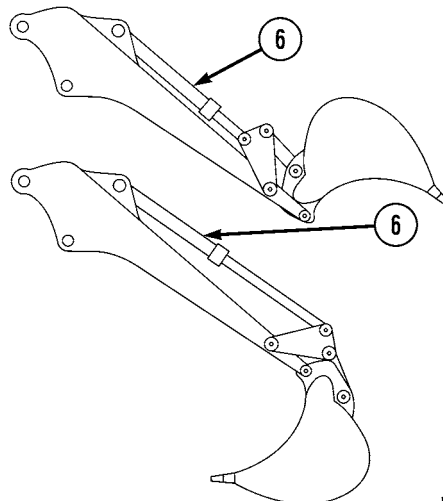
- (1) Perform smooth extend and retract movements of bucket cylinder (6).



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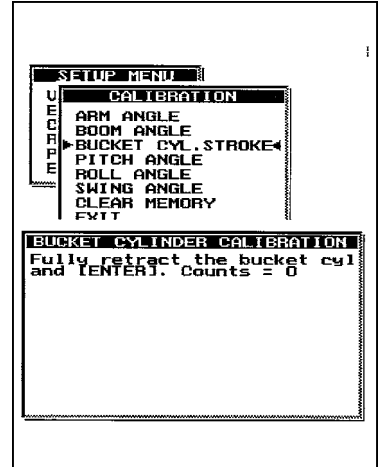


LLE00814

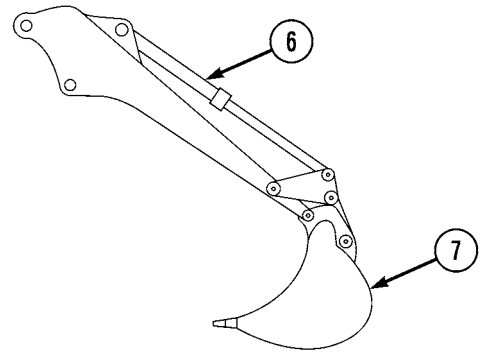
NOTE

Maximum bucket-cylinder stroke is limited to 6 ft 6 and 23/32 in. (2.000 m). Greater length than this may cause a display failure to respond.

- (2) Select BUCKET CYL. STROKE CALIBRATION.
- (3) Fully extend bucket cylinder (6) to curl bucket (7) under.
- (4) Press ENTER button.

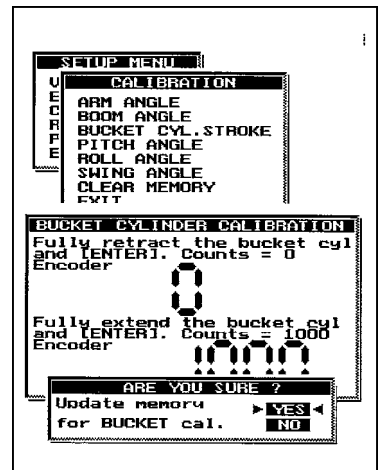


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- (5) In the ARE YOU SURE? dialog box, select YES, using the Up and Down (↑↓) buttons, and update data.

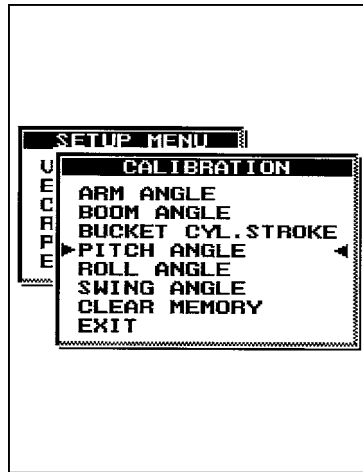


LLE00379

g. Pitch Angle Calibration.

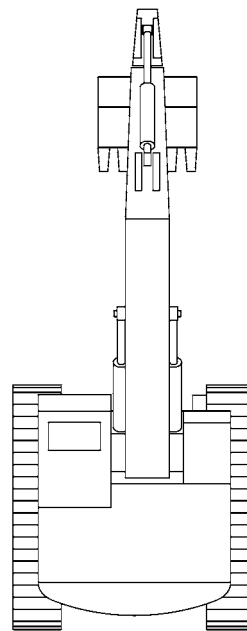
NOTE

Dual-Axis Tilt Sensor compensates EM2E-24 Electric Mast height for grade elevation as machine attitude changes, by rotating the machine 180 degrees.



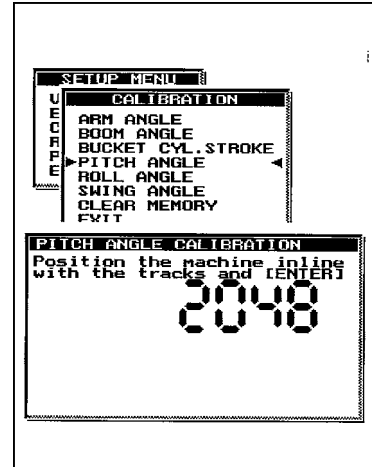
LLE00380

- (1) Select PITCH ANGLE. Align frame of machine parallel to tracks, using swing control.



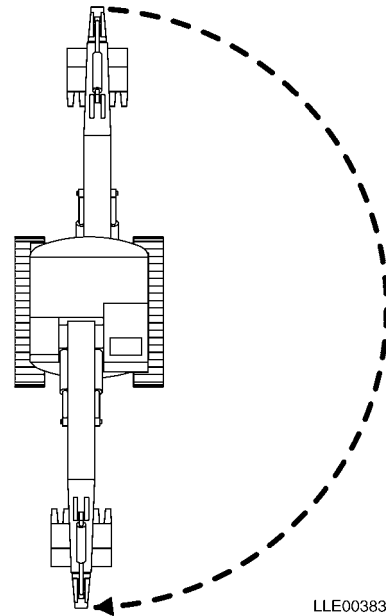
LLE00381

- (2) Press ENTER button.



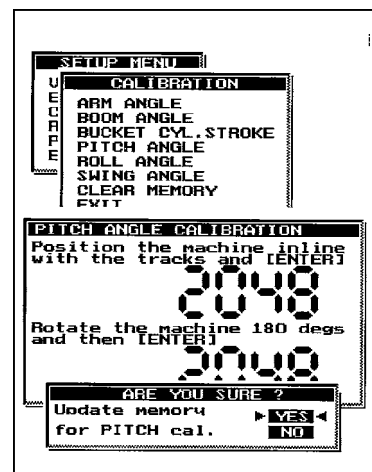
LLE00382

- (3) Rotate frame of machine and align frame parallel to tracks, using swing control.



LLE00383

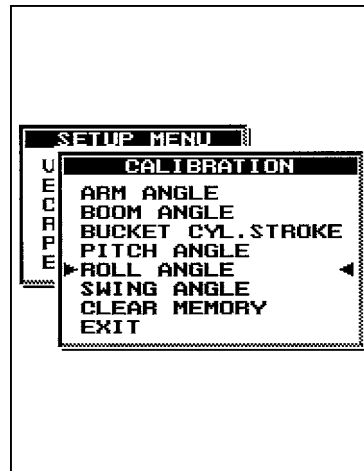
- (4) Press ENTER button again.



LLE00384

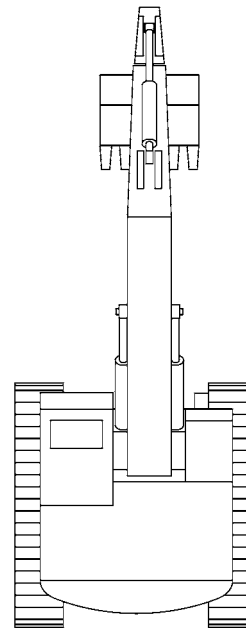
h. Roll Angle Calibration.

- (1) Select ROLL ANGLE.



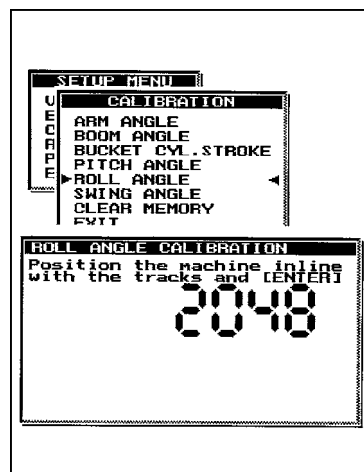
LLE00385

- (2) Align frame of machine parallel to tracks, using swing control.



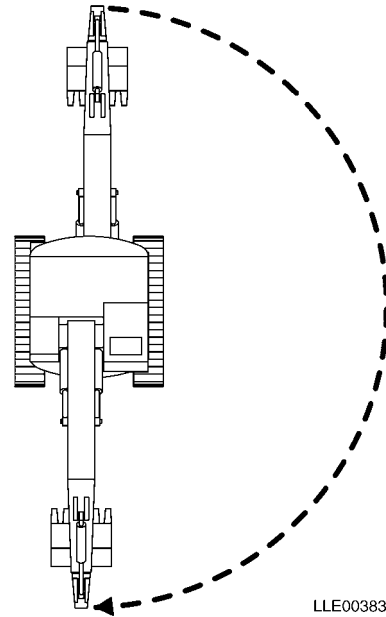
LLE00381

- (3) Press ENTER button.

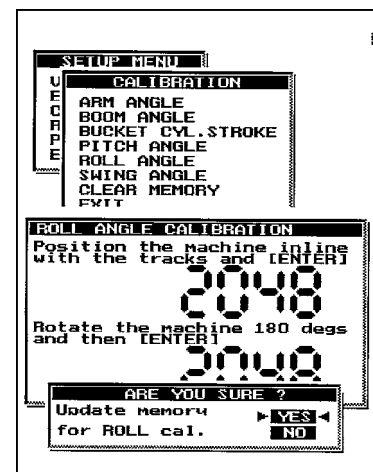


LLE00386

- (4) Rotate frame of machine, using swing control.
- (5) Align frame of machine parallel to tracks, using swing control.



- (6) Press ENTER button again.

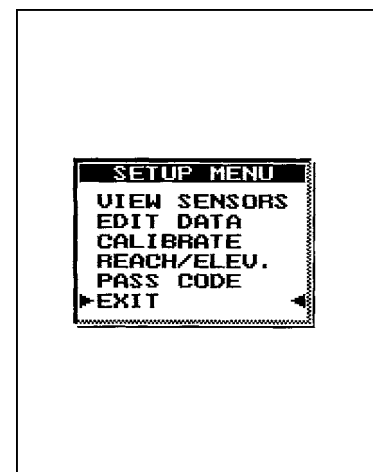


- (7) Select EXIT.
- (8) Press ENTER button.

i. Follow-On Maintenance.

- (1) Turn OFF engine (TM 5-3805-280-10).
- (2) Remove chocks (TM 5-3805-280-10).

END OF TASK



CHAPTER 5

1145-2 LASER TRANSMITTER, 1275 LASER RECEIVER, AND ELEVATING BASE AND TRIPOD, USED WITH 130G GRADER, D7F, D7G, D7H, AND D7R DOZERS, 613B AND 621B SCRAPERS, AND HYEX

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SECTION I. GENERAL INFORMATION

5-1. SCOPE.

This chapter contains operation, maintenance, safety, and service information on the 1145-2 Laser Transmitter and 1275 Laser Receiver. The 1275 Laser Receiver is a portable, battery-operated device that locates the elevation of a rotating laser beam. Hand-held or rod-mounted, the 1275 Laser Receiver indicates its position via a nine-channel LCD or with synchronous audible tones. The 1145-2 Laser Transmitter is used with the 1275 Laser Receiver.

5-2. 1145-2 LASER TRANSMITTER EQUIPMENT CHARACTERISTICS, CAPABILITIES, AND FEATURES.

- a. **Characteristics.** 1145-2 Laser Transmitter provides a reference plane of light above a job site. The 1145-2 Laser Transmitter is capable of generating slope in two axes for optimum control of drainage.

TM 5-6675-348-13&P

- b. **Capabilities.** The 1145-2 Laser Transmitter electronically self-levels to within ± 5 degrees, whenever it is rough leveled. The Early Warning System shuts off the laser beam if the laser setup is knocked out of level and it turns back on again only after the electronic self-leveling system has releveled the laser beam.

The 1145-2 Laser Transmitter is designed for use at distances up to 1000 ft (305 m). Beyond this distance, curvature of the earth becomes a consideration. Error from the earth's curvature affects a 1145-2 Laser Transmitter the way it does a surveying instrument. Elevation readings at long distances will appear lower than they actually are. The following table shows amount of error for a straight line of sight due to curvature of the earth.

500 ft (152 m)	0.005 ft (0.0015 m)
1000 ft (305 m)	0.02 ft (0.0060 m)
1500 ft (457 m)	0.05 ft (0.0152 m)
2000 ft (610 m)	0.08 ft (0.0244 m)

WARNING

Do not look into 1145-2 Laser Transmitter for a long period of time. Failure to comply may cause injury to personnel.

- c. **Features.** The 1145-2 Laser Transmitter projects a beam of infrared laser light produced by a battery-operated diode laser. The beam of light rotates at 600 rpm and establishes a flat reference plane over a work area. The reference plane of light can be tilted up to 9.99% grade in two axes that are perpendicular to each other. The system electronically self-levels at any combination of grade settings preset by the user. If the 1145-2 Laser Transmitter is disturbed, the laser beam automatically shuts off until it has releveled. The 1145-2 Laser Transmitter, with dual axes, provides precise reference automatically for control of compound grades on a job site.

5-3. 1145-2 LASER TRANSMITTER LOCATION AND DESCRIPTION OF MAJOR COMPONENTS.

- a. **1145-2 Laser Transmitter Characteristics.**

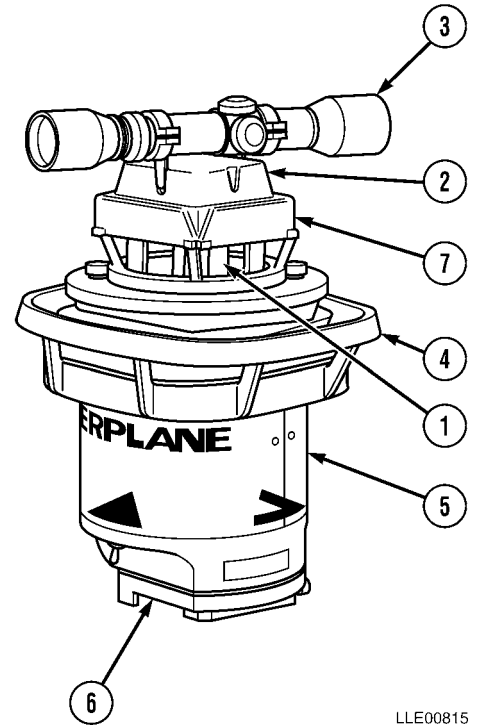
The 1145-2 Laser Transmitter operating temperature range is -4 to 120° F (-20 to 49° C) and storage temperature range is -40 to 140° F (-40 to 60° C).

- (1) **ROTOR PENTAMIRROR ASSEMBLY.** Contains a spinning optical pentamirror, rotating at 600 rpm, that projects the laser beam over a job site.
- (2) **UPPER HOUSING ASSEMBLY.** Protects the precision optics in the pentamirror assembly from being damaged by swinging objects or being dropped, and from wind-blown dust and rain.
- (3) **SIGHTING TELESCOPE.** Permits precision alignment of both grade axes when the 1145-2 Laser Transmitter is set up over the benchmark. Sighting telescope mounting rings fit into grooves on the upper housing assembly (2).

CAUTION

The 1145-2 Laser Transmitter should never be carried by sighting telescope or upper housing assembly. Failure to comply will damage the laser.

- (4) **CARRYING HANDLE.** Used to transport 1145-2 Laser Transmitter and mount on accessory tripod system.
- (5) **HOUSING.** Provides enclosure for leveling system to protect from rough handling and damage suffered on busy job sites.
- (6) **BOTTOM MOUNTING PLATE.** Includes a quick-disconnect adapter.
- (7) **SHUTTERS.** Block transmission of laser beam when lowered over upper housing assembly windows.



LLE00815

- (8) **CONTROL SWITCH.** Used to establish the 1145-2 Laser Transmitter's mode of operation.
- a When the Control Switch is set to the AUTO position, the electronic self-leveling system is activated and the laser beam will not turn on until it is level.
 - b When the Control Switch is set to the OFF/CHARGE position, the system is shut off and the internal battery-charging mode is activated.
 - c When the Control Switch is set to the MANUAL position, the 1145-2 Laser Transmitter remains in the last leveled position.

NOTE

The electronic self-leveling system and early warning system are overridden in MANUAL position so the laser beam stays on no matter what position the outer housing of the 1145-2 Laser Transmitter may be in. This allows the 1145-2 Laser Transmitter to be manually adjusted into greater than 9.99% slopes in unusual steep slope conditions.



- (9) **AUTO-LEVEL INDICATOR LAMP.** Flashes when the 1145-2 Laser Transmitter is in AUTO mode and the laser is not level. The indicator lamp stops flashing when the electronic self-leveling system has leveled the laser beam. The indicator lamp stays on when the 1145-2 Laser Transmitter is in MANUAL mode.
- (10) **GRADE ADJUST KNOB.** Used to adjust "Y" axis (open legged triangle).
- (11) **TRIPOD INTERFACE.** The quick-connect adapter connects the 1145-2 Laser Transmitter to the elevating base and tripod.
- (12) **STANDING FEET.** Provide three-point contact when the 1145-2 Laser Transmitter is set on flat surface, such as a wall top or other setup where a tripod is not being used.
- (13) **WARRANTY STICKER.** A seal put over one Bottom Mounting Plate hold-down screw, used to determine if unauthorized service has been performed on the 1145-2 Laser Transmitter.
- (14) **FINE THREAD ADJUSTING KNOB.** An adjustment screw used for precise alignment of 1145-2 Laser Transmitter and sighting telescope to forward point of predetermined line when the 1145-2 Laser Transmitter is set up over benchmark.

- (15) **BREATHER VENT.** Allows rapid evaporation of any accumulated moisture caused when 1145-2 Laser Transmitter passes through dew point.
- (16) **LOW VOLTAGE INDICATOR LAMP.** A red LED miniature warning lamp that flashes when the 6-Vdc internal battery falls below the safe operating voltage. The Low Voltage Indicator Lamp stays on continuously when transmitter is hooked to 12-Vdc external battery, to warn that external battery has discharged below safe operating voltage. Laser beam automatically shuts off and rotor pentamirror assembly stops rotating when Low Voltage Indicator Lamp comes on. At 60° F (16° C), battery operating time is approximately 40 hours after battery has been charged for 16 hours.

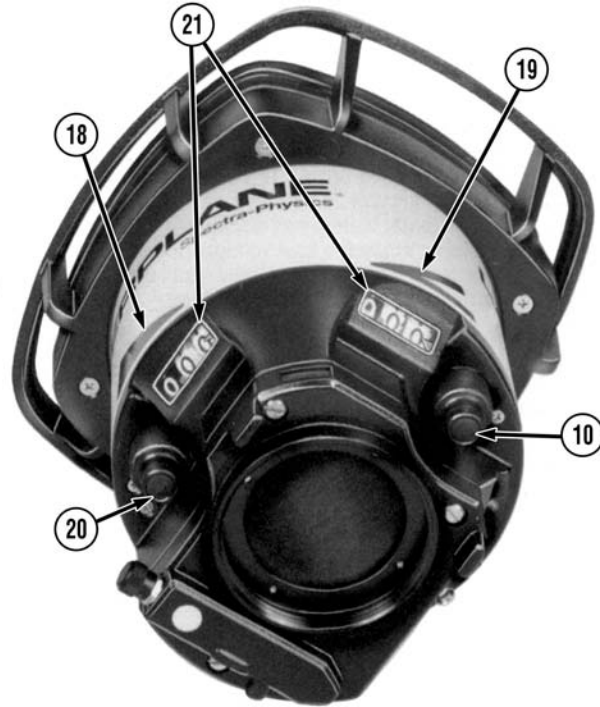


CAUTION

Do not connect the 1145-2 Laser Transmitter to a 24 Vdc charging system or damage to equipment will result.

- (17) **POWER/CHARGER CONNECTOR.** Receptacle for all external electrical connections. When control switch is in OFF/Change position the internal battery charging circuit is activated. Internal battery can be charged from the 110-/220-Vac Wall Outlet Charger or from a 12-Vdc external vehicle battery. The 12-Vdc charging options allow you to charge the 6-Vdc internal battery from your truck battery on remote job sites where AC electrical power is not readily available. Maximum charge and longest battery life occurs when internal battery is charged frequently between 60° F and 90° F (16° C and 32° C).
- (18) **“X” AXIS INDICATOR.** A solid triangle on two sides of the 1145-2 Laser Transmitter case.

- (19) **“Y” AXIS INDICATOR.** The “Y” axis indicator is an open-legged triangle that shows orientations of opposite grade axes.
- (20) **GRADE ADJUST KNOB.** Used to adjust the “X” axis slope percentage of grade (solid triangle).
- (21) **GRADE COUNTER WINDOW.** Has large numerals, a decimal point, and a grade reading indicator. Windows are tilted downward at an angle so grade readings are easily visible from ground level even when tallest tripod legs are used.



LLE00817

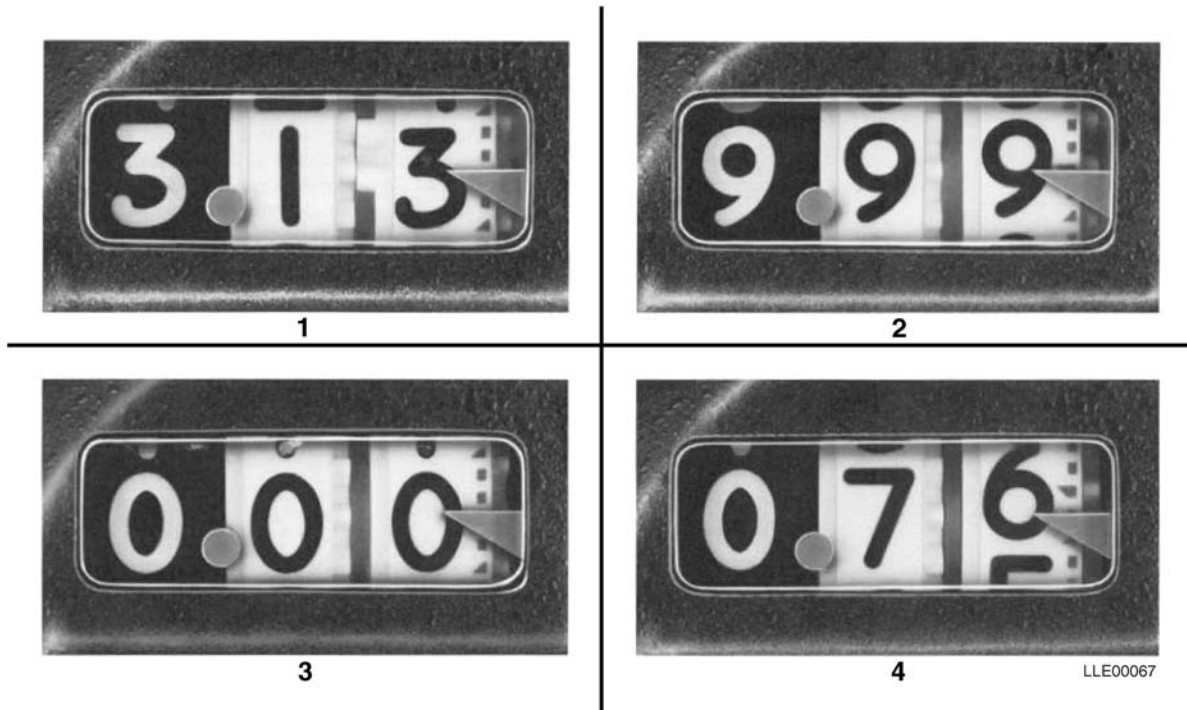
b. Operation and Grade Axis Orientation.

- (1) Notice relationship of “X” axis (20) and “Y” axis (10) Grade Adjust Knobs, Grade Counter Windows, and triangles on transmitter housing. A solid triangle indicates “X” axis and an open triangle indicates “Y” axis.
- (2) “Y” AXIS GRADE ADJUST KNOB showing position of Grade Adjust Knob, Grade Counter Window, and Open Legged “Y” Axis Triangle on housing.
- (3) 1145-2 Laser Transmitter has two grade axes that are marked, and when entering the desired grade into the rotating beam, the grade axis must be aligned in the direction of the desired slope. This is accomplished by sighting through the telescope mounted on top of the 1145-2 Laser Transmitter or sighting along the “V” groove in the top cover. When one grade axis is on desired line, opposite axis will be perpendicular. Large solid and open-legged triangles painted on side of unit housing indicate UP SLOPE and DOWN SLOPE direction. Sample grade readings.



LLE00818

- (4) Notice indicator marks on white outside grade counter wheel look just like marks on a typical grade rod. The large decimal point is easily visible from ground. Here are some sample % grade readings: (1) = 3.13%, (2) = 9.99%, (3) = 0.00%, and (4) = 0.758%.



c. 1145-2 Laser Transmitter Maintenance.

Your 1145-2 Laser Transmitter is a rugged construction tool that has met rigorous qualification tests more severe than it will ever see in normal use on a job site. It will require little maintenance and give long years of good service if it is properly cared for like any piece of valuable equipment. To ensure trouble-free operation, follow these simple procedures:

- (1) Always store and transport 1145-2 Laser Transmitter in its carrying case. When transporting 1145-2 Laser Transmitter in a vehicle, ensure 1145-2 Laser Transmitter is secured.
- (2) Extended storage, such as for winter months, should be in a dry, heated place.
- (3) Keep power cord connector clean.
- (4) Clean windows with a clean, lint-free cloth and light glass-cleaning solvent. Do not use harsh solvents that are strong enough to dissolve plastic compounds, such as solvents containing acetone, trichloroethylene, etc.
- (5) Never wipe windows with a dry cloth or your fingers, as you may scratch the windows.
- (6) Never allow mud, rocks, concrete, or water to get on foam rubber shock-absorbing pads in carrying case. Always close the carrying case after you have completed setting up the unit.
- (7) Repair frayed and cracked electrical cables immediately. Be careful not to pinch electrical cords in sides of the carrying case.
- (8) Sighting telescope should be treated with the same care as the 1145-2 Laser Transmitter.
- (9) Keep bottom mounting plate free of dirt and debris. Keep threads clean and ensure proper engagement of threaded adapters. If this is not done, 1145-2 Laser Transmitter may not tighten securely to Elevating Base and will be susceptible to ground vibration and wind.

- (10) After extended storage (3 months or more), the 1145-2 Laser Transmitter's internal battery should be charged for 24 to 48 hours.
- (11) Battery life is extended by frequent charging. We recommend charging overnight every other night.

5-4. 1275 LASER RECEIVER LOCATION AND DESCRIPTION OF MAJOR COMPONENTS.

a. 1275 Laser Receiver Characteristics.

The 1275 Laser Receiver is a battery-operated, hand-held laser receiver designed to detect a rotating laser beam and provide other functions as described below. The 1275 Laser Receiver operating temperature range is -4° F to 122° F (-20° C to 50° C) and storage temperature range is -4° F to -158° F (-20° C to 70° C).

- (1) **POWER BUTTON.** Turns the 1275 Laser Receiver ON and OFF.

When turned on, the 1275 Laser Receiver displays information about elevation, on-grade sensitivity, audio status, low-battery condition, and back lighting.

- (2) **ON-GRADE SENSITIVITY BUTTON.** Changes the 1275 Laser Receiver's on-grade sensitivity.

Ultra Fine (1)	0.0 in. (0.0 cm)
Super Fine (2)	1/32 in. (0.08 cm)
Fine	1/16 in. (0.16 cm)
Medium	1/8 in. (0.32 cm)
Coarse	1/4 in. (0.64 cm)

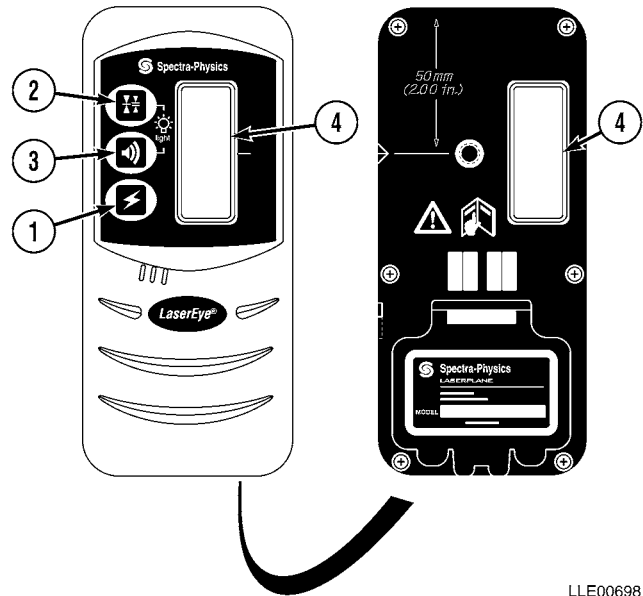
- a The Graphic Display shows which sensitivity is selected.
- b Simultaneously pressing 1275 Laser Receiver power and on-grade sensitivity buttons while the 1275 Laser Receiver is powering up configures 1275 Laser Receiver for a 0.0-in. (0.0 cm) on-grade sensitivity.
- c The 1275 Laser Receiver can also be service center configured for a 1/32-in. (0.79 cm) on-grade sensitivity.

- (3) **AUDIO BUTTON AND SOUNDER.** Turns the 1275 Laser Receiver audio sounder to Loud, Soft, or OFF.

- a The 1275 Laser Receiver always turns ON with audio set to OFF. The 1275 Laser Receiver beeps quickly when receiver is slightly above laser beam, slowly when below it, and continuously when centered in laser plane or on grade.
- b Simultaneously pressing the 1275 Laser Receiver's power and audio buttons while the 1275 Laser Receiver is powering up configures the 1275 Laser Receiver to have Audio/On-Grade off for applications where the 1275 Laser Receiver is used for monitoring.

- (4) **FRONT AND BACK LIQUID CRYSTAL DISPLAYS (LCD).** Provide information about elevation, on-grade sensitivity, audio status, low-battery and transmitter out-of-level conditions, and back lighting.

Simultaneously pressing all three receiver buttons during power up configures receiver to perform a Graphic Display self-diagnostics test, flashing each Graphic Display symbol independently until the power button is pressed again.



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- (5) **ELEVATION DISPLAY.** Shows the 1275 Laser Receiver's position with respect to the laser beam.

Arrows show direction receiver needs to be moved to be centered in laser beam or on-grade. Audio feature must be turned ON for high/low tone to function.

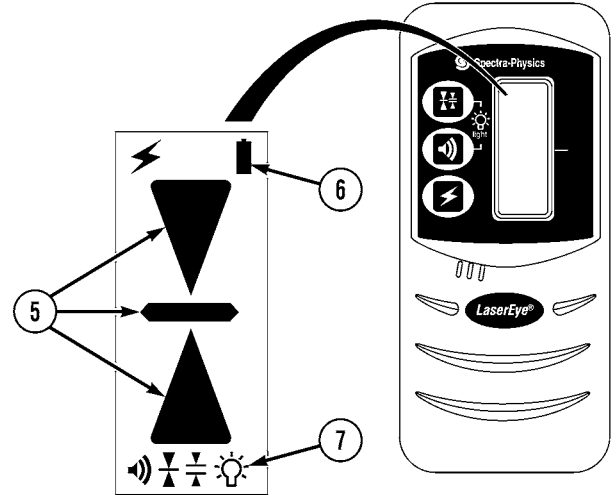
- (6) **LOW-BATTERY INDICATION.** Displays when the 1275 Laser Receiver's batteries need to be replaced. Battery life is approximately 74 hours at 68° F (20° C).
- (7) **LCD BACK LIGHTING.** Lights up LCD for easy viewing in dimly lit areas. To activate this feature, simultaneously press audio and on-grade sensitivity buttons until back lighting symbol appears in LCD.

Back lighting LCDs turn OFF to conserve power when the laser isn't striking the 1275 Laser Receiver. When the 1275 Laser Receiver is placed into beam's path, the backlighting feature returns.

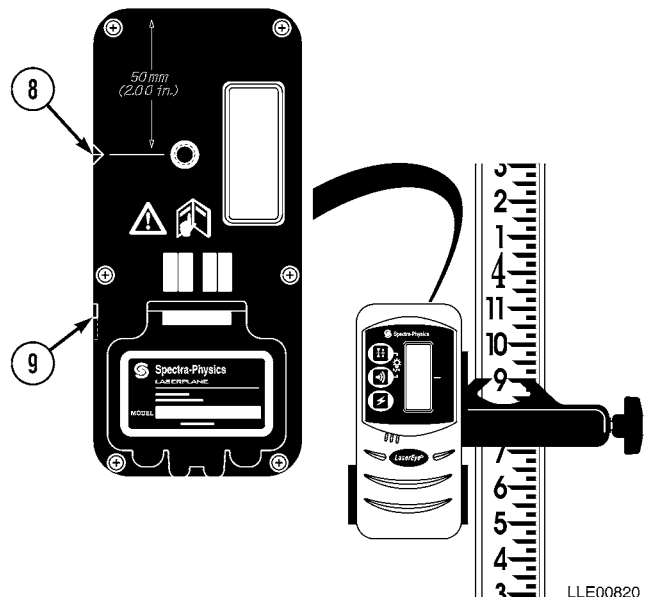
- (8) **MARKING NOTCH.** Aligns with on-grade portion of photocell and is used for transferring elevation marks.

Top of receiver is 2 in. (5.1 cm) above marking notch.

- (9) **DISPLAY OUTPUT/ATTACHMENT.** Attaches the 1278 Remote Display Accessory to the 1275 Laser Receiver when the 1275 Laser Receiver is being used high above or below the Operator's head.



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CAUTION

Batteries should be removed when storing unit more than 30 days or batteries may become corroded and damage to equipment will result.

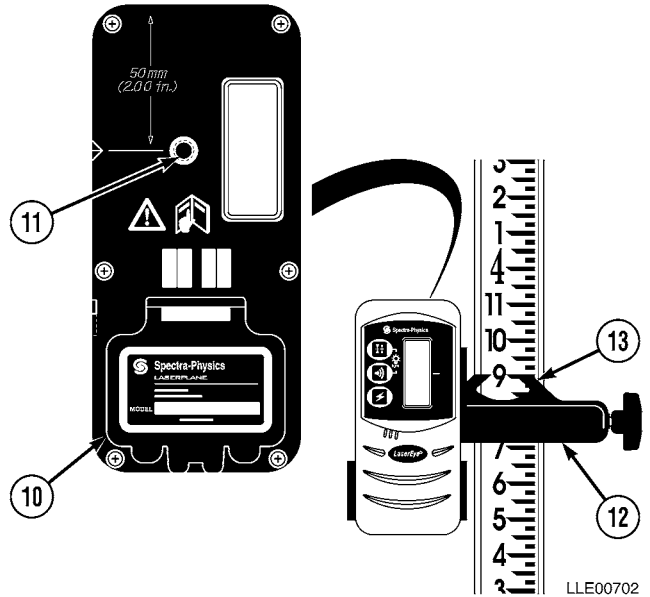
(10) BATTERY COMPARTMENT. Holds two alkaline batteries for powering the 1275 Laser Receiver.

- a Use your thumbnail or a coin to open battery door.
- b Insert batteries, noting diagram inside housing. If batteries are installed incorrectly, no damage occurs, but the unit will not work. Install batteries for proper operation.
- c If the battery symbol appears on the LCD, replace alkaline batteries.

(11) FASTENER/RECEPTACLE. Accepts a rod-clamp fastening screw.

(12) GENERAL PURPOSE CLAMP. Attaches 1275 Laser Receiver to grade rod staff, or similar measuring device with width up to 2 1/2 in. (6.4 cm).

(13) 1275 LASER RECEIVER ROD CLAMP REFERENCE INDICATORS. Aligned with on-grade portion of 1275 Laser Receiver when it is used on grade rod, staff, or similar measuring device.



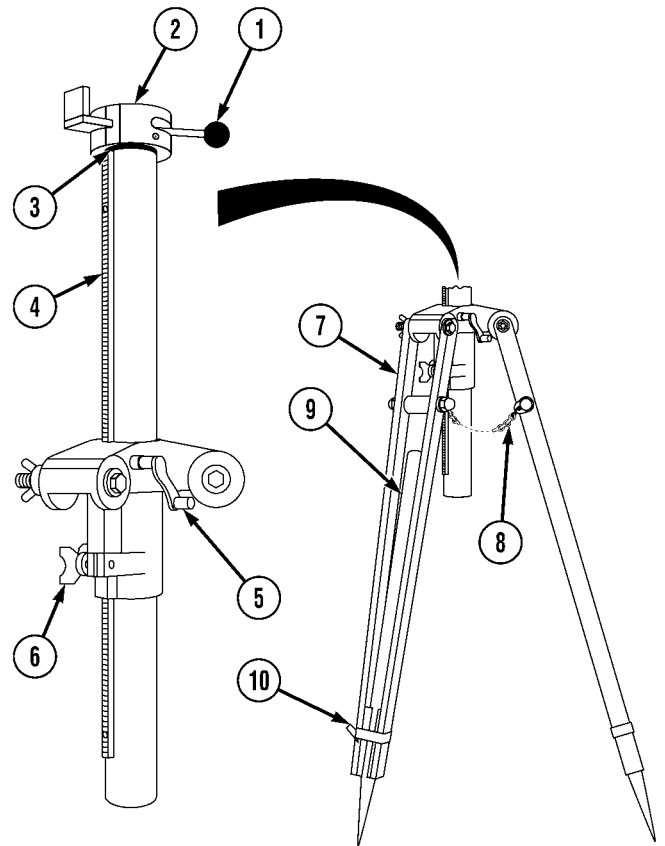
LLE00702

5-5. ELEVATING BASE AND TRIPOD LOCATION AND DESCRIPTION OF MAJOR COMPONENTS.

a. Elevating Base and Tripod Characteristic.

The Elevating Base and Tripod unit provides a telescoping and locking mount for the 1145-2 Laser Transmitter. Fine 1145-2 Laser Transmitter height adjustment are made with the elevating Base. Coarse height adjustments are made with the Leg Extensions of the Tripod.

- (1) **QUICK-RELEASE LEVER.** Allows fast and easy 1145-2 Laser Transmitter setup.
- (2) **LOCKING RING.** Enables 1145-2 Laser Transmitter to fasten to tripod base.
- (3) **O-RING STOP.** Helps prevent damage to elevating base when elevating column is lowered.
- (4) **STEEL RACK AND ELEVATING BASE TUBE.** Incorporates a graduated scale to allow precise movement of the elevating column.
- (5) **RAISE/LOWER CRANK.** Used to move elevating column up or down. It incorporates an adjustable locking mechanism to prevent transmitter from dropping if tube is not secured.
- (6) **CLAMPING KNOB.** Used to clamp the elevating column in position.
- (7) **TRIPOD LEGS.** Provide support for the Elevating Base.
- (8) **CHAINS.** Are connected to tripod legs to prevent slippage on a hard surface.
- (9) **LEG EXTENSIONS.** Provide height adjustment. Located in ends of legs, with footpads for pushing pointed leg into ground.
- (10) **LEG CLAMP.** Tightens the tripod leg extension in place after height adjustment.

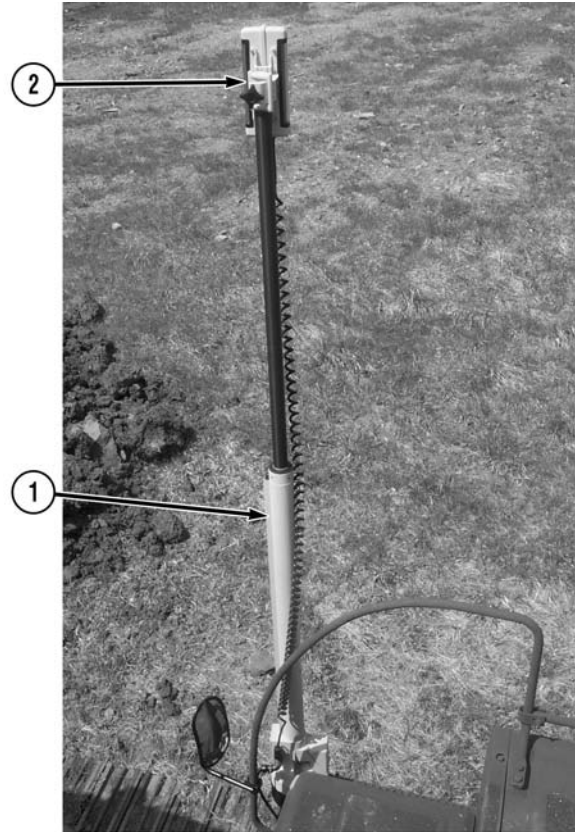


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5-6. BUCKET-PRO™ SYSTEM LASER OPERATION.

The Laser Reference System accessories include EM2E-24 Electric Mast (1) and R2S-S Laser Receiver (2). The Laser Reference System also includes mounting brackets and electrical cables for installation on most HYEXs.

The Laser Reference System compensates for changes in elevation when HYEX moves. In trenching applications, for example, the Laser Reference System allows you to move down the trench line several times without having to rebenchmark the Bucket-Pro™ System. The R2S-S Laser Receiver stays locked onto laser beam and EM2E-24 Electric Mast retracts/extends in response to up/down movement of the HYEX. The EM2E-24 Electric Mast measures the change in elevation and signals the Control Box to compensate for the change.



LLE00307



The Laser Reference System is designed for use with Model 1145-2 Laser Transmitter (3). The 1145-2 Laser Transmitter provides factory-guaranteed performance to specifications. R2S-S Laser Receiver (2), mounted on EM2E-24 Electric Mast (1), is also compatible with other manufacturers' laser transmitters.

To use the Laser Reference System with the Bucket-Pro™ System, complete the following steps:

- (1) Set up tripod and 1145-2 Laser Transmitter (3) so that height of 1145-2 Laser Transmitter (3) laser beam is within search range of R2S-S Laser Receiver (2) for terrain and placement of HYEX (4) (Para 5-2).

NOTE

- Distance and terrain make judging correct height difficult. Using 1275 Laser Receiver for finding location of laser beam makes judging right height easier.
- (2) Ensure Grade Axis of 1145-2 Laser Transmitter (3) is aligned so that one laser slope axis is on centerline of your trench or footing.

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- (3) Dial percent of grade desired into aligned laser beam using knobs (5) and (6).
- (4) Inspect slope-axis markings on side of transmitter and ensure percent grade entered aligns to proper axis.
- (5) Perform grade axis alignment on job site (Para 5-16).



LLE00310

SECTION II. 1145-2 LASER TRANSMITTER, 1275 LASER RECEIVER, AND ELEVATING BASE AND TRIPOD PMCS

5-7. PMCS INTRODUCTION.

Preventive Maintenance Checks and Services (PMCS) means systematic caring for, inspecting, and servicing equipment to keep it in good condition and to prevent malfunctions. As a 1145-2 Laser Receiver, and Elevating Base and Tripod system Operator, your mission is to:

- a. Be sure to perform your PMCS each time you operate the 1145-2 Laser Receiver, and Elevating Base and Tripod system. Always do your PMCS in the same order so it becomes a habit. Once you've had some practice, you'll quickly spot anything wrong.
- b. Do your Before PMCS just before you operate the 1145-2 Laser Transmitter, 1275 Laser Receiver, and Elevating Base and Tripod system. Pay attention to WARNINGS, CAUTIONS, and NOTES.
- c. Do your AFTER PMCS right after operating the 1145-2 Laser Transmitter, 1275 Laser Receiver, and Elevating Base and Tripod system. Pay attention to WARNINGS, CAUTIONS, and NOTES.
- d. Use DA Form 2404 or DA Form 5988-E (Equipment Inspection and Maintenance Worksheet) to record any faults that you don't immediately fix.

5-8. PMCS PROCEDURES.

- a. PMCS table (Table 5-1.) lists inspections and care required to keep your 1145-2 Laser Transmitter, 1275 Laser Receiver, and Elevating Base and Tripod system in good operating condition. This table is set up so you can do BEFORE and AFTER PMCS while walking around the 1145-2 Laser Transmitter, 1275 Laser Receiver, and Elevating Base and Tripod system.
- b. The "Interval" column tells you when to do a certain check or service.
- c. The "Procedure" column tells you how to do required checks and services. Carefully follow these instructions.
- d. The "Not Fully Mission Capable If" column tells you when your 1145-2 Laser Transmitter, 1275 Laser Receiver, and Elevating Base and Tripod system is nonmission capable and why the 1145-2 Laser Transmitter, 1275 Laser Receiver, and Elevating Base and Tripod system cannot be used.
- e. When something looks wrong that you cannot fix, write down the problem on your DA Form 2404 or DA Form 5988-E. Immediately report the problem to your supervisor.

- f. When you do your PMCS, you will always need a rag or two. The following are checks common to the entire 1145-2 Laser Transmitter, 1275 Laser Receiver, and Elevating Base and Tripod system.

WARNING

- Degreasing Solvent (MIL-PRF-680, Type II) is TOXIC and flammable. Wear protective goggles and gloves, use only in a well-ventilated area, avoid contact with skin, eyes, and clothes, and do not breathe vapors. Keep away from heat or flame. Never smoke when using solvent; the flash point for degreasing solvent type II is 200° F (93° C). Failure to comply may result in injury or death to personnel.
 - If personnel become dizzy while using cleaning solvent, immediately get fresh air and medical help. If solvent contacts skin or clothes, flush with cold water. If solvent contacts eyes, immediately flush eyes with water and get immediate medical attention. Do not use diesel fuel, gasoline, or benzene (benzol) for cleaning.
 - Adhesives, solvents, and sealing compounds burn easily and give off vapors that are harmful to the skin and clothing. To avoid injury or death, keep away from open fire when using these materials, and use only in well-ventilated areas. If adhesives, solvents, or sealing compounds contact the skin or clothing, wash immediately with soap and water, and rinse thoroughly. Failure to comply may result in injury or death to personnel.
- (1) **Keep It Clean.** Dirt, grease, oil, and debris only get in the way and may cover up a serious problem. Clean as you work. Use degreasing solvent (MIL-PRF-680, type II) on all metal surfaces. Use soap and water when you clean rubber or plastic material.
 - (2) **Rust and Corrosion.** Check 1145-2 Laser Transmitter, 1275 Laser Receiver, and Elevating Base and Tripod system brackets for rust and corrosion. When any bare metal or corrosion exists, clean and apply a coat of paint. Report bare metal or corrosion to your supervisor.
 - (3) **Bolts, Nuts, and Screws.** Check all bolts, nuts, and screws for obvious looseness, missing, bent, or broken condition. You can't check them all with a tool, but look for chipped paint, bare metal, or rust around bolt heads. When you find a bolt, nut, or screw you think is loose, tighten it or report it to your supervisor.
 - (4) **Welds.** Look for loose or chipped paint, rust, or gaps where parts are welded together. When you find a bad weld, report it to your supervisor.
 - (5) **Electric Wires and Connectors.** Look for cracked, frayed, or broken insulation, bare wires, and loose or broken connectors. Tighten loose connectors. Report any damaged wires to your supervisor.
 - (6) **Hydraulic Lines and Fittings.** Look for wear, damage, and leaks; ensure clamps and fittings are tight. Stains around a fitting or connector can mean a leak. If a leak comes from a loose fitting or connector, tighten it. If something is broken or worn out, report it to Unit Maintenance.
 - (7) When you check operating conditions, look to see if component is serviceable.

5-9. SHORTENED MAINTENANCE INSTRUCTIONS.

Local conditions of extreme heat, dust, cold, or wetness dictate that service intervals shall be shortened.

5-10. ADDITIONAL MAINTENANCE INSPECTIONS.

Additional maintenance inspections are required for the following reasons:

- a. Prolonged storage. Inspect 1145-2 Laser Transmitter, 1275 Laser Receiver, and Elevating Base and Tripod system components that have been stored for a period of 3 months or more.
- b. Initial preparation upon receipt.
- c. Preparation for storage.

5-11. LEAKAGE CLASSIFICATION AND DEFINITION.

There are no fluid reservoirs on 1145-2 Laser Transmitter and Elevating Base and Tripod system.

5-12. GENERAL LUBRICATION INSTRUCTIONS.

WARNING

Do not look into 1145-2 Laser Transmitter for a long period of time. Failure to comply may cause injury to personnel.

- a. **Intervals.** Intervals (on-condition or hard time) and related man-hour times are based on normal operation. Man-hour time specified is time needed to do all services prescribed for a particular interval. Change hard-time interval when operating equipment under adverse operating conditions, including longer-than-usual operating hours. The calendar interval will be extended during periods of low activity. When extended, adequate preservation precautions must be taken. Hard-time intervals must be applied during warranty period. Intervals shown in this section are based on calendar and hourly times.

5-13. PMCS COLUMN ENTRY EXPLANATION.

- a. **Item No. Column.** Checks and services are numbered in interval order showing a walk-around sequence around the 1145-2 Laser Transmitter and Elevating Base and Tripod system. Use these numbers in the "Item No." column on DA Form 2404 or DA Form 5988-E when recording faults that you don't immediately fix.
- b. **Interval Column.** This column indicates when the lubrication, check, and/or service should be performed.
- c. **Location, Item to Check/Service Column.** Underlined items listed in this column are divided into groups indicating the portion of the equipment of which they are a part (e.g., brakes, fuel, and engine). Under these groupings, a few common words are used to identify the specific item being checked.
- d. **Procedure Column.** This column contains procedures required to perform checks and services.
- e. **Not Fully Mission Capable If Column.** This column contains criteria that cause the equipment to be classified as NOT READY/AVAILABLE because of an inability to perform its primary mission. An entry in this column will:
 - (1) Identify conditions that make equipment not available for readiness reporting purposes.
 - (2) Deny use of equipment until corrective maintenance has been performed.

5-14. 1145-2 LASER TRANSMITTER, 1275 LASER RECEIVER, AND ELEVATING BASE AND TRIPOD SYSTEM OPERATOR'S PMCS TABLE.

Table 5-1. 1145-2 LASER TRANSMITTER, 1275 LASER RECEIVER, AND ELEVATING BASE AND TRIPOD SYSTEM OPERATOR'S PMCS (Before/After)

Item No.	Interval	Location	Procedure	Not Fully Mission Capable If:
		Item to Check/Service		
1	Before/After	Exterior 1145-2 Laser Transmitter	<p>Wipe dirt and dust from all metal components with a dry cloth.</p> <p>Inspect exterior of 1145-2 Laser Transmitter for damage or cracks.</p> <p>Inspect windows for cracks, scratches, and dirt. Clean windows with clean water and a soft cloth.</p> <p>Inspect bottom mounting plate for dirt and debris.</p> <p>Ensure grade adjustment knobs for "Y" and "X" axes rotate freely and function properly.</p> <p>Ensure breather vent is free of dirt and debris.</p> <p>Ensure power/charge connector is free of dirt and damage.</p>	<p>Exterior of 1145-2 Laser Transmitter is damaged or cracked.</p> <p>Windows are cracked, scratched, or dirty.</p> <p>Bottom mounting plate is dirty.</p> <p>Knobs will not rotate or adjust properly.</p> <p>Breather vent is plugged.</p> <p>Broken or bent pin is evident.</p>
2	Before/After	Electrical Cables	Ensure electrical cables are not frayed, cracked, or exposed.	Frayed, cracked, or exposed wires are evident.
3	Before/After	Elevating Base and Tripod	Check all screws, fasteners, and legs.	Screws, fasteners, or legs are missing or damaged.
4	Before/After	1275 Laser Receiver	Inspect 1275 Laser Receiver for cracks or any damage to exterior.	Exterior of 1275 Laser Receiver is cracked or damaged.
5	Before/After	1275 Laser Receiver Grade Rod	Inspect Grade Rod for cracks or damage.	Grade Rod is cracked or damaged.

SECTION III. OPERATION

5-15. 1145-2 LASER TRANSMITTER ADJUSTMENT.

The 1145-2 Laser Transmitter has two horizontal level adjust screws by the windows on upper frame of unit. These screws permit you to make minor adjustments along two axes of the horizontal plane. Axes are labeled "X" and "Y" and rubber caps over adjustment screws tell you which axis is which.

5-16. 1145-2 LASER TRANSMITTER CALIBRATION.

a. Calibration.

- (1) All calibration procedures are done at zero reading on right-hand white counter wheel – not against mechanical stop if past zero point. The following items are required to make a calibration adjustment on 1145-2 Laser Transmitter:
 - a A 5/32-in. (0.40 cm) Allen head driver.
 - b Model 1275 Laser Receiver.
 - c Elevating Base and Tripod allows you to rotate 1145-2 Laser Transmitter in 90-degree increments.
 - d A minimum 200-ft (60.96 m) range that is unobstructed and as close to flat as possible.
- (2) Mount unit on tripod at one end of 200 ft (60.96 m) range and rough level it within ± 5 degrees. Set "X" and "Y" axis grade counters at zero reading (not against counter wheel mechanical stop).
- (3) Turn 1145-2 Laser Transmitter control switch to AUTO position and wait for Auto Mode Indicator Lamp to stop flashing.
- (4) Station a rodman with one of the suitable detectors at other end of range, 200 ft (60.96 m) away.

NOTE

The appropriate axis may be identified by checking triangular markings of the "X" axis indicator.

- (5) Align laser, using sighting scope or groove, such that "X" axis is pointed directly at rodman. Ensure pentamirror is rotating and Auto Mode Indicator Lamp has stopped flashing.
- (6) Have rodman take a precise reading to within 1/16 in. (0.16 cm) and mark reading as X1.
- (7) Rotate transmitter 180 degrees and wait at least 2 minutes for it to relevel. Have rodman take another accurate reading and mark reading as X2.

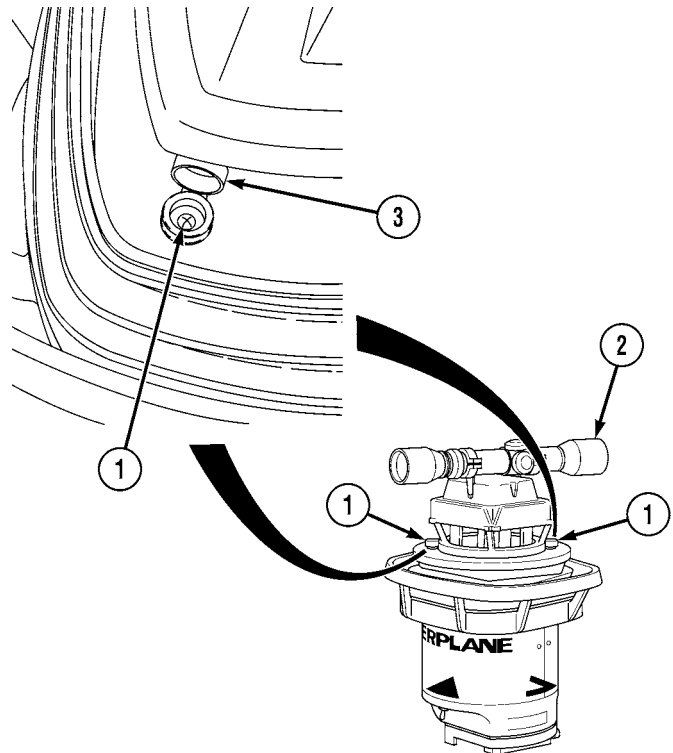
NOTE

- If difference between X1 and X2 is less than 0.02 ft (1/4 in. or 0.64 cm), no adjustment is necessary.
 - If difference is between 0.02 ft (1/4 in. or 0.64 cm) and 0.12 ft (1-1/2 in. or 3.81 cm), you can continue with this procedure.
 - If difference is 0.12 ft (1-1/2 in. or 3.81 cm) or greater, the unit must be recalibrated at an authorized service center. You cannot recalibrate the unit in the field without damage to the unit.
- (8) Calculate the “X” average = $(X 1 + X 2)/2$ and have rodman adjust detector on rod to the “X” average. (Center of detector is between the two readings.)

NOTE

Calibration screws are labeled “X” and “Y”.

- (9) Locate the “X” calibration screw (1) and adjust it to align beam to the “X” average at 1145-2 Laser Transmitter. One full turn of calibration screw moves beam approximately 0.04 ft (1/2 in. or 1.3 cm) in 200 ft (60.96 m). If beam cannot be aligned by gentle turning of calibration screw (1), return unit to an authorized service center for calibration.
- (10) After adjusting beam, allow 4 minutes for unit to stabilize before taking next reading. Repeat Steps (4) through (8) to check your work. Do a fine readjust, if necessary.
- (11) After adjusting the “X” axis to rotate 1145-2 Laser Transmitter 90 degrees to the “Y” axis.
- (12) Point the “Y” axis directly at rodman.
- (13) Using sighting telescope (2) or groove and repeat above Steps (6) through (10).
- (14) Call readings Y1 and Y2 and calculate the “Y” axis average just as you did in Step (8).
- (15) Secure rubber caps (3) over calibration screws (1).

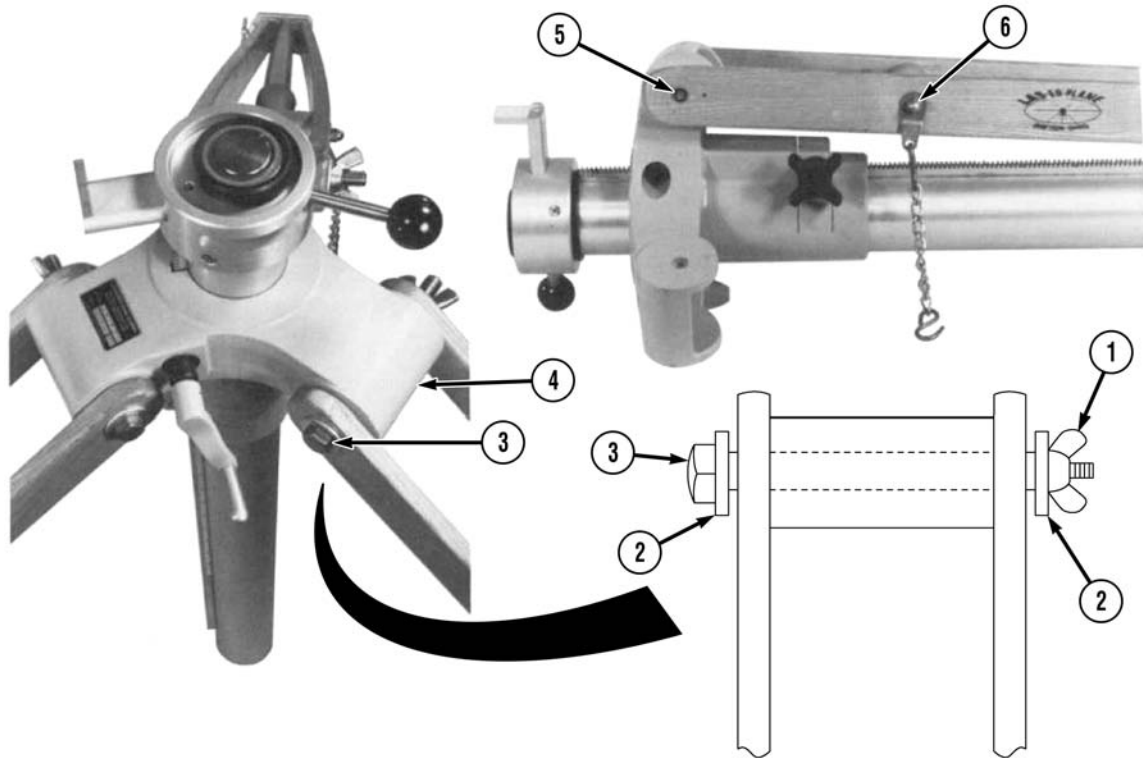


LLE00704

5-17. ELEVATING BASE AND TRIPOD ASSEMBLY AND OPERATION.

This section illustrates the assembly and the operation of the Elevating Base and Tripod assembly. Setup may change, depending on the job site requirements.

a. Assembly.



LLE00103

NOTE

All tripod legs install the same. Only one leg is shown.

- (1) Remove wing nuts (1), washers (2), and mounting bolts (3) from tripod base (4).
- (2) Align tripod leg mounting holes (5) with the hole in tripod base (4). Chain tabs (6) need to face inward.

NOTE

Ensure the bolt hex heads face the raise/lower crank to provide the necessary clearance to operate the raise/lower crank.

- (3) Install mounting bolt (3) through washer (2), tripod leg mounting holes (5), and tripod base (4).
- (4) Install washer (2) and wing nut (1) onto mounting bolt (3).
- (5) Tighten wing nut (1).

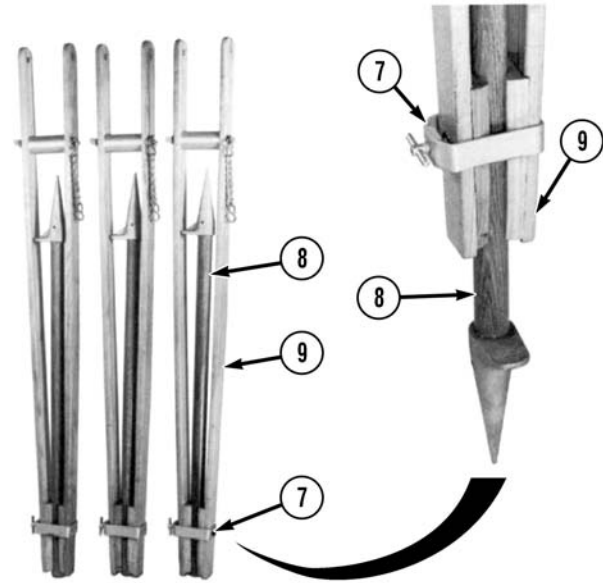
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- (6) Loosen leg clamp (7) and remove each extension foot (8).
- (7) Insert extension foot (8) into tripod legs (9), with steps on tripod legs (9) facing outward.
- (8) Tighten leg clamps (7).

b. Operation.

NOTE

- The recommended working range for the 1145-2 Laser Transmitter is 1000 ft (305 m).
- The area encompassed by this sweep of laser beam is 72 acres (29 hectares). In flat fields, the center of the field is usually the best location. In rolling fields, locate the 1145-2 Laser Transmitter at an elevation so the receiver can pick up the plane of light approximately midway in its receiver (or survey rod) travel.

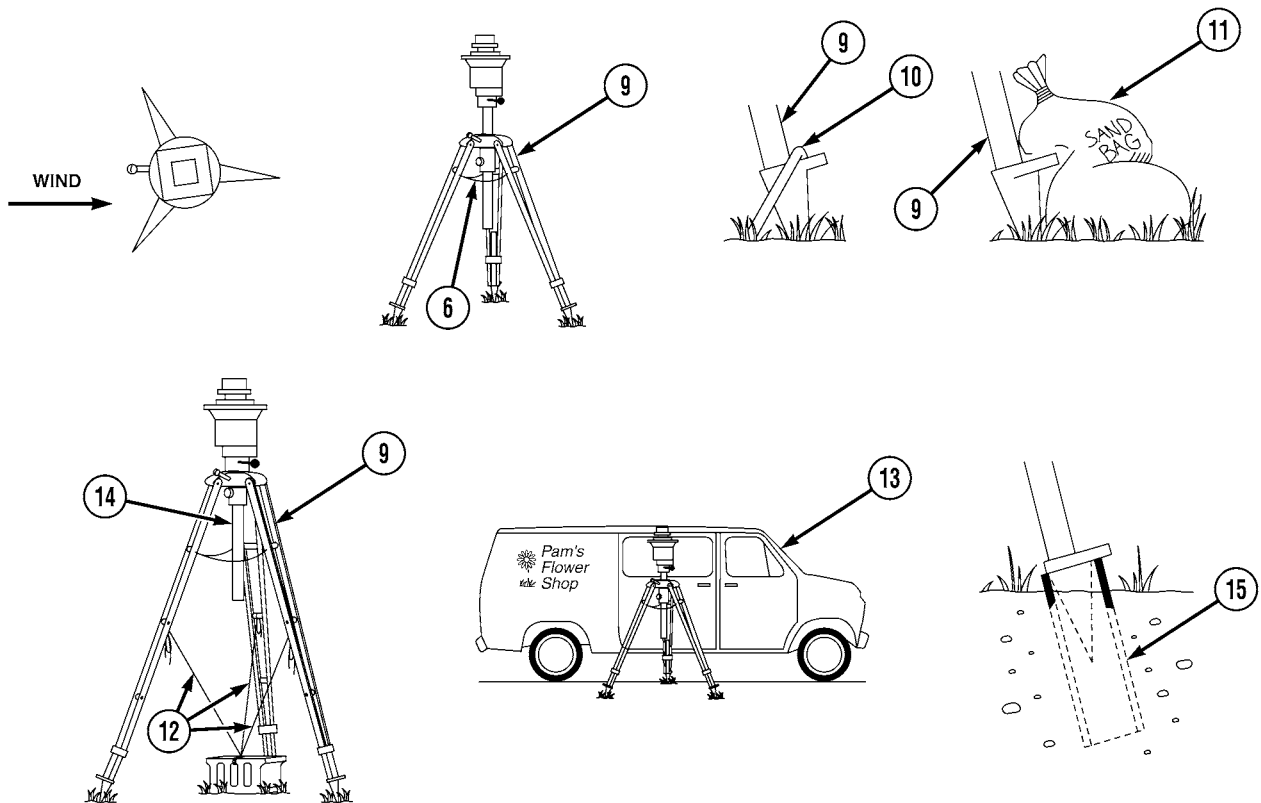


LLE00104

- (1) Select a location to utilize the 1145-2 Laser Transmitter.

NOTE

- Consistent results with the 1145-2 Laser Transmitter require that the plane of light remains stable. For this reason, the 1145-2 Laser Transmitter, the base, and the legs are all carefully designed to use heavy components and special materials to minimize any tendency to vibrate or drift.
 - When setting up the tripod assembly, it is important to obtain the most level and stable base possible for the 1145-2 Laser Transmitter. The less the self-leveling mechanisms have to work, the more stable the plane of light will be. Ground vibration, wind, or extreme temperatures can influence the plane of light.
 - Ground vibration can be a problem in certain soils when working at long range from the transmitting unit. Peat or muck readily conducts traffic vibration to the tripod legs. A simple test is to stand next to the tripod assembly while heavy traffic passes. If you can feel traffic vibration in your feet and legs, you may have a problem at longer ranges where the vibrational effect on the 1145-2 Laser Transmitter will be magnified. Select your site for the tripod assembly carefully.
- (2) Position Elevating Base and Tripod assembly with elevating base quick-release pointing upwind and elevating base as vertical as possible.

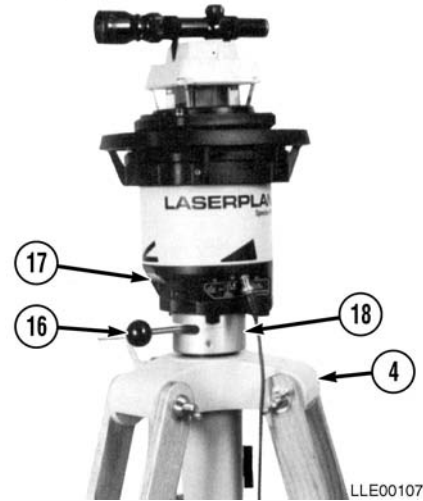


LLE00705

- (3) Chains (6) between tripod legs (9) should be slightly loose to allow for thermal expansion.
- (4) On windy, gusty days, it is advisable to tie down the tripod assembly. This can be done in several ways:
 - a Drive a stake (10) into ground, over foot of each tripod leg (9).
 - b Lay a sandbag (11) over foot of each tripod leg (9).
 - c Use three tie-down straps or cables (12) secured midway up each tripod leg (9) and fastened to a weight or stake on the ground.
 - d Position large equipment (13) as a wind block.
- (5) Keep height of 1145-2 Laser Transmitter as low as possible. When height is needed, extend tripod legs (9) before adjusting elevating column (14) height.
- (6) When setting up on frozen ground that may thaw during the day, drive pipes (15) into the ground below the frost line and set the tripod legs (9) into the pipes (15).

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- (7) With tripod unit properly set up, unlock Tripod Base Quick-Release Lever (16).
- (8) Insert Transmitter Tripod Mounting Ring (17) into Elevating Base Locking Ring (18).
- (9) Firmly lock Tripod Base Quick-Release Lever (16) to secure the 1145-2 Laser Transmitter to tripod unit.
- (10) Set up transmitter with proper grade and direction.



c. Coarse Height Adjustment.

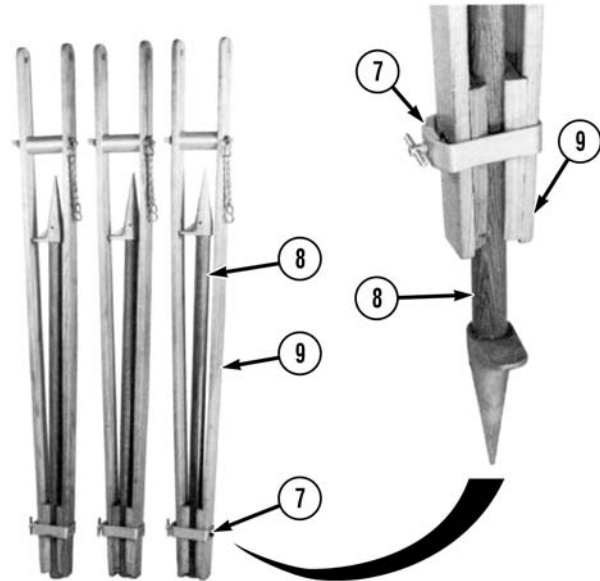
NOTE

Coarse or fine height adjustments may be required to locate plane of laser light within 1275 Laser Receiver's reception range.

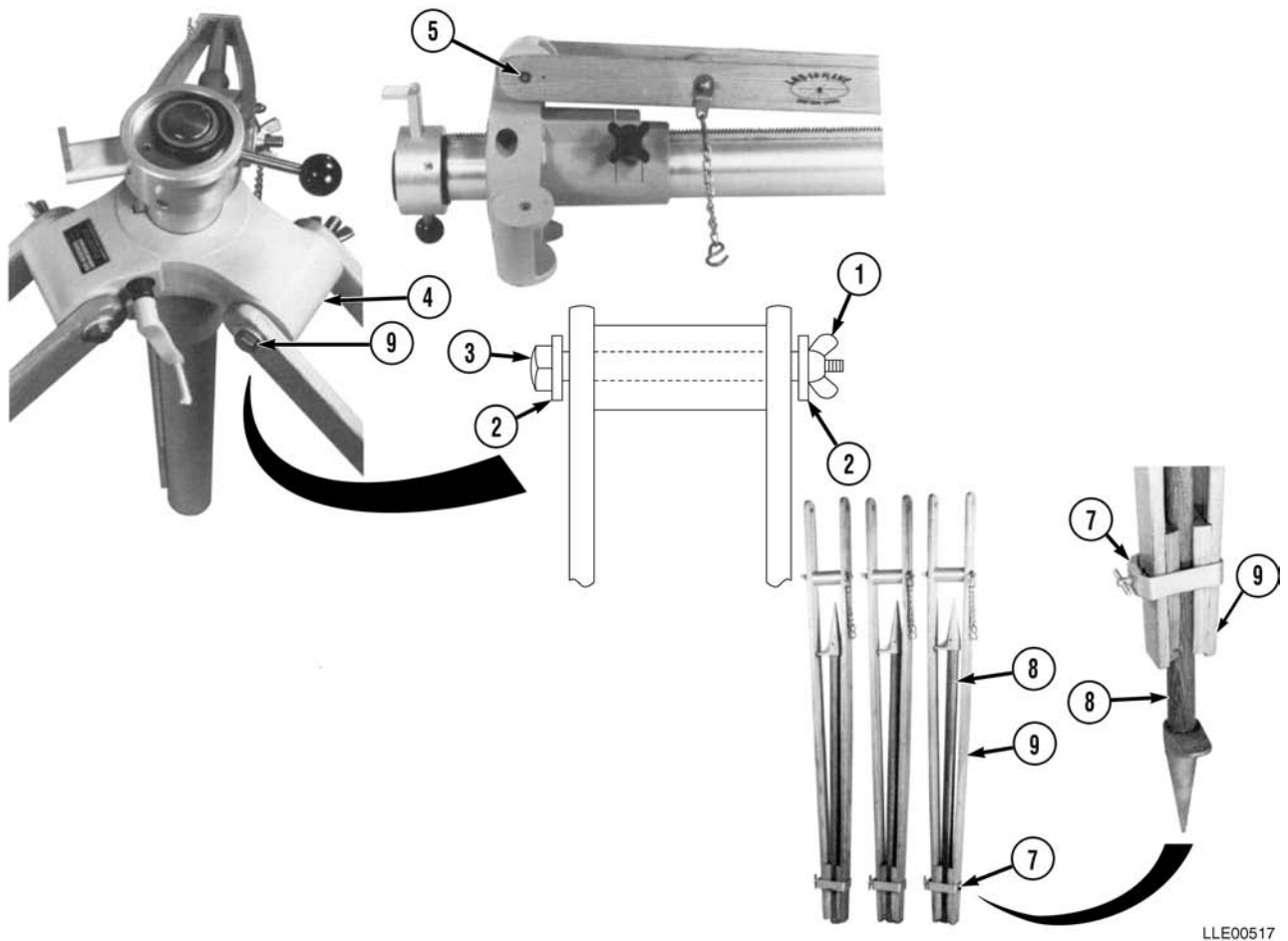
- (1) Loosen tripod Leg Clamps (7).
- (2) Adjust height of tripod Leg Extensions (8) as required and tighten Leg Clamps (7). Remember to maintain Tripod Base (4) as level as possible.

d. Fine Height Adjustment.

- (1) Loosen tripod base clamping knob.
- (2) Use tripod base raise/lower crank to adjust height of plane of laser light.
- (3) Tighten tripod base clamping knob to secure plane of light at desired height.



e. Disassembly.



LLE00517

CAUTION

Elevating Base and Tripod Assembly is top-heavy when upright. When disassembling unit, use an assistant, or damage to equipment may occur.

NOTE

All tripod legs are removed the same. Only one leg is shown.

- (1) Loosen leg clamps (7) and remove leg extensions (8) from tripod legs (9).
- (2) Return each leg extension (8) to stowed position and tighten leg clamps (7).
- (3) Remove wing nuts (1), washers (2), and mounting bolts (3) from tripod base (4) and tripod leg mounting holes (5).
- (4) Remove tripod legs (9) from tripod base (4).
- (5) Install wing nuts (1), washers (2), and mounting bolts (3) on tripod base (4).
- (6) Tighten wing nuts (1).

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f. Elevating Base and Tripod Maintenance.

- (1) Check tension on raise/lower crank handle twice a year. Tension on clutch can be adjusted by pulling back black boot on shaft, turning exposed nut (to the right to tighten, to the left to loosen).
- (2) Check condition of small O-ring stop annually. Remove and replace as required.
- (3) Check condition of locking ring twice a year. Should original mating surface be worn, rotate ring 180 degrees. Remove and replace as required.

SECTION IV. 1145-2 LASER TRANSMITTER TROUBLESHOOTING

While the 1145-2 Laser Transmitter is a highly accurate system, you may encounter problems as you work in the field. Use this section to troubleshoot your problems. You may want to have a qualified maintenance person troubleshoot and fix any problems.

Table 5-2. 1145-2 Laser Transmitter Fault Index

Fault No.	Description	Page
5-1.	No Laser Beam	5-28
5-2.	Laser Beam Will Not Shut Off When 1145-2 Laser Transmitter is Bumped Out of Level.....	5-29
5-3.	1145-2 Laser Transmitter Low Voltage Indicator Lamp is On.....	5-29
5-4.	Laser Beam Appears Weak.....	5-30
5-5.	1145-2 Laser Transmitter Will Not Self-Level	5-31

Table 5-3. 1145-2 Laser Transmitter Troubleshooting

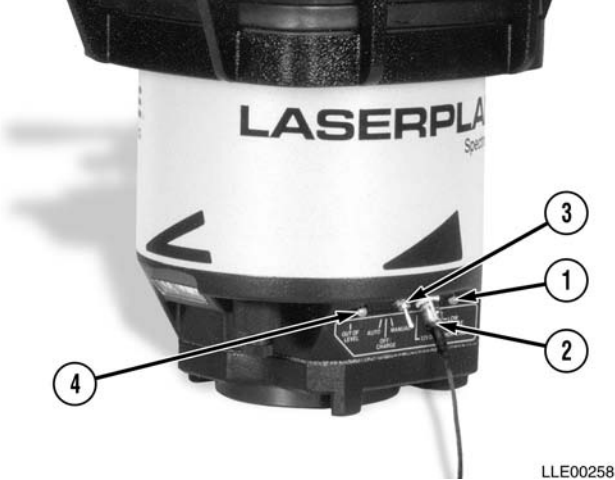
Malfunction	Test or Inspection	Corrective Action
<p>FAULT 5-1. NO LASER BEAM.</p>	 <p style="text-align: right;">LLE00258</p>	<p style="text-align: center;">CAUTION</p> <p>Connecting to 24 Vdc will damage laser. Ensure external power is 12 Vdc. Failure to comply will result in damage to equipment</p>
		<p>Step 1. Verify Battery Low Voltage Indicator Lamp (1) is not on.</p> <p style="padding-left: 40px;">If Battery Low Voltage Indicator Lamp (1) is on, recharge internal Battery (2) or hook up to 12-Vdc external Battery using cables provided.</p> <p>Step 2. Verify 1145-2 Laser Transmitter is set up within ± 5 degrees of self-leveling range.</p> <p>Step 3. Ensure Control Switch (3) is in AUTO position.</p> <p style="padding-left: 40px;">Wait for a minute until Auto Mode Indicator Lamp (4) stops flashing.</p> <p style="padding-left: 40px;">Laser beam should now be lit. Check it with 1275 Laser Receiver (Para 5-4).</p>

Table 5-3. 1145-2 Laser Transmitter Troubleshooting (Cont)



Malfunction	Test or Inspection	Corrective Action
<p>FAULT 5-2. LASER BEAM WILL NOT SHUT OFF WHEN 1145-2 LASER TRANSMITTER IS BUMPED OUT OF LEVEL.</p>	 <p>LLE00259</p>	<p>Step 1. Ensure Control Switch (1) is in AUTO position.</p>
	<p>FAULT 5-3. 1145-2 LASER TRANSMITTER LOW VOLTAGE INDICATOR LAMP IS ON.</p>	 <p>LLE00260</p>

Table 5-3. 1145-2 Laser Transmitter Troubleshooting (Cont)



Malfunction	Test or Inspection	Corrective Action
FAULT 5-4. LASER BEAM APPEARS WEAK.		
		
CAUTION		
Do not attempt to clean windows dry or damage to equipment may result.		
Step 1.	Windows are dirty.	Ensure windows (1) are clean under Upper Housing Assembly. Use a soft clean cloth or lens cleaning tissue with a window cleaning solution.
Step 2.	Check to see that Low Voltage Indicator Lamp (2) is not on.	If Low Voltage Indicator Lamp (2) is on, recharge battery.

Table 5-3. 1145-2 Laser Transmitter Troubleshooting (Cont)

Malfunction	Test or Inspection	Corrective Action
FAULT 5-5. 1145-2 LASER TRANSMITTER WILL NOT SELF-LEVEL.		
 <p style="text-align: right;">LLE00262</p>		
	Step 1.	Place Control Switch (1) in AUTO position.
	Step 2.	Verify 1145-2 Laser Transmitter is within ± 5 degrees self-leveling range. Adjust as needed (Para 5-15).
	Step 3.	Ensure Auto Mode Indicator Lamp (2) has stopped flashing.

5-18. 1145-2 LASER TRANSMITTER AND 1275 LASER RECEIVER STORAGE AND TRANSPORTATION.

CAUTION

1145-2 Laser Transmitter and 1275 Laser Receiver are not designed to be air dropped. Damage to equipment may result.

- a. Proper storage of 1145-2 Laser Transmitter and 1275 Laser Receiver, when they are not being used, is essential to ensure long trouble-free operation.
- b. Ensure carrying case pads are dry and rocks or other debris are removed before the 1145-2 Laser Transmitter and 1275 Laser Receiver are stored in carrying case.
- c. Fully discharge battery prior to storage longer than 3 months.

APPENDIX A REFERENCES

A-1. SCOPE.

This appendix lists forms, field manuals, technical manuals, and other publications either referenced in this manual or which apply to the operation and maintenance of the LLE equipment.

A-2. DEPARTMENT OF THE ARMY PAMPHLETS.

Consolidated Index of Army Publications and Blank Forms DA Pam 310-1
 The Army Maintenance Management System (TAMMS) DA Pam 738-750

A-3. FORMS.

Recommended Changes to Publications and Blank Forms DA Form 2028
 Equipment Inspection and Maintenance Worksheet DA Form 2404
 Equipment Inspection and Maintenance Worksheet DA Form 5988-E
 Quality Deficiency Report (QDR) SF368

A-4. TECHNICAL BULLETINS.

Equipment Improvement Report and Maintenance Digest (EIR MD)
 (U.S. Army Tank-automotive and Armaments Command)
 Tank-Automotive Equipment TB 43-0001-62 Series

A-5. TECHNICAL MANUALS.

Operator's Manual for Welding Theory and Application TM 9-237
 Care and Use of Hand Tools and Measuring Tools TM 9-243
 Materials Used for Cleaning, Preserving, Abrading, and Cementing
 Ordnance Materiel and Related Items Including Chemicals TM 9-247
 Operator's Manual, Tractor, Full, Tracked: (Caterpillar Model D7F) TM 2-2410-233-10
 Operator's Manual, Tractor, Full Tracked: (DED, Medium Drawbar Pull Model D7G) TM 5-2410-237-10
 Operator's Manual, Scraper, Earth Moving, Motorized, (DED) TM 5-3805-248-10
 Operator's Manual, Scraper, Tractor, Elevating, Self-Propelled TM 5-3805-260-10
 Operator's Manual, Grader, Heavy, Road, Motorized: (Caterpillar Model 130G) TM 5-3805-261-10
 Tool Outfit Hydraulic System Test and Repair Unit (HYSTRU) TM 9-4940-468-14
 Operator, Unit, Direct Support, and General Support Maintenance
 Manual for Lead Storage Batteries TM 9-6140-200-14
 Principals of Automotive Vehicles TM 9-8000
 Painting Instructions for Field Use TM 43-0139
 Equipment Improvement Report and Maintenance Summary (EIR MS) TM 43-0143
 Basic Electrical Wire Repair TM 43-0158
 Procedures for Destruction of Tank-Automotive Equipment
 to Prevent Enemy Use TM 750-244-6

TM 5-6675-348-13&P

A-6. OTHER PUBLICATIONS.

Army Medical Department Expendable/Durable Items CTA 8-100
Expendable/Durable Items (Except Medical, Class V, Repair Parts, and Heraldic Items). CTA 50-970
Operator's Circular Welding Theory and Application.TC 9-237

APPENDIX B

MAINTENANCE ALLOCATION CHART (MAC)

Section I. INTRODUCTION

B-1. THE ARMY MAINTENANCE SYSTEM MAC.

a. This introduction (Section I) provides a general explanation of all maintenance and repair functions authorized at various maintenance levels under The Army Maintenance Management System (TAMMS) concept.

b. The Maintenance Allocation Chart (MAC) in Section II designates overall authority and responsibility for the performance of maintenance functions on the identified end item or component. The application of the maintenance functions to the end item or component will be consistent with the capacities and capabilities of the designated maintenance levels, which are shown on the MAC in column (4) as:

- *Unit* - Includes two subcolumns, C (Operator/Crew) and O (Unit) maintenance.
- *Direct Support* - Includes an F subcolumn.
- *General Support* - Includes an H subcolumn.
- *Depot* - Includes a D subcolumn.

c. Section III lists the tools and test equipment (both special tools and common tool sets) required for each maintenance function as referenced from Section II.

d. Section IV contains supplemental instructions and explanatory notes for a particular maintenance function.

B-2. MAINTENANCE FUNCTIONS.

Maintenance functions are limited to and defined as follows:

a. *Inspect.* To determine the serviceability of an item by comparing its physical, mechanical, and/or electrical characteristics with established standards through examination (e.g., by sight, sound, or feel).

b. *Test.* To verify serviceability by measuring the mechanical, pneumatic, hydraulic, or electrical characteristics of an item and comparing those characteristics with prescribed standards.

c. *Service.* Operations required periodically to keep an item in proper operating condition; i.e., to clean (includes decontaminate, when required), to preserve, to drain, to paint, or to replenish fuel, lubricants, chemical fluids, or gases.

d. *Adjust.* To maintain or regulate, within prescribed limits, by bringing into proper position, or by setting the operating characteristics to specified parameters.

e. *Align.* To adjust specified variable elements of an item to bring about optimum or desired performance.

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f. Calibrate. To determine and cause corrections to be made or to be adjusted on instruments or test, measuring, and diagnostic equipment used in precision measurement. Consists of comparisons of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

g. Remove/Install. To remove and install the same item when required to perform service or other maintenance functions. Install may be the act of emplacing, seating, or fixing into position a spare, repair part, or module (component or assembly) in a manner to allow the proper functioning of an equipment or system.

h. Replace. To remove an unserviceable item and install a serviceable counterpart in its place. "Replace" is authorized by the MAC and the assigned maintenance level is shown as the third position code of the SMR code.

i. Repair. The application of maintenance services¹ including fault location/troubleshooting², removal/installation and disassembly/assembly³ procedures, and maintenance actions⁴ to identify troubles and restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module (component or assembly), end item, or system.

j. Overhaul. That maintenance effort (service/action) prescribed to restore an item to a completely serviceable/operational condition as required by maintenance standards in appropriate technical publications (e.g., DMWR). Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to like-new condition.

k. Rebuild. Consists of those services/actions necessary for the restoration of unserviceable equipment to a like-new condition in accordance with original manufacturing standards. Rebuild is the highest degree of material maintenance applied to Army equipment. The rebuild operation includes the act of returning to zero those age measurements (e.g., hours/miles) considered in classifying Army equipment/components.

B-3. EXPLANATION OF COLUMNS IN THE MAC, SECTION II.

a. Column (1), Group No. Column 1 lists functional group code numbers, the purpose of which is to identify maintenance significant components, assemblies, subassemblies, and modules with the next higher assembly.

b. Column (2), Component/Assembly. Column 2 contains the item names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

c. Column (3), Maintenance Function. Column 3 lists functions to be performed on the item listed in Column 2. (For detailed explanation of these functions, see paragraph B-2.)

-
1. Services - Inspect, test, service, adjust, align, calibrate, and/or replace.
 2. Fault location/troubleshooting - The process of investigating and detecting the cause of equipment malfunctioning; the act of isolating a fault within a system or unit under test (UUT).
 3. Disassembly/assembly - The step-by-step breakdown (taking apart) of a spare/functional group coded item to the level of its least component that is assigned an SMR code for the level of maintenance under consideration (i.e., identified as maintenance significant).
 4. Actions - Welding, grinding, riveting, straightening, facing, machining, and/or resurfacing.

d. Column (4), Maintenance Level. Column 4 specifies each level of maintenance authorized to perform each function listed in Column 3, by indicating work time required (expressed as manhours in whole hours or decimals) in the appropriate subcolumn. This work-time figure represents the active time required to perform that maintenance function at the indicated level of maintenance. If the number or complexity of the tasks within the listed maintenance function vary at different maintenance levels, appropriate work-time figures are shown for each level.

The work-time figure represents the average time required to restore an item (assembly, subassembly, component, module, end item, or system) to a serviceable condition under typical field operating conditions. This time includes preparation time (including any necessary disassembly/assembly time), troubleshooting/fault location time, and quality assurance time in addition to the time required to Perform the specific tasks identified for the maintenance functions authorized in the maintenance allocation chart. The symbol designations for the various maintenance levels are as follows:

C	Operator or crew maintenance
O	Unit maintenance
F	Direct Support maintenance
H.....	General Support maintenance
D.....	Depot maintenance

e. Column (5), Tools and Equipment. Column 5 specifies, by code, those common tool sets (not individual tools), common TMDE, special tools, special TMDE, and special support equipment required to perform the designated function. Codes are keyed to tools and test equipment in Section III.

f. Column (6), Remarks. When applicable, this column contains a letter code, in alphabetical order, which is keyed to the remarks contained in Section III.

B-4. EXPLANATION OF COLUMNS IN TOOL AND TEST EQUIPMENT REQUIREMENTS, SECTION III.

a. Column (1), Item No. The item number correlates with a code used in the MAC, Section II, Column 5.

b. Column (2), Maintenance Category. The lowest level of maintenance authorized to use the tool or test equipment.

c. Column (3), Nomenclature. Name or identification of the tool or test equipment.

d. Column (4), National Stock Number. The National/Nato Stock Number of the tool or test equipment.

e. Column (5), Tool No. The manufacturer's part number, model number, or type number.

B-5. EXPLANATION OF COLUMNS IN REMARKS, SECTION IV.

a. Column (1), Reference Code. The code recorded in the MAC, Section II, Column 6.

b. Column (2), Remarks. This column lists information pertinent to the maintenance function being performed as indicated in the MAC, Section II.

Section II. MAC

Table B-1. Gradio® Control System Maintenance Allocation Chart

(1) Group No.	(2) Component/Assembly	(3) Maintenance Function	(4) Maintenance Level					(5) Tools & Equipment	(6) Remarks
			C	O	F	H	D		
06	Gradio® Control System ELECTRICAL SYSTEM								
0606	Voltage Protection Cable	Inspect Test Replace	0.5	0.5 0.5				2, 3 2	
	Cable, Electrical	Inspect Test	0.5	0.5				2	
67	PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC								
6709	Gradio® RT2S Laser Receiver	Inspect Test Repair Replace	0.5	0.5 0.5				2 2	B
6711	Gradio® Display, DR2	Inspect Test Repair Replace	0.5	0.5 0.5				2	B
6712	Rigid Mast Mounting Bracket	Inspect Replace	0.5	0.5				2, 4	A
6712	Manual Mast Mounting Plate	Inspect Replace	0.5	0.5				2	A
6714	MM2E Manual Mast	Inspect Replace Repair	0.5	0.5 0.5				4 4	
	RM2E-3 Rigid Mast	Inspect Replace Repair	0.5	0.5 0.5				4 4	

Table B-2. Blade Pro® Motor Grader Control System Maintenance Allocation Chart

(1) Group No.	(2) Component/Assembly	(3) Maintenance Function	(4) Maintenance Level					(5) Tools & Equipment	(6) Remarks
			C	O	F	H	D		
06	Blade Pro® Motor Grader Control System ELECTRICAL SYSTEM								
0606	Voltage Protection Cable	Inspect Test Replace	0.5	0.5 0.5			1 1		
43	HYDRAULIC, FLUID, AIR, AND VACUUM SYSTEMS								
4301	Hydraulic Tubes and Fittings	Inspect Replace	0.5	1.0			1		
4305	Hydraulic Valves	Inspect Test Replace Repair Calibration	0.5	0.5 0.5 2.0 2.0			1 1 1		
4316	Hydraulic Hoses	Inspect Replace	0.5	1.0			1		
67	PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC								
6703	Mast Mounting Base	Inspect Replace	0.5	0.5			2, 4	A	
6709	R2S-S Laser Receiver	Inspect Repair Replace	0.5	0.5			1	B	
6709	EM2E-24 Electric Mast, Assembly	Inspect Repair Replace	0.5	0.5 0.5			1	B	
6711	Operator Interface Box	Inspect Repair Replace	0.5	0.5			1	B	

Table B-2. Blade Pro[®] Motor Grader Control System Maintenance Allocation Chart (Cont)

(1) Group No.	(2) Component/Assembly	(3) Maintenance Function	(4) Maintenance Level					(5) Tools & Equipment	(6) Remarks
			C	O	F	H	D		
6711	Blade Pro [®] Motor Grader Control System (Cont.) Remote Interface Box	Inspect	0.5					1	B
		Repair		0.5					
		Replace							
6711	Mainfall Slope Sensor and Blade Slope Sensors	Inspect	0.5					1	B C
		Test		0.5					
		Replace		0.5					
6711	Circle Rotation Sensor	Repair	0.5					1	B C
		Calibration							
		Inspect		0.5					
6711	Tracer [®] Sonic Grade Controller	Replace		0.5				1	B
		Repair							
		Inspect	0.5						
6713	Electrical Cables and Coil Cords	Repair		1.0				1	B C
		Calibration		1.0					
		Inspect	0.5						
		Test		0.5				1	
		Replace		0.5					
		Inspect	0.5						

Table B-3. Bucket-Pro™ Control System Maintenance Allocation Chart

(1) Group No.	(2) Component/Assembly	(3) Maintenance Function	(4) Maintenance Level					(5) Tools & Equipment	(6) Remarks
			C	O	F	H	D		
06	Bucket-Pro™ Control System								
	ELECTRICAL SYSTEM								
0606	Voltage Protection Cable	Inspect Test Replace	0.5	0.5 0.5			1 1		
35	PULLEYS, BELTS, SHAFTS								
3501	Flat belt Assembly	Inspect Replace	0.5	1.0			1		
67	PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC								
6709	EM2E-24 Laser Receiver, R2S-S	Inspect Repair Replace	0.5	0.5			1	B	
6709	EM2E-24 Electric Mast Assembly	Inspect Replace Repair	0.5	0.5			1	B	
6711	Graphic Display	Inspect Repair Replace	0.5 0.5				1	B	
6711	Remote Interface Box	Inspect Repair Replace	0.5	0.5			1	B	
6711	Arm Sensors	Inspect Calibrate Replace	0.5	0.5			1	A	
6711	Boom Pendulous Angle Sensors	Inspect Replace	0.5	0.5			1	A	
6711	Cable Encoder Sensors	Inspect Replace	0.5	0.5			1		
6713	Electrical Cables and Coil Cords	Inspect Test Replace	0.5	0.5 0.5			1 1		

Table B-4. Transmitter Control System Maintenance Allocation Chart

(1) Group No.	(2) Component/Assembly	(3) Maintenance Function	(4) Maintenance Level					(5) Tools & Equipment	(6) Remarks
			C	O	F	H	D		
06	Transmitter Control System								
6702	ELECTRICAL SYSTEM								
	1145-2 Laser Transmitter	Inspect Repair Replace Calibrate	0.5 0.5	1.0			1	B C	
67	PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC								
6709	1275 Laser Receiver and Grade Rod	Inspect Replace	0.5	0.5			1		
6709	Tripod	Inspect Replace Repair	0.5	0.5 0.5			1 1		
6713	Electrical Cable and Coil Cords	Inspect Test Replace	0.5	0.5 0.5			1 1		
6719	Elevating Base	Inspect Repair Replace	0.5	0.5 0.5			1 1		

Section III. TOOL AND TEST EQUIPMENT REQUIREMENTS

Item No.	Maintenance Category	Nomenclature	National/ NATO Stock Number	Tool No.
1	O, F, H	Tool Kit, Automotive Maintenance, Common No. 1 (4910-95-A73)	4910-00-754-0654	SC4910-95CLA74
2	O, F, H	Tool Kit, Automotive Maintenance, Common No. 2 (4910-95-A72)	4910-00-754-0650	SC4910-95CLA72
3	O	Tool Kit, Electric Contact	5180-00-876-9336	7550526
4	F, H	Tool Kit, Welders	5180-00-754-0661	SC 5180-90-N39

Section IV. REMARKS

Reference Code	Remarks
A	Limited welding
B	Return to Trimble ^a .
C	Return to Trimble if calibration fails. ^a

a. Trimble Navigation
5475 Kellenburger Rd.
Dayton, OH 45424
1-800-538-7800

APPENDIX C

REPAIR PARTS AND SPECIAL TOOLS LIST (RPSTL)

Section I. INTRODUCTION

C-1. SCOPE.

This RPSTL lists and authorizes spares and repair parts; special tools; special test, measurement, and diagnostic equipment (TMDE); and other special support equipment required for performance of Unit, Direct Support, and General Support maintenance of the Laser Leveling Equipment. It authorizes the requisitioning, issue, and disposition of spares, repair parts, and special tools as indicated by the source, maintenance, and recoverability (SMR) codes.

C-2. GENERAL.

In addition to Section I, Introduction, this RPSTL is divided into the following sections:

- a. **Section II. Repair Parts List.** A list of spares and repair parts authorized by this RPSTL for use in the performance of maintenance. The list also includes parts which must be removed for replacement of the authorized parts. Parts lists are composed of functional groups in ascending alphanumeric sequence, with the parts in each group listed in ascending figure and item number sequence. Repair parts kits are listed separately in their own functional group within Section II. Repair parts for repairable special tools are also listed in this section. Items listed are shown on the associated illustration(s)/figure(s).
- b. **Section III. Cross-Reference Index.** A list, in National Item Identification Number (NIIN) sequence, of all National Stock Numbered (NSN) items appearing in the listing, followed by a list in alphanumeric sequence of all part numbers appearing in the listing. NSN and part numbers are cross-referenced to each illustration figure and item number appearance. The figure and item number index lists figure and item numbers in alphanumeric sequence and cross-reference NSN, CAGE, and part numbers.

C-3. EXPLANATION OF COLUMNS (SECTION II).

- a. **Item No. (Column (1)).** Indicates the number used to identify items called out in the illustrations.
- b. **CAGE (Column (3)).** The Commercial And Government Entity Code (CAGE) is a 5-digit numeric code which is used to identify the manufacturer, distributor, or Government agency, etc., that supplies the item.
- c. **Part Number (Column (4)).** Indicates the primary number used by the manufacturer (individual, company, firm, corporation, or Government activity), which controls the design and characteristics of the item by means of its engineering drawings, specifications, standards, and inspection requirements, to identify an item or range of items.
- d. **Description and Usable On Codes (Column (5)).** This column includes the following information:
 - (1) The Federal item name and, when required, a minimum description to identify the item.
 - (2) Spare/repair parts that make up an assembled item are listed immediately following the assembled item line entry.

- e. **Qty (Column (6)).** The QTY (quantity per figure column) indicates the quantity of the item used in the breakout shown on the illustration figure, which is prepared for a functional group, subfunctional group, or an assembly. A “V” appearing in this column in lieu of a quantity indicates that the quantity is variable and the quantity may vary from application to application.

C-4. EXPLANATION OF COLUMNS (SECTION III).

- a. **Part Number Index.** Part numbers in this index are listed by part number in ascending alphanumeric sequence (i.e., vertical arrangement of letter and number combination which places the first letter or digit of each group in order A through Z, followed by the numbers 0 through 9 and each following letter or digit in like order).
 - (1) **PART NUMBER column.** Indicates the primary number used by the manufacturer (individual, company, firm, corporation, or Government activity), which controls the design and characteristics of the item by means of its engineering drawings, specifications, standards, and inspection requirements, to identify an item or range of items.
 - (2) **FIG. column.** This column lists the number of the figure where the item is identified/located in Section II.
 - (3) **ITEM column.** The item number is that number assigned to the item as it appears in the figure referenced in the adjacent figure number column.

C-5. SPECIAL INFORMATION.

- a. **Usable On Code.** Not applicable.
- b. **Assembly Instructions.** Detailed assembly instructions for items source coded to be assembled from component spare/repair parts are found in chapters 2 through 4. Items that make up the assembly are listed immediately following the assembled item entry, or reference is made to an applicable figure.
- c. **Kits.** Line item entries for repair kits appear in a group in Section II. (See Table of Contents.)

C-6. HOW TO LOCATE REPAIR PARTS.

- a. **When Part Number Is Unknown:**
 - (1) Using the table of contents, determine the assembly group or subassembly group to which the item belongs. This is necessary since figures are prepared for assembly groups and subassembly groups, and listings are divided into the same groups.
 - (2) Find the figure covering the assembly group or subassembly group to which the item belongs.
 - (3) Identify the item on the figure and use the part number listed to reorder.
- b. **When Part Number Is Known:**
 - (1) Locate the part number in the Part Number Index. The part numbers in the Part Number Index are listed in ascending alphanumeric sequence (see C-4), and you can cross-reference to the illustration figure and item number of the item you are looking for.
 - (2) After finding the figure and item number, verify that the item is the one you're looking for, then locate the item number in the repair parts list for the figure.

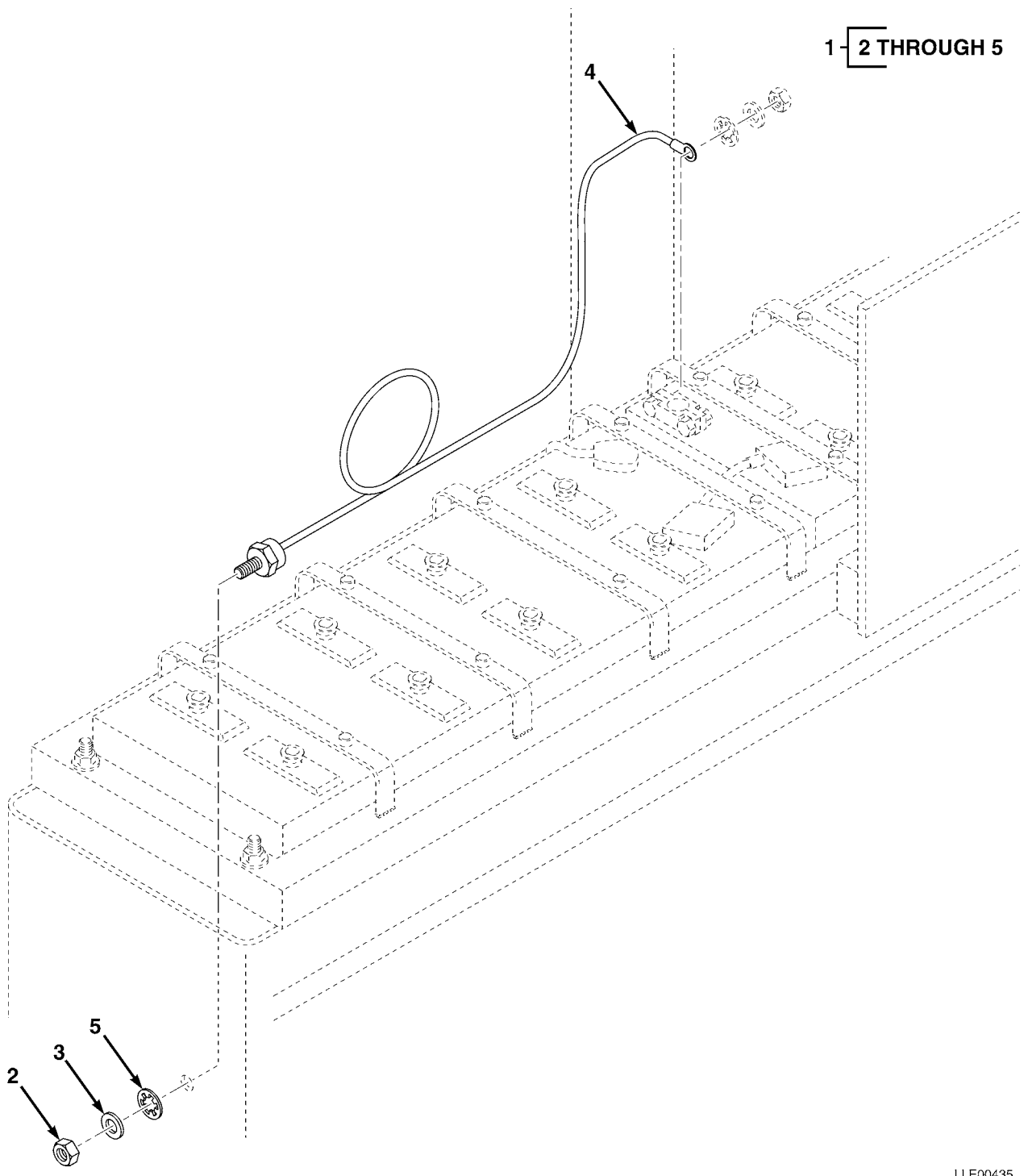
Section II. REPAIR PARTS LIST

	Page	Figure
Subsection A - Gradio®		
Group 06	Electrical System	
	Dozer Voltage Protection Cable	1-1 1
	Scraper Voltage Protection Cable	2-1 2
	Gradio® Carrying Case	3-1 3
Group 22	Body Chassis or Hull, and Accessory Items	
	Dozer Decals and Instruction Plates	4-1 4
	Scraper Decals and Instruction Plates	5-1 5
Group 67	Precision Instruments and Systems, Mechanical, Electrical, Electronic	
	Dozer/Scraper Gradio® RT2S Laser Receiver	6-1 6
	Dozer/Scraper Gradio® Display	7-1 7
	Dozer/Scraper Gradio® Display Mount	8-1 8
	RM2E-3 Scraper Rigid Mast Mount	9-1 9
	Dozer Manual Mast Mount	10-1 10
	Dozer MM2E Manual Mast	11-1 11
	Dozer/Scraper Electrical Cables	12-1 12
	Scraper Rigid Mast	13-1 13
Subsection B - Blade Pro® Motor Grader Control System		
Group 06	Electrical System	
	Grader Voltage Protection Cable	14-1 14
	Blade Pro® Carrying Cases.	15-1 15
Group 22	Body Chassis or Hull, and Accessory Items	
	Decals, Plates, and Instruction Holders.	16-1 16
Group 43	Hydraulic, Fluid, Air, and Vacuum Systems	
	Return Line Fittings	17-1 17
	Load Sense and Return Valves and Fittings	18-1 18
	Pipes and Fittings (Per Valve)	19-1 19
	Proportional Valve Assembly	20-1 20
	Hydraulic Hoses.	21-1 21
Group 67	Precision Instruments and Systems, Mechanical, Electrical, Electronic	
	Tracer® Tube and Base Clamp Assembly	22-1 22
	Tracer® Arm Bracket Assembly	23-1 23
	Tracer® Clamp Base Mounting	24-1 24
	EM2E-24 Electrical Mast Assembly	25-1 25
	R2S-S Laser Receiver	26-1 26
	Circle Rotation Sensor	27-1 27
	Operator Interface Box	28-1 28
	Remote Interface Box	29-1 29
	Slope Sensors	30-1 30
	Tracer® Sonic Grade Controller	31-1 31
	Control Knob Switches	32-1 32
	Connector Holder Assembly	33-1 33
	Mast Mount Base	34-1 34
	Mainfall Slope Sensor Bracket	35-1 35
	Operator Control Box Mount	36-1 36
	Blade Slope Sensor Mount	37-1 37
	Cables and Coil Cords	38-1 38

Section II. REPAIR PARTS LIST (CONT)

	Page	Figure
Subsection C - Bucket-Pro™		
Group 06	Electrical System	
	HYEX Voltage Protection Cable	39-1 39
Group 22	Body Chassis or Hull, and Accessory Items	
	Bucket-Pro™ Decals and Instruction Plates.	40-1 40
Group 35	Pulleys, Belts, Shafts	
	Bucket Cylinder Belt Systems	41-1 41
	Bucket Cylinder Belt System Accessory	42-1 42
	Bucket Cylinder Belt System Tool Box	43-1 43
Group 67	Precision Instruments and Systems, Mechanical, Electrical, Electronic	
	Electrical Mast Assembly	44-1 44
	Graphic Display	45-1 45
	Remote Interface Box	46-1 46
	Cable Encoder Sensors	47-1 47
	Arm Sensors	48-1 48
	Boom Pendulous Angle Sensor	49-1 49
	Dual Axis Sensor.	50-1 50
	Bucket-Pro™ Electrical Cables	51-1 51
Subsection D - Transmitter		
Group 06	Electrical System	
	1145-2 Laser Transmitter Carrying Case	52-1 52
Group 67	Precision Instruments and Systems, Mechanical, Electrical, Electronic	
	1145-2 Laser Transmitter	53-1 53
	1275 Laser Receiver and Grade Rod	54-1 54
	Tripod	55-1 55
	Elevating Base	56-1 56
Group 33	Special Purpose Kits	Kits-1

SUBSECTION A - GRADIO®

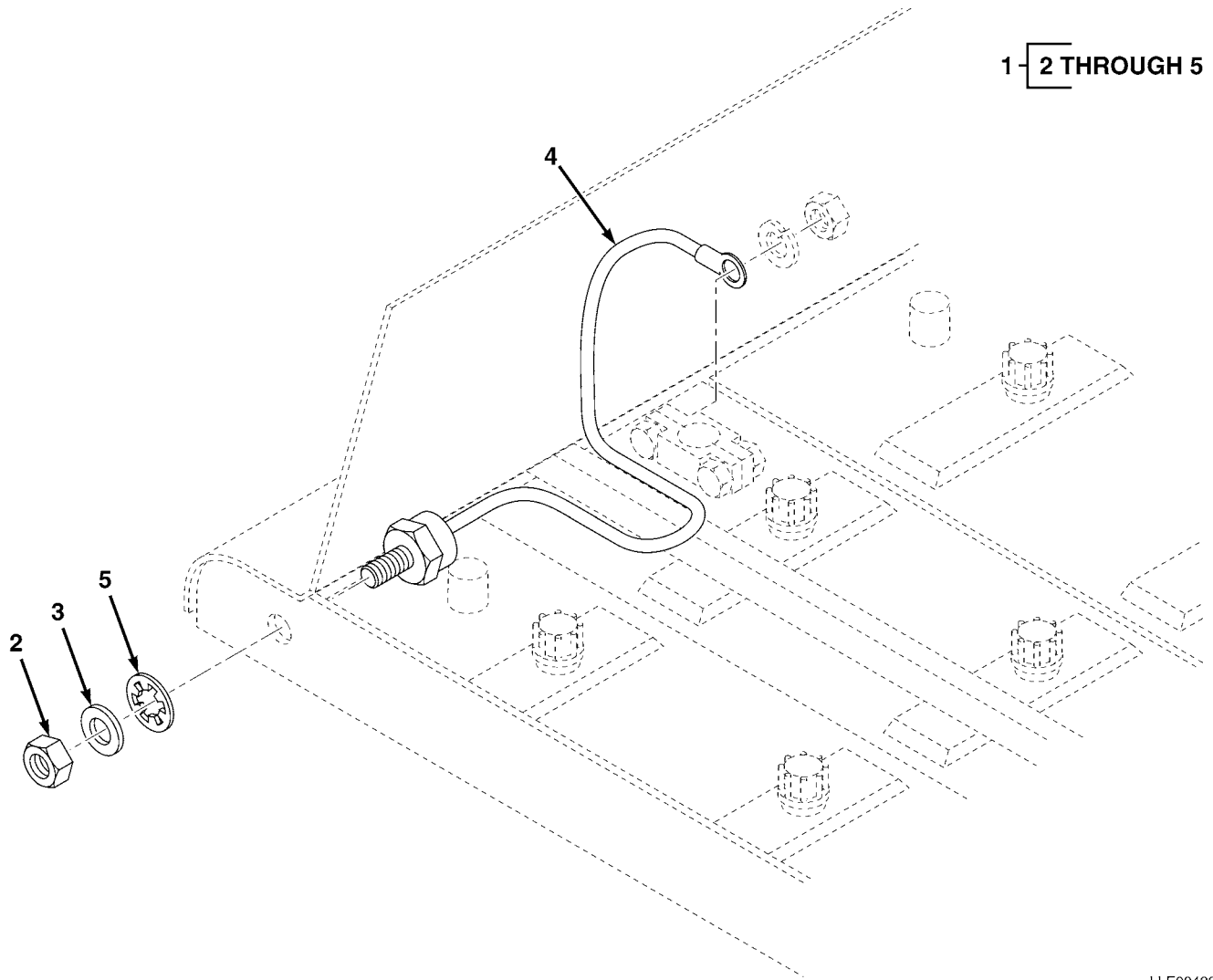


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FIG. 1 DOZER VOLTAGE PROTECTION CABLE

(1) ITEM NO	(2) SMR CODE	(3) CAGE CODE	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 06 ELECTRICAL SYSTEM	
				GROUP 0606 ENGINE SAFETY CONTROLS	
				FIG. 1 DOZER VOLTAGE PROTECTION CABLE	
1	56009		121022	KIT,VOLTAGE PROTECTION	1
2	56009		005274	• NUT,HEX,3/8-16 IN.	1
3	56009		003834-010	• WSHR,FL,3/8 X 1.08 IN. (10/PKG)	1
4	56009		221089	• CABLE,VOLTAGE PROTECTION	1
5	56009		2802-1010	• LKWSHR,INTERNAL,3/8 IN.	1

END OF FIGURE



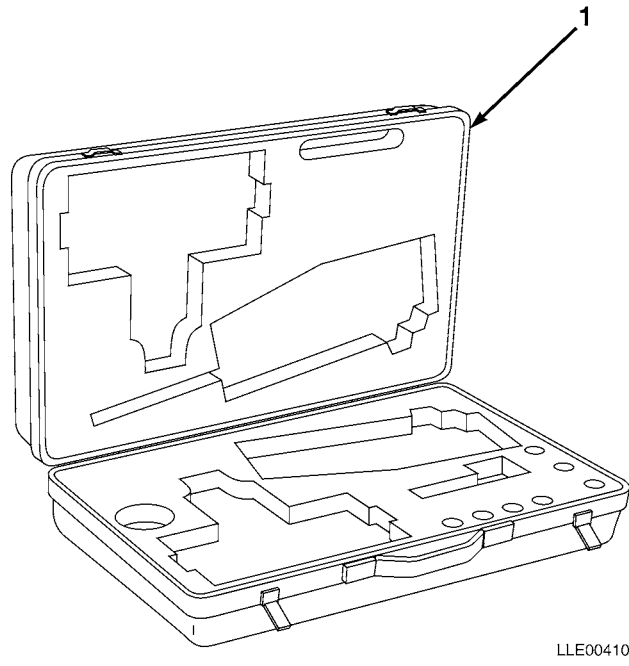
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FIG. 2 SCRAPER VOLTAGE PROTECTION CABLE

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 06 ELECTRICAL SYSTEM	
				GROUP 0606 ENGINE SAFETY CONTROLS	
				FIG. 2 SCRAPER VOLTAGE PROTECTION CABLE	
1	56009		121022	KIT,VOLTAGE PROTECTION	1
2	56009		005274	• NUT,HEX,3/8-16 IN.	1
3	56009		003834-010	• WSHR,FL,3/8 X 1.08 IN. (10/PKG)	1
4	56009		221089	• CABLE,VOLTAGE PROTECTION	1
5	56009		2802-1010	• LKWSHR,INTERNAL,3/8 IN.	1

END OF FIGURE



LLE00410

FIG. 3 GRADIO® CARRYING CASE

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 06 ELECTRICAL SYSTEM	
				GROUP 0612 CARRYING CASE	
				FIG. 3 GRADIO® CARRYING CASE	
1		56009	0225-0520	CASE, CARRYING, GRADIO®	1

END OF FIGURE

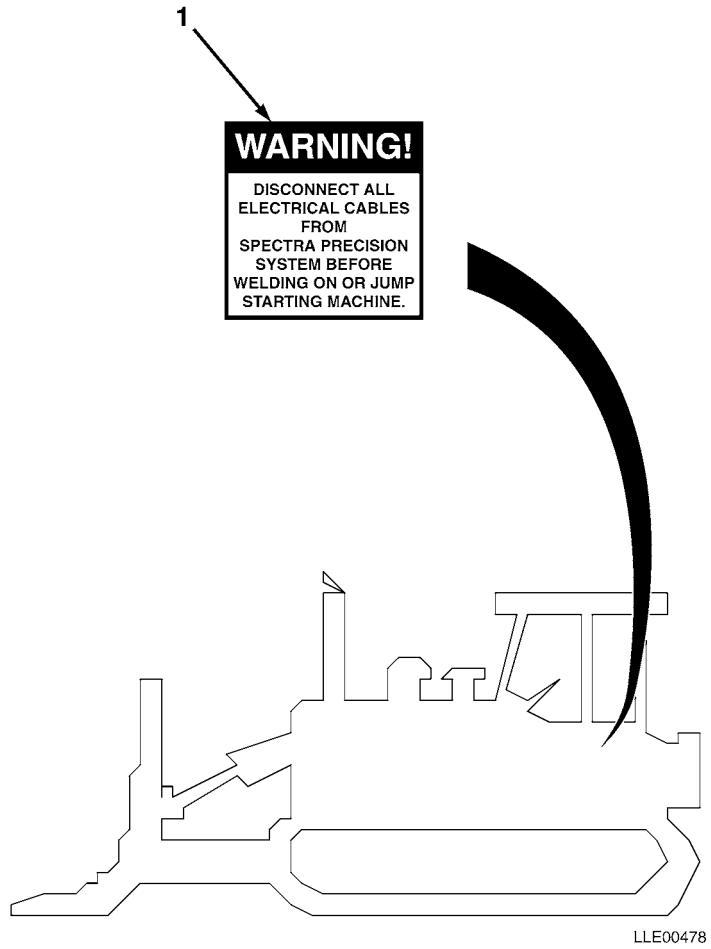
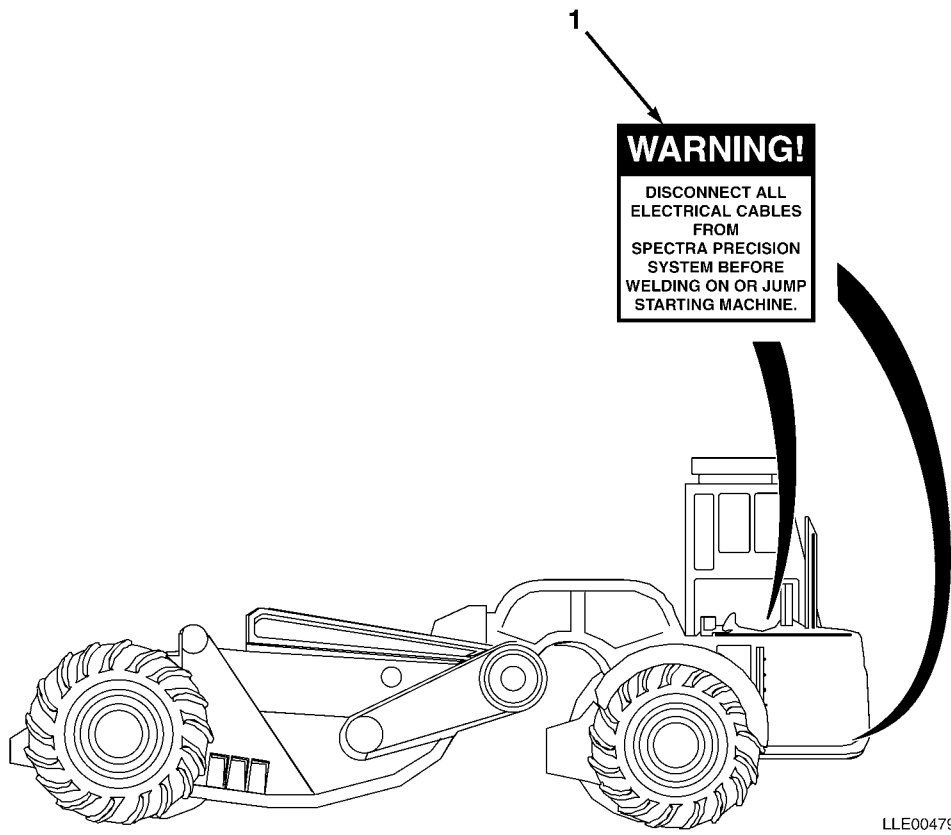


FIG. 4 DOZER DECALS AND INSTRUCTION PLATES

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 22 BODY CHASSIS OR HULL, AND ACCESSORY ITEMS	
				GROUP 2210 DATA PLATES AND INSTRUCTION HOLDERS	
				FIG. 4 DOZER DECALS AND INSTRUCTION PLATES	
1		56009	111741	LABEL,WARNING,WELDING/JUMP STARTING	1

END OF FIGURE

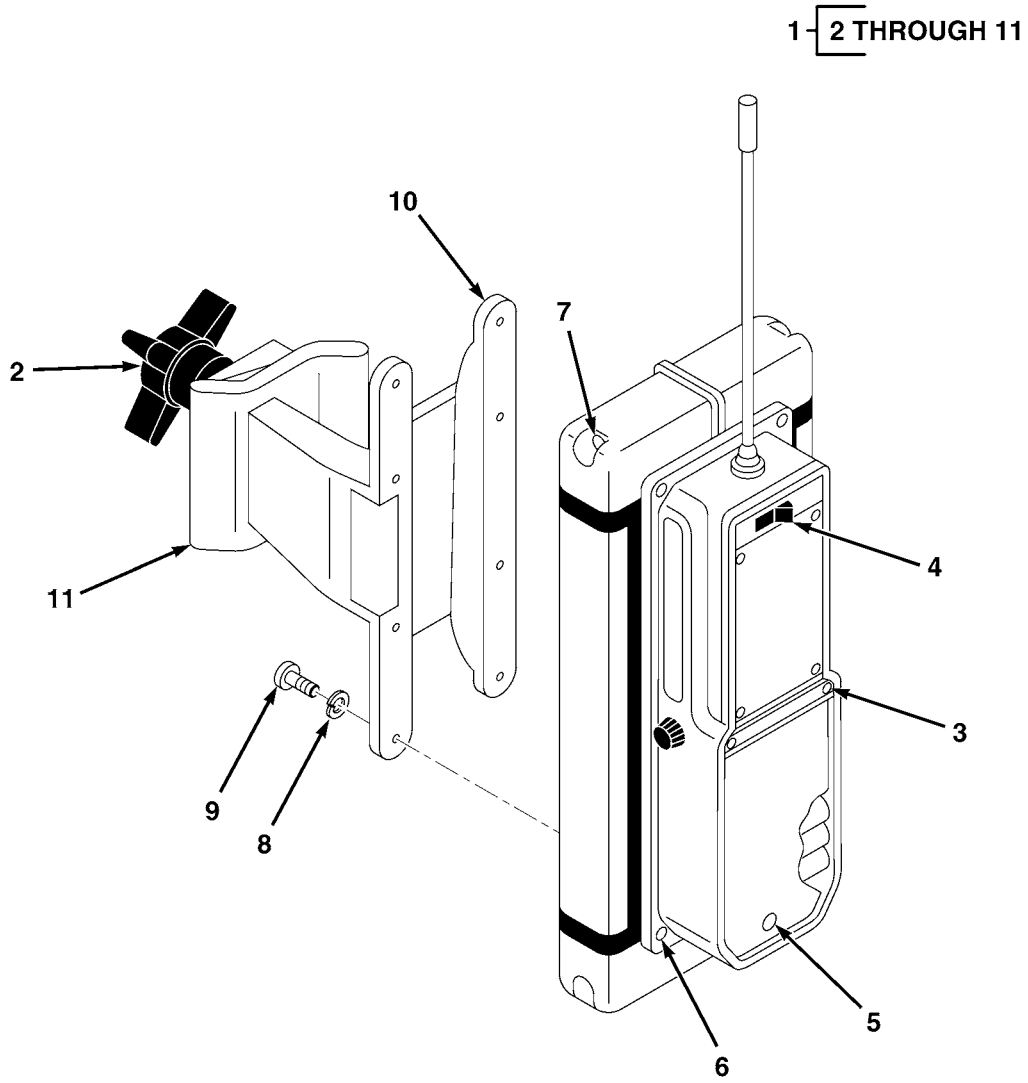


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FIG. 5 SCRAPER DECALS AND INSTRUCTION PLATES

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 22 BODY CHASSIS OR HULL, AND ACCESSORY ITEMS	
				GROUP 2210 DATA PLATES AND INSTRUCTION HOLDERS	
				FIG. 5 SCRAPER DECALS AND INSTRUCTION PLATES	
1		56009	111741	LABEL, WARNING, WELDING/JUMP STARTING	1

END OF FIGURE

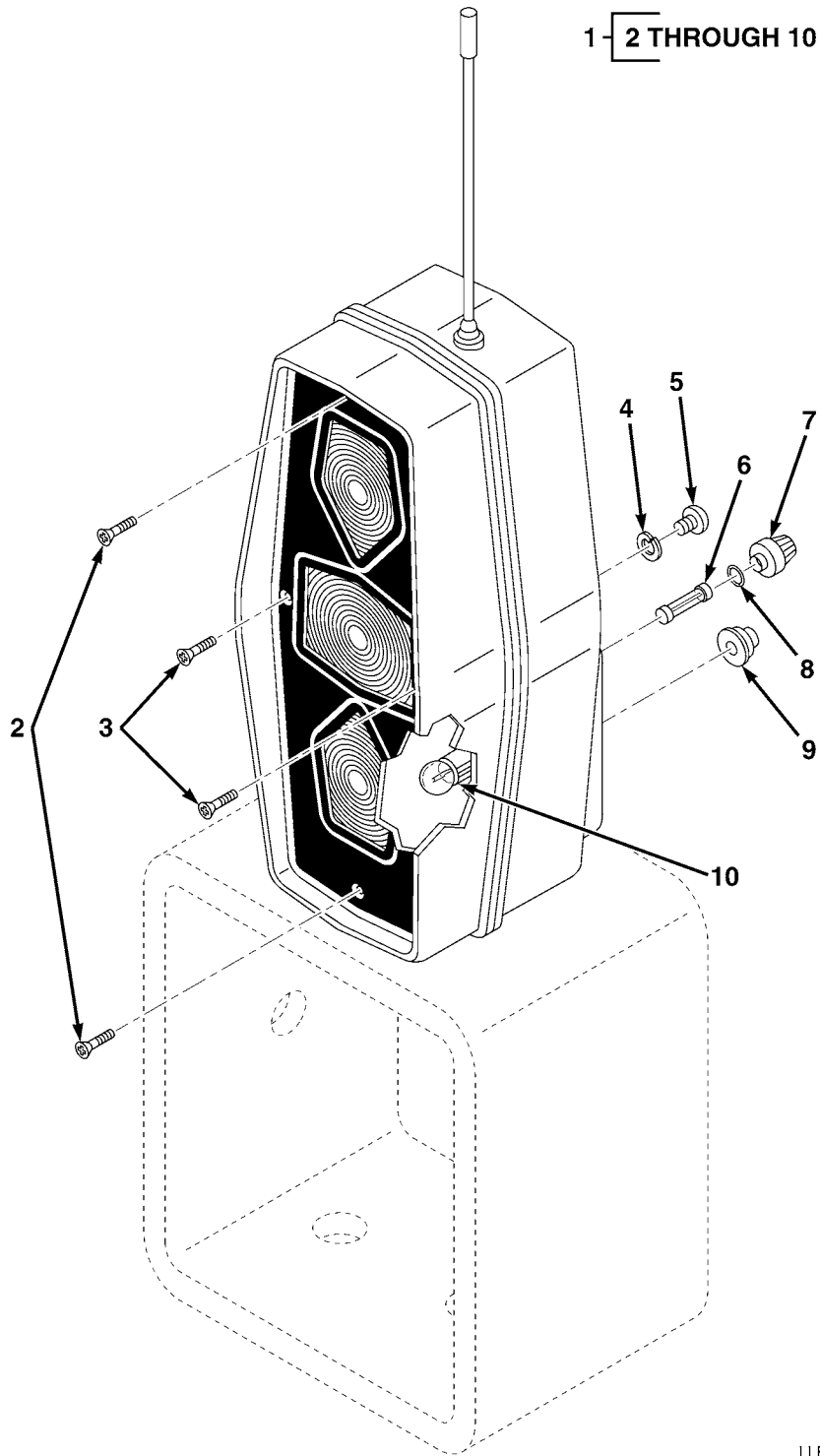


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FIG. 6 DOZER/SCRAPER GRADIO® RT2S LASER RECEIVER

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
GROUP 67 PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC					
GROUP 6709 ANTENNAS, GROUNDS, AND RELATED EQUIPMENT					
FIG. 6 DOZER/SCRAPER GRADIO® RT2S LASER RECEIVER					
1		56009	RT2S-1	TRANSMITTER,GRADIO® (USED WITH DR2-1 GRADIO® DISPLAY)	1
		56009	RT2S-2	TRANSMITTER,GRADIO® (USED WITH DR2-2 GRADIO® DISPLAY)	1
		56009	RT2S-3	TRANSMITTER,GRADIO® (USED WITH DR2-3 GRADIO® DISPLAY)	1
		56009	RT2S-4	TRANSMITTER,GRADIO® (USED WITH DR2-4 GRADIO® DISPLAY)	1
		56009	RT2S-5	TRANSMITTER,GRADIO® (USED WITH DR2-5 GRADIO® DISPLAY)	1
2		56009	0250-1470	• RETAINER CLAMP KNOB	1
3		56009	7181-0605-010	• SCR,MACH,RND,SST 6-32 X 5/16 IN.(10/PKG) .	1
4		56009	2508-0520	• BOOT,SWITCH (PLASTIC)	1
5		56009	1409-0990	• STUD,FRONT LOAD 4MM	1
		56009	1409-0980	•• RECEPTACLE,FRONT LOAD 4MM	1
		56009	0225-0390	•• RETAINER,STUD HALF GROMMET GP	1
6		56009	7181-0806	• SCR,ROUND HEAD PHIL 8-32 (10/PKG)	1
		56009	2802-0250	•• WSHR,INT-T LOCK,#8 STL (10/PKG)	1
7		56009	012192	• SCR,OVAL,XREC,10-32 X 4 IN. (5/PKG)	1
8		56009	2802-0030-010	• LKWASH,SPLIT,#8 SST (10/PKG)	1
9		56009	8201-0810	• SCR,SOCKET HEAD CAP 8-32 X 5/8 IN.	8
10		56009	0225-1770	• CLAMP,BASE RECEIVER	1
11		56009	0250-1430	• KNOB,MOLDED CLAMPING	1

END OF FIGURE

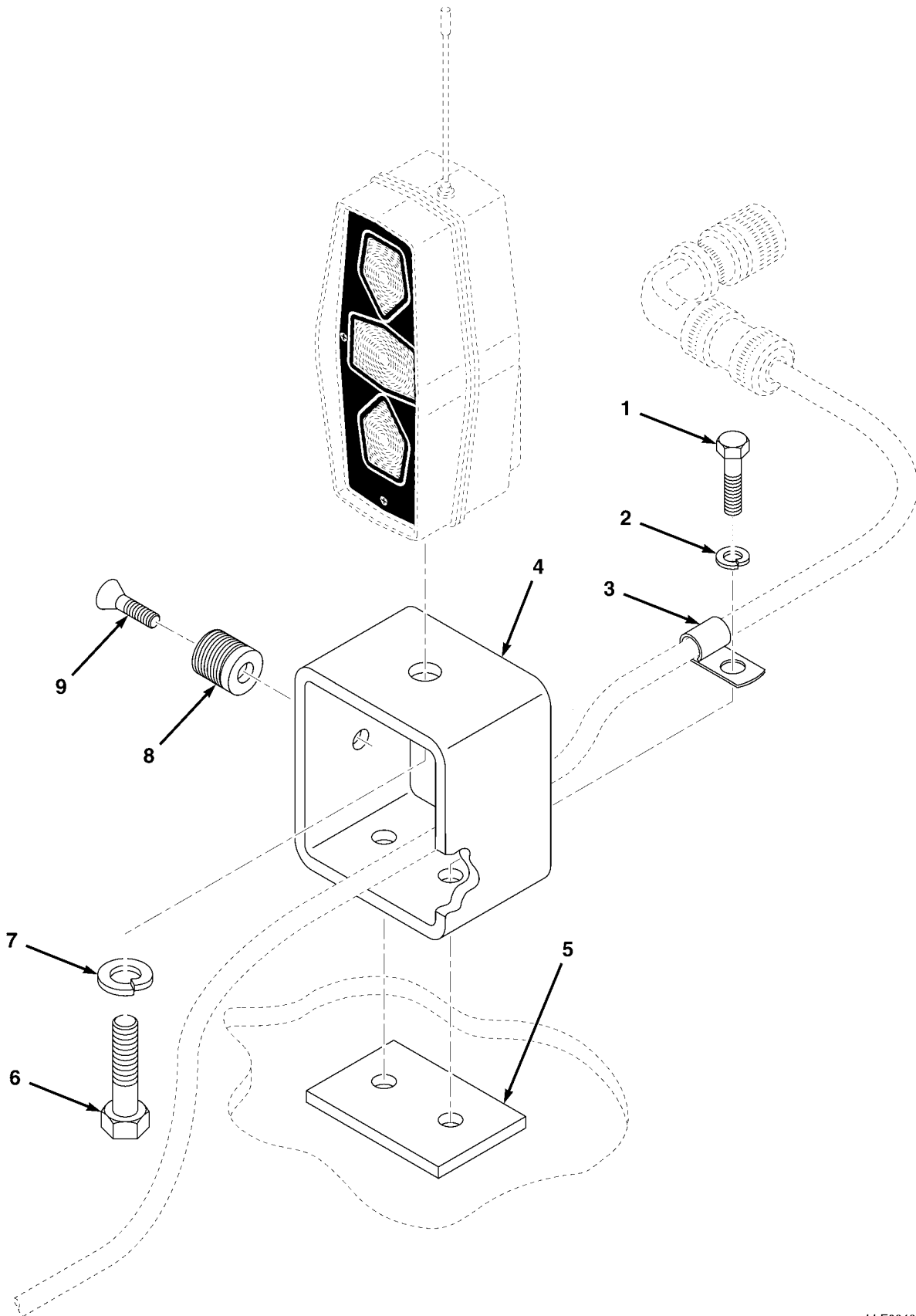


LLE00074

FIG. 7 DOZER/SCRAPER GRADIO® DISPLAY

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 67 PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC	
				GROUP 6711 CONTROLS, INDICATORS, AND SPECIAL COMPONENTS	
				FIG. 7 DOZER/SCRAPER GRADIO® DISPLAY	
1		56009	DR2-1	TRANSMITTER,GRADIO® (USED WITH RT2S-1 GRADIO® TRANSMITTER).....	1
		56009	DR2-2	TRANSMITTER,GRADIO® (USED WITH RT2S-2 GRADIO® TRANSMITTER).....	1
		56009	DR2-3	TRANSMITTER,GRADIO® (USED WITH RT2S-3 GRADIO® TRANSMITTER).....	1
		56009	DR2-4	TRANSMITTER,GRADIO® (USED WITH RT2S-4 GRADIO® TRANSMITTER).....	1
		56009	DR2-5	TRANSMITTER,GRADIO® (USED WITH RT2S-5 GRADIO® TRANSMITTER).....	1
2		56009	012708	• SCR,FL,XREC,1/4-20 X 1.75 IN. (10/PKG)	1
3		56009	2816-1970	• SCR,FL,XREC,6-32 X 0.375 IN. (10/PKG)	1
4		56009	2802-0020-010	• LKWASH,SPLIT,#6,SST (10/PKG)	1
5		56009	7181-0606-010	• SCR,RND,XREC,6-32 X 3/8 IN. (10/PKG)	1
6		56009	003376	• FUSE,5 AMP	1
7		56009	010716	• CAP,FUSE HOLDER SEAL	1
8		56009	011023	• SEAL,FUSE CAP HOLDER	1
9		56009	2508-0500	• SEAL,BOOT,TOG SW,15/32-32 NS,BL	1
10		56009	011179	• LAMP,24 VOLT	3

END OF FIGURE

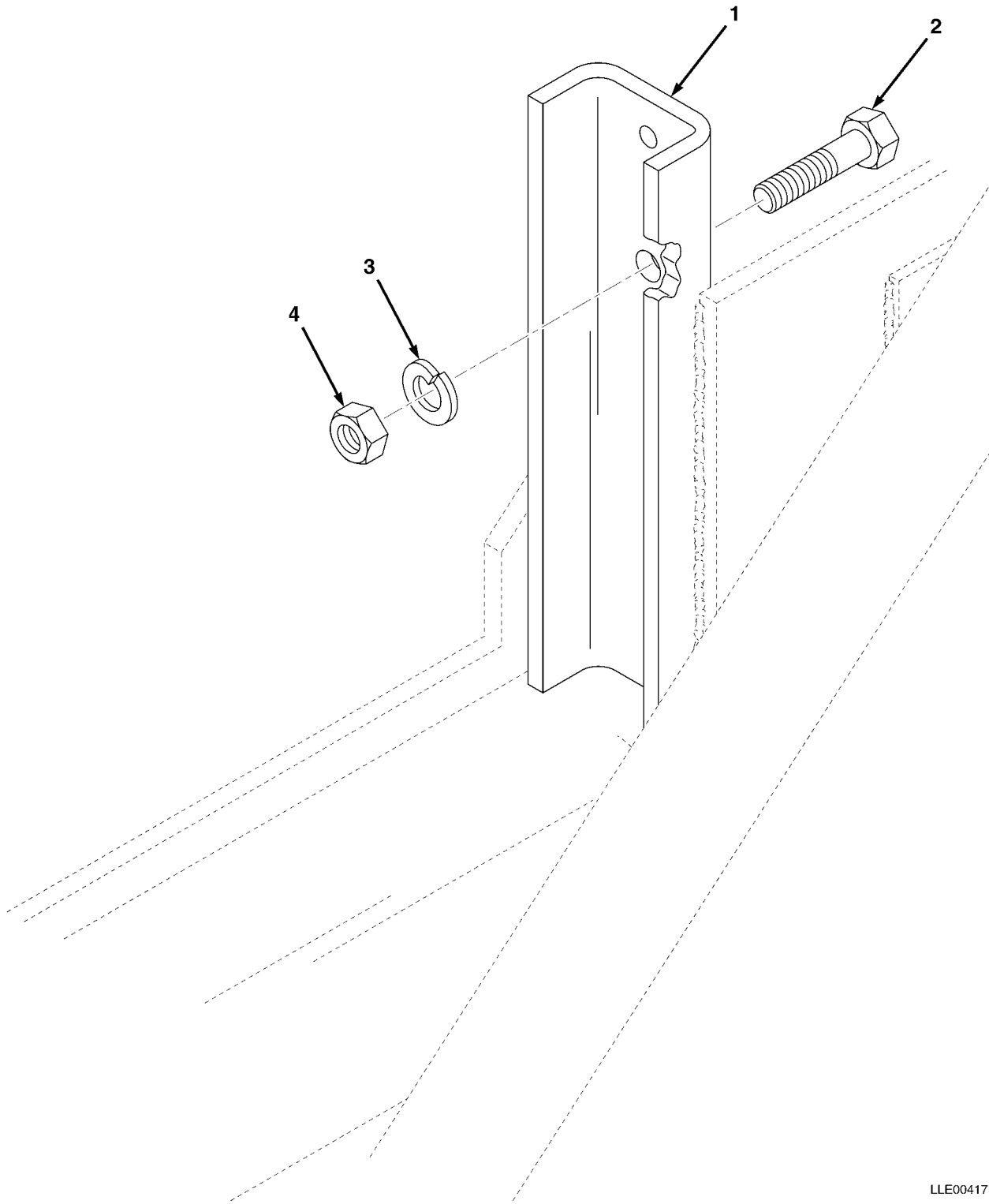


LLE00421

FIG. 8 DOZER/SCRAPER GRADIO® DISPLAY MOUNT

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC) GROUP 67 PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC GROUP 6712 MOUNTING CONNECTING DEVICE FIG. 8 DOZER/SCRAPER GRADIO® DISPLAY MOUNT	(6) QTY
1	56009	9837-1624-005	SCR,CAP,HEX,3/8-16 X 1-1/2 IN. (5/PKG)		1
2	56009	003847-010	LKWSHR,SPLIT,3/8 X 0.68 X 0.09 IN. (10/PKG)		1
3	56009	006649	CLAMP,HOSE		3
4	56009	209930	MOUNT,DISPLAY		1
5	56009	220318	PLATE,DISPLAY MOUNT		1
6	56009	9837-1820-010	SCR,CAP,HEX,1/2-13 X 1 IN. (10/PKG)		1
7	56009	003855-010	LKWSHR,SPLIT,0.50 X 0.51 X 0.12 IN. (10/PKG)		1
8	56009	0790-1980	BULKHEAD,BLANK #16		1
9	56009	7121-6008-010	SCR,FL,XREC,10-32 X 0.5 IN. (10/PKG)		1

END OF FIGURE

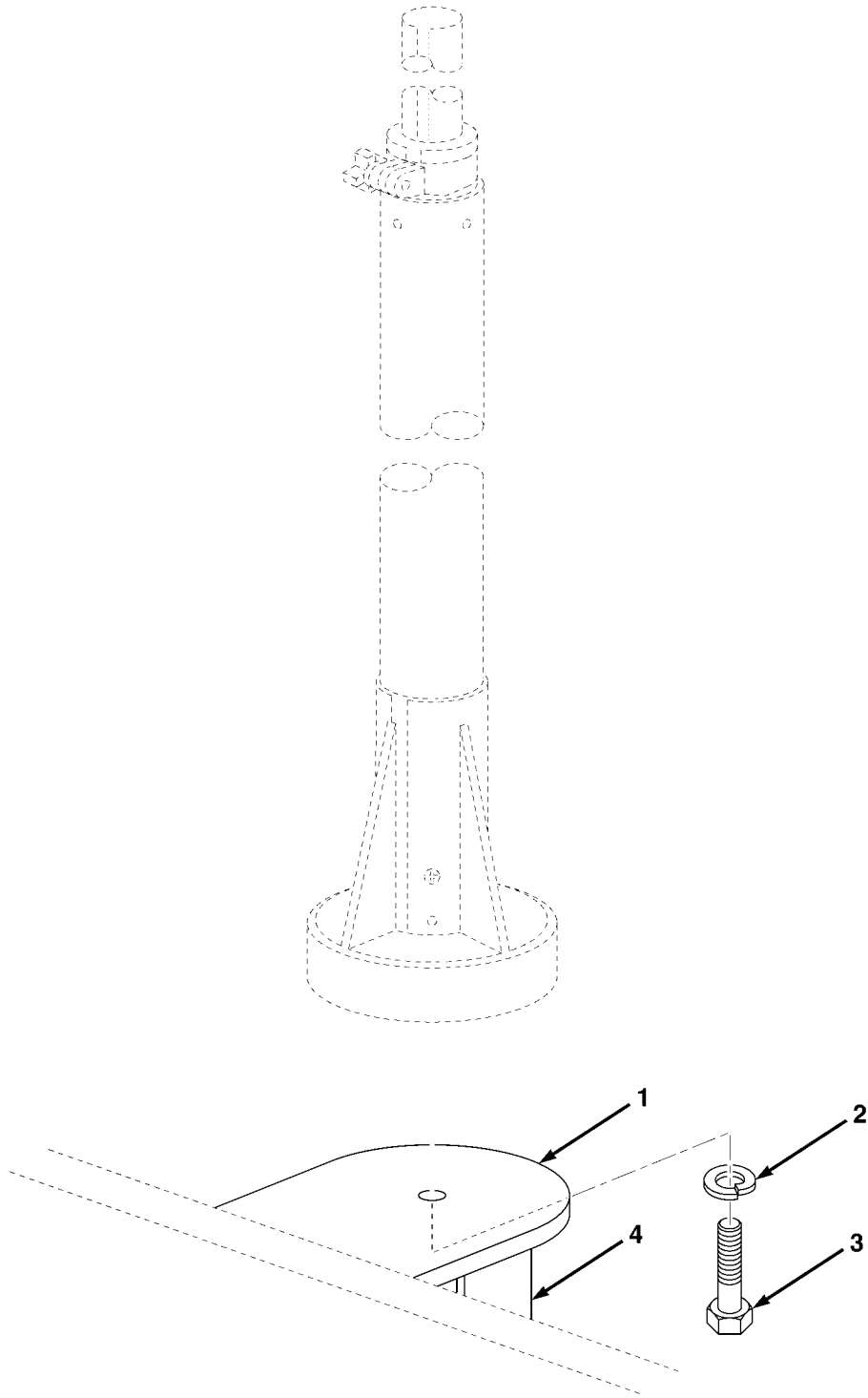


LLE00417

FIG. 9 RM2E-3 SCRAPER RIGID MAST MOUNT

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 67 PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC	
				GROUP 6712 MOUNTING CONNECTING DEVICE	
				FIG. 9 RM2E-3 SCRAPER RIGID MAST MOUNT	
1		56009	209254	MOUNT,RIGID MAST,MG	1
2		56009	9837-7034	SCR,CAP,HEX,5/8-18 X 2-1/2 IN.,STL	1
3		56009	003810	NUT,HEX,5/8-18 X 0.93 X 0.55 IN.,STL,CD	1
4		56009	003857	LKWSHR,SPLIT,5/8 X 1.07 X 0.16 IN.STL,CD ...	1

END OF FIGURE



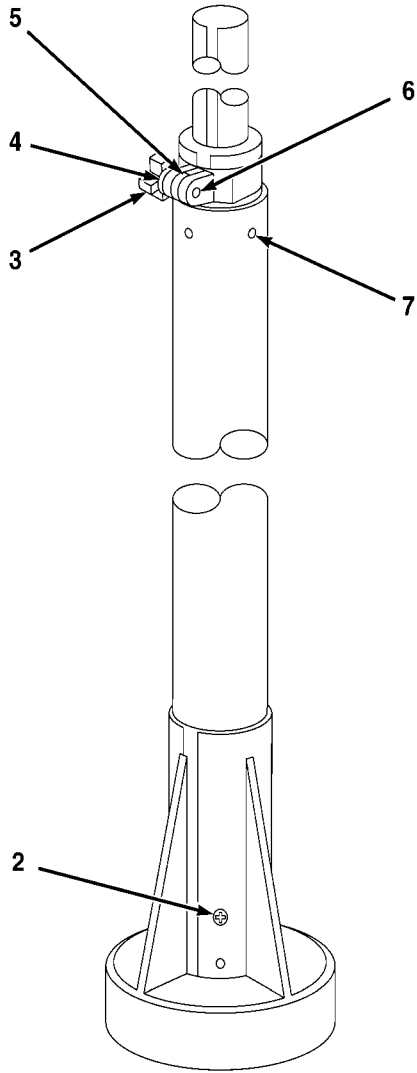
LLE00414

FIG. 10 DOZER MANUAL MAST MOUNT

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 67 PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC	
				GROUP 6712 MOUNTING CONNECTING DEVICE	
				FIG. 10 DOZER MANUAL MAST MOUNT	
1		56009	201476	MOUNT,MAST	1
2		56009	003859-010	LKWSHR,SPLIT,3/4 X 1.27 X 0.19 IN.,STL,CD (10/PKG)	1
3		56009	010185-005	SCR,CAP,HEX,3/4-16 X 1-1/2 IN.,STL (5/PKG ..	1
4		56009	220286	BRACKET,MAST MOUNT	2

END OF FIGURE

1-2 THROUGH 7



LLE00077

FIG. 11 DOZER MM2E-T MANUAL MAST

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 67 PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC	
				GROUP 6714 ANTENNAS, GROUNDS, AND RELATED EQUIPMENT	
				FIG. 11 DOZER MM2E-T MANUAL MAST	
1		56009	MM2E-T	MANUAL MAST	1
2		56009	003656	• SCR, MH FL PHIL, SSTL, 10-32 X 0.58 IN.	1
3		56009	122420	• STUD, LOCKING ASSEMBLY	1
4		56009	122014	• WSHR, FL, 3/8 X 0.50 X 0.03 IN.	1
5		56009	0230-2080	• SPACER	1
6		56009	7181-6006-010	• SCR, RND, XREC, 10-32 X 3/8 IN. (10/PKG)	1
7		56009	003655	• SCR, FL, XREC, 10-32 X 0.5 IN. (10/PKG)	1

END OF FIGURE

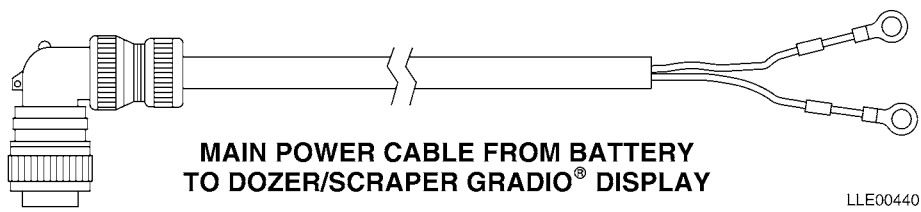
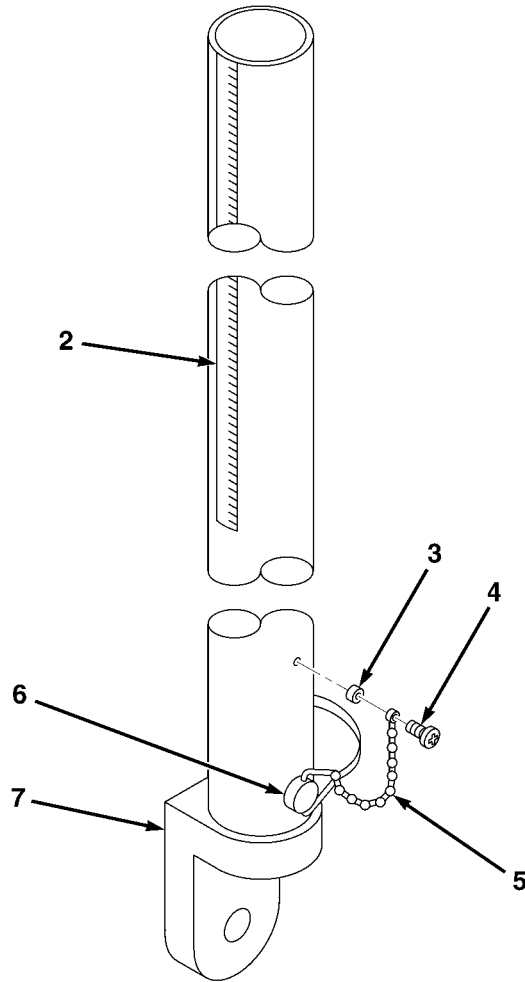


FIG. 12 DOZER/SCRAPER ELECTRICAL CABLES

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 67 PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC	
				GROUP 6713 MISCELLANEOUS WIRING AND FITTINGS	
				FIG. 12 DOZER/SCRAPER ELECTRICAL CABLES	
1		56009	222621-200	CABLE,2 COND,BASIC POWER	1

END OF FIGURE

1-2 THROUGH 6



LLE00076

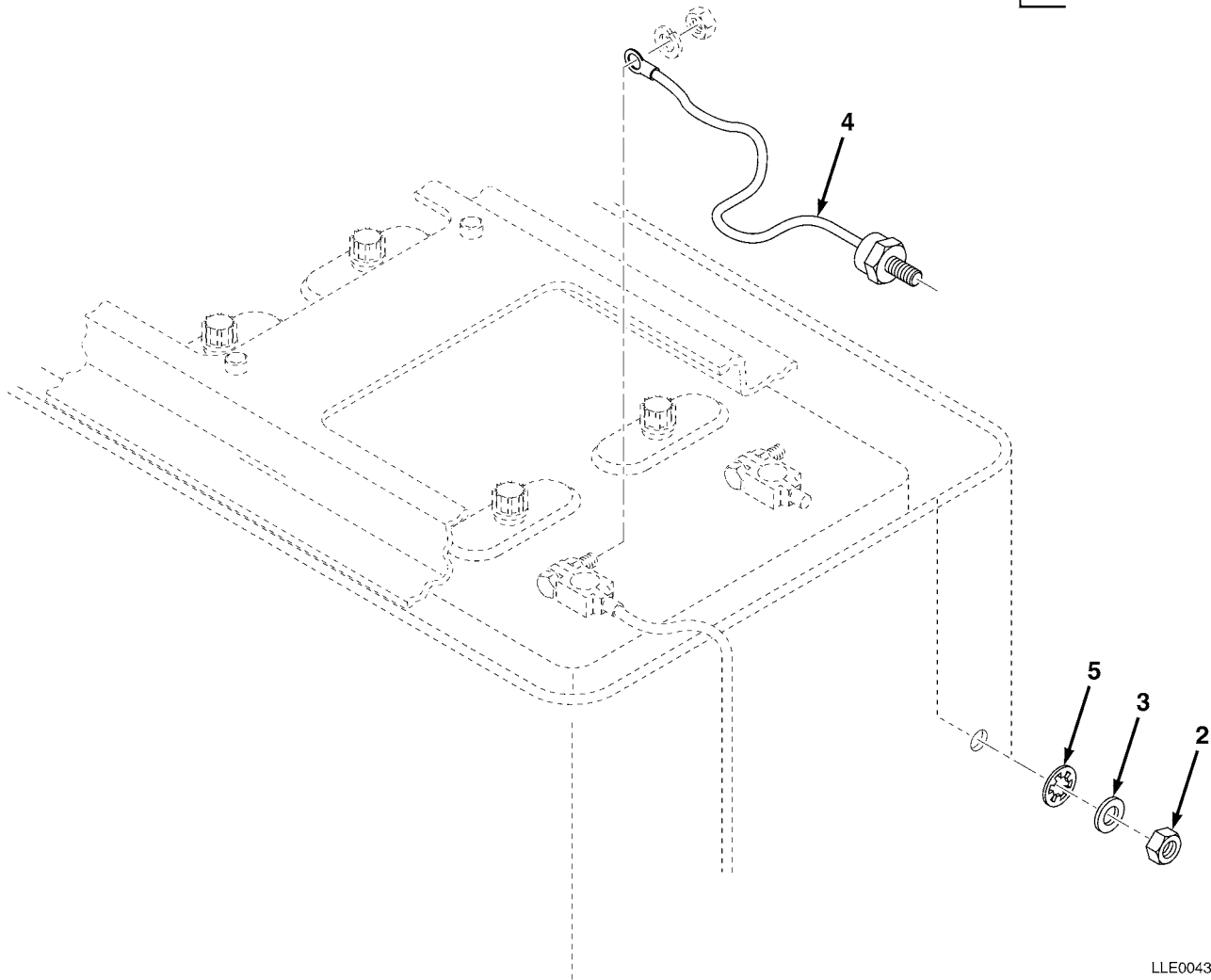
FIG. 13 SCRAPER RIGID MAST

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 67 PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC	
				GROUP 6714 ANTENNAS, GROUNDS, AND RELATED EQUIPMENT	
				FIG. 13 SCRAPER RIGID MAST	
1		56009	RM2E-3	RIGID MAST	1
2		56009	209099	• SCALE, 3 FOOT MAST	1
3		56009	2507-4270-010	• SPACER, RND, 0.203 X 0.312 X 0.194 IN. (10/PKG)	1
4		56009	7181-6008-010	• SCR, RND, XREC (10/PKG)	1
5		56009	3502-0420	• CHAIN	1
6		56009	2509-6780	• PIN	1
7		56009	201634	• MOUNT, RIGID MAST, LPO	1

END OF FIGURE

SUBSECTION B - BLADE PRO[®] MOTOR GRADER CONTROL SYSTEM

1 - 2 THROUGH 5

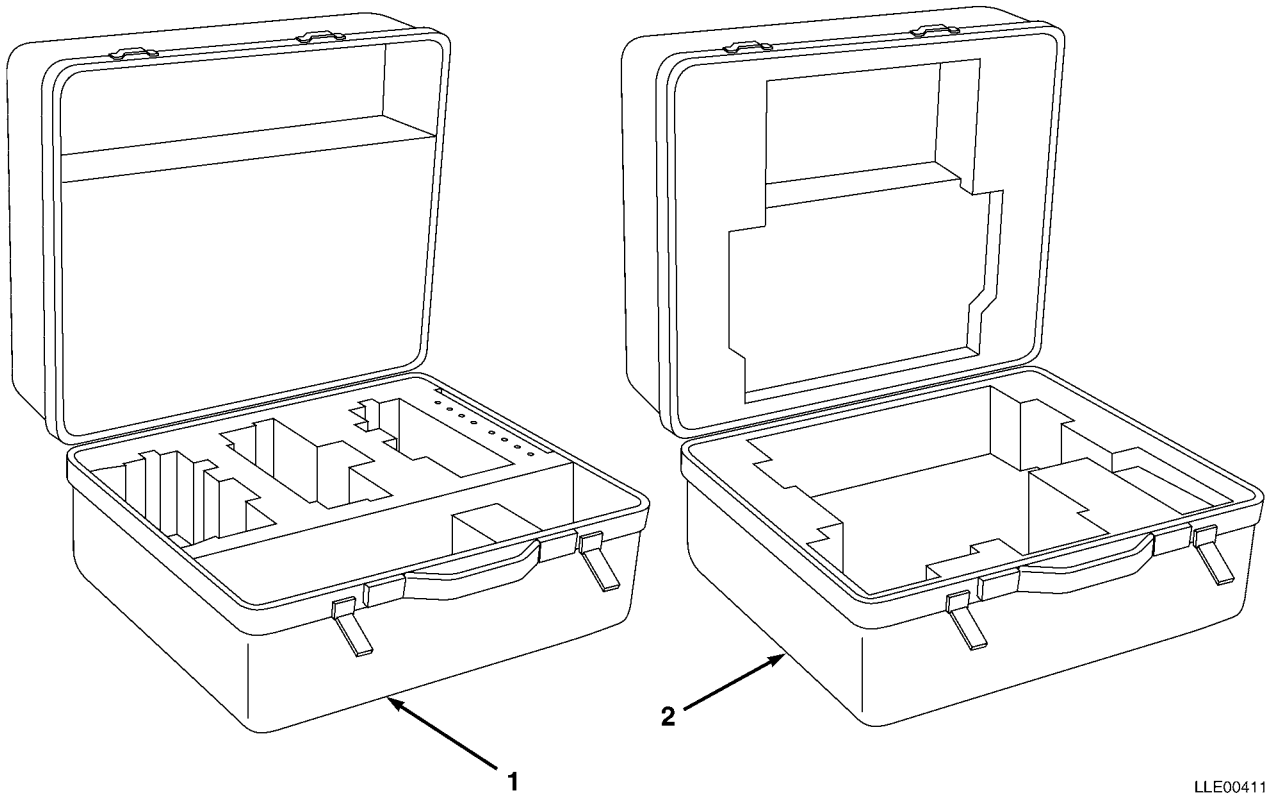


LLE00434

FIG. 14 GRADER VOLTAGE PROTECTION CABLE

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 06 ELECTRICAL SYSTEM	
				GROUP 0606 ENGINE SAFETY CONTROLS	
				FIG. 14 GRADER VOLTAGE PROTECTION CABLE	
1	56009		121022	KIT,VOLTAGE PROTECTION	1
2	56009		005274	• NUT,HEX,3/8-16 IN.	1
3	56009		003834-010	• WSHR,FL,3/8 X 1.08 IN. (10/PKG)	1
4	56009		221089	• CABLE,VOLTAGE PROTECTION	1
5	56009		2801-1010	• LKWASH,INTERNAL,3/8	1

END OF FIGURE



LLE00411

FIG. 15 BLADE PRO[®] CARRYING CASES

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 06 ELECTRICAL SYSTEM	
				GROUP 0612 CARRYING CASE	
				FIG. 15 BLADE PRO® CARRYING CASES	
1		56009	0365-2630	CASE,CARRYING,LABELED,BLADE PRO®.....	1
2		56009	0225-0530	CASE,CARRYING,RT2S RCVR	1


END OF FIGURE

Spectra Precision
Keep Blade
Cushion OFF
When Using
Automatic Blade
Control System

CAUTION!
When circle is rotated past 45° or when
Centershift Lock Pin is used past center
position. Disconnect cables at Rotation
Sensor.

Conversion Chart

Millimeters Per Meter	Inches Per Foot	Approx. % Slope
10mm	3/8"	1.0%
16mm	3/16"	1.6%
21mm	1/4"	2.1%
26mm	5/16"	2.6%
31mm	3/8"	3.1%
36mm	7/16"	3.6%
42mm	1/2"	4.2%
52mm	5/8"	5.2%
63mm	3/4"	6.3%
73mm	7/8"	7.3%
83mm	1 "	8.3%
104mm	1 1/8"	10.4%
125mm	1 1/2"	12.5%
146mm	1 3/4"	14.6%
167mm	2 "	16.7%
188mm	2 1/4"	18.8%
198mm	2 3/8"	19.8%



**SPECTRA™
PRECISION**

P/N 0790-8510

WARNING!
DISCONNECT ALL
ELECTRICAL CABLES
FROM
SPECTRA PRECISION
SYSTEM BEFORE
WELDING ON OR JUMP
STARTING MACHINE.

CAUTION

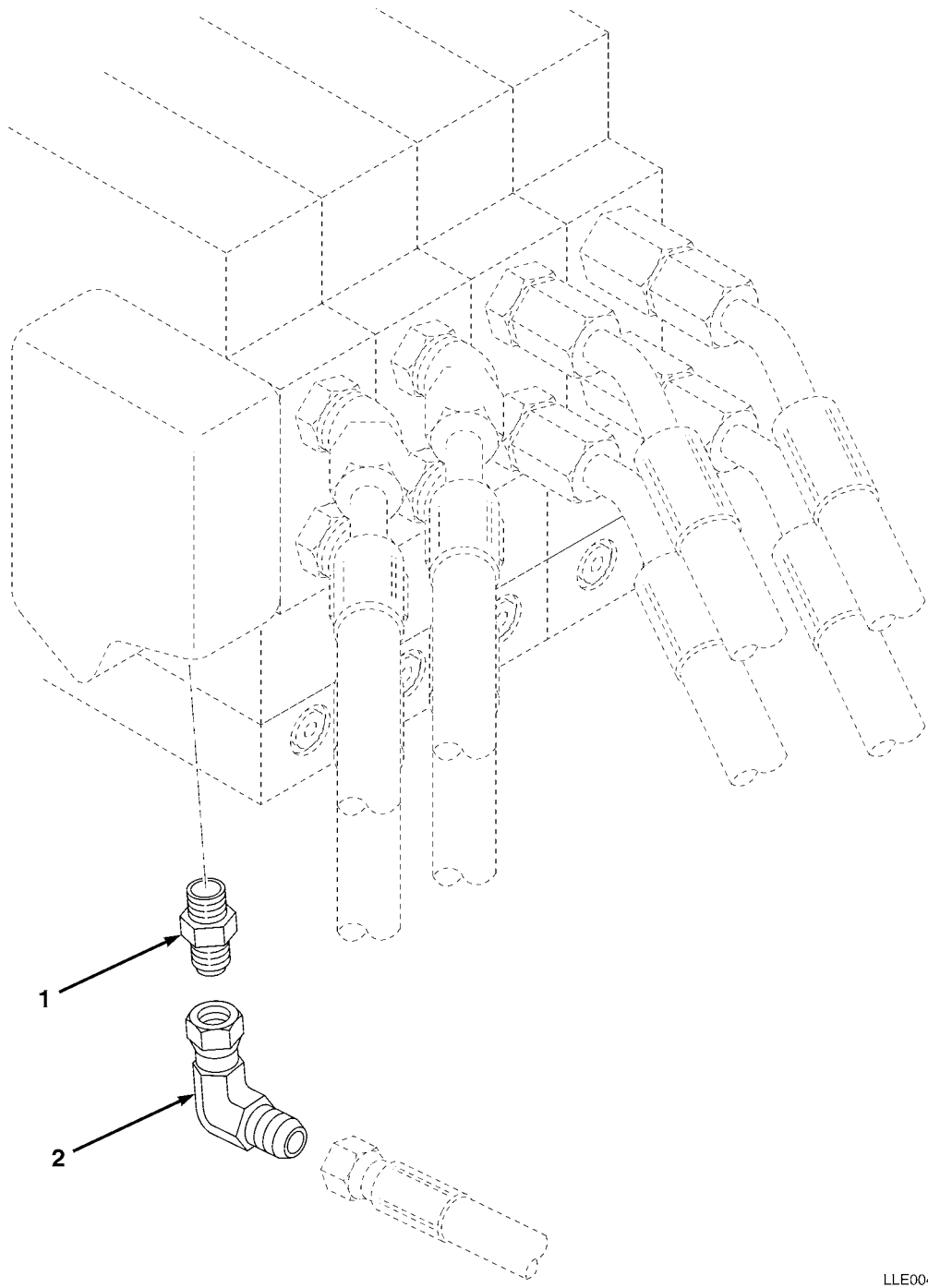
THE ROTATIONAL SENSOR
CAN BE DAMAGED IF
THE BLADE IS FULLY
RETRACTED WHILE THE
CENTER SHIFT LOCK PIN
IS IN THE FAR LEFT
POSITION.

LLE00073

FIG. 16 DECALS, PLATES, AND INSTRUCTION HOLDERS

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 22 BODY CHASSIS OR HULL, AND ACCESSORY ITEMS	
				GROUP 2210 DATA PLATES AND INSTRUCTION HOLDERS	
				FIG. 16 DECALS, PLATES, AND INSTRUCTION HOLDERS	
1	56009	0355-7470		LABEL, CAUTION, ROTATIONAL SENSOR	1
2	56009	111741		LABEL, WARNING, WELDING/JUMP STARTING	3
3	56009	0790-8510		LABEL, CHART, CONVERSION	1

END OF FIGURE

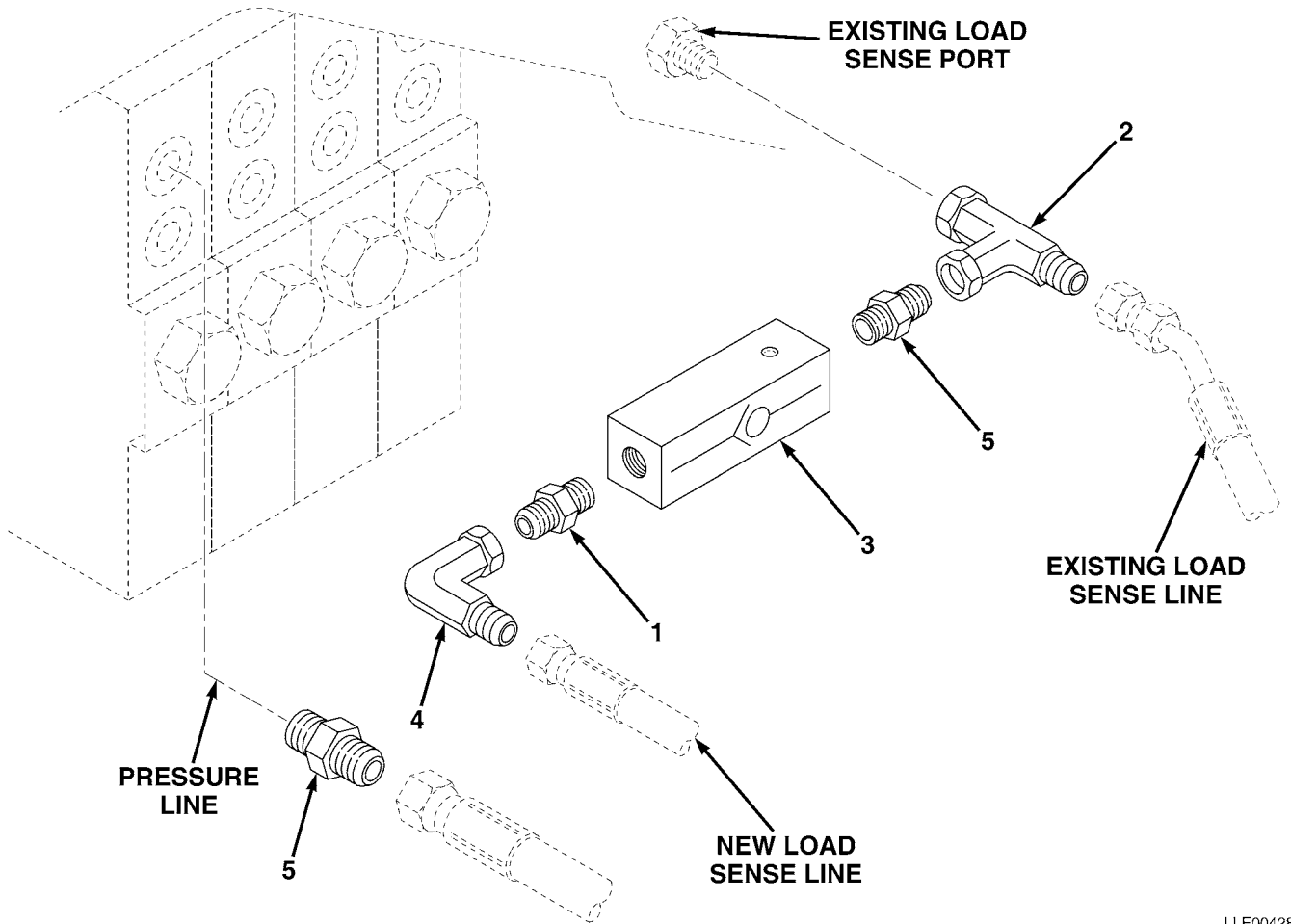


LLE00429

FIG. 17 RETURN LINE FITTINGS

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 43 HYDRAULIC, FLUID, AIR, AND VACUUM SYSTEMS	
				GROUP 4301 STRAINER, FILTERS, HOSE, PIPE FITTINGS, TUBING, ETC.	
				FIG. 17 RETURN LINE FITTINGS	
1		56009	004196	FITTING,STR SAE-JIC #6	2
2		56009	004277	ADAPTER,90-DEGREE ELB,#6 JIC,SWIVEL NUT	2

END OF FIGURE

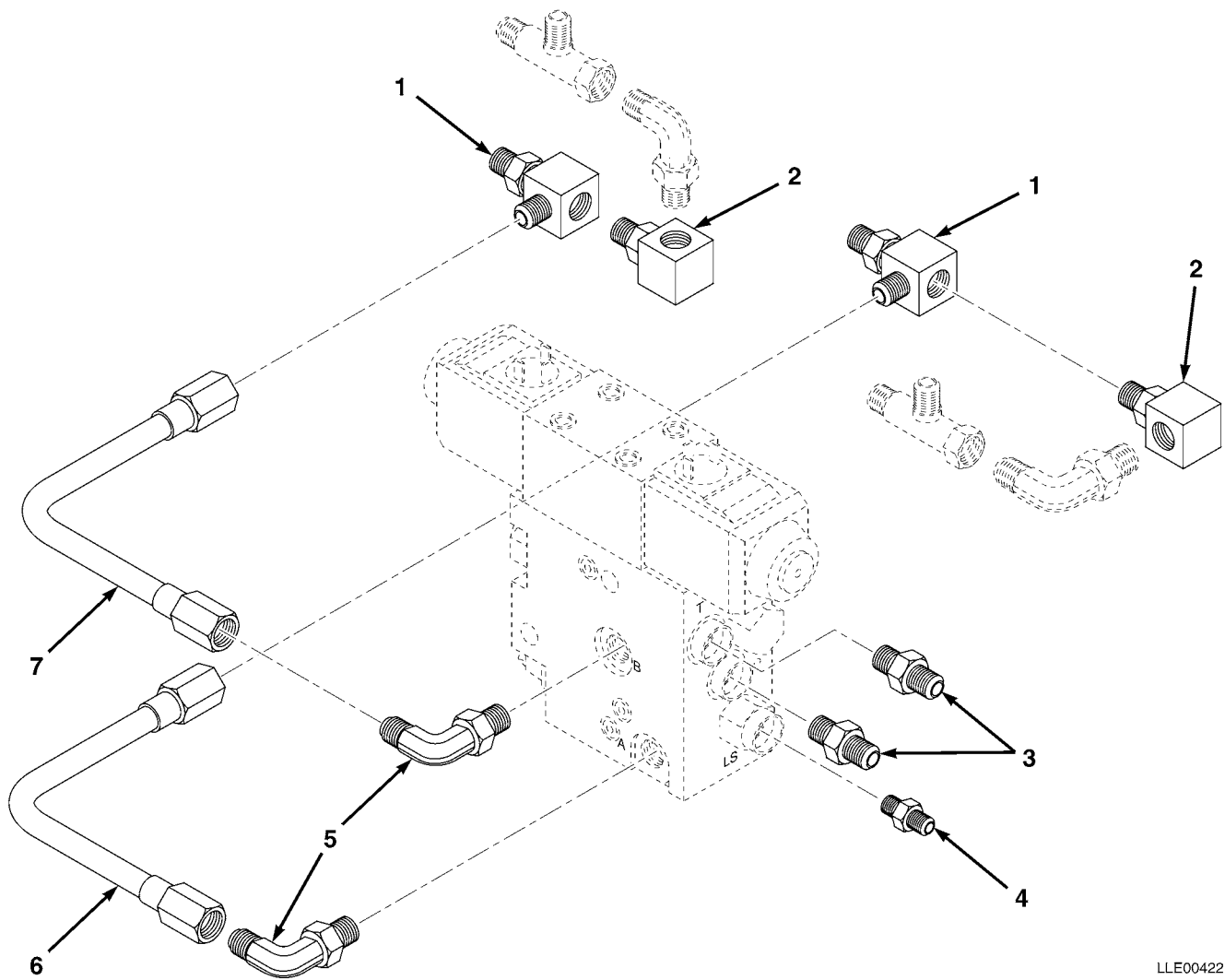


LLE00428

FIG. 18 LOAD SENSE AND RETURN VALVES AND FITTINGS

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 43 HYDRAULIC, FLUID, AIR, AND VACUUM SYSTEMS	
				GROUP 4301 STRAINER, FILTERS, HOSE, PIPE FITTINGS, TUBING, ETC.	
				FIG. 18 LOAD SENSE AND RETURN VALVES AND FITTINGS	
1	56009	004195		FITTING,STR,SAE-JIC 6	2
2	56009	005272		FITTING,TEE,SW RUN #6 JIC	2
3	56009	2523-1949		VALVE,CHECK,#6 SAE INLINE	2
4	56009	005467		FITTING,90-DEGREE,#4 JIC	2
5	56009	004196		FITTING,STR,SAE-JIC #6	4

END OF FIGURE

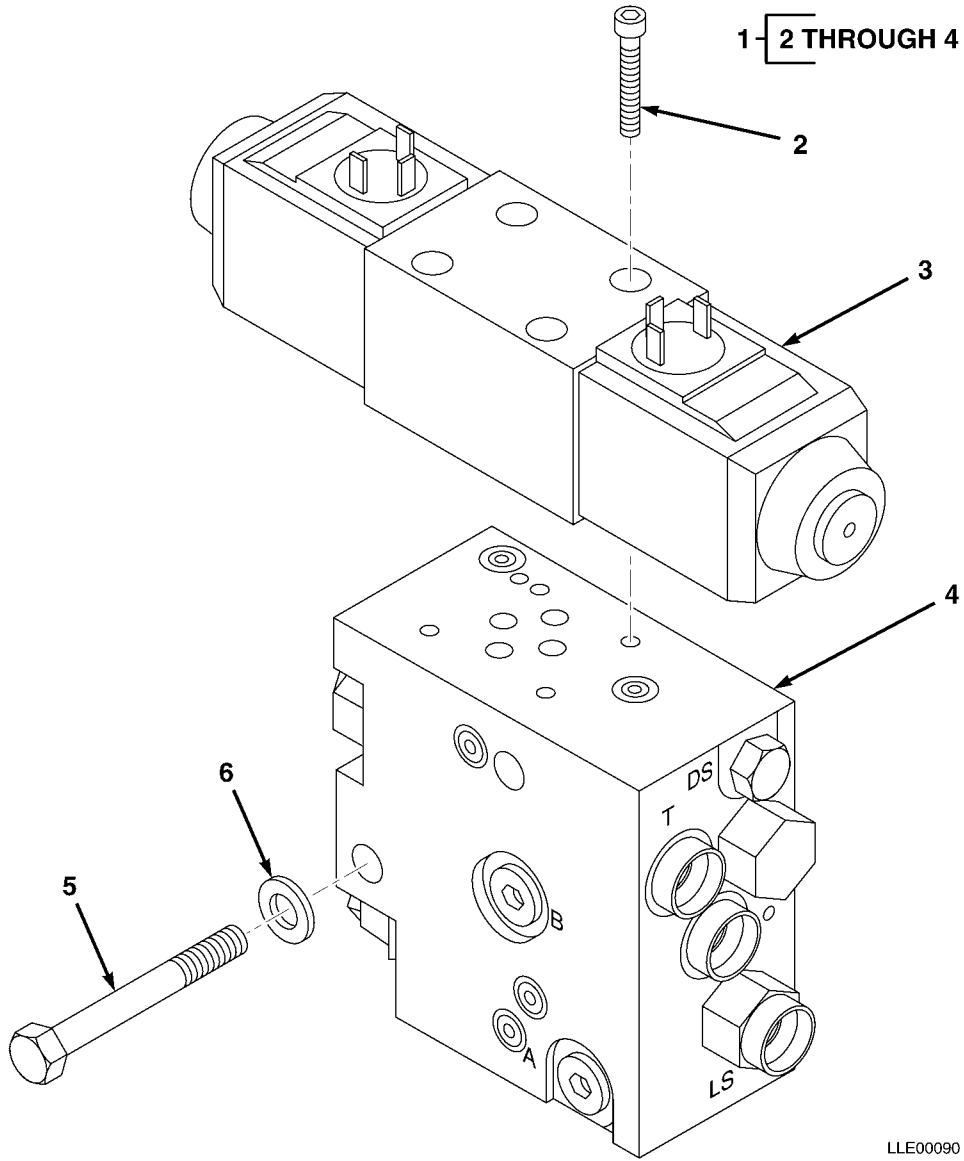


LLE00422

FIG. 19 PIPES AND FITTINGS (PER VALVE)

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
GROUP 43 HYDRAULIC, FLUID, AIR, AND VACUUM SYSTEMS					
GROUP 4301 STRAINER, FILTERS, HOSE, PIPE FITTINGS, TUBING, ETC.					
FIG. 19 PIPES AND FITTINGS (PER VALVE)					
1	56009	2542-0059	FITTING, TEE, #8	.....	2
2	56009	2542-0062	FITTING, 90-DEGREE BLOCK #8	.....	2
3	56009	004196	FITTING, STR, SAE-JIC, #6	.....	2
4	56009	004194	FITTING, STR, SAE-JIC, #4	.....	1
5	56009	004261	FITTING, 90-DEGREE, SAE-JIC, #6	.....	2
6	56009	0720-2450	TUBE, STEEL, RIGHT RAISE, G BLOCK	.....	1
	56009	0720-2470	TUBE, STEEL, LEFT RAISE, G BLOCK (NOT SHOWN)	.....	1
7	56009	0720-2460	TUBE, STEEL, RIGHT LOWER, G BLOCK	.....	1
	56009	0720-2480	TUBE, STEEL, LEFT LOWER, G BLOCK (NOT SHOWN)	.....	1

END OF FIGURE



LLE00090

FIG. 20 PROPORTIONAL VALVE ASSEMBLY

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC) GROUP 43 HYDRAULIC, FLUID, AIR, AND VACUUM SYSTEM GROUP 4305 MANIFOLD AND/OR CONTROL VALVES FIG. 20 PROPORTIONAL VALVE ASSEMBLY	(6) QTY
1		56009	PSV2D06-24	CONTROL VALVE ASSEMBLY, PROPORTIONAL	2
2		56009	2816-4244-005	• SCR, SOCKET HEAD, 10-24 X 1-1/4 IN.	4
3		56009	0720-2400	• MANIFOLD, PROPORTIONAL W/CARTRIDGES	4
4		56009	0720-2510	• VALVE, PROPORTIONAL, VICKERS	1
5		56009	9839-1656-005	BOLT, CAP, HEX, 3/8-16 X 4-3/4 IN., STL (5/PKG)	4
6		56009	003834-010	WSHR, FL, 3/8 IN. X 1.08 IN. (10/PKG)	4

END OF FIGURE

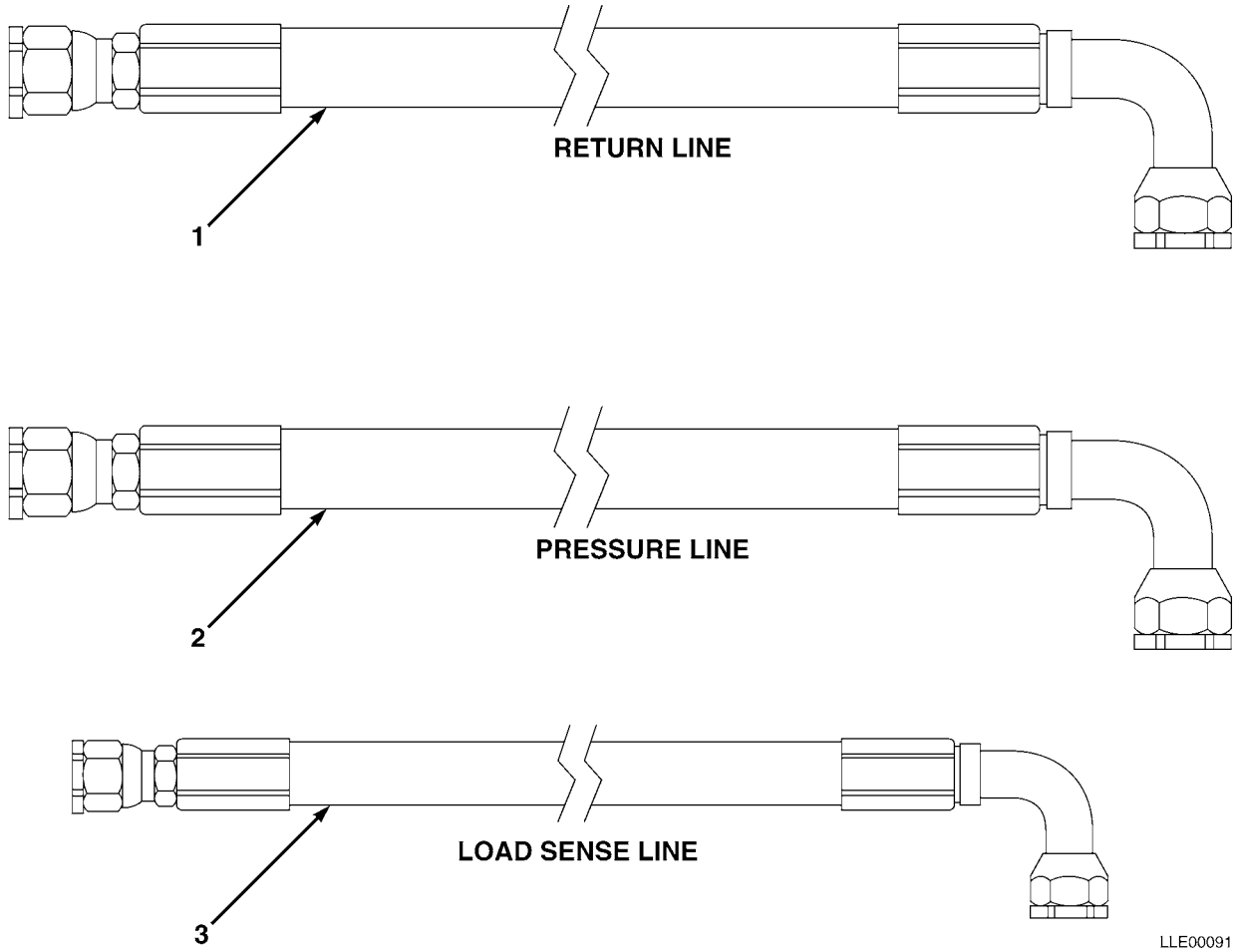
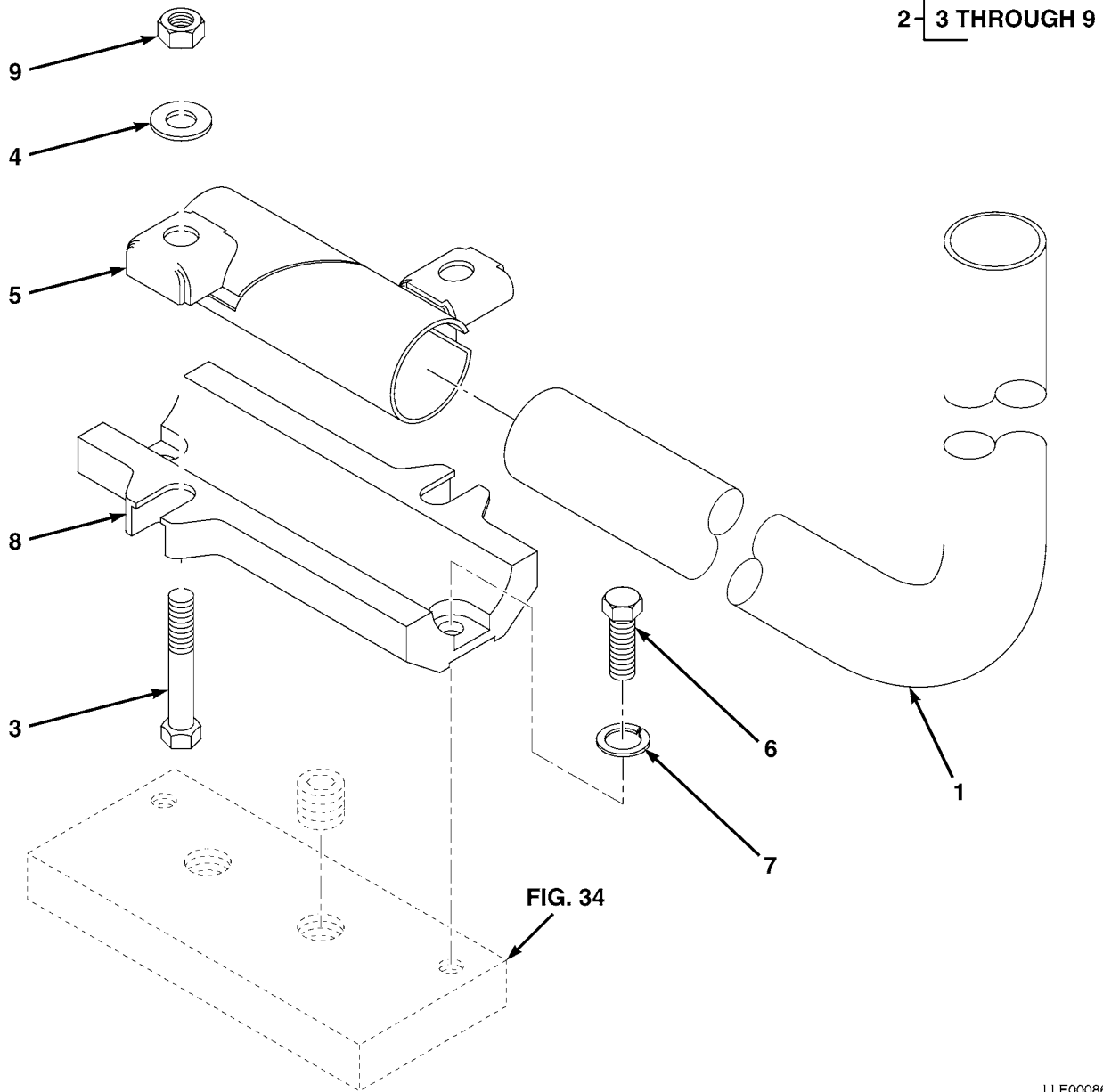


FIG. 21 HYDRAULIC HOSES

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 43 HYDRAULIC, FLUID, AIR, AND VACUUM SYSTEM	
				GROUP 4316 ASSEMBLED HOSE, FITTINGS, LINE BREATHERS, FILTERS, AND TRAPS	
				FIG. 21 HYDRAULIC HOSES	
1	56009	208688-063	HOSE,3/8 ID,HYDRAULIC (RETURN LINE)		2
2	56009	208688-085	HOSE,3/8 ID,HYDRAULIC (PRESSURE LINE)		2
3	56009	0791-3120-085	HOSE,1/4 ID,HYDRAULIC,STR-90-DEGREE (LOAD SENSE LINE)		2

END OF FIGURE



LLE00086

FIG. 22 TRACER® TUBE AND BASE CLAMP ASSEMBLY

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 67 PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC	
				GROUP 6703 MECHANICAL, STRUCTURAL, AND PRECISION PARTS	
				FIG. 22 TRACER® TUBE AND BASE CLAMP ASSEMBLY	
1		56009	0790-8900	TUBES,TRACER,90-DEGREE	2
2		56009	0355-9600	BASE CLAMP ASSY	2
3		56009	011506	• SCR,CAP,HEX,0.5-13 X 2.75 IN. (5/PKG)	1
4		56009	003836	• WSHR,FL,0.562 X 0.375 X 0.109 IN. (10/PKG)	1
5		56009	0355-9630	• BASE CLAMP	2
6		56009	9837-1822	• SCR,CAP,HEX,0.50-13 X 1.25 IN.,STL	8
7		56009	003855-010	• LKWSHR,SPLIT,0.50 X 0.51 X 0.12 IN. (10/PKG)	1
8		56009	0355-8960	• CLAMP,CAST	4
9		56009	004964	• NUT,HEX,0.50-13 X 0.75 X 0.44 IN. (10/PKG)	1

END OF FIGURE

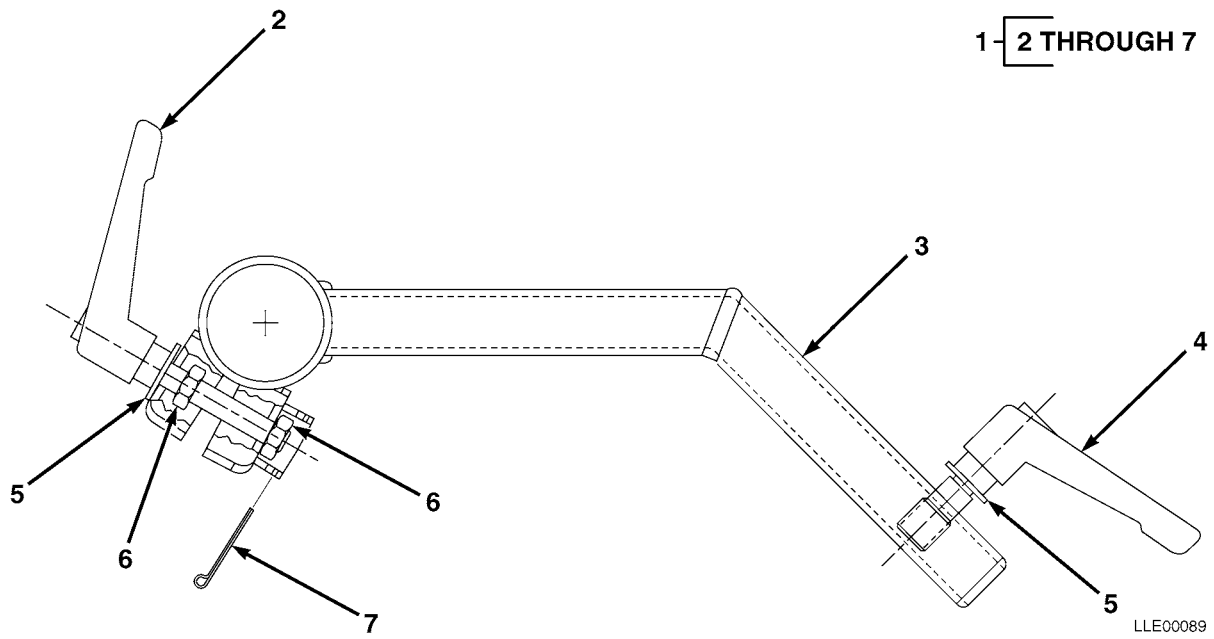
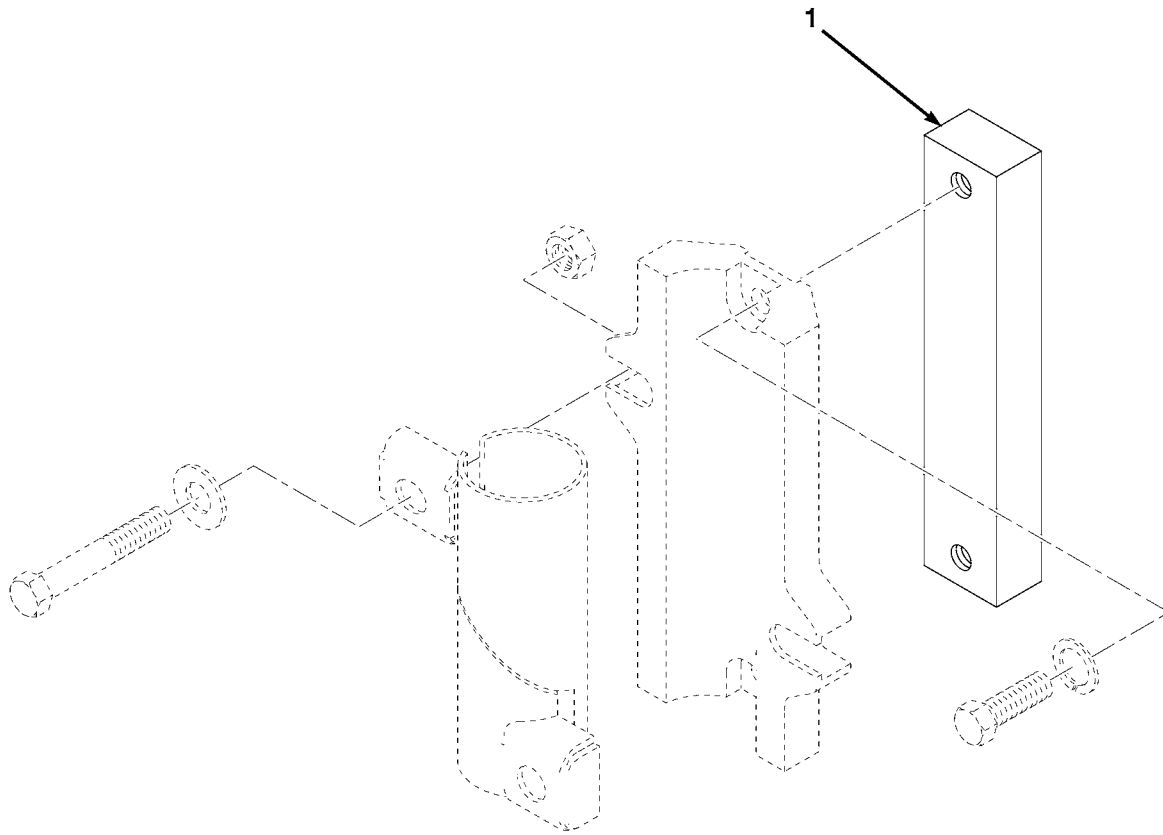


FIG. 23 TRACER[®] ARM BRACKET ASSEMBLY

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 67 PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC	
				GROUP 6703 MECHANICAL, STRUCTURAL, AND PRECISION PARTS	
				FIG. 23 TRACER® ARM BRACKET ASSEMBLY	
1	56009	0355-8550	BRKT,TRACER® MTG ARM.....		1
2	56009	0355-8680	• LEVER ASSEMBLY		1
3	56009	0355-8580	• WELDMENT,TRACER ARM		1
4	56009	0355-8590	• LEVER ASSEMBLY		1
5	56009	003834-010	• WSHR,FL,3/8 X 1.08 IN.,STL,CD (10/PKG)		1
6	56009	005274	• NUT,HEX 3/8-16 IN.		2
7	56009	2817-0051	• PIN,COTTER STD.,3/32 X 1-1/4 IN. (10/PKG)		1

END OF FIGURE

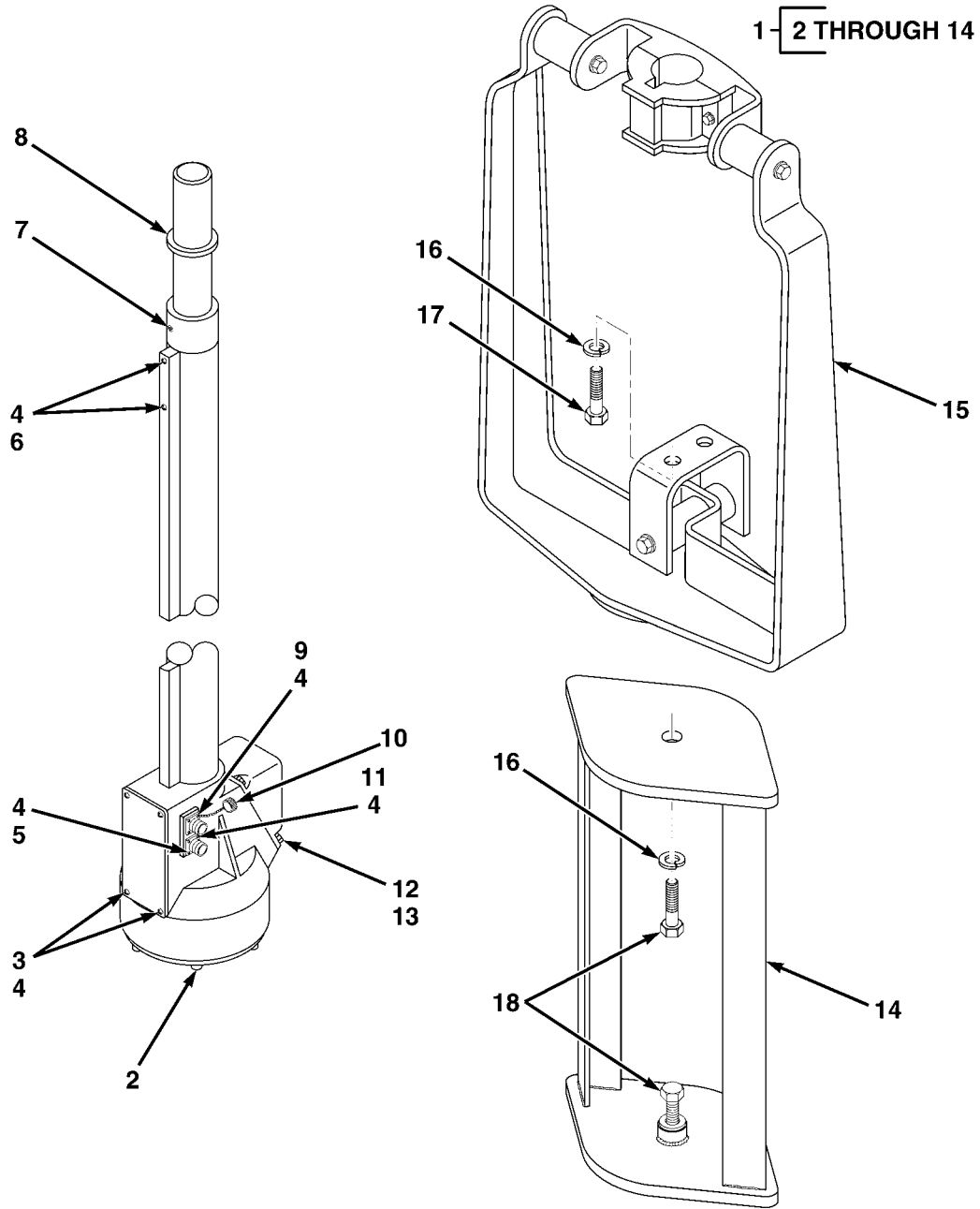


LLE00087

FIG. 24 TRACER® CLAMP BASE MOUNTING

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 67 PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC	
				GROUP 6703 MECHANICAL, STRUCTURAL, AND PRECISION PARTS	
				FIG. 24 TRACER® CLAMP BASE MOUNTING	
1		56009	0355-8620	TRACER® MOUNTING BLOCK.....	2

END OF FIGURE

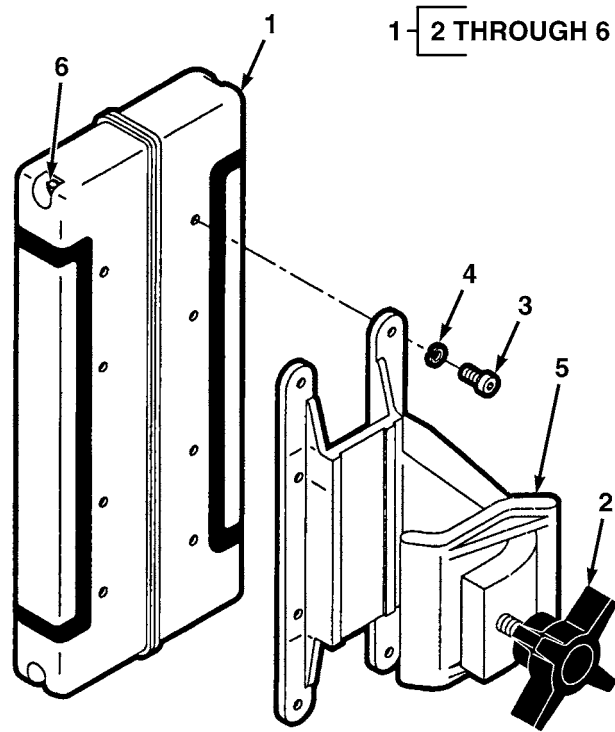


LLE00085

FIG. 25 EM2E-24 ELECTRIC MAST ASSEMBLY

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 67 PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC	
				GROUP 6709 ANTENNAS, GROUNDS, AND RELATED EQUIPMENT	
				FIG. 25 EM2E-24 ELECTRIC MAST ASSEMBLY	
1	56009		EM2E-24	EM2E-24 ELECTRIC MAST - ENG,24V	1
2	56009		8207-1514	• SCR,CAP SKT,5/16-18 X 7/8 IN. (10/PKG)	1
3	56009	7181-0604-010		• SCR,RND XREC,6-32 X 0.25 IN. (10/PKG)	1
4	56009	2802-0020-010		• LKWSHR,SPLIT #6,SSTL (10/PKG)	1
5	56009	7181-0612-010		• SCR,RND XREC,6-32 X 0.75 IN. (10/PKG)	1
6	56009	2802-0030-010		• LKWSHR,SPLIT #8 SST (10/PKG)	1
7	56009	7121-6007-010		• SCR,FL XREC,10-32 X 7/16 IN. (10/PKG)	1
8	56009		012697	• RING,RETAINING	1
9	56009	7181-0608-010		• SCR,RND XREC,6-32 X 0.50 IN. (10/PKG)	1
10	56009		003184	• DUST CAP RECEPTACLE	1
11	56009	7181-0605-010		• SCR,RND HEAD PHIL,6-32 X 5/16 IN. (10/PKG)	1
12	56009		011887-005	• SCR,HEX 10-32 X 0.5 IN. STL,CD (5/PKG)	1
13	56009	2802-0040-010		• LKWASH,SPLIT #10	4
14	56009		0790-4241	RISER,MOTOR 130G GRADER MAST MOUNT	1
15	56009		M2-T	SHOCK MOUNT,HIGH VIBRATION	1
16	56009		003859-010	LKWSHR,SPLIT,STL,CD, 3/4 X 1.27 X 0.19 IN. (10/PKG)	2
17	56009	9837-7222-005		SCR,CP HEX,STL,CD, 3/4-16 X 1 IN. (5/PKG)	2
18	56009		011137	SCR,CP HEX,STL,CD, 3/4-16 X 2 IN.	2

END OF FIGURE

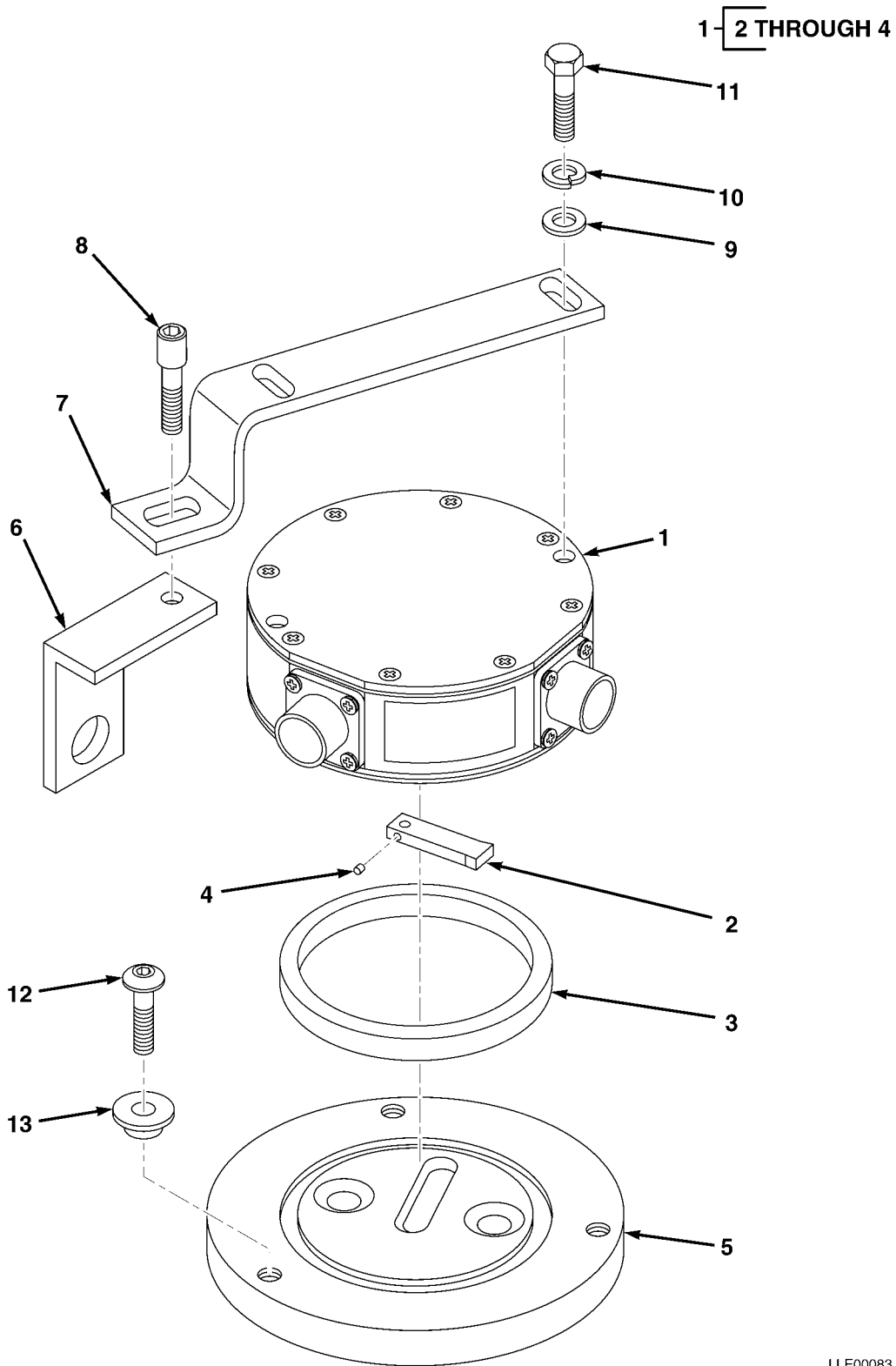


LLE00084

FIG. 26 R2S-S LASER RECEIVER

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 67 PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC	
				GROUP 6709 ANTENNAS, GROUNDS, AND RELATED EQUIPMENT	
				FIG. 26 R2S-S LASER RECEIVER	
1	56009		R2S-S	R2S-S LASER RECEIVER SB W/CASE	1
2	56009		2403-1680	• KNOB, PLASTIC PRONGED	1
3	56009		8201-0808-020	• SCREW, CAP SKT 8-32 X 1/2 IN. (20/PKG)	1
4	56009		2802-0030-010	• LKWSHR, SPLIT #8 SSTL(10/PKG)	4
5	56009		321815	• CLAMP, RECEIVER	1
6	56009		012192-005	• SCREW, OVAL XREC SSTL 10-32 X 4 IN. (5/PKG)	1

END OF FIGURE



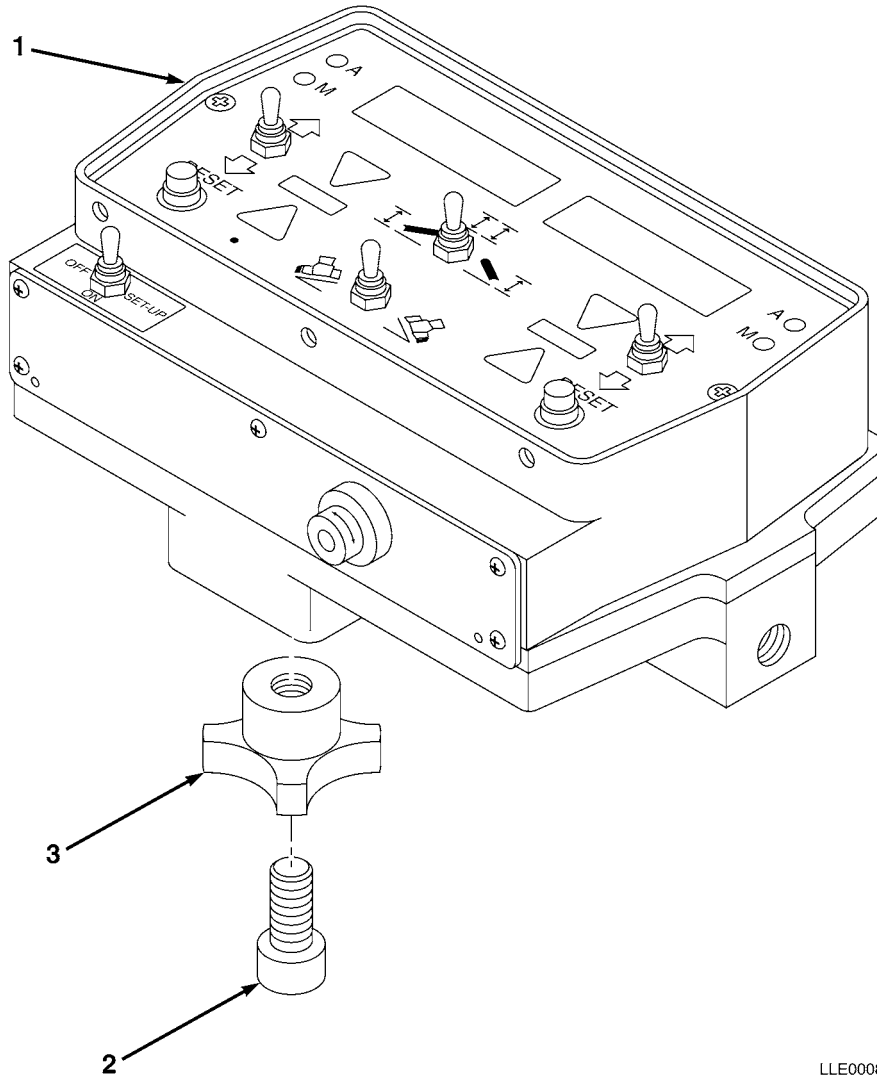
LLE00083

FIG. 27 CIRCLE ROTATION SENSOR

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
GROUP 67 PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC					
GROUP 6711 CONTROLS, INDICATORS, AND SPECIAL COMPONENTS					
FIG. 27 CIRCLE ROTATION SENSOR					
1	56009	0365-3000	HSNG,ASSY,ROTATIONAL SNSR		1
2	56009	0355-3170	• BONE,DOG		1
3	56009	0355-3190	• BEARING,TEFLON ROT SNSR HSG		1
4	56009	8311-0402	• SCR,SET COP 4-40 X 0.125 IN. (10/PKG)		1
5	56009	0355-3180	DISK,ORIENTATION		1
6	56009	0355-3130	MTG BRKT,ROTATION SNSR ARM		1
7	56009	0355-3140	ARM MTG BRKT,ROTATION SNSR		1
8	56009	2816-2260-010	SCR,SHLDR,SKT,10-32 X 0.75 IN. (10/PKG)		1
9	56009	003833	WSHR,FL,5/16 X 0.87 X 0.08 IN.,STL CD (10/PKG)		1
10	56009	003851-010	LKWASH,SPLIT,5/16 X 0.59 X 0.08 IN. STL, CD (10/PKG)		1
11	56009	9837-1520-010	SCR,CAP,HEX,5/16-18 X 1.00 IN. (10/PKG)		2
12	56009	8241-6008-010	SCR,BUT,SKT,10-32 X 0.5 SST,PSVT (10/PKG) ..		3
13	56009	0365-5310	BSHG,ROTATIONAL SNSR MTG		3

END OF FIGURE

1-2 THROUGH 3

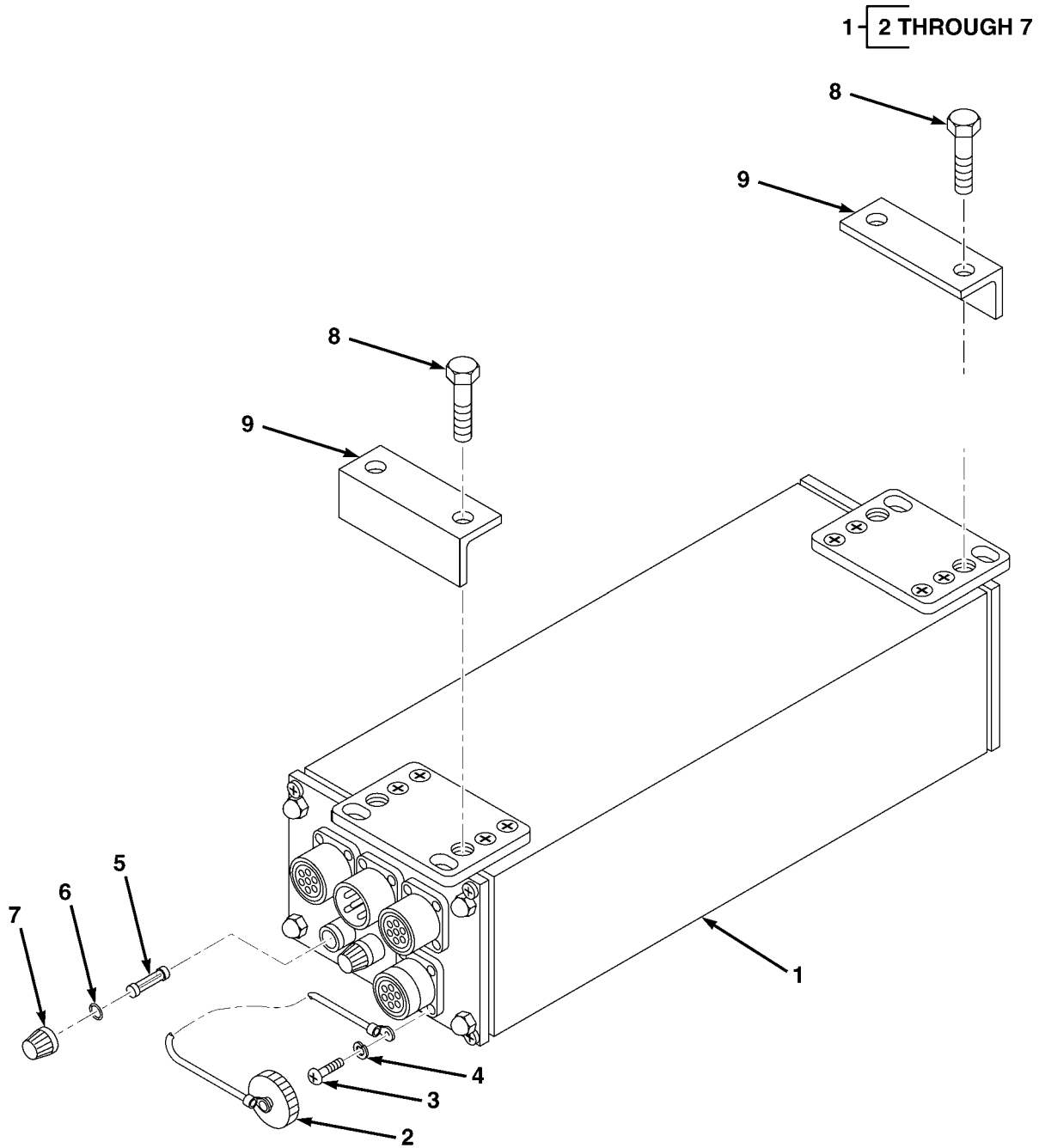


LLE0081

FIG. 28 OPERATOR INTERFACE BOX

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 67 PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC	
				GROUP 6711 CONTROLS, INDICATORS, AND SPECIAL COMPONENTS	
				FIG. 28 OPERATOR INTERFACE BOX	
1	56009	0365-2040	0365-2040	OPERATOR INTERFACE PROP FINAL ASSY	1
2	56009	8201-1626	8201-1626	• SCR,SOC,CAP 3/8-16 X 1-3/4 IN., SST F/T	1
3	56009	2403-1680	2403-1680	• KNOB,PLASTIC PRONGED	1

END OF FIGURE

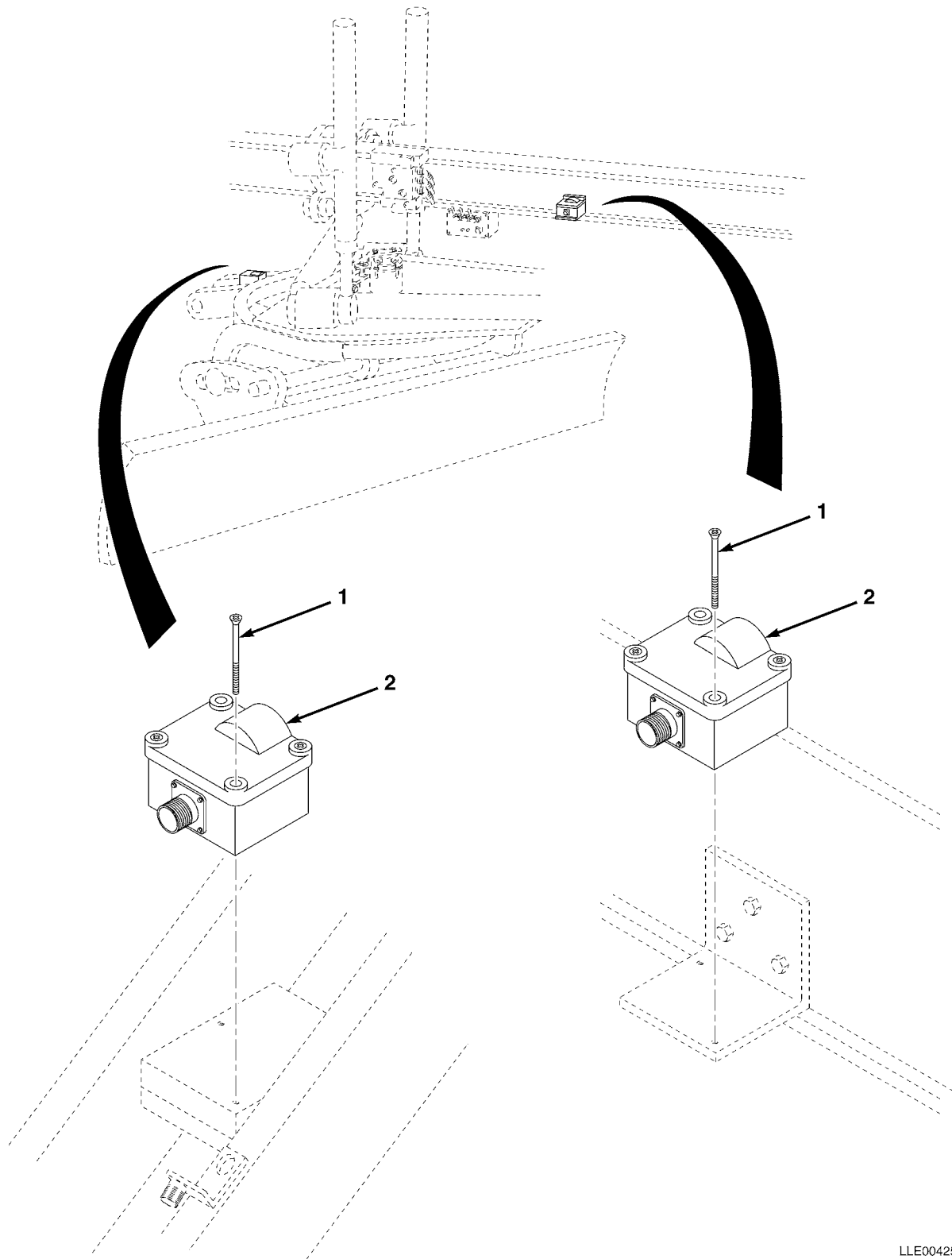


LLE00082

FIG. 29 REMOTE INTERFACE BOX

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 67 PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC	
				GROUP 6711 CONTROLS, INDICATORS, AND SPECIAL COMPONENTS	
				FIG. 29 REMOTE INTERFACE BOX	
1	56009	0365-1140		BOX,REMOTE,INTERFACE	1
2	56009	2117-1710		• CAP,DUST,W/WIRE ROPE 0.125 IN. DIA	1
3	56009	7181-0606-010		• SCR,RND,6-32 X 3/8 IN. SST PSVT (10/PKG) .	4
4	56009	2802-0770		• LKWASH,SPLIT,6-32,STL,2N	4
5	56009	011894		• FUSE,25 AMP	2
6	56009	011023		• SEAL,FUSE CAP	2
7	56009	010716		• CAP,FUSE	2
8	56009	9837-1634		SCR,CAP,HEX,1/4 X 20 X 1 IN., 3/8 X 16 2 1/2 SSL STEEL(5/PKG)	1
9	56009	0365-3160		CLAMP,REMOTE BOX MTG	2

END OF FIGURE

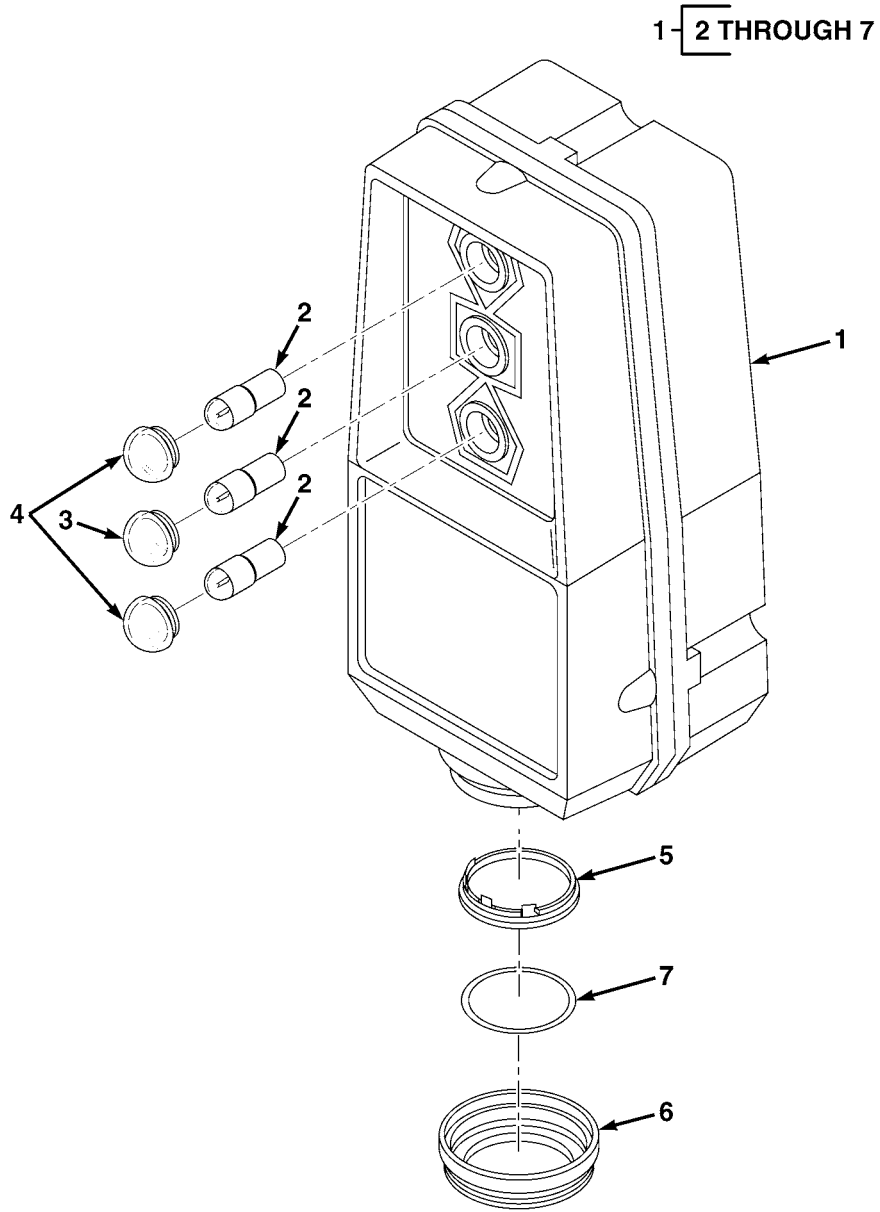


LLE00425

FIG. 30 SLOPE SENSORS

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 67 PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC	
				GROUP 6711 CONTROLS, INDICATORS, AND SPECIAL COMPONENTS	
				FIG. 30 SLOPE SENSORS	
1	56009	8201-1432-005	SCR,CAP SOCKET,1/4-20 X 2-1/4 IN. (5/PKG)		1
2	56009	0365-4010	SNSR,SLOPE		2

END OF FIGURE

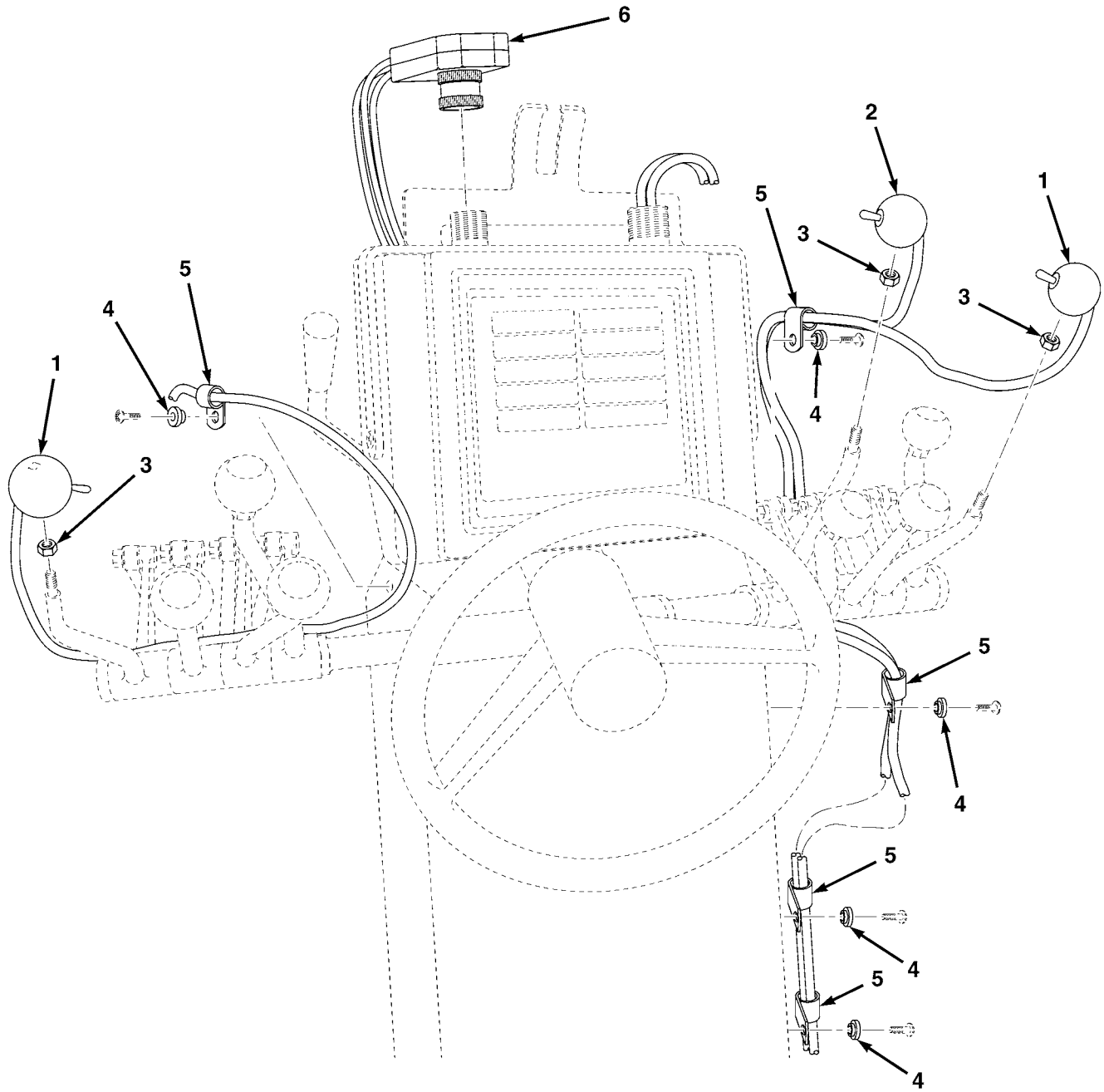


LLE00080

FIG. 31 TRACER® SONIC GRADE CONTROLLER

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 67 PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC	
				GROUP 6711 CONTROLS, INDICATORS, AND SPECIAL COMPONENTS	
				FIG. 31 TRACER® SONIC GRADE CONTROLLER	
1	56009		ST2-20	NON-CONTACT SONIC TRACER	1
2	56009		3901-2110	• LAMP, INCAND T3-14	3
3	56009		3902-0603	• LENS, GREEN, 0.625 IN. DIA, STOVEPIPE	1
4	56009		3902-0604	• LENS, AMBER, 0.625 IN. DIA, STOVEPIPE	2
5	56009		5501-0151	• TRANSDUCER, SND, POLAROID, 604142	1
6	56009		0365-8420	• TRANSDUCER RING	1
7	56009		2504-6000	• O-RING, 1.50 ID X 1.688 OD X 0.094 IN.	1

END OF FIGURE

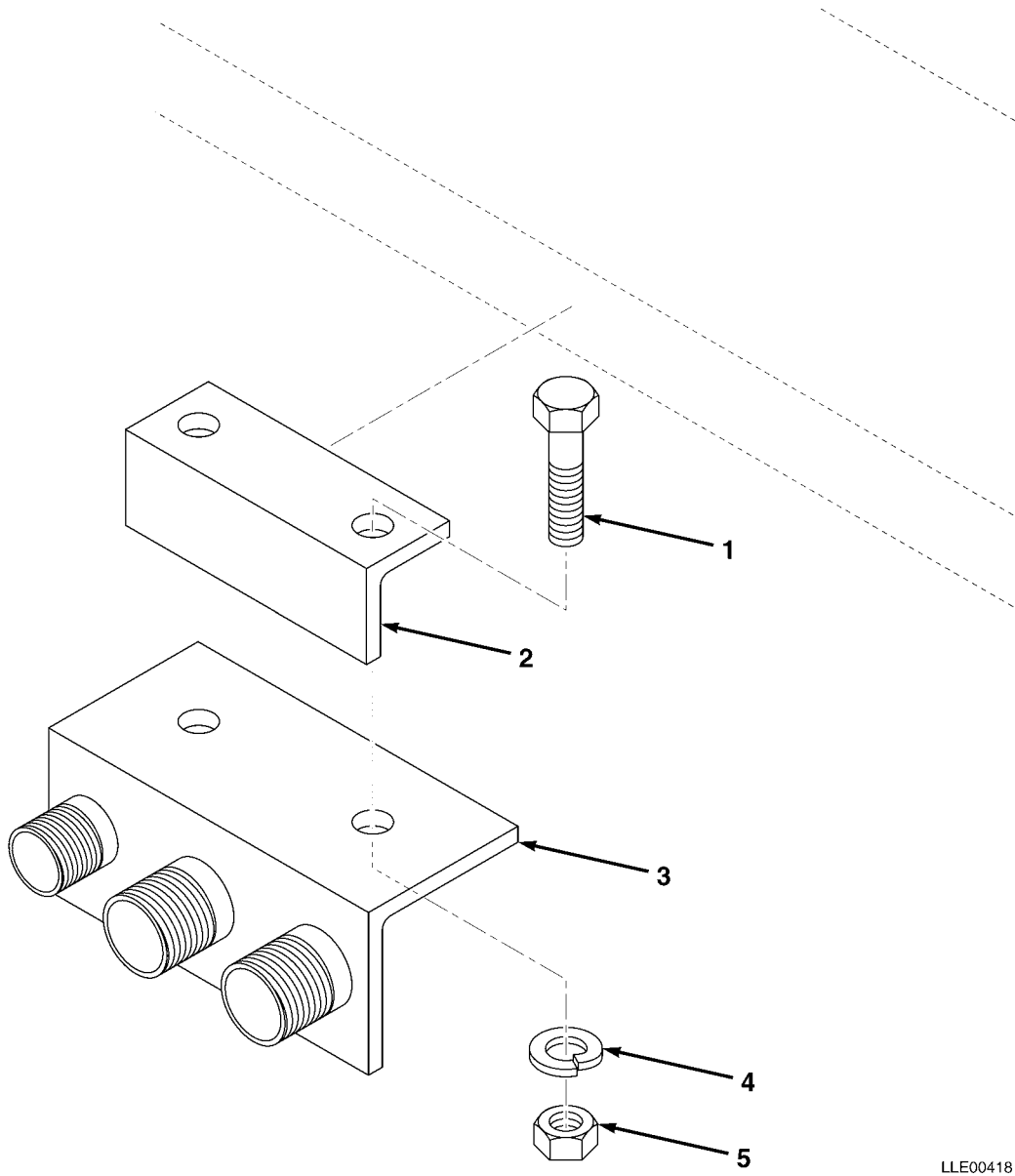


LLE00424

FIG. 32 CONTROL KNOB SWITCHES

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 67 PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC	
				GROUP 6711 CONTROLS, INDICATORS, AND SPECIAL COMPONENTS	
				FIG. 32 CONTROL KNOB SWITCHES	
1	56009	0791-1890-090	0791-1890-090	CABLE, 3-CONNECTOR, REMOTE, R/L SWITCH	2
2	56009	0791-1850-090	0791-1850-090	CABLE, 3-CONNECTOR, REMOTE, SWITCH	1
3	56009	003805-010	003805-010	NUT, HEX, 3/8-24 X 0.56 X 0.22 IN. (10/PKG)	3
4	56009	0365-5310	0365-5310	BSHG	6
5	56009	006649	006649	CLAMP, HOSE	6
6	56009	0365-2700	0365-2700	ASSY, REMOTE SPLICE	1

END OF FIGURE



LLE00418

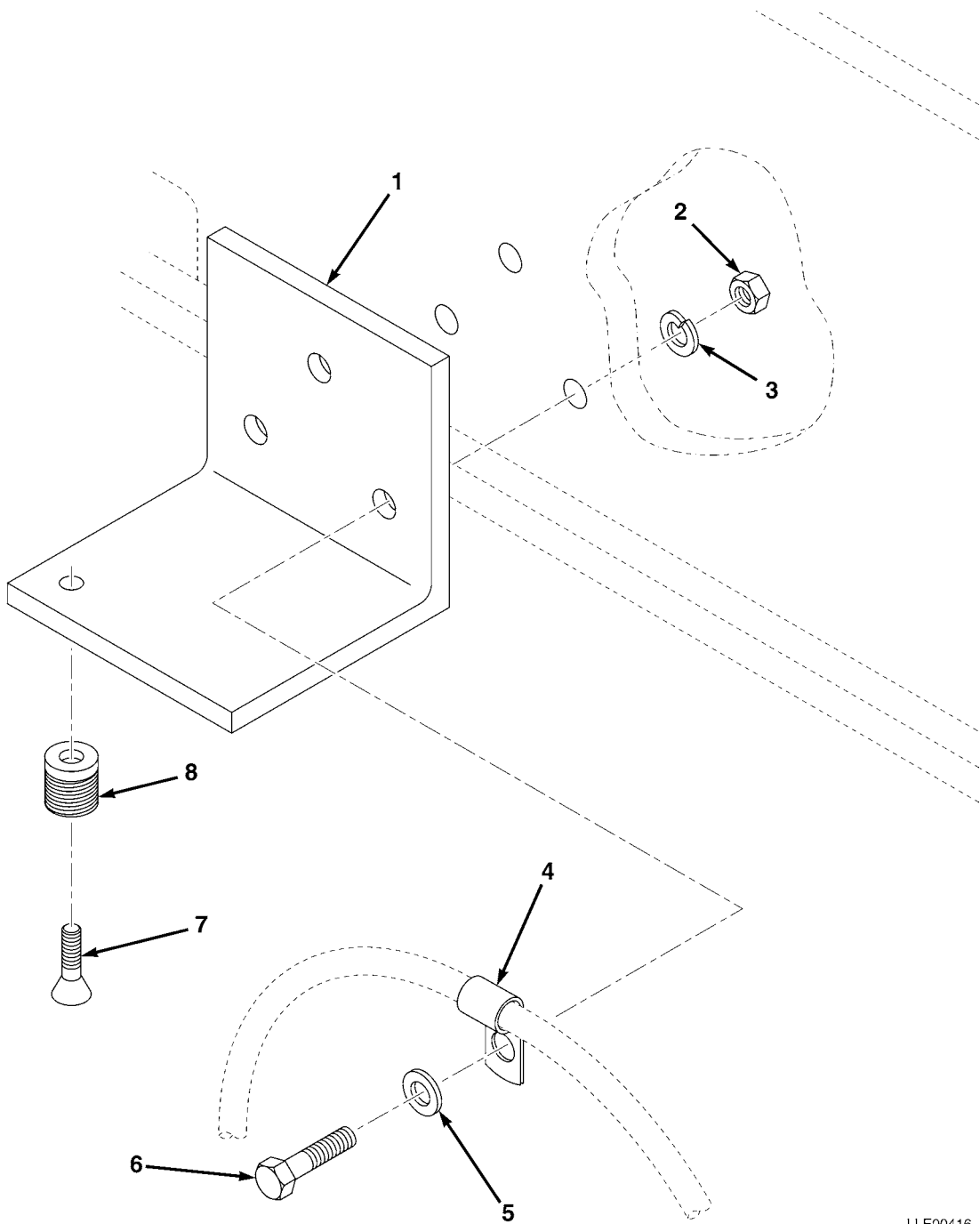
FIG. 33 CONNECTOR HOLDER ASSEMBLY

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC) GROUP 67 PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC GROUP 6712 MOUNTED CONNECTING DEVICES FIG. 33 CONNECTOR HOLDER ASSEMBLY	(6) QTY
1	56009	9837-1624-005	SCR,CAP,HEX,3/8-16 X 1-1/2 IN. (5/PKG)		1
2	56009	0365-3160	BRKT,CLAMP REMOTE BOX MTG		1
3	56009	0792-3910	BRKT,CABLE (RT)		1
	56009	0792-3920	BRKT,CABLE (LT)		1
4	56009	0365-8740	• ANGLE, CABLE		1
5	56009	0790-1980	• BULKHEAD, BLANK, #16		1
6	56009	0790-1990	• BULKHEAD, BLANK, #18 (RT)		2
	56009	0790-1970	• BULKHEAD, BLANK, #14 (LT)		2
7	56009	7121-6006-010	• SCR, 10-32 X 3/8 (10/PKG)		1
8	56009	003847-010	LKWASH,SPLIT 3/8 X 0.68 X 0.09 IN.		4
9	56009	005274	NUT,HEX 3/8-16 IN.		4

END OF FIGURE

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 67 PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC	
				GROUP 6712 MOUNTING CONNECTING DEVICES	
				FIG. 34 MAST MOUNT BASE	
1	56009	0791-1740		ASSEMBLY MAST MOUNT BASE COMPLETE	1
2	56009	0791-1380		• YOKE MAST MOUNT	1
3	56009	0791-1990		• MOUNT,MAST BASE	1
4	56009	2816-4315		• SCR,CAP HEX,5/8-11 X 1.25 IN.	4
5	56009	003857		• LKWASH,SPLIT,5/8 IN.	4
6	56009	9837-2224		• SCR,CAP HEX,3/4-10 X 1.5 IN. STL	2
7	56009	003859-010		• LKWASH,SPLIT,3/4 X 1.27 X 0.19 IN. (10/PKG)	1
8	56009	0791-8820		PLATE,TRACER/MAST MTG	2
9	56009	8319-2212		• SCR,SET CUP,3/4-10 X 0.75 IN., ZNC PLT	2

END OF FIGURE

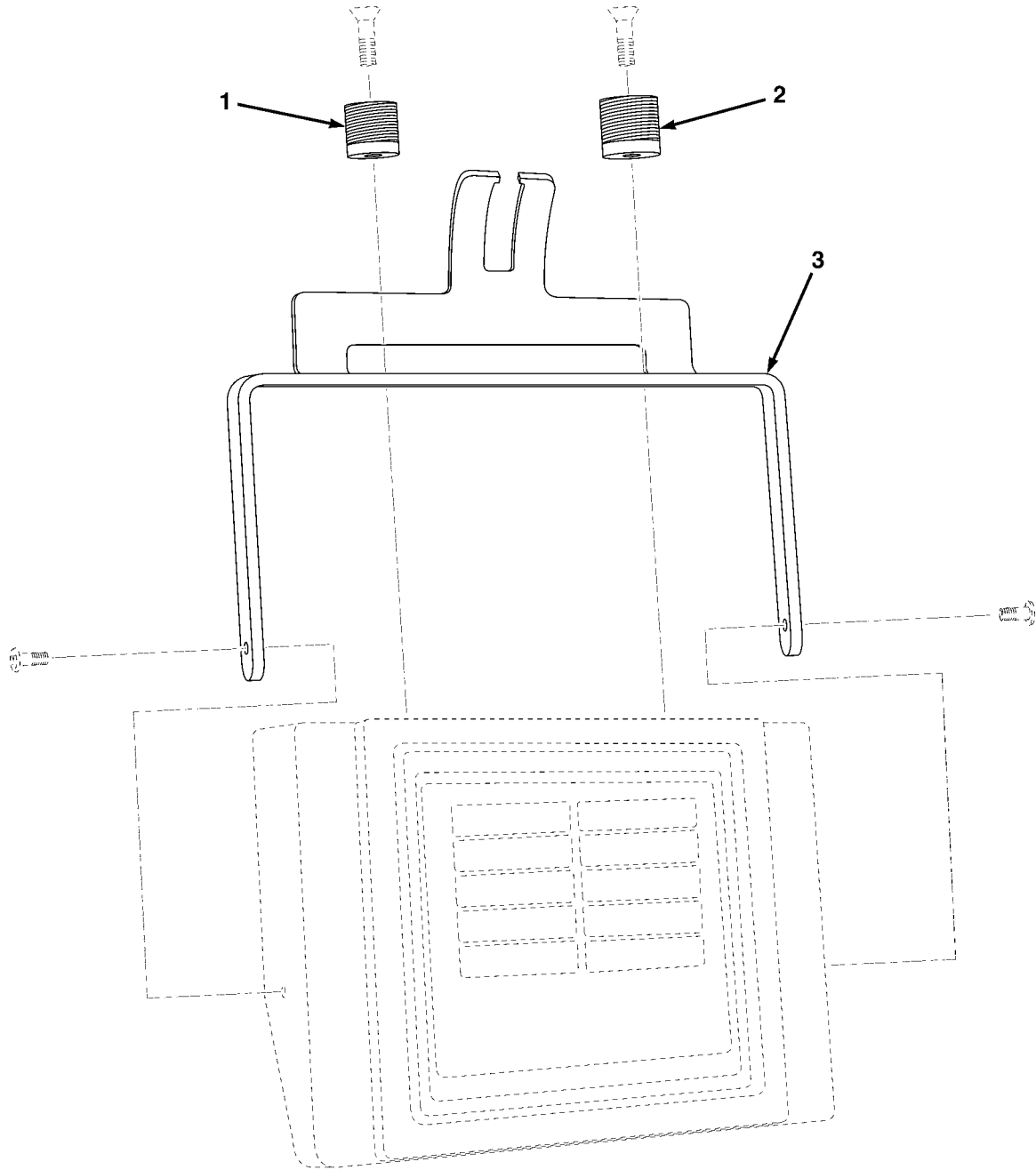


LLE00416

FIG. 35 MAINFALL SLOPE SENSOR BRACKET

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 67 PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC	
				GROUP 6712 MOUNTING CONNECTING DEVICES	
				FIG. 35 MAINFALL SLOPE SENSOR BRACKET	
1	56009	0355-5200	BRKT,MAINFALL SNSR MTG		1
2	56009	005274	NUT,HEX		2
3	56009	003847-010	LKWSHR,SPLIT,3/8 X 0.68 X 0.09 IN. (10/PKG)		2
4	56009	006649	CLAMP,HOSE		1
5	56009	003834-010	WSHR,FL,3/8 X 1 X 0.08 IN.,STL, CD (10/PKG)		2
6	56009	9837-1622-010	SCR,CAP,HEX,3/8-16 X 1 1/4 IN. STL (10/PKG)		2
7	56009	7129-1408-010	SCR,RND,XREC,10-32 X 3/8 IN. (10/PKG)		1
8	56009	0790-1970	HOLDER,CONNECTOR #14		1

END OF FIGURE

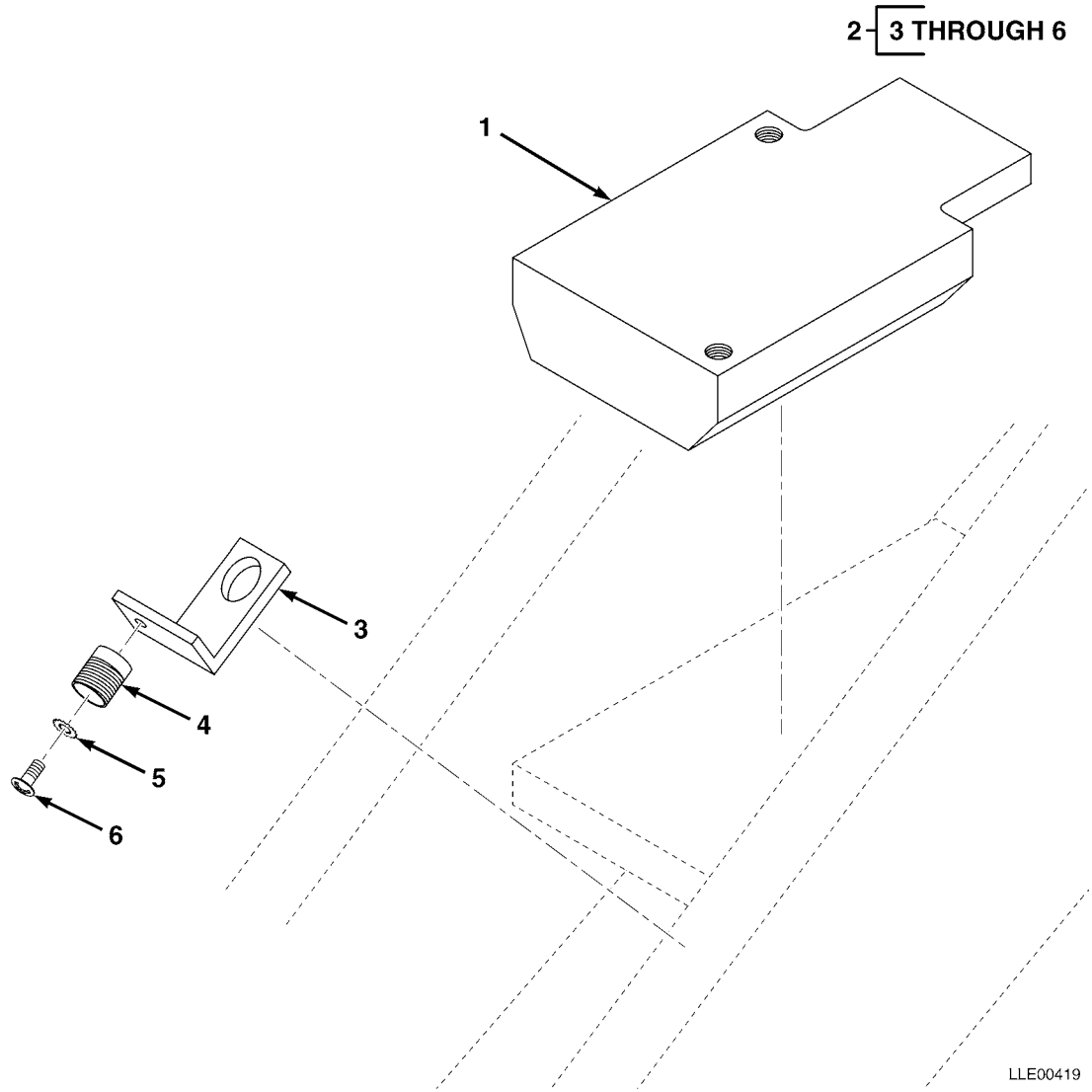


LLE00423

FIG. 36 OPERATOR CONTROL BOX MOUNT

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 67 PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC	
				GROUP 6712 MOUNTING CONNECTING DEVICES	
				FIG. 36 OPERATOR CONTROL BOX MOUNT	
1		56009	0790-1970	HOLDER,CONNECTOR,#14	1
2		56009	0790-1990	HOLDER,CONNECTOR,#18	1
3		56009	0365-5000	MOUNT,OPERATOR CONTROL BOX	1

END OF FIGURE



LLE00419

FIG. 37 BLADE SLOPE SENSOR MOUNT

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 67 PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC	
				GROUP 6712 MOUNTING CONNECTING DEVICES	
				FIG. 37 BLADE SLOPE SENSOR MOUNT	
1		56009	0355-5100	PLATE,SLOPE SNSR MTG	1
2		56009	0792-3930	HOLDER,CONNECTOR	1
3		56009	0355-3140	• BRKT, ARM MOUNTING	1
4		56009	0790-1970	• BULKHEAD, BLANK #14	1
5		56009	2802-0420	• WASHER, EXT-LICK, #10, STL, CD	1
6		56009	7121-6006-010	• SCR, 10-32 X 3/8 IN. (10/PKG)	1

END OF FIGURE

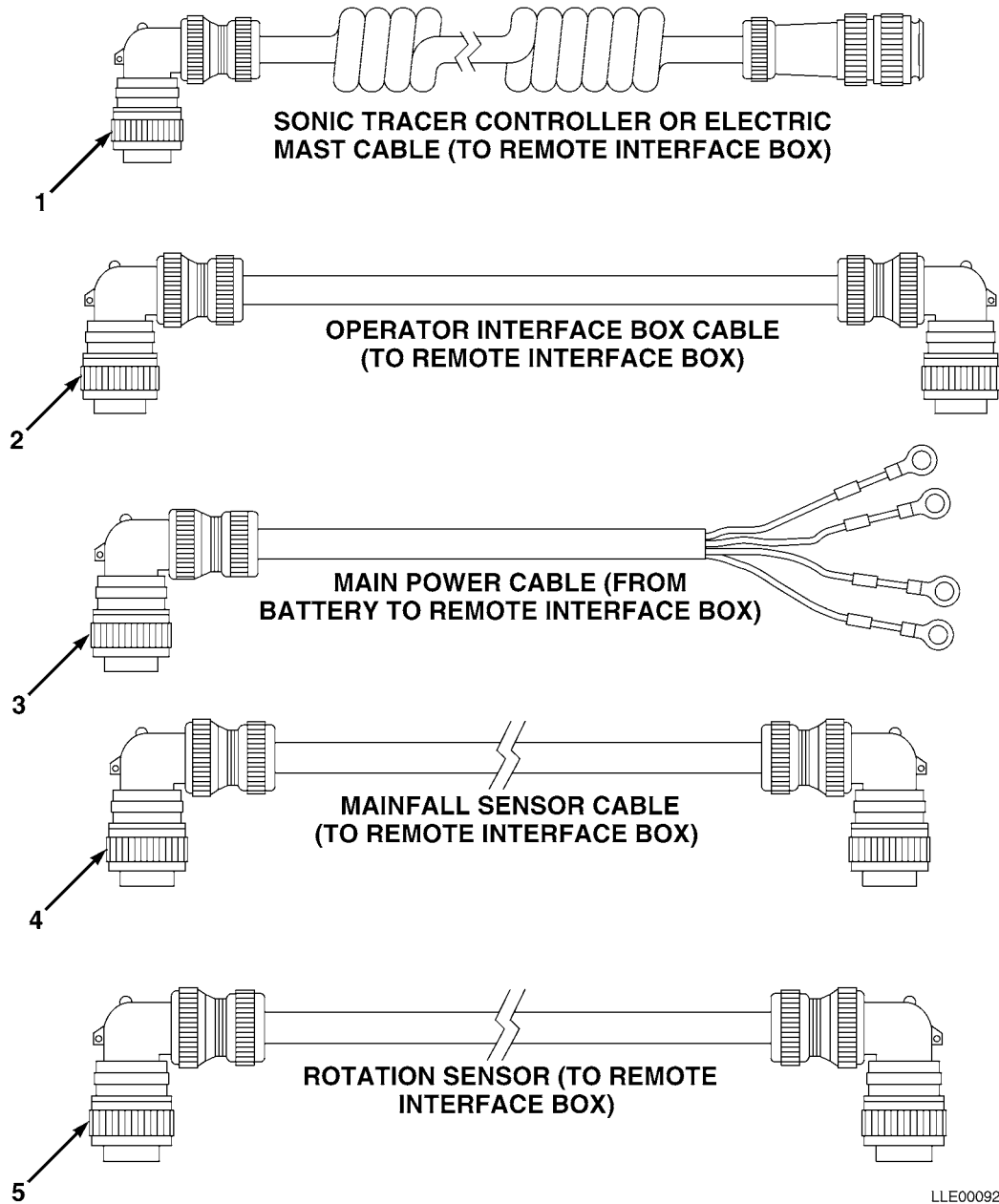
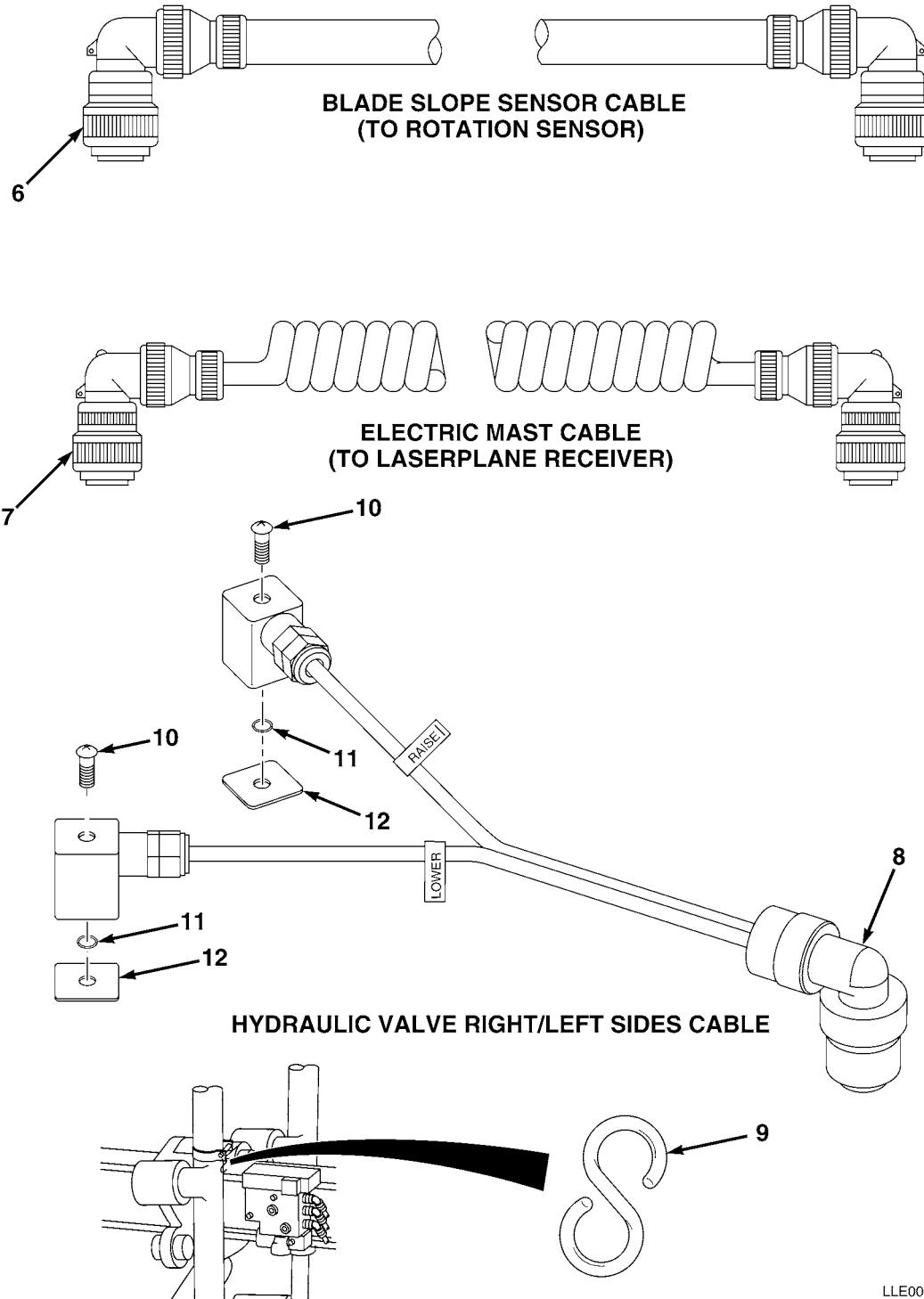


FIG. 38 CABLES AND COIL CORDS (SHEET 1 OF 2)



LLE00093

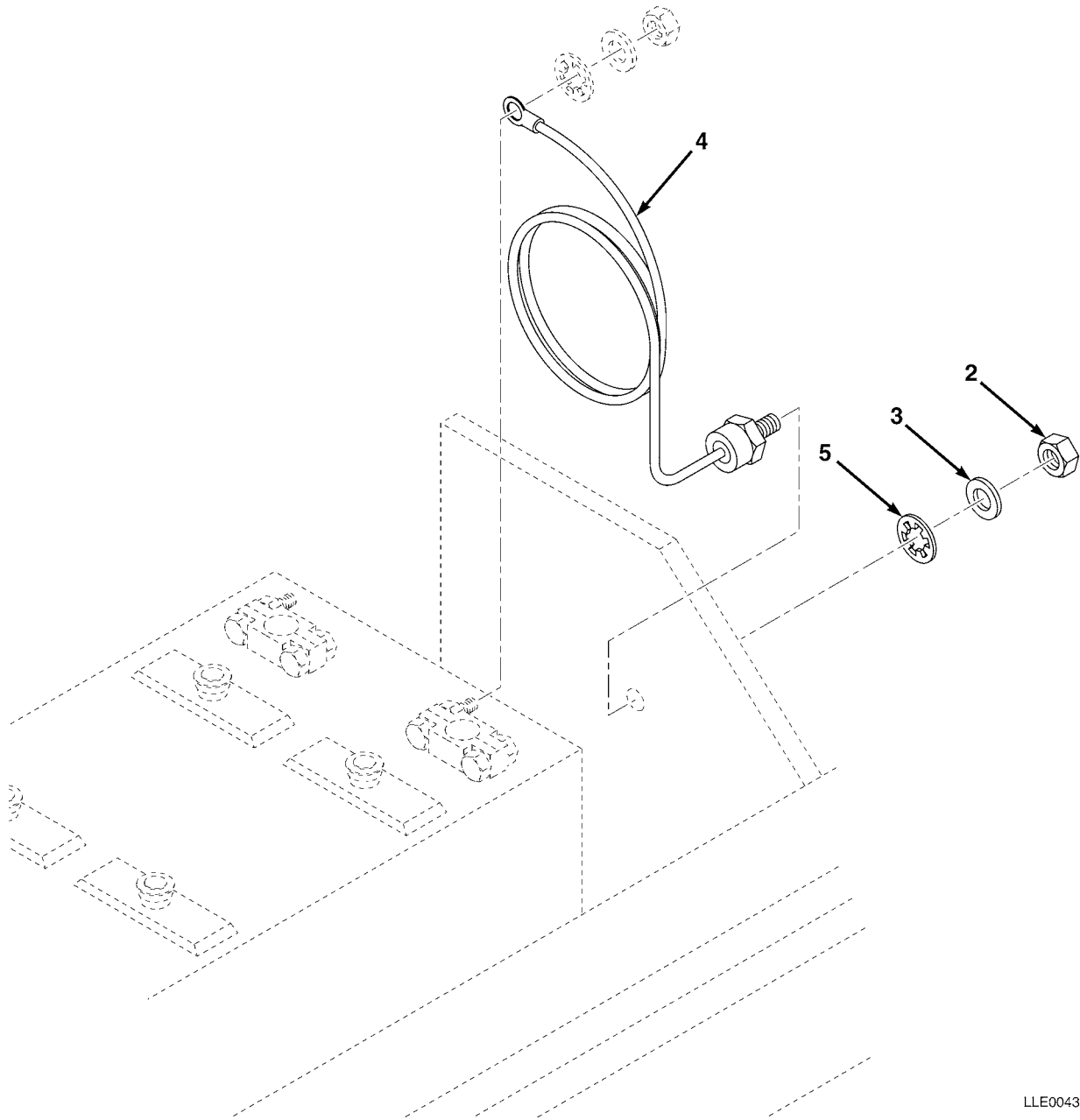
FIG. 38 CABLES AND COIL CORDS (SHEET 2 OF 2)

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
GROUP 67 PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC GROUP 6713 MISCELLANEOUS WIRING AND FITTINGS FIG. 38 CABLES AND COIL CORDS					
1	56009	0790-8700	0790-8700	CABLE,SONIC TRACER CONTROLLER OR ELECTRIC MAST (TO REMOTE INTERFACE BOX)	1
2	56009	0791-5700-150	0791-5700-150	CABLE,OPERATOR (TO REMOTE INTERFACE BOX)	1
3	56009	0791-5710-240	0791-5710-240	CABLE,MAIN POWER (FROM BATTERY TO REMOTE INTERFACE BOX)	1
4	56009	0791-5680-085	0791-5680-085	CABLE,MAINFALL SENSOR (TO REMOTE INTERFACE BOX)	1
5	56009	0791-5690-250	0791-5690-250	CABLE,ROTATION SENSOR (TO REMOTE INTERFACE BOX)	1
6	56009	0790-5590-070	0790-5590-070	CABLE,BLADE SLOPE SNSR (TO ROTATION SNSR)	1
7	56009	0790-9000	0790-9000	CABLE,ELECTRIC MAST (TO LASERPLANE RECEIVER CABLE)	1
8	56009	0792-0360-035	0792-0360-035	CABLE,PROPORTIONAL VALVE	1
	56009	0792-0370-035	0792-0370-035	CABLE,PROPORTIONAL VALVE (NOT SHOWN)	1
9	56009	2509-6870	2509-6870	HOOK,S	2
10	56009	7111-3430	7111-3430	SCREW,CAP M3 X 0.05 MM X 30 MM,SST	2
11	56009	2504-5998-010	2504-5998-010	O-RING,0.101 X 0.07 (10/PKG)	2
12	56009	2504-6025	2504-6025	GASKET,FLAT,SQ	2

END OF FIGURE

SUBSECTION C - BUCKET-PRO™

1-2 THROUGH 5



LLE00436

FIG. 39 HYEX VOLTAGE PROTECTION CABLE

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 06 ELECTRICAL SYSTEM	
				GROUP 0606 ENGINE SAFETY CONTROLS	
				FIG. 39 HYEX VOLTAGE PROTECTION CABLE	
1	56009	121022		KIT,VOLTAGE PROTECTION	1
2	56009	005274		• NUT,HEX,3/8-16 IN.	1
3	56009	003834-010		• WSHR,FL,3/8 X 1.08 IN. (10/PKG)	1
4	56009	221089		• CABLE,VOLTAGE PROTECTION	1
5	56009	2802-1010		• LKWASH,INTERNAL,3/8 IN.	1

END OF FIGURE

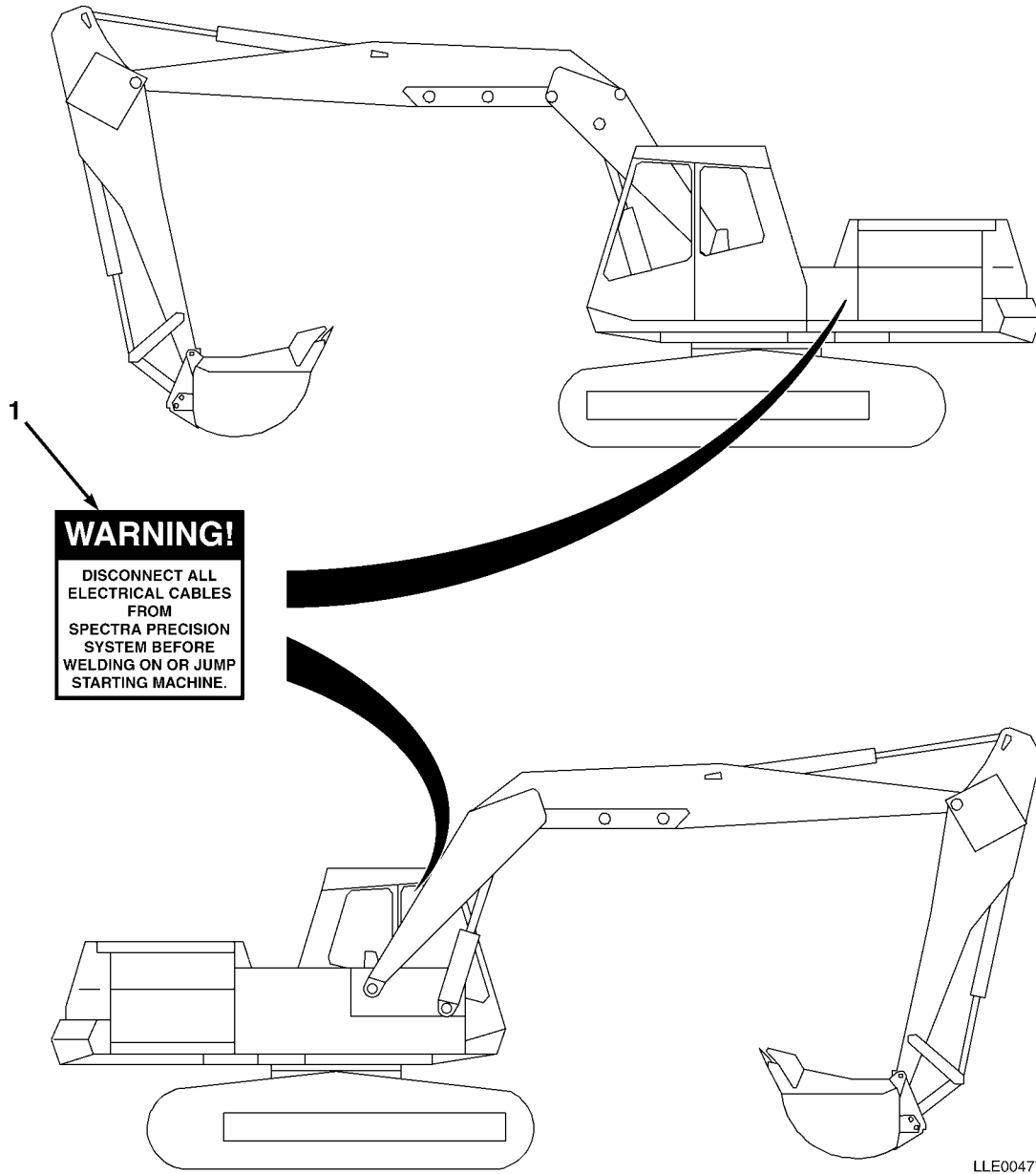
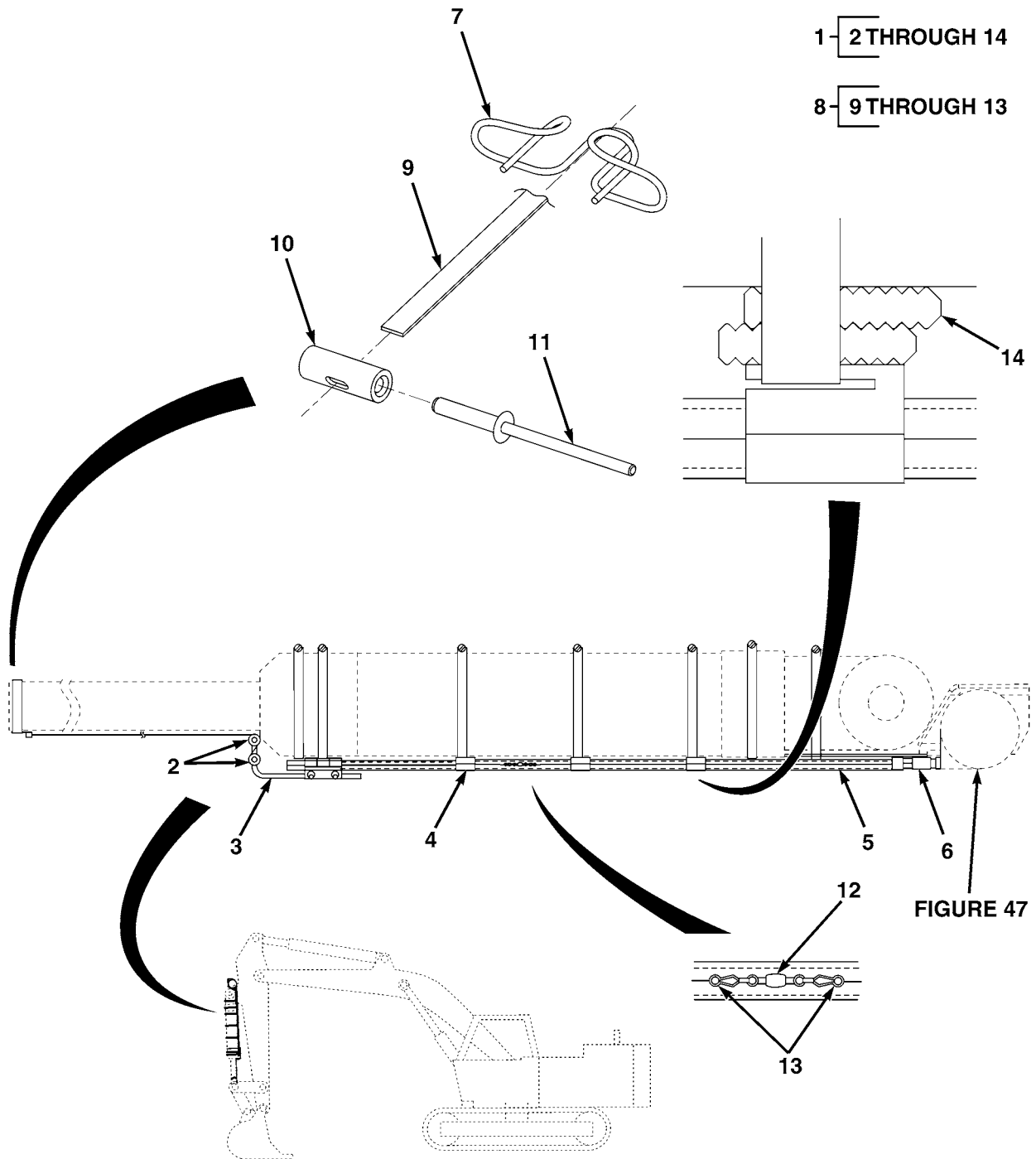


FIG. 40 BUCKET-PRO™ DECALS AND INSTRUCTION PLATES

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 22 BODY CHASSIS OR HULL, AND ACCESSORY ITEMS	
				GROUP 2210 DATA PLATES AND INSTRUCTION HOLDERS	
				FIG. 40 BUCKET-PRO™ DECALS AND INSTRUCTION PLATES	
1		56009	111741	LABEL, WARNING, WELDING	2

END OF FIGURE



LLE00096

FIG. 41 BUCKET CYLINDER BELT SYSTEMS

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 35 PULLEYS, BELTS, SHAFTS	
				GROUP 3501 PULLEYS, BELTS, SHAFTS	
				FIG. 41 BUCKET CYLINDER BELT SYSTEMS	
1	56009	0389-0710		KIT, FLAT BELT DELIVERY	1
2	56009	0389-3060		• SWIVEL, RUNNERS	2
3	56009	0389-2110		• ROD, GUIDE	1
4	56009	0389-3240		• CLIP, POLY TUBE	3
5	56009	3239-0001		• TUBING, POLY 1/2 IN. O.D. X 0.062 IN. BLK .	1
6	56009	0389-3200		• ADPTR, POLY TUBE	3
7	56009	0389-3110		• CLIP, BELT	1
8	56009	0389-0720		• KIT, BELT, BUCKET PRO	1
9	56009	0389-3040		•• BELT ASSY, FLAT	1
10	56009	0389-3130		•• STOP, BELT	2
11	56009	2808-0959		•• RIVET, POP DOME	2
12	56009	2509-7055		•• FASTENER, SWIVEL	2
13	56009	2509-7048		•• CLIP, SPEED	4
14	56009	0389-3300		• WEDGE, RISER	5

END OF FIGURE

1-2 THROUGH 5

FIGURE 41

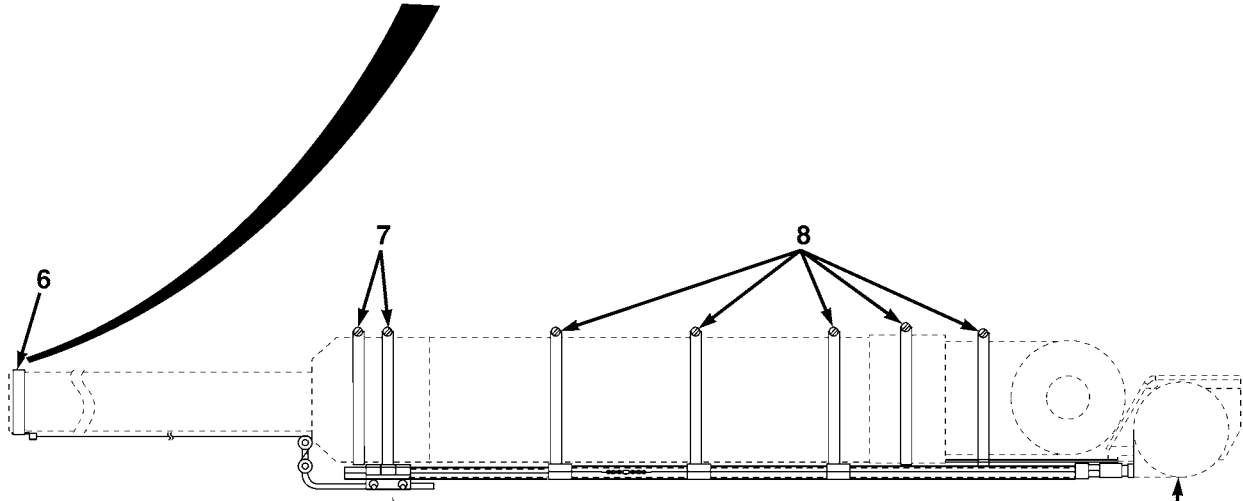
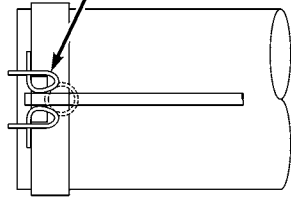
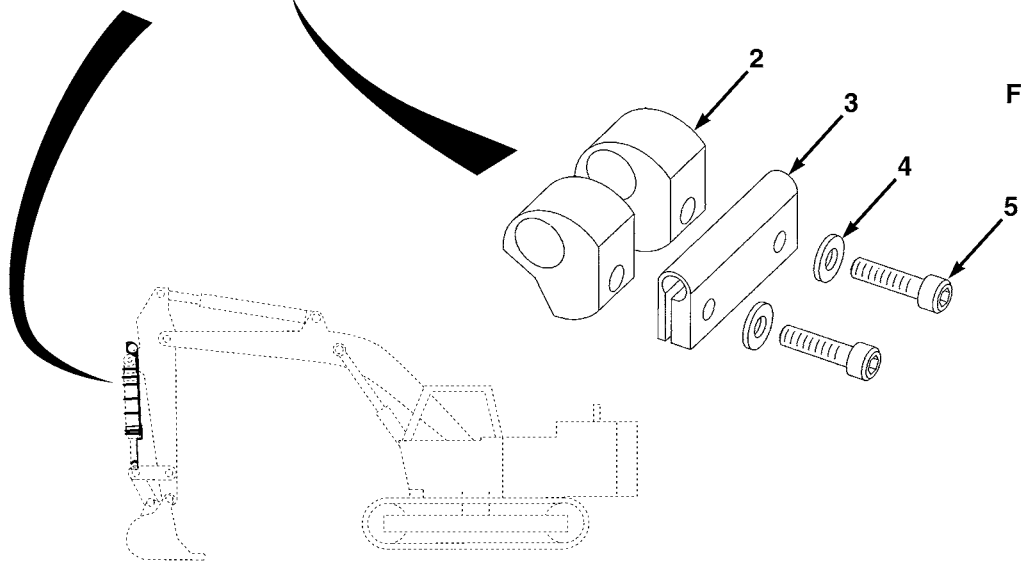


FIGURE 47

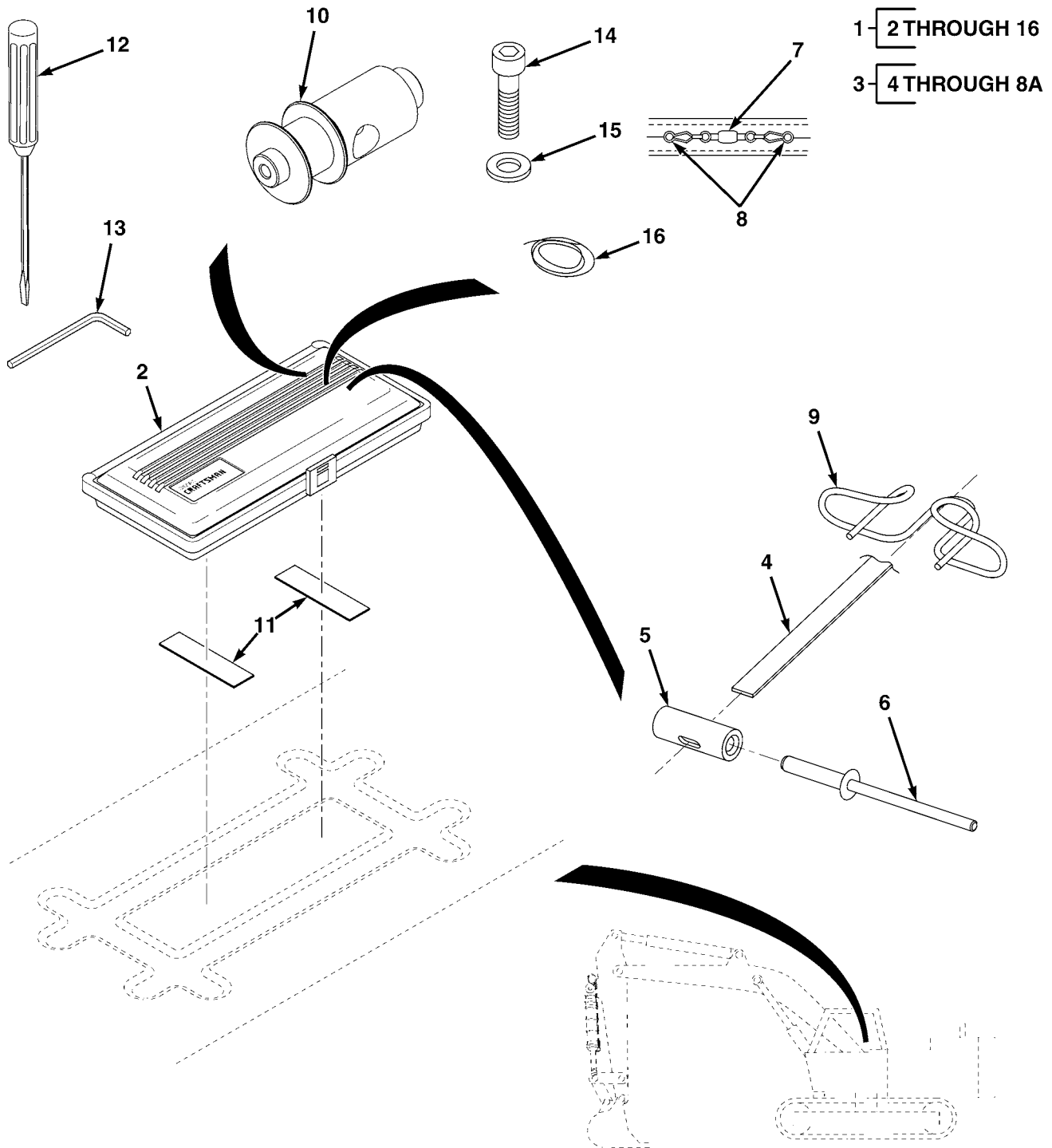


LLE00707

FIG. 42 BUCKET CYLINDER BELT SYSTEM ACCESSORY

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 35 PULLEYS, BELTS, SHAFTS	
				GROUP 3501 PULLEYS, BELTS, SHAFTS	
				FIG. 42 BUCKET CYLINDER BELT SYSTEM ACCESSORY	
1	56009	0389-3030	BRACKET ROD, GUIDE		1
2	56009	0389-3320	•• STAND, POLY TUBE		1
3	56009	0389-1060	•• CLAMP, PULLEY TUBE		1
4	56009	2801-0040	•• WASHER, FLAT, SST, 10-24		2
5	56009	8201-1012	•• SCR, SOCKET, CAP 10-24 X 3/4 IN.		2
6	56009	2818-0910	• CLAMP,HOSE		1
7	56009	2818-0906	• CLAMP,HOSE		2
8	56009	2818-0907	• CLAMP,HOSE		5

END OF FIGURE

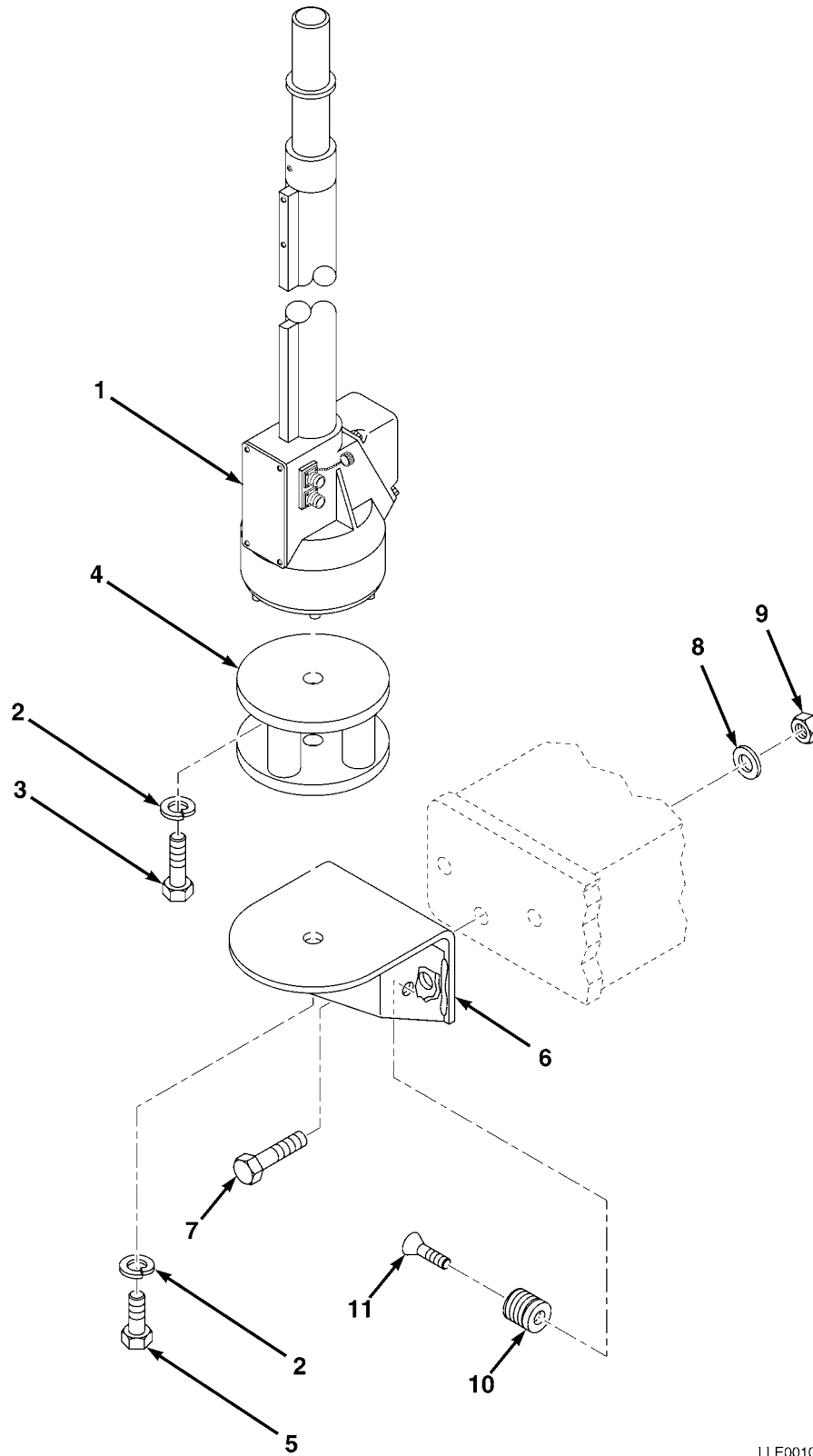


LLE00706

FIG. 43 BUCKET CYLINDER BELT SYSTEM TOOL BOX

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 35 PULLEYS, BELTS, SHAFTS	
				GROUP 3501 PULLEYS, BELTS, SHAFTS	
				FIG. 43 BUCKET CYLINDER BELT SYSTEM TOOL BOX	
1		56009	0389-9000	BELT SYSTEM,BOX,TOOL	1
2		56009	1402-0164	• CASE, BUCKET PRO TOOL KIT	1
3		56009	0389-0720	• KIT, BELT BUCKET PRO	1
4		56009	0389-3040	•• BELT ASSY, FLAT	1
5		56009	0389-3130	•• STOP,BELT	2
6		56009	2808-0959	•• RIVET, POP DOME	2
7		56009	2509-7055	•• FASTENER, SWIVEL	2
8		56009	2509-7048	•• CLIP, SPEED	4
9		56009	0389-3110	• CLIP,BELT	1
10		56009	0389-3060	• SWIVEL, RUNNERS	2
11		56009	0389-0710	• ADHESIVE,BACKING,TOOL BOX	1
12		56009	5401-1555	• SCREWDRIVER, FLAT 1/4 X 1 1/4 IN.	1
13		56009	5401-1560	• WRENCH, HEX, ALLEN 5/32 IN.	1
14		56009	8201-1012	• SCR, CAP, SOCKET, SST 10-24 X 3/4 IN. ...	4
15		56009	2801-0040	• WASHER, FLAT, SST, 10-24	4
16		56009	005203	• WIRE, SAFETY, SS, 15 FT.	1

END OF FIGURE

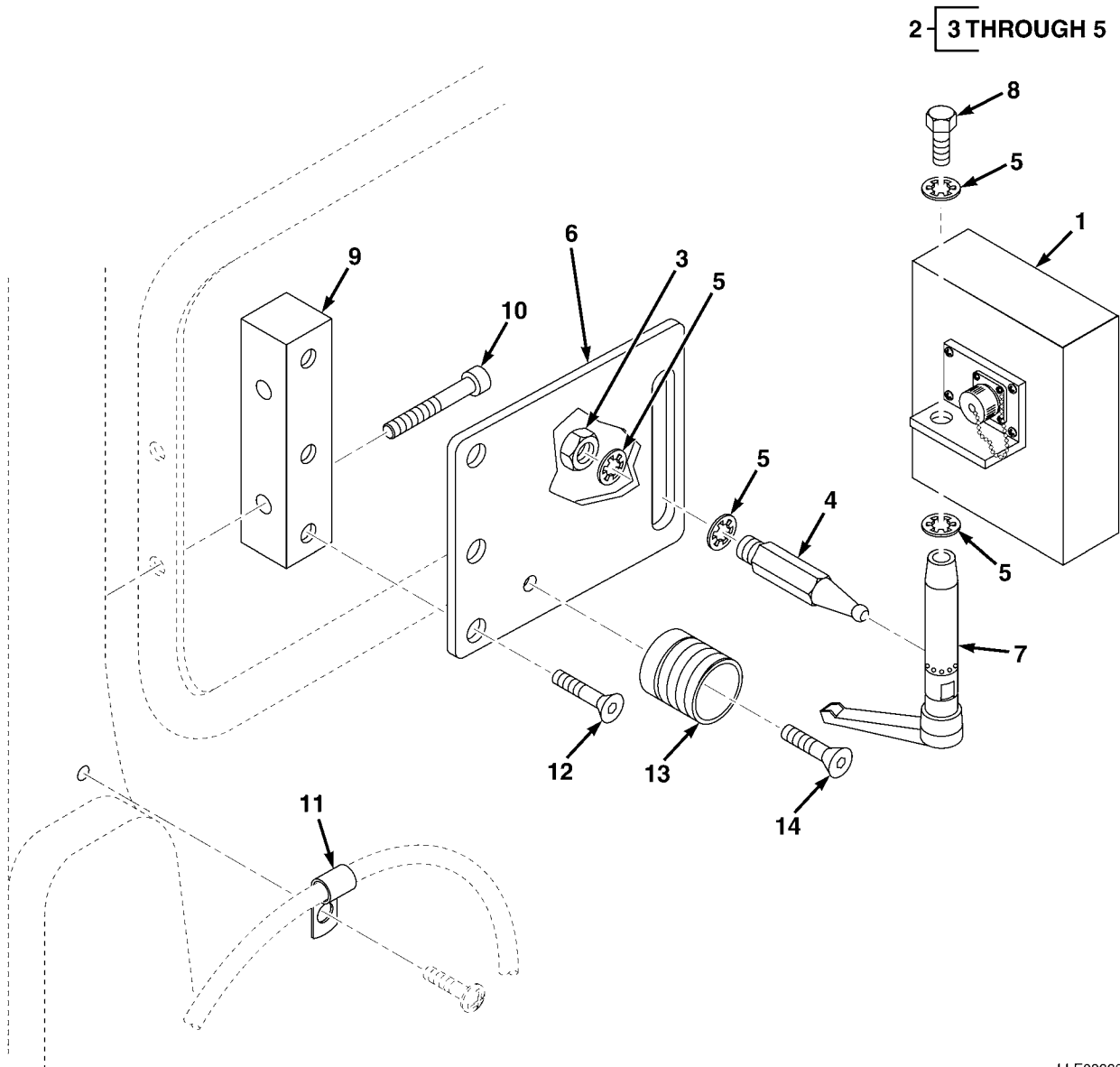


LLE00101

FIG. 44 ELECTRICAL MAST ASSEMBLY

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 67 PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC	
				GROUP 6709 ANTENNA, GROUNDS, AND RELATED EQUIPMENT	
				FIG. 44 ELECTRICAL MAST ASSEMBLY	
1	56009		EM2E-24	ELECTRIC MAST-ENG,24V	1
2	56009		003859-010	• LKWSHR,SPLIT,0.75 X 1.27 X 0.19 IN. (10/PKG)	1
3	56009		010185-005	• SCR,CAP,HEX 0.75-16 X 1.5 IN. (5/PKG)	1
4	56009		0389-0660	MAST,SHOCK,MOUNT	1
5	56009		003755	• SCR,FL,SKT 5-13 X 0.75 IN. STL (5/PKG)	1
6	56009		0389-0890	BRKT,MAST MTG	1
7	56009		9837-1826	• SCR,CAP,HEX, 1/2-13 X 1 3/4 IN.,STL	3
8	56009		003836	• WSHR,FL,0.562 X 0.375 X 0.109 IN.,STL,CD (10/PKG)	1
9	56009		004964	• NUT,HEX,1/2-13 X 0.75 X 0.44 IN. (10/PKG)	1
10	56009		7129-1408-010	• SCREW, RND X REC 10-32 X 3/8 IN. (10/PKG)	1
11	56009		0790-1990	• CANNON PLUG,BLANK	1

END OF FIGURE

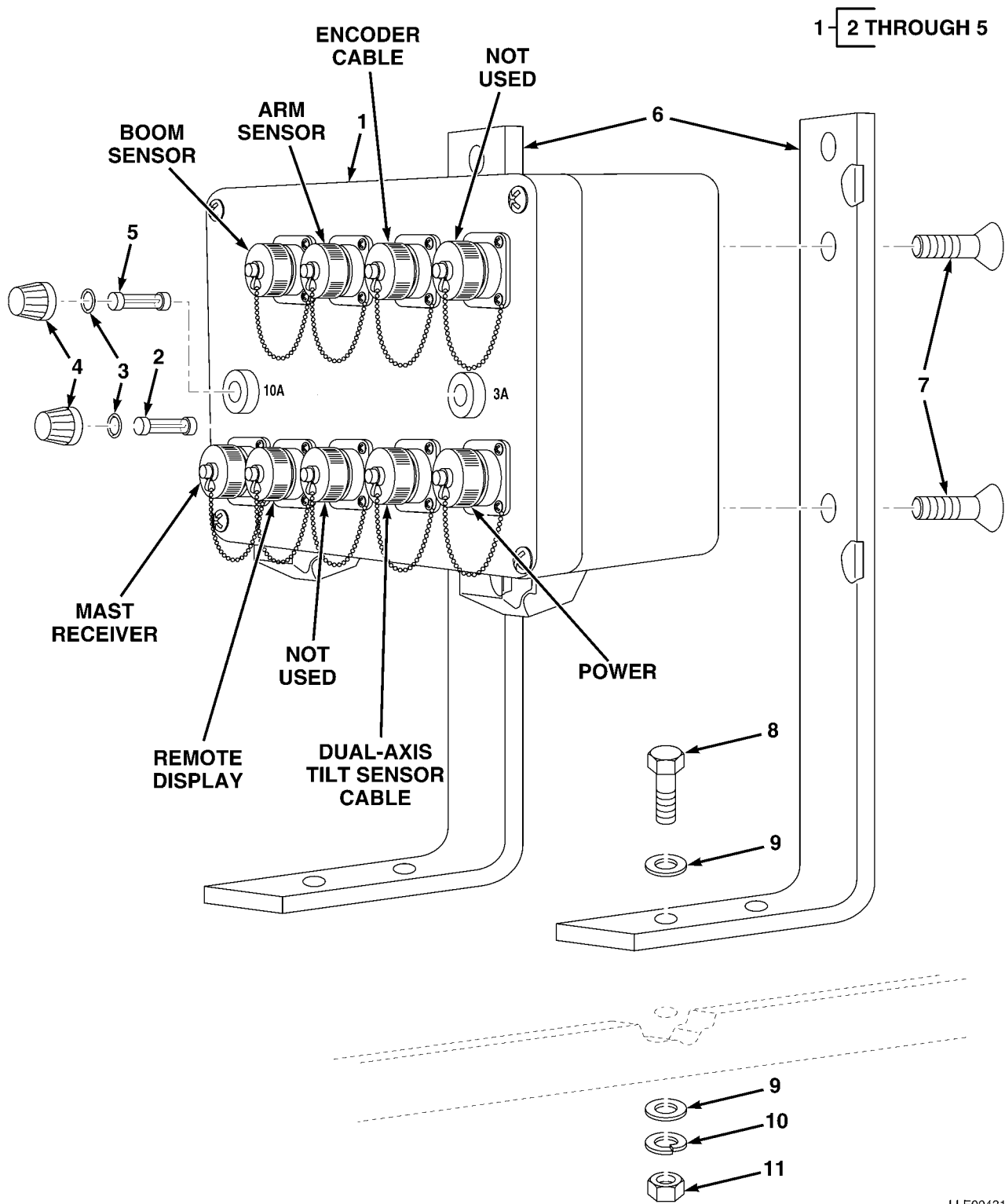


LLE00099

FIG. 45 GRAPHIC DISPLAY

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 67 PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC	
				GROUP 6711 CONTROLS, INDICATORS, AND SPECIAL COMPONENTS	
				FIG. 45 GRAPHIC DISPLAY	
1	56009	0389-2020	0389-2020	DISPLAY GRAPHICAL OPERATOR	1
2	56009	0389-0310	0389-0310	DISPLAY BRCKT ASSY	1
3	56009	011860	011860	• NUT,1/2-20 X 3/4 X 0.32 IN. SST	1
4	56009	0389-0220	0389-0220	• BALL,DISPLAY MOUNT SWIVEL	1
5	56009	2802-1010	2802-1010	• LKWASH,INTERNAL 1/2 X 0.86 X 0.035 IN.	4
6	56009	0260-2870	0260-2870	BRKT,MPLC MTG	1
7	56009	0389-2010	0389-2010	RATCHETING HANDLE ASSY	1
8	56009	011860	011860	BOLT,1/2-20 X 3/4 IN.	1
9	56009	0389-6350	0389-6350	BLOCK,BRACKET	1
10	56009	8202-4025	8202-4025	SCREW,CAP	2
11	56009	8221-1410	8221-1410	CLAMP,LOOP	2
12	56009	006648	006648	SCREW	3
13	56009	0790-1990	0790-1990	HOLDER,CONNECTOR	1
14	56009	7129-1408	7129-1408	SCREW	1

END OF FIGURE



LLE00431

FIG. 46 REMOTE INTERFACE BOX

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 67 PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC	
				GROUP 6711 CONTROLS, INDICATORS, AND SPECIAL COMPONENTS	
				FIG. 46 REMOTE INTERFACE BOX	
1		56009	0389-1000	REMOTE INTERFACE BOX	1
2		56009	5101-0170	• FUSE,AGC 3 AMP,250V	1
3		56009	011023	• SEAL,FUSE CAP	1
4		56009	010716	• FUSE CAP	1
5		56009	003378	• FUSE,AGC 10 AMP	1
6		56009	0389-7240	BRKT,REM BOX MTG.BUCKET-PRO™	2
7		56009	8822-1620	SCR,FL HF SOC,3/8-16 X 1	4
8		56009	9837-1620-010	SCR,CAP,HEX 3/8-16 X 1	4
9		56009	003834-010	WSHR,FL,3/8 X 1.08 IN. (10/PKG)	8
10		56009	003847-010	LKWSHR,SPLIT,3/8 X 0.68 X 0.09,STL,CD (10/PKG)	4
11		56009	005274	NUT,HEX 3/8-16 X 0.56 X 0.33,STL,CD	4

END OF FIGURE

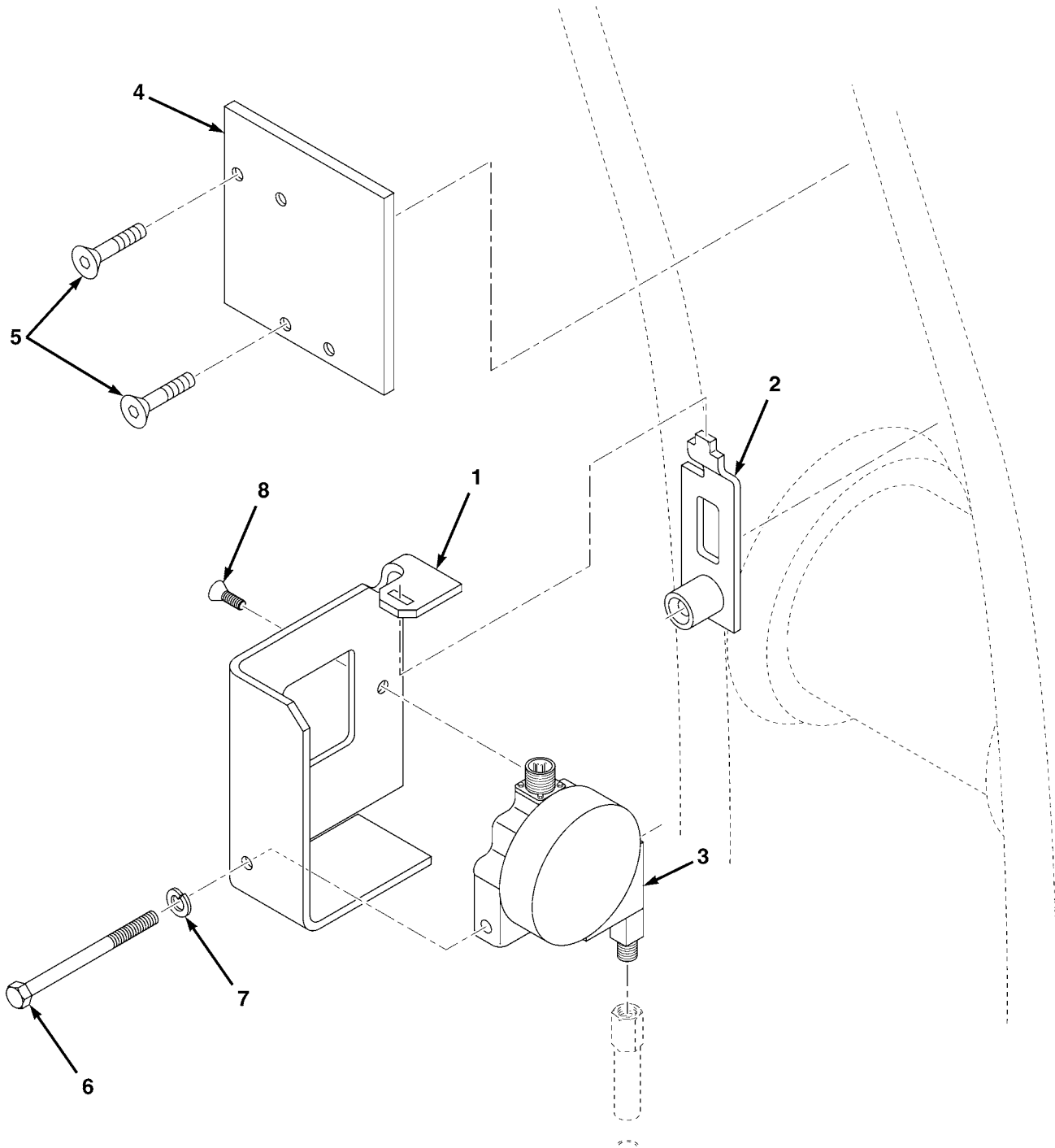
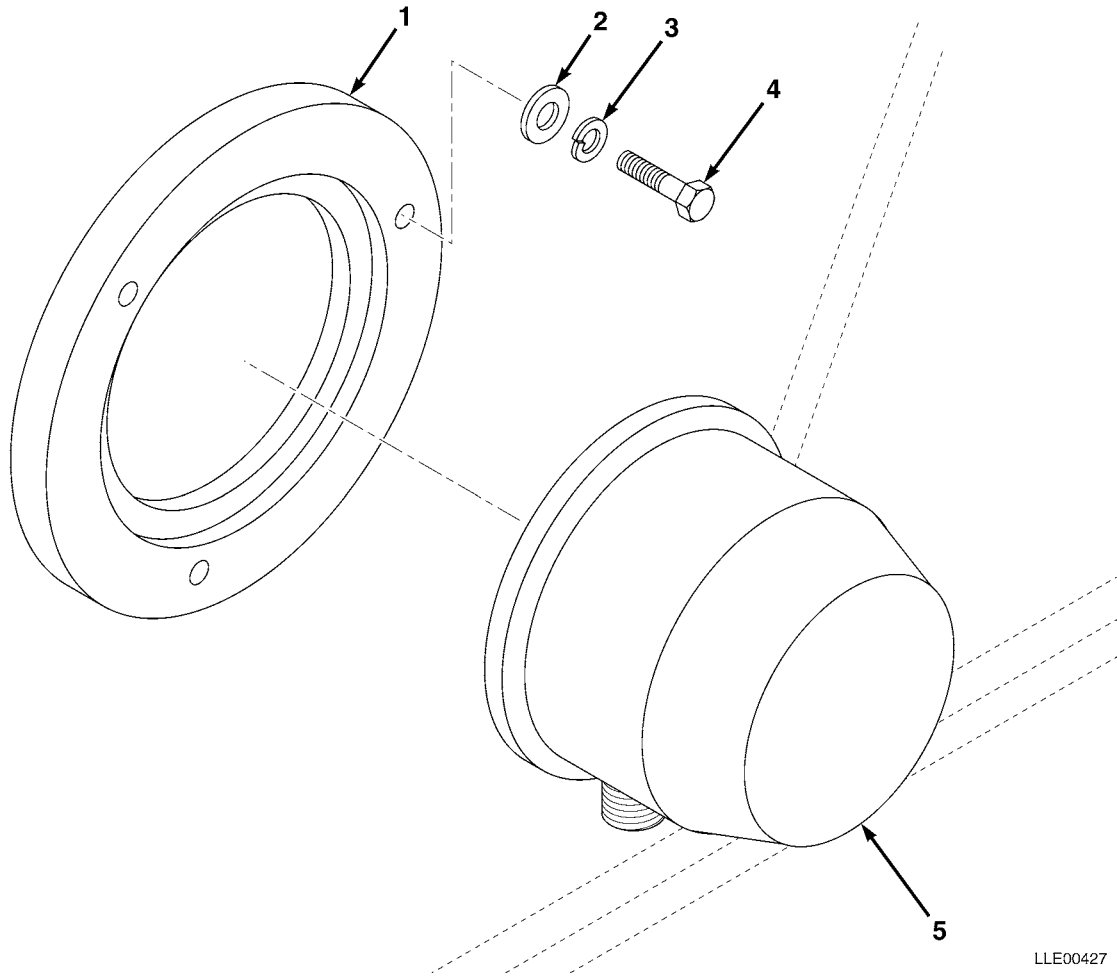


FIG. 47 CABLE ENCODER

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 67 PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC	
				GROUP 6711 CONTROLS, INDICATORS AND SPECIAL COMPONENTS	
				FIG. 47 CABLE ENCODER	
1	56009		0389-3410	BRKT, ENCDR MTG	1
2	56009		0389-3270	BRKT, WELDED, ENCODER	1
3	56009		0389-5020	ENCODER	1
4	56009		0389-6380	PLATE, ADAPTER, BUCKET VALVE	1
5	56009			SCR, FL HF SOC, 3/8-16 X 1	2
6	56009	9839-1656-005		BOLT, CAP, HEX, 3/8-16 X 4-3/4 IN., STL	1
7	56009		003857	LKWASH, SPLIT, 5/8 IN.	1
8	56009		8822-1620	SCR, FL HF SOC, 3/8-16 X 1	2

END OF FIGURE

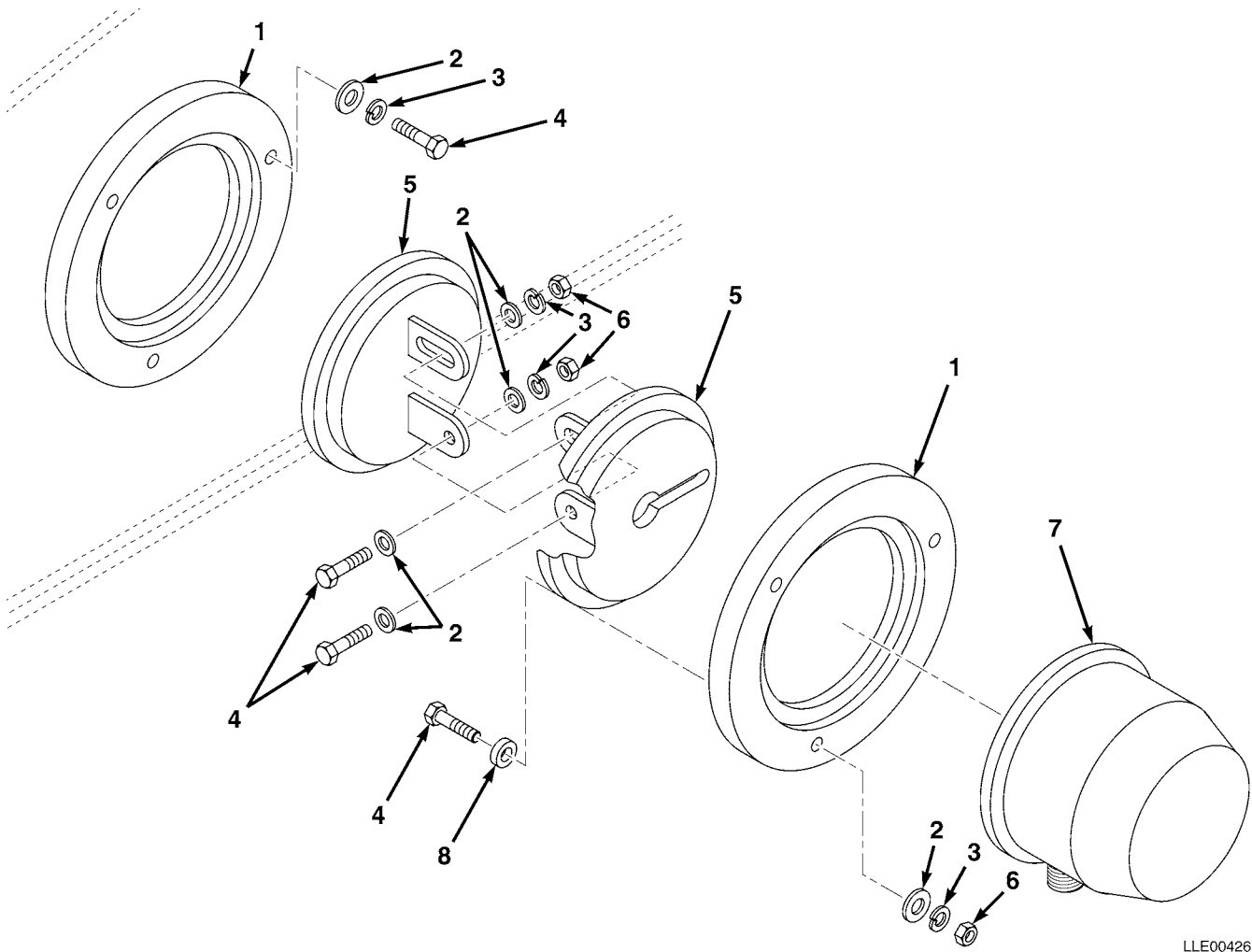


LLE00427

FIG. 48 ARM SENSOR

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 67 PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC	
				GROUP 6711 CONTROLS, INDICATORS AND SPECIAL COMPONENTS	
				FIG. 48 ARM SENSOR	
1	56009	0389-4400		RING,MTG,ARM SENSOR	1
2	56009	003834-010		WSHR,FL,3/8 X 1.08 IN. (10/PKG)	3
3	56009	003847-010		LKWSHR,SPLIT 3/8 X 0.68 X 0.09 IN., STL, CD (10/PKG)	3
4	56009	004870		SCR,CAP 3/8-16 X 1/2	3
5	56009	0389-1840		ARM SENSOR SW ASSY	1

END OF FIGURE

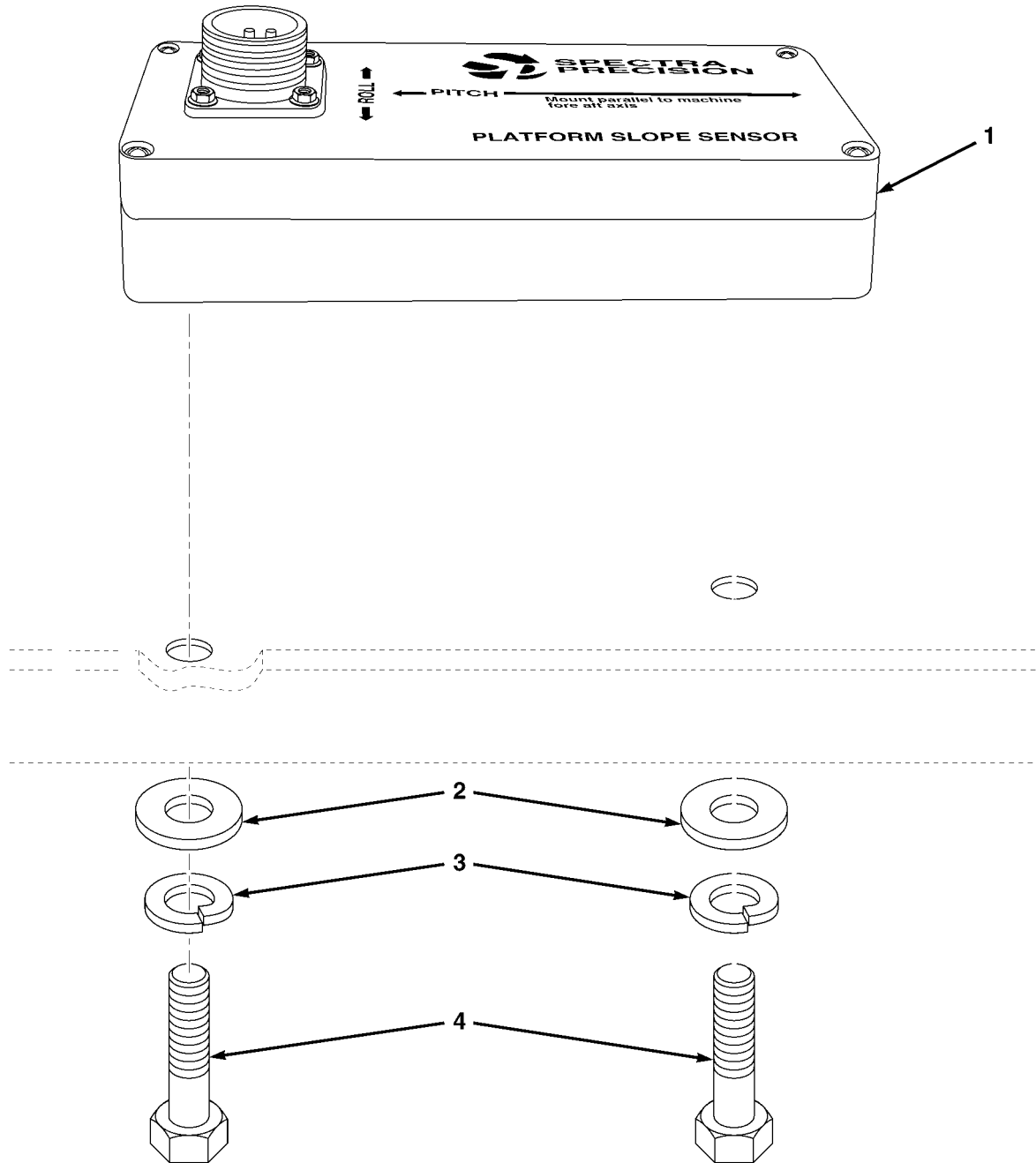


LLE00426

FIG. 49 BOOM PENDULOUS ANGLE SENSOR

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 67 PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC	
				GROUP 6711 CONTROLS, INDICATORS AND SPECIAL COMPONENTS	
				FIG. 49 BOOM PENDULOUS ANGLE SENSOR	
1		56009	0389-4400	RING,MTG, BOOM SENSOR	2
2		56009	003834-010	WSHR,FL,3/8 X 1.08 IN. (10/PKG)	8
3		56009	003847-010	LKWSHR,SPLIT 3/8 X 0.68 X 0.09 IN., STL, CD (10/PKG)	8
4		56009	004870	SCR,CAP 3/8-16 X 1/2	8
5		56009	0389-1840	BOOM SENSOR SW MOUNT	2
6		56009	005275	NUT,HEX 3/8-16	5
7		56009	0389-3000	SENSOR,BOOM	1
8		56009	0389-1810	SPACER	3

END OF FIGURE

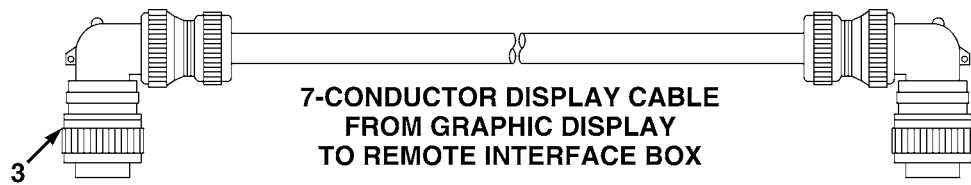
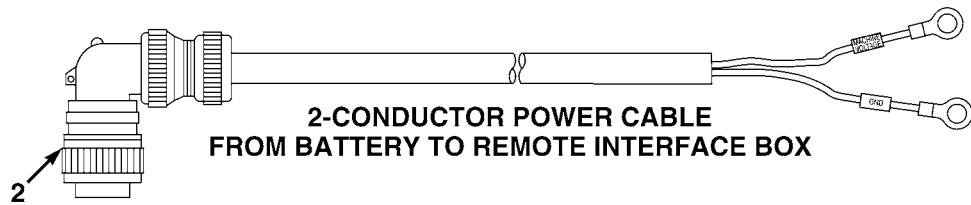
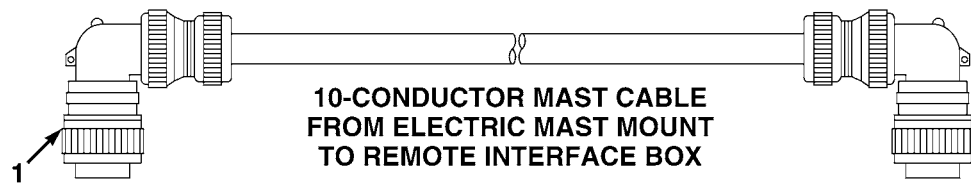


LLE00430

FIG. 50 DUAL AXIS SENSOR

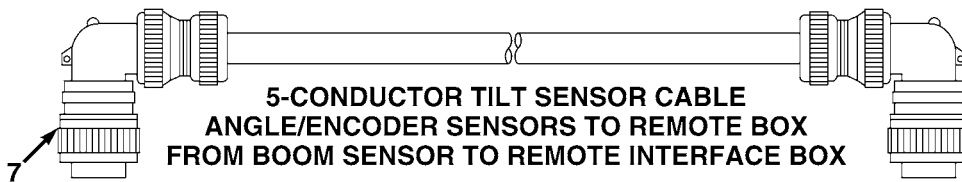
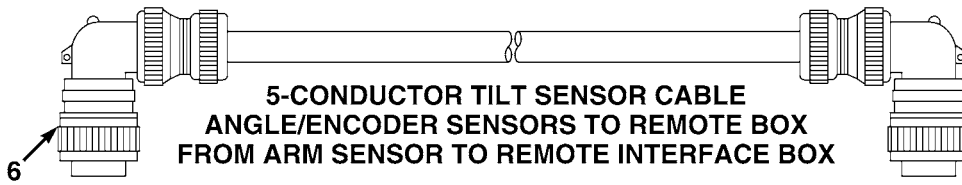
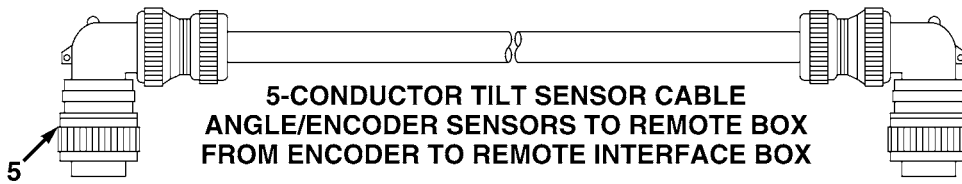
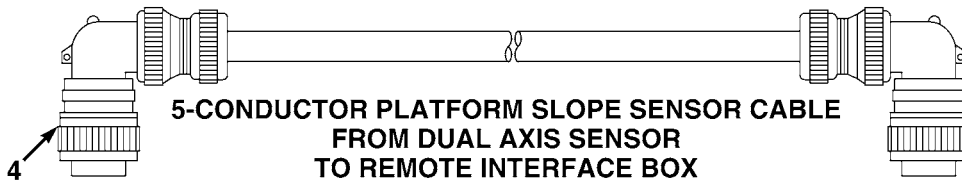
(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 67 PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC	
				GROUP 6711 CONTROLS, INDICATORS AND SPECIAL COMPONENTS	
				FIG. 50 DUAL AXIS SENSOR	
1		56009	0389-4000	SENSOR,SLOPE	1
2		56009	003831-010	WASHER,FLAT 1/4 X 0.73 X 0.06,STL	2
3		56009	003851-010	WASHER,SPLIT 5/16 X 0.59 X 0.08,STL,CD (10/PKG)	2
4		56009	9837-1420	SCREW,HEX 1/4-20 X 1	2

END OF FIGURE



LLE00095

FIG. 51 BUCKET-PRO™ ELECTRICAL CABLES (SHEET 1 OF 2)



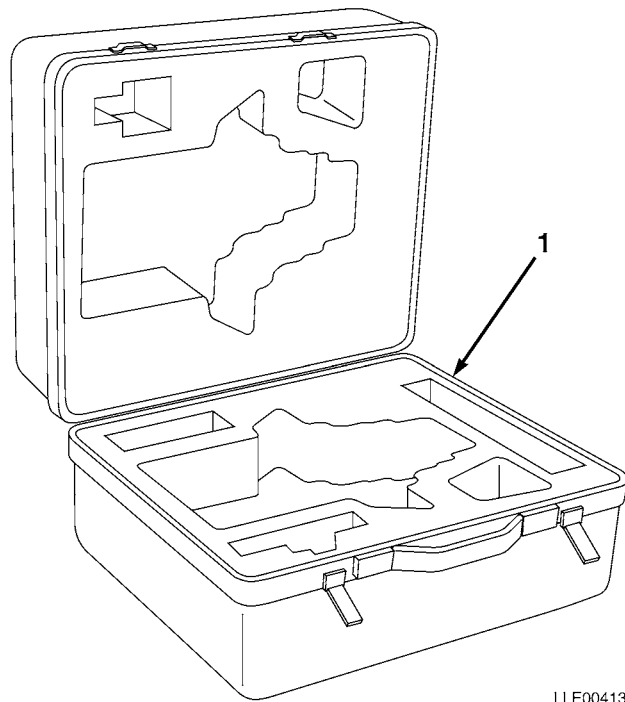
LLE00420

FIG. 51 BUCKET-PRO™ ELECTRICAL CABLES (SHEET 2 OF 2)

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 67 PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC	
				GROUP 6713 MISCELLANEOUS WIRING AND FITTINGS	
				FIG. 51 BUCKET-PRO™ ELECTRICAL CABLES	
1		56009	0792-4250-150	CABLE,10-CONDUCTOR,MAST	1
2		56009	0792-4300-050	CABLE,2-CONDUCTOR,POWER	1
3		56009	0792-4200-150	CABLE,7-CONDUCTOR,DISPLAY	1
4		56009	0792-4100-020	CABLE,4-CONDUCTOR,PLATFORM SLOPE SENSOR	1
5		56009	0792-4150-450	CABLE,4-CONDUCTOR,BUCKET	1
6		56009	0792-4150-400	CABLE,4-CONDUCTOR,ARM	1
7		56009	0792-4150-150	CABLE,4-CONDUCTOR,BOOM	1

END OF FIGURE

SUBSECTION D - TRANSMITTER



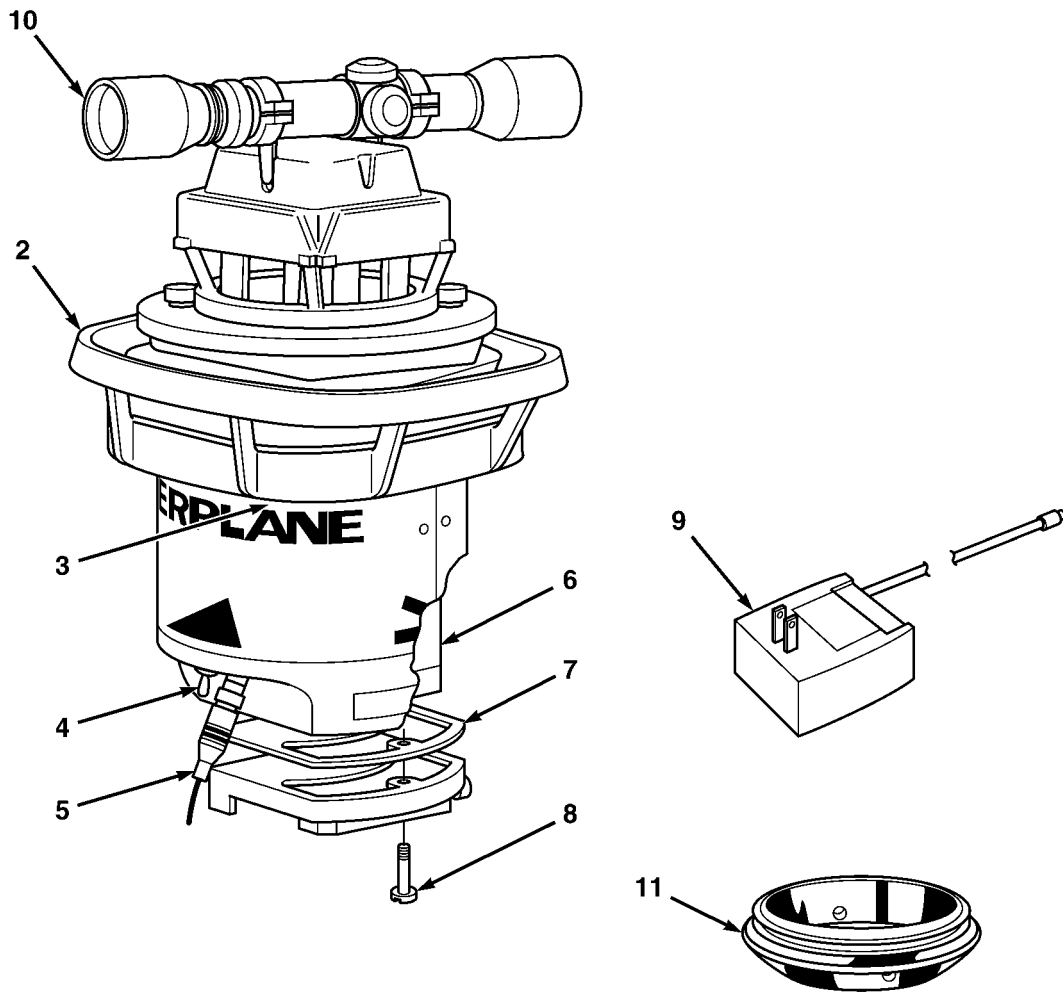
LLE00413

FIG. 52 1145-2 LASER TRANSMITTER CARRYING CASE

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 06 ELECTRICAL SYSTEM	
				GROUP 0612 CARRYING CASE	
				FIG. 52 1145-2 LASER TRANSMITTER CARRYING CASE	
1		56009	1250-0693	CASE,CARRYING,1145-2 LASER TRANSMITTER	1

END OF FIGURE

1-2 THROUGH 11

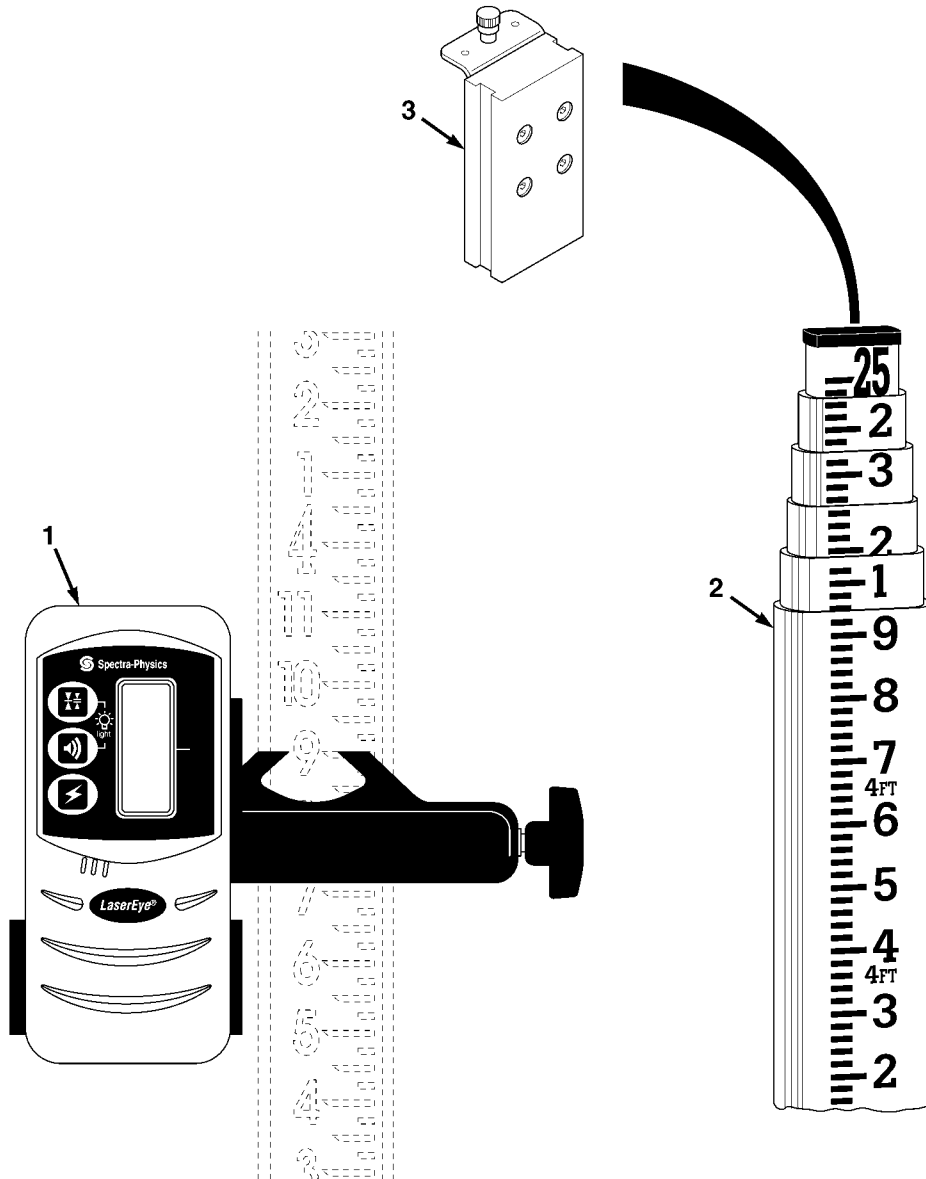


LLE00069

FIG. 53 1145-2 LASER TRANSMITTER

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 67 PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC	
				GROUP 6702 OPTICS: REFLECTING AND TRANSMITTING TYPE	
				FIG. 53 1145-2 LASER TRANSMITTER	
1	56009		L1145-2	1145-2 LASER TRANSMITTER,US	1
2	56009		1145-5531	• HANDLE,CARRYING	1
3	56009		003654-005	• SCREW,FLAT XREC 10-32 X 7/16 IN. (5/PKG)	1
4	56009		5103-2320	• SWITCH,CONTROL	1
5	56009		1145-2420	• CORD,POWER	1
6	56009		1145-4270	• BATTERY,MODIFIED	1
7	56009		1145-1510	• GASKET,BASE PLATE	1
8	56009		1145-1280	• SCREW,CAPTIVE	1
9	56009		1145-2350	• POWER CHARGER,110 VAC,60HZ	1
10	56009		1145-7710	• SCOPE,SIGHTING,SLOPE,1145	1
11	56009		1145-0310	• ADAPTER,QCK DISCONNECT	1

END OF FIGURE



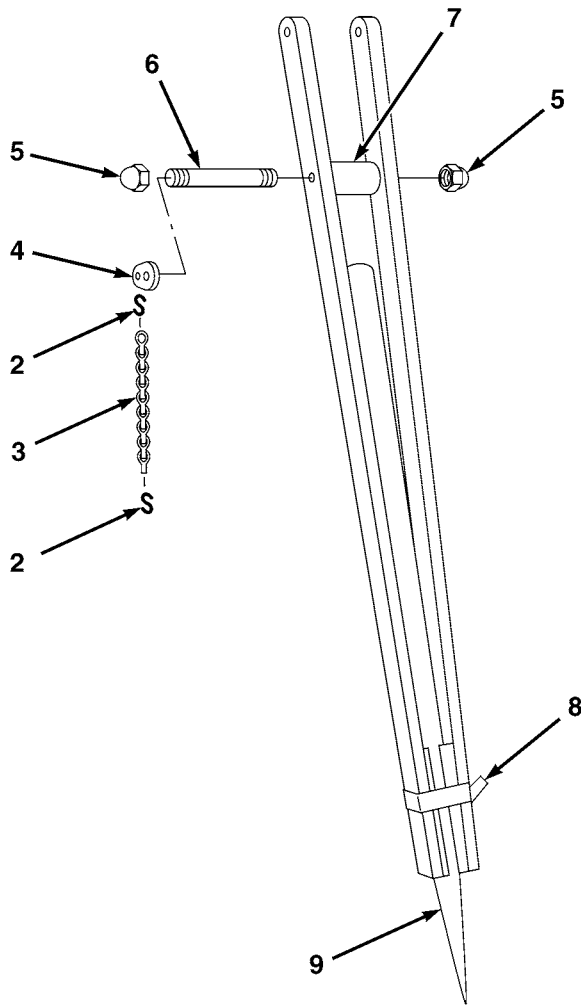
LLE00071

FIG. 54 1275 LASER RECEIVER AND GRADE ROD

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 67 PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC	
				GROUP 6709 ANTENNAS, GROUNDS, AND RELATED EQUIPMENT	
				FIG. 54 1275 LASER RECEIVER AND GRADE ROD	
1		56009	1275	1275 LASER RECEIVER	1
2		56009	0600-1270	GRADE ROD	1
3		56009	0600-1250	TOP MOUNT BLOCK 25 FT	1

END OF FIGURE

1-2 THROUGH 9



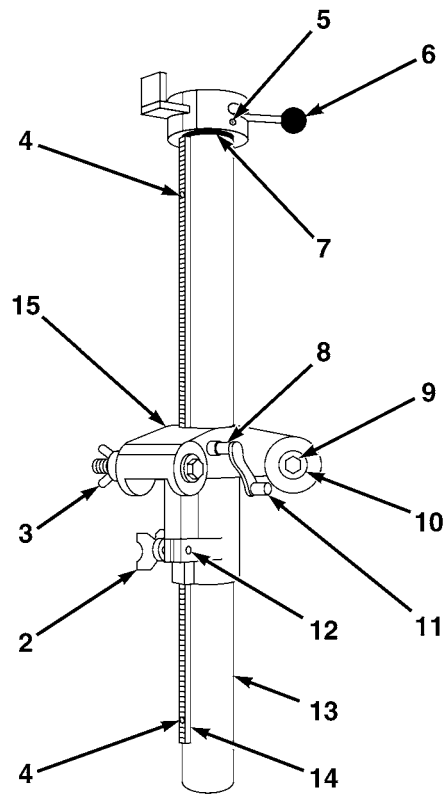
LLE00072

FIG. 55 TRIPOD

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
				GROUP 67 PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC	
				GROUP 6719 TRIPODS	
				FIG. 55 TRIPOD	
1		56009	302612-02	LASER LEGS [®] TRIPOD 4 FT (NOT SHOWN).....	1
		56009	302612-03	LASER LEGS [®] TRIPOD 6.5 FT (ISSUED).....	1
		56009	302612-04	LASER LEGS [®] TRIPOD 8 FT (NOT SHOWN).....	1
		56009	302612-06	LASER LEGS [®] TRIPOD 10 FT (NOT SHOWN).....	1
2		56009	003369	• S-HOOK	2
3		56009	005029	• MACH CHAIN #4 BULK,BLU CHR FNSH	1
4		56009	100136	• MOUNT,CHAIN	1
5		56009	003801-005	• NUT,CAP,HEX 0.25-20 X 0.48 IN. (5/PKG)	2
6		56009	102317	• STUD,LEG	1
7		56009	100122	• SPACER,LEG	1
8		56009	100168	• CLAMP,LEG	1
9		56009	202415	• LEG,EXTENSION	1

END OF FIGURE

1-2 THROUGH 15



LLE00070

FIG. 56 ELEVATING BASE

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
GROUP 67 PRECISION INSTRUMENTS AND SYSTEMS, MECHANICAL, ELECTRICAL, ELECTRONIC					
GROUP 6719 TRIPODS					
FIG. 56 ELEVATING BASE					
1	56009	408700-03	ELEVATING BASE-ENG		1
2	56009	122420	• STUD,LOCKING ASSY		1
3	56009	003825-010	• NUT,WING-ST CD 1/2-1 (10/PKG)		3
4	56009	8201-0808-020	• SCREW,CAP SOC HD STAINLESS STEEL 8-32 X 1/2 (20/PKG)		2
5	56009	003658	• SCREW,MACH. FL HD PHIL STAINLESS STEEL 10-32 X 7/8		1
6	56009	010008	• KNOB,BALL		1
7	56009	003562-005	• O-RING STOP		1
8	56009	003868-010	• PIN,ROLL,STAINLESS STEEL (10/PKG)		1
9	56009	003783	• BOLT,MH HEX,SS-1/2		3
10	56009	003837-010	• WASHER,FL 0.5 X 1.25 X 0.10 IN.,AL (10/PKG)		1
11	56009	208844	• CRANK,RAISE/LOWER		1
12	56009	7181-6006-010	• SCREW,ROUND XREC 10-32 X 3/8 (10/PKG)		1
13	56009	408040-01	• TUBE,ELEVATING BASE		1
14	56009	202407-01	• STEEL RACK		1
15	56009	408847	• ELEVATING TRIPOD BASE		1

END OF FIGURE

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
GROUP 33 SPECIAL PURPOSE KITS					
GROUP 3307 SPECIAL PURPOSE KITS					
FIG. 1 KITS					
			121022	KIT,VOLTAGE PROTECTION	1
			005274	NUT,HEX,3/8-16 IN.	1
		003834-010		WSHR,FL,3/8 X 1.08 IN. (10/PKG)	1
			221089	CABLE,VOLTAGE PROTECTION	1
		2802-1010		LKWSHR,INTERNAL,3/8	1
			121022	KIT,VOLTAGE PROTECTION	1
			005274	NUT,HEX,3/8-16 IN.	1
		003834-010		WSHR,FL,3/8 X 1.08 IN. (10/PKG)	1
			221089	CABLE,VOLTAGE PROTECTION	1
		2802-1010		LKWSHR,INTERNAL,3/8	1
			RT2S-1	TRANSMITTER,GRADIO® (USED WITH DR2-1 GRADIO® DISPLAY)	1
			RT2S-2	TRANSMITTER,GRADIO® (USED WITH DR2-2 GRADIO® DISPLAY)	1
			RT2S-3	TRANSMITTER,GRADIO® (USED WITH DR2-3 GRADIO® DISPLAY)	1
			RT2S-4	TRANSMITTER,GRADIO® (USED WITH DR2-4 GRADIO® DISPLAY)	1
			RT2S-5	TRANSMITTER,GRADIO® (USED WITH DR2-5 GRADIO® DISPLAY)	1
			0250-1470	RETAINER CLAMP KNOB	1
		7181-0605-010		SCR,MACH,RND,SST 6-32 X 5/16 IN. (10/PKG)	1
			2508-0520	BOOT,SWITCH (PLASTIC)	1
			1409-0990	STUD,FRONT LOAD 4MM	1
			1409-0980	RECEPTACLE,FRONT LOAD 4MM	1
			0225-0390	RETAINER,STUD HALF GROMMET GP	1
			7181-0806	SCR,ROUND HEAD PHIL 8-32 (10/PKG)	1
			2802-0250	WSHR,INT-T LOCK,#8 STL (10/PKG)	1
			012192	SCR,OVAL,XREC,10-32 X 4 IN. (5/PKG)	1
		2802-0030-010		LKWASH,SPLIT,#8 SST (10/PKG)	1
			8201-0810	SCR,SOCKET HEAD CAP 8-32 X 5/8 IN.	8
			0225-1770	CLAMP,BASE RECEIVER	1
			0250-1430	KNOB,MOLDED CLAMPING	1
			DR2-1	TRANSMITTER,GRADIO® (USED WITH RT2S-1 GRADIO® TRANSMITTER)	1
			DR2-2	TRANSMITTER,GRADIO® (USED WITH RT2S-2 GRADIO® TRANSMITTER)	1
			DR2-3	TRANSMITTER,GRADIO® (USED WITH RT2S-3 GRADIO® TRANSMITTER)	1

SECTION II

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(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
			DR2-4	TRANSMITTER,GRADIO® (USED WITH RT2S-4 GRADIO® TRANSMITTER)	1
			DR2-5	TRANSMITTER,GRADIO® (USED WITH RT2S-5 GRADIO® TRANSMITTER)	1
			012708	SCR,FL,XREC,1/4-20 X 1.75 IN. (10/PKG) .	1
			2816-1970	SCR,FL,XREC,6-32 X 0.375 IN. (10/PKG) ..	1
			2802-0020-010	LKWASH,SPLIT,#6,SST (10/PKG)	1
			7181-0606-010	SCR,RND,XREC,6-32 X 3/8 IN. (10/PKG) ...	1
			003376	FUSE,5 AMP	1
			010716	CAP,FUSE HOLDER SEAL	1
			011023	SEAL,FUSE CAP HOLDER	1
			2508-0500	SEAL,BOOT,TOG SW,15/32-32 NS,BL	1
			011179	LAMP,24 VOLT	3
			MM2E-T	MANUAL MAST	1
			003656	SCR,MH FL PHIL,SSTL,10-32 X 0.58 IN. ...	1
			122420	STUD,LOCKING ASSEMBLY	1
			122014	WSHR,FL,3/8 X 0.50 X 0.03 IN.	1
			0230-2080	SPACER	1
			7181-6006-010	SCR,RND,XREC,10-32 X 3/8 IN.(10/PKG) ...	1
			003655	SCR,FL,XREC,10-32 X 0.5 IN.(10/PKG)	1
			RM2E-3	RIGID MAST	1
			209099	SCALE,3 FOOT MAST	1
			2507-4270-010	SPACER,RND,0.203 X 0.312 X 0.194 IN. (10/PKG)	1
			7181-6008-010	SCR,RND,XREC (10/PKG)	1
			3502-0420	CHAIN	1
			2509-6780	PIN	1
			201634	MOUNT,RIGID MAST,LPO	1
			121022	KIT,VOLTAGE PROTECTION	1
			005274	NUT,HEX,3/8-16 IN.	1
			003834-010	WSHR,FL,3/8 X 1.08 IN. (10/PKG)	1
			221089	CABLE,VOLTAGE PROTECTION	1
			2802-1010	LKWWSHR,INTERNAL,3/8 IN.	1
			PSV2D06-24	CONTROL VALVE ASSEMBLY,PROPORTIONAL	2
			2816-4244-005	SCR,SOCKET HEAD,10-24 X 1-1/4 IN.	4
			0720-2400	MANIFOLD,PROPORTIONAL W/CARTRIDGES	4
			0720-2510	VALVE,PROPORTIONAL,VICKERS	1
			0355-9600	BASE CLAMP ASSY	2
			011506	SCR,CAP,HEX,0.5-13 X 2.75 IN.(5/PKG) ...	1
			003836	WSHR,FL,0.562 X 0.375 X 0.109 IN. (10/PKG)	1
			0355-9630	BASE CLAMP	2
			9837-1822	SCR,CAP,HEX,0.50-13 X 1.25 IN.,STL	8
			003855-010	LKWWSHR,SPLIT,0.50 X 0.51 X 0.12 IN. (10/PKG)	1
			0355-8960	CLAMP,CAST	4

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
			004964	NUT,HEX,0.50-13 X 0.75 X 0.44 IN. (10/PKG)	1
			0355-8550	BRKT,TRACER MTG ARM	1
			0355-8680	LEVER ASSEMBLY	1
			0355-8580	WELDMENT,TRACER ARM	1
			0355-8590	LEVER ASSEMBLY	1
			003834-010	WSHR,FL,3/8 X 1.08 IN.,STL,CD (10/PKG)	1
			005274	NUT,HEX 3/8-16 IN.	2
			2817-0051	PIN,COTTER STD.,3/32 X 1-1/4 IN. (10/PKG)	1
			EM2E-24	EM2E-24 ELECTRIC MAST - ENG,24V	1
			8207-1514	SCR,CAP SKT,5/16-18 X 7/8 IN. (10/PKG)	1
			7181-0604-010	SCR,RND XREC,6-32 X 0.25 IN. (10/PKG)	1
			2802-0020-010	LKWSHR,SPLIT #6,SSTL (10/PKG)	1
			7181-0612-010	SCR,RND XREC,6-32 X 0.75 IN.(10/PKG) ...	1
			2802-0030-010	LKWSHR,SPLIT #8 SST (10/PKG)	1
			7121-6007-010	SCR,FL XREC,10-32 X 7/16 IN.(10/PKG) ...	1
			012697	RING,RETAINING	1
			7181-0608-010	SCR,RND XREC,6-32 X 0.50 IN.(10/PKG) ...	1
			003184	DUST CAP RECEPACLE	1
			7181-0605-010	SCR,RND HEAD PHIL,6-32 X 5/16 IN. (10/PKG)	1
			011887-005	SCR,HEX 10-32 X 0.5 IN. STL,CD(5/PKG) ..	1
			2802-0040-010	LKWASH,SPLIT #10	4
			0790-4241	RISER,MOTOR 130G GRADER MAST MOUNT	1
			M2-T	SHOCK MOUNT,HIGH VIBRATION	1
			003859-010	LKWSHR,SPLIT,STL,CD,3/4 X 1.27 X 0.19 IN. (10/PKG)	2
			9837-7222-005	SCR,CP HEX,STL,CD,3/4-16 X 1 IN. (5/PKG)	2
			011137	SCR,CP HEX,STL,CD,3/4-16 X 2 IN.	2
			R2S-S	R2S-S LASER RECEIVER SB W/CASE	1
			2403-1680	KNOB,PLASTIC PRONGED	1
			8201-0808-020	SCREW,CAP SKT 8-32 X 1/2 IN.(20/PKG) ...	1
			2802-0030-010	LKWSHR,SPLIT #8 SSTL(10/PKG)	4
			321815	CLAMP,RECEIVER	1
			012192-005	SCREW,OVAL XREC SSTL 10-32 X 4 IN. (5/PKG)	1
			0365-3000	HSG,ASSY,ROTATIONAL SNSR	1
			0355-3170	BONE,DOG	1
			0355-3190	BEARING,TEFLON ROT SNSR HSG	1
			8311-0402	SCR,SET COP 4-40 X 0.125 IN.(10/PKG) ...	1
			0365-2040	OPERATOR INTERFACE PROP FINAL ASSY	1
			8201-1626	SCR,SOC,CAP 3/8-16 X 1-3/4 IN., SST F/T	1

SECTION II

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(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
			2403-1680	KNOB, PLASTIC PRONGED	1
			0365-1140	BOX, REMOTE, INTERFACE	1
			2117-1710	CAP, DUST, W/WIRE ROPE 0.125 IN. DIA	1
		7181-0606-010	SCR, RND, 6-32 X 3/8 IN. SST PSVT (10/PKG)		4
			2802-0770	LKWASH, SPLIT, 6-32, STL, 2N	4
			011894	FUSE, 25 AMP	2
			011023	SEAL, FUSE CAP	2
			010716	CAP, FUSE	2
			ST2-20	NON-CONTACT SONIC TRACER	1
			3901-2110	LAMP, INCAND T3-14	3
			3902-0603	LENS, GREEN, 0.625 IN. DIA, STOVEPIPE	1
			3902-0604	LENS, AMBER, 0.625 IN. DIA, STOVEPIPE	2
			5501-0151	TRANSDUCER, SND, POLAROID, 604142	1
			0365-8420	TRANSDUCER RING	1
			2504-6000	O-RING, 1.50 ID X 1.688 OD X 0.094 IN. ..	1
			0791-1740	ASSEMBLY MAST MOUNT BASE COMPLETE	1
			0791-1380	YOKE MAST MOUNT	1
			0791-1990	MOUNT, MAST BASE	1
			2816-4315	SCR, CAP HEX, 5/8-11 X 1.25 IN.	4
			003857	LKWASH, SPLIT, 5/8 IN.	4
			9837-2224	SCR, CAP HEX, 3/4-10 X 1.5 IN. STL	2
		003859-010	LKWASH, SPLIT, 3/4 X 1.27 X 0.19 IN. (10/PKG)		1
			0791-8820	PLATE, TRACER/MAST MTG	2
			8319-2212	SCR, SET CUP, 3/4-10 X 0.75 IN., ZNC PLT ..	2
			0792-3930	HOLDER, CONNECTOR	1
			0355-3140	BRKT, ARM MOUNTING	1
			0790-1970	BULKHEAD, BLANK #14	1
			2802-0420	WASHER, EXT-LICK, #10, STL, CD	1
		7121-6006-010	SCR, 10-32 X 3/8 IN. (10/PKG)		1
			121022	KIT, VOLTAGE PROTECTION	1
			005274	NUT, HEX, 3/8-16 IN.	1
		003834-010	WSHR, FL, 3/8 X 1.08 IN. (10/PKG)		1
			221089	CABLE, VOLTAGE PROTECTION	1
			2802-1010	LKWASH, INTERNAL, 3/8 IN.	1
			0389-0710	KIT, FLAT BELT DELIVERY	1
			0389-3060	SWIVEL, RUNNERS	2
			0389-2110	ROD, GUIDE	1
			0389-3240	CLIP, POLY TUBE	3
			3239-0001	TUBING, POLY 1/2 IN. O.D. X 0.062 IN. BLK	1
			0389-3200	ADPTR, POLY TUBE	3
			0389-3110	CLIP, BELT	1
			0389-0720	KIT, BELT, BUCKET PRO	1
			0389-3040	BELT ASSY, FLAT	1
			0389-3130	STOP, BELT	2
			2808-0959	RIVET, POP DOME	2

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
			2509-7055	FASTENER, SWIVEL	2
			2509-7048	CLIP, SPEED	4
			0389-3300	WEDGE, RISER	5
			0389-3030	BRACKET ROD, GUIDE	1
			0389-3320	STAND, POLY TUBE	1
			0389-1060	CLAMP, PULLEY TUBE	1
			2801-0040	WASHER, FLAT, SST, 10-24 IN.	2
			8201-1012	SCR, SOCKET, CAP 10-24 X 3/4 IN.	2
			0389-9000	BELT SYSTEM,BOX,TOOL	1
			1402-0164	CASE, BUCKET PRO TOOL KIT	1
			0389-0720	KIT, BELT BUCKET PRO	1
			0389-3040	BELT ASSY, FLAT	1
			0389-3130	STOP,BELT	2
			2808-0959	RIVET, POP DOME	2
			2509-7055	FASTENER, SWIVEL	2
			2509-7048	CLIP, SPEED	4
			0389-3110	CLIP,BELT	1
			0389-3060	SWIVEL, RUNNERS	2
			0389-0710	ADHESIVE,BACKING,TOOL BOX	1
			5401-1555	SCREWDRIVER, FLAT 1/4 X 1 1/4 IN.	1
			5401-1560	WRENCH, HEX, ALLEN 5/32 IN.	1
			8201-1012	SCR, CAP, SOCKET, SST 10-24 X 3/4 IN. ..	4
			2801-0040	WASHER, FLAT, SST, 10-24 IN.	4
			005203	WIRE, SAFETY, SS, 15 FT.	1
			0389-0310	DISPLAY BRCKT ASSY	1
			011860	NUT,1/2-20 X 3/4 X 0.32 IN. SST	1
			0389-0220	BALL,DISPLAY MOUNT SWIVEL	1
			2802-1010	LKWASH,INTERNAL 1/2 X 0.86 X 0.035 IN. .	4
			0389-1000	REMOTE INTERFACE BOX	1
			5101-0170	FUSE,AGC 3 AMP,250V	1
			011023	SEAL,FUSE CAP	1
			010716	FUSE CAP	1
			003378	FUSE,AGC 10 AMP	1
			L1145-2	1145-2 LASER TRANSMITTER,US	1
			1145-5531	HANDLE,CARRYING	1
			003654-005	SCREW,FLAT XREC 10-32 X 7/16 IN. (5/PKG)	1
			5103-2320	SWITCH,CONTROL	1
			1145-2420	CORD,POWER	1
			1145-4270	BATTERY,MODIFIED	1
			1145-1510	GASKET,BASE PLATE	1
			1145-1280	SCREW,CAPTIVE	1
			1145-2350	POWER CHARGER,110 VAC,60HZ	1
			1145-7710	SCOPE,SIGHTING,SLOPE,1145	1
			1145-0310	ADAPTER,QCK DISCONNECT	1
			302612-02	LASER LEGS TRIPOD 4 FT (NOT SHOWN)	1
			302612-03	LASER LEGS TRIPOD 6.5 FT (ISSUED)	1

SECTION II

TM 5-6675-348-13&P

(1) ITEM NO	(2) SMR CODE	(3) CAGEC	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES (UOC)	(6) QTY
			302612-04	LASER LEGS TRIPOD 8 FT (NOT SHOWN)	1
			302612-06	LASER LEGS TRIPOD 10 FT (NOT SHOWN)	1
			003369	S-HOOK	2
			005029	MACH CHAIN #4 BULK,BLU CHR FNSH	1
			100136	MOUNT,CHAIN	1
		003801-005	NUT,CAP,HEX 0.25-20 X 0.48 IN.(5/PKG) ..		2
			102317	STUD,LEG	1
			100122	SPACER,LEG	1
			100168	CLAMP,LEG	1
			202415	LEG,EXTENSION	1
		408700-03	ELEVATING BASE-ENG		1
			122420	STUD,LOCKING ASSY	1
		003825-010	NUT,WING-ST CD 1/2-1 IN. (10/PKG)		3
		8201-0808-020	SCREW,CAP SOC HD STAINLESS STEEL 8-32 X 1/2 IN. (20/PKG)		2
			003658	SCREW,MACH. FL HD PHIL STAINLESS STEEL 10-32 X 7/8 IN.	1
			010008	KNOB,BALL	1
		003562-005	O-RING STOP		1
		003868-010	PIN,ROLL,STAINLESS STEEL (10/PKG)		1
			003783	BOLT,MH HEX,SS-1/2 IN.	3
		003837-010	WASHER,FL 0.5 X 1.25 X 0.10 IN.,AL (10/PKG)		1
			208844	CRANK,RAISE/LOWER	1
		7181-6006-010	SCREW,ROUND XREC 10-32 X 3/8 IN. (10/PKG)		1
			408040-01	TUBE,ELEVATING BASE	1
			202407-01	STEEL RACK	1
			408847	ELEVATING TRIPOD BASE	1

CROSS-REFERENCE INDEXES

PART NUMBER INDEX					
PART NUMBER	FIG.	ITEM	PART NUMBER	FIG.	ITEM
003184	25	10	004964	22	9
003369	55	2	004964	44	9
003376	7	6	005029	55	3
003378	46	5	005203	43	16
003562-005	56	7	005274	1	2
003654-005	53	3	005274	2	2
003655	11	7	005274	14	2
003656	11	2	005274	23	6
003658	56	5	005274	33	10
003755	44	5	005274	35	2
003783	56	9	005274	39	2
003801-005	55	5	005274	46	11
003805-010	32	3	005275	49	6
003810	9	3	006648	45	12
003825-010	56	3	006649	8	3
003831-010	50	2	006649	32	5
003833	27	9	006649	35	4
003834-010	1	3	010008	56	6
003834-010	2	3	010185-005	10	3
003834-010	14	3	010185-005	44	3
003834-010	20	6	010716	7	7
003834-010	23	5	010716	29	7
003834-010	35	5	010716	46	4
003834-010	39	3	011023	7	8
003834-010	46	9	011023	29	6
003834-010	48	2	011023	46	3
003834-010	49	2	011137	25	18
003836	22	4	011179	7	10
003836	44	8	011506	22	3
003837-010	56	10	011860	45	3
003847-010	8	2	011860	45	8
003847-010	33	9	011887-005	25	12
003847-010	35	3	011894	29	5
003847-010	46	10	012192	6	7
003847-010	48	3	012192-005	26	6
003847-010	49	3	012697	25	8
003851-010	27	10	012708	7	2
003851-010	50	3	0225-0390	6	5
003855-010	8	7	0225-0520	3	1
003855-010	22	7	0225-0530	15	2
003857	9	4	0225-1770	6	10
003857	34	5	0230-2080	11	5
003857	47	7	0250-1430	6	11
003859-010	10	2	0250-1470	6	2
003859-010	25	16	0260-2870	45	6
003859-010	34	7	0355-3130	27	6
003859-010	44	2	0355-3140	27	7
003868-010	56	8	0355-3140	37	3
004194	19	4	0355-3170	27	2
004196	17	1	0355-3180	27	5
004196	18	1	0355-3190	27	3
004196	18	3	0355-5100	37	1
004196	18	5	0355-5200	35	1
004196	19	3	0355-7470	16	1
004261	19	5	0355-8550	23	1
004277	17	2	0355-8580	23	3
004277	18	2	0355-8590	23	4
004277	18	4	0355-8620	24	1
004870	48	4	0355-8680	23	2
004870	49	4	0355-8960	22	8

CROSS-REFERENCE INDEXES (CONT)

PART NUMBER INDEX					
PART NUMBER	FIG.	ITEM	PART NUMBER	FIG.	ITEM
0355-9600	22	2	0720-2470	19	6
0355-9630	22	5	0720-2480	19	7
0365-1140	29	1	0720-2510	20	4
0365-2040	28	1	0790-1970	33	7
0365-2630	15	1	0790-1970	35	8
0365-2700	32	6	0790-1970	36	1
0365-3000	27	1	0790-1970	37	4
0365-3160	29	9	0790-1980	8	8
0365-3160	33	2	0790-1980	33	6
0365-4010	30	2	0790-1990	33	6
0365-5000	36	3	0790-1990	36	2
0365-5310	27	13	0790-1990	44	11
0365-5310	32	4	0790-1990	45	13
0365-8420	31	6	0790-4241	25	14
0365-8740	33	5	0790-5590-070	38	6
0389-0220	45	4	0790-8510	16	3
0389-0310	45	2	0790-8700	38	1
0389-0660	44	4	0790-8900	22	1
0389-0710	41	1	0790-9000	38	7
0389-0710	43	11	0791-1380	34	2
0389-0720	41	8	0791-1740	34	1
0389-0720	43	3	0791-1850-090	32	2
0389-0890	44	6	0791-1890-090	32	1
0389-1000	46	1	0791-1990	34	3
0389-1060	42	3	0791-3120-085	21	3
0389-1810	49	8	0791-5680-085	38	4
0389-1840	48	5	0791-5690-250	38	5
0389-1840	49	5	0791-5700-150	38	2
0389-2010	45	7	0791-5710-240	38	3
0389-2020	45	1	0791-8820	34	8
0389-2110	41	3	0792-0360-035	38	8
0389-3000	49	7	0792-0370-035	38	9
0389-3030	42	1	0792-3910	33	3
0389-3040	41	9	0792-3920	33	4
0389-3040	43	4	0792-3930	37	2
0389-3060	41	2	0792-4100-020	51	4
0389-3060	43	10	0792-4150-150	51	7
0389-3110	41	7	0792-4150-400	51	6
0389-3110	43	9	0792-4150-450	51	5
0389-3130	41	10	0792-4200-150	51	3
0389-3130	43	5	0792-4250-150	51	1
0389-3200	41	6	0792-4300-050	51	2
0389-3240	41	4	100122	55	7
0389-3270	47	2	100136	55	4
0389-3300	41	14	100168	55	8
0389-3320	42	2	102317	55	6
0389-3410	47	1	111741	4	1
0389-4000	50	1	111741	5	1
0389-4400	48	1	111741	16	2
0389-4400	49	1	111741	40	1
0389-5020	47	3	1145-0310	53	11
0389-6350	45	9	1145-1280	53	8
0389-6380	47	4	1145-1510	53	7
0389-7240	46	6	1145-2350	53	9
0389-9000	43	1	1145-2420	53	5
0600-1250	54	3	1145-4270	53	6
0600-1270	54	2	1145-5531	53	2
0720-2400	20	3	1145-7710	53	10
0720-2450	19	6	121022	1	1
0720-2460	19	7	121022	2	1

CROSS-REFERENCE INDEXES (CONT)

PART NUMBER INDEX					
PART NUMBER	FIG.	ITEM	PART NUMBER	FIG.	ITEM
121022	14	1	2808-0959	43	6
121022	39	1	2816-1970	7	3
122014	11	4	2816-2260-010	27	8
122420	11	3	2816-4244-005	20	2
122420	56	2	2816-4315	34	4
1250-0693	52	1	2817-0051	23	7
1275	54	1	2818-0906	42	7
1402-0164	43	2	2818-0907	42	8
1409-0980	6	5	2818-0910	42	6
1409-0990	6	5	302612-02	55	1
201476	10	1	302612-03	55	1
201634	13	7	302612-04	55	1
202407-01	56	14	302612-06	55	1
202415	55	9	321815	26	5
208688-063	21	1	3239-0001	41	5
208688-085	21	2	3502-0420	13	5
208844	56	11	3901-2110	31	2
209099	13	2	3902-0603	31	3
209254	9	1	3902-0604	31	4
209930	8	4	408040-01	56	13
2117-1710	29	2	408700-03	56	1
220286	10	4	408847	56	15
220318	8	5	5101-0170	46	2
221089	1	4	5103-2320	53	4
221089	2	4	5401-1555	43	12
221089	14	4	5401-1560	43	13
221089	39	4	5501-0151	31	5
222621-200	12	1	7111-3430	38	11
2403-1680	26	2	7121-6006-010	33	8
2403-1680	28	3	7121-6006-010	37	6
2504-5998-010	38	12	7121-6007-010	25	7
2504-6000	31	7	7121-6008-010	8	9
2507-4270-010	13	3	7129-1408	45	14
2508-0500	7	9	7129-1408-010	35	7
2508-0520	6	4	7129-1408-010	44	10
2509-6780	13	6	7181-0604-010	25	3
2509-6870	38	10	7181-0605-010	6	3
2509-7048	41	13	7181-0605-010	25	11
2509-7048	43	8	7181-0606-010	7	5
2509-7055	41	12	7181-0606-010	29	3
2509-7055	43	7	7181-0608-010	25	9
2542-0059	19	1	7181-0612-010	25	5
2542-0062	19	2	7181-0806	6	6
2801-0040	42	4	7181-6006-010	11	6
2801-0040	43	15	7181-6006-010	56	12
2801-1010	14	5	7181-6008-010	13	4
2802-0020-010	7	4	8201-0808-020	26	3
2802-0020-010	25	4	8201-0808-020	56	4
2802-0030-010	6	8	8201-0810	6	9
2802-0030-010	25	6	8201-1012	42	5
2802-0030-010	26	4	8201-1012	43	14
2802-0040-010	25	13	8201-1432-005	30	1
2802-0250	6	6	8201-1626	28	2
2802-0420	37	5	8202-4025	45	10
2802-0770	29	4	8207-1514	25	2
2802-1010	1	5	8221-1410	45	11
2802-1010	2	5	8241-6008-010	27	12
2802-1010	39	5	8311-0402	27	4
2802-1010	45	5	8319-2212	34	9
2808-0959	41	11	8822-1620	46	7

CROSS-REFERENCE INDEXES (CONT)

PART NUMBER	FIG.	PART NUMBER INDEX		FIG.	ITEM
		FIG.	ITEM		
8822-1620	47		8		
9837-1420	50		4		
9837-1520-010	27		11		
9837-1620-010	46		8		
9837-1622-010	35		6		
9837-1624-005	8		1		
9837-1624-005	33		1		
9837-1634	29		8		
9837-1820-010	8		6		
9837-1822	22		6		
9837-1826	44		7		
9837-2224	34		6		
9837-7034	9		2		
9837-7222-005	25		17		
9839-1656-005	20		5		
9839-1656-005	47		6		
DR2-1	7		1		
DR2-2	7		1		
DR2-3	7		1		
DR2-4	7		1		
DR2-5	7		1		
EM2E-24	25		1		
EM2E-24	44		1		
L1145-2	53		1		
M2-T	25		15		
MM2E-T	11		1		
PSV2D06-24	20		1		
R2S-S	26		1		
RM2E-3	13		1		
RT2S-1	6		1		
RT2S-2	6		1		
RT2S-3	6		1		
RT2S-4	6		1		
RT2S-5	6		1		
ST2-20	31		1		
	47		5		

APPENDIX D
COMPONENTS OF END ITEM AND BASIC ISSUE ITEMS LISTS

NOT APPLICABLE

**APPENDIX E
ADDITIONAL AUTHORIZED LIST**

NOT APPLICABLE

APPENDIX F

EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST

Section I. INTRODUCTION

F-1. SCOPE.

This appendix lists expendable supplies and materials you will need to operate and maintain the Laser Leveling Equipment. These items are authorized to you by CTA 50-970, Expendable/Durable Items (Except Medical, Class V, Repair Parts, and Heraldic Items), or CTA 8-100, Army Medical Department Expendable/Durable Items.

F-2. EXPLANATION OF COLUMNS.

a. Column (1) - Item Number. This number is assigned to the entry in the listing and is referenced in the narrative task box to identify the material (e.g., "Compound, Antiseize, Item 14, Appendix B").

b. Column (2) - Level. This identifies the level of maintenance authorized to use the material as approved by the Maintenance Allocation Chart (MAC).

c. Column (3) - National Stock Number. This is the National Stock Number assigned to the item; use it to request or requisition the item.

d. Column (4) - Description. Indicates the Federal item name and, if required, a description to identify the item. The last line for each item indicates the Commercial and Government Entity (CAGE) code in parentheses followed by the part number.

e. Column (5) - Unit of Measure (U/M). Indicates the measure used in performing the actual maintenance function. This measure is expressed by two-character alphabetical abbreviations (e.g., in., pr). If the unit of measure differs from the unit of issue, requisition the lowest unit of issue that will satisfy your requirements.

Section II. EXPENDABLE AND DURABLE ITEMS

(1) Item Number	(2) Level	(3) National Stock Number	(4) Description	(5) U/M
1	O	7920-00-291-5815	Brush, Wire	ea
2	O	5340-00-450-5718	Cap and Plug Set, Moisture, Seal	st
3	O	7902-00-044-9281	Cloth, Lint-Free (MIL-C-85043) 10-pound box	lb
4	O	8415-00-641-4601	Gloves, Chemical Oil Protective	st
5	O	4140-00-269-7912	Goggles, Industrial	ea
6	O	0389-0710	Hook, Pile	rl
7	O	9505-00-293-4208	Non-Electrical, Safety Wire	rl
8	O	8010-00-582-5382	Paint, Spray, Black	cn
9	O	7920-00-205-1711	Rags, Wiping (A-A-531) (58536) 50-pound bale	lb
10	O	3439-01-297-1836	Solder, Lead-Tin Alloy	rl
11			Sealing Compound, MIL-S-46163A Type 2 Grade N	
		8030-01-104-5392	10-milliliter bottle	ml
		8030-01-014-5869	50-milliliter bottle	ml
		8030-01-025-1692	250-milliliter bottle	ml
12	C		Solvent, Degreasing, Type II (81348) MIL-PRF-680	
		6850-01-474-2319	1 - gallon can	gal
		6850-01-474-2317	5 - gallon can	gal
		6850-01-378-0698	15 - gallon can	gal
		6850-01-474-2316	55 - gallon can	gal
13	O	8135-00-178-9200	Tags, Identification (MIL-S-29190) 1,000 per carton	ct
14	O	9320-01-053-8266	Tape, Teflon	rl
15	O	5975-00-273-8133	Ties, Cable, (56501) TY525MX	ea

APPENDIX G

DECAL GUIDE

Section I. INTRODUCTION

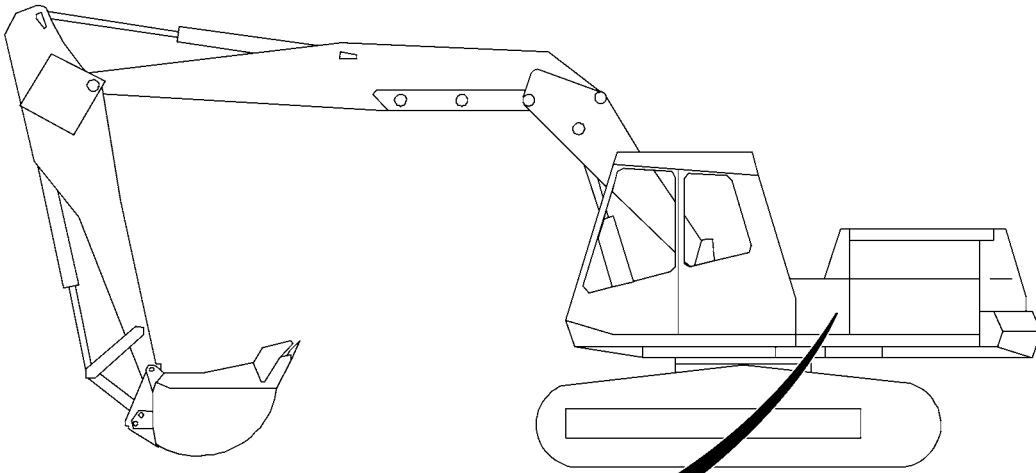
G-1. SCOPE.

This appendix shows locations for data plates, decals, and stencils that are required to be in place on the Laser Leveling Equipment.

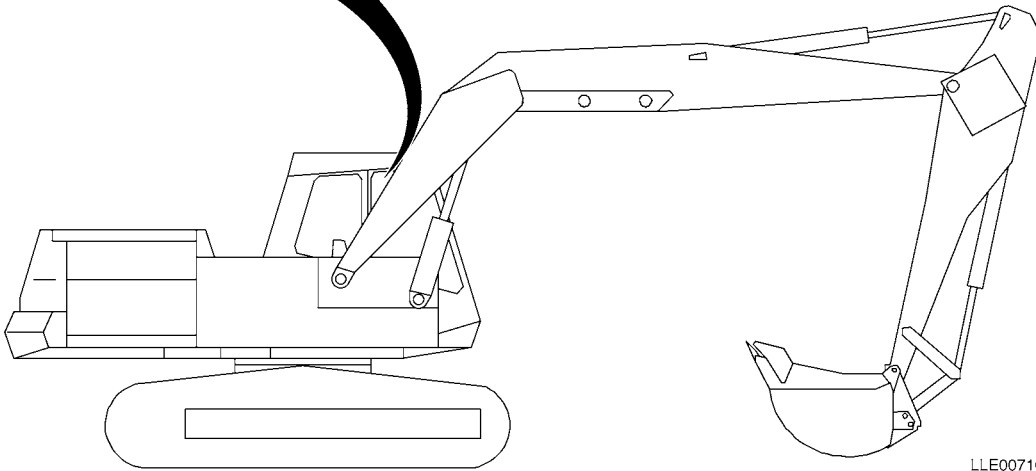
G-2. GENERAL.

The figures on the next pages show the location of metal signs, decals, and stencils used on the vehicle. Most of these signs and stencils contain warnings, cautions, or information needed to operate the vehicle safely.

Section II. DECALS



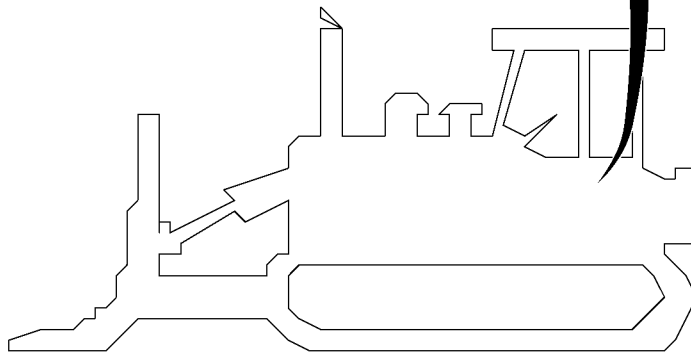
WARNING!
DISCONNECT ALL
ELECTRICAL CABLES
FROM
SPECTRA PRECISION
SYSTEM BEFORE
WELDING ON OR JUMP
STARTING MACHINE.



LLE00710

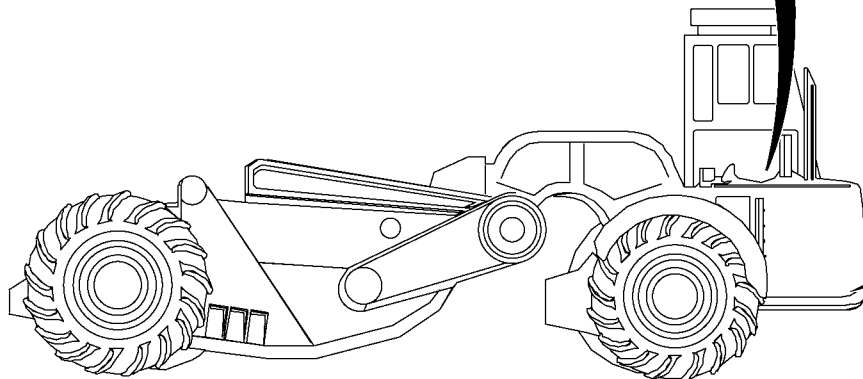
WARNING!

DISCONNECT ALL
ELECTRICAL CABLES
FROM
SPECTRA PRECISION
SYSTEM BEFORE
WELDING ON OR JUMP
STARTING MACHINE.



WARNING!

DISCONNECT ALL
ELECTRICAL CABLES
FROM
SPECTRA PRECISION
SYSTEM BEFORE
WELDING ON OR JUMP
STARTING MACHINE.



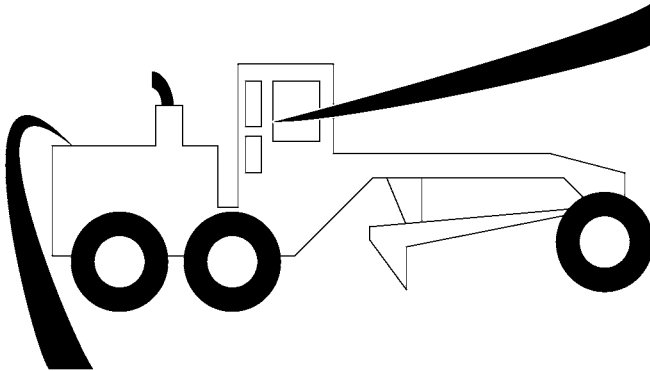
LLE00709

Spectra Precision
 Keep Blade
 Cushion OFF
 When Using
 Automatic Blade
 Control System

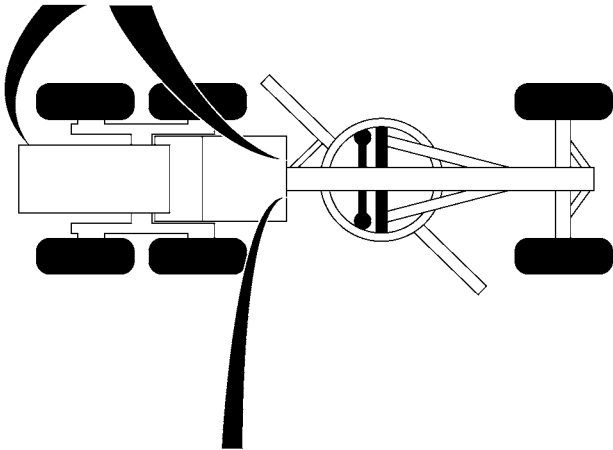
CAUTION!
 When circle is rotated past 45° or when
 Centershift Lock Pin is used past center
 position. Disconnect cables at Rotation
 Sensor.

Conversion Chart

Millimeters Per Meter	Inches Per Foot	Approx. % Slope
10mm	1/8"	1.0%
16mm	3/16"	1.6%
21mm	1/4"	2.1%
26mm	5/16"	2.6%
31mm	3/8"	3.1%
36mm	7/16"	3.6%
42mm	1/2"	4.2%
52mm	5/8"	5.2%
63mm	3/4"	6.3%
73mm	7/8"	7.3%
83mm	1 "	8.3%
104mm	1 1/4"	10.4%
125mm	1 1/2"	12.5%
146mm	1 3/4"	14.6%
167mm	2 "	16.7%
188mm	2 1/4"	18.8%
198mm	2 3/8"	19.8%



WARNING!
 DISCONNECT ALL
 ELECTRICAL CABLES
 FROM
 SPECTRA PRECISION
 SYSTEM BEFORE
 WELDING ON OR JUMP
 STARTING MACHINE.



CAUTION

THE ROTATIONAL SENSOR
 CAN BE DAMAGED IF
 THE BLADE IS FULLY
 RETRACTED WHILE THE
 CENTER SHIFT LOCK PIN
 IS IN THE FAR LEFT
 POSITION.



P/N 0790-8510

**APPENDIX H
ILLUSTRATED LIST OF MANUFACTURED ITEMS**

NOT APPLICABLE

APPENDIX J

TORQUE LIMITS

Section I. INTRODUCTION

J-1. SCOPE.

This appendix provides general torque limits for the screws, hoses, and fittings used on the Laser Leveling Equipment. Special torque limits are listed in the maintenance procedures for applicable components. The general torque limits given in this appendix shall be used when specific torque limits are not indicated in the maintenance procedure. These general torque limits cannot be applied to screws that retain rubber components. The rubber components will be damaged before the torque limit is reached. If a special torque limit is not given in the maintenance instructions, tighten the screw or nut until it touches the metal bracket, then tighten it one more turn.

Section II. TORQUE LIMITS

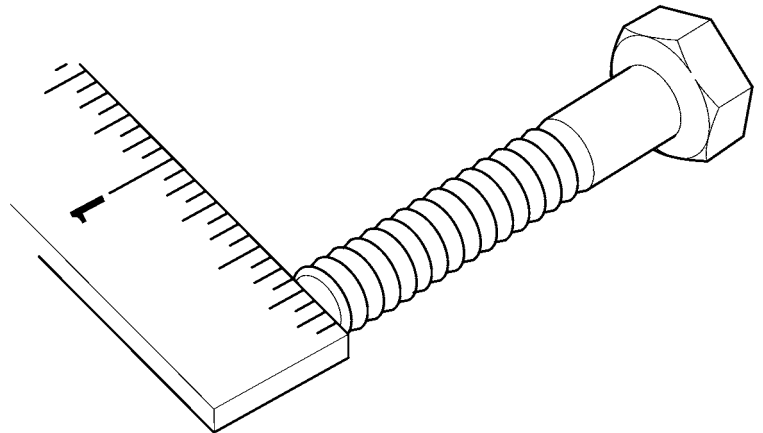
J-2. TORQUE LIMITS.

Table J-1 lists the torque limits for wet flange nuts. Table J-2 lists the torque limits for wet socket head capscrews. Table J-3 lists torque limits for dry fasteners. Dry torque limits are used on screws that do not have high pressure lubricants applied to the threads. Table J-4 lists torque limit for wet fasteners. Wet torque limits are used on screws that have high pressure lubricants applied to the threads. Table J-5 lists the torque limits for SAE 37-degree flare hose connections. Table J-6 lists the torque limits for SAE 45-degree flare hose connections. Table J-7 lists the torque limits for ORS preformed packing face seal hose connections. Table J-8 lists the torque limits for NPSM swivel connections.

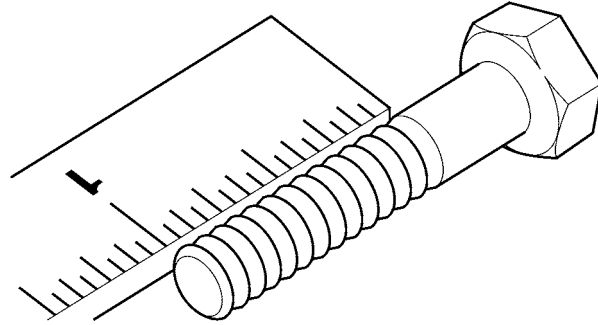
J-3. HOW TO USE THE TORQUE TABLE.

a. Screws and Nuts.

- (1) Measure the diameter of the screw you are installing with a ruler.



- (2) Measure out 1 in. with a ruler and count the number of threads per inch.
- (3) Under the heading SIZE, look down the left-hand column until you find the diameter of the screw you are installing (there will usually be two lines beginning with the same size).
- (4) In the second column under SIZE, find the number of threads per inch that matches the number of threads per inch you counted in Step (2). (Not required for metric screws.)
- (5) To find the grade screw you are installing, match the markings on the head to the correct picture of CAPSCREW HEAD MARKINGS on the torque table.
- (6) Look down the column under the picture you found in Step (5). until you find the torque limit (lb-ft or N•m) for the diameter and threads per inch of the screw you are installing.
- (7) Use wet torque values.



CAPSCREW HEAD MARKINGS

<p>Manufacturer's marks may vary. These are all SAE Grade 5 (3-line).</p>	<p>Metric screws are of three grades: 8.8, 10.9, & 12.9. Manufacturer's marks & Grades appear on the screw head.</p>
<p>STANDARD</p>	<p>METRIC</p>

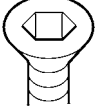
Table J-1. Torque Limits for Wet Flange Nuts

Spirallock Flange Nut Markings Grade 8	Diameter		Threads per In.	Torque	
	In.	mm		lb-ft	N•m
	1/4	6.35	20	15	20
	5/16	7.94	18	25	34
	3/8	9.53	16	45	61
	1/2	12.70	13	110	149
	5/8	15.87	11	210	285
	3/4	19.05	10	375	508

Table J-2. Torque Limits for Wet Socket Head Capscrews

SOC HEAD/12 PT.	Torque in Ft Lb (Capscrews) Lubed		
	Size	Socket Head or 12 Pt	Socket Flat Head
	0.10-24	55	2.5
	0.25-20	12	6
	0.31-18	25	12
	0.38-16	44	22
	0.50-13	70	36

Table J-2. Torque Limits for Wet Socket Head Capscrews (Continued)

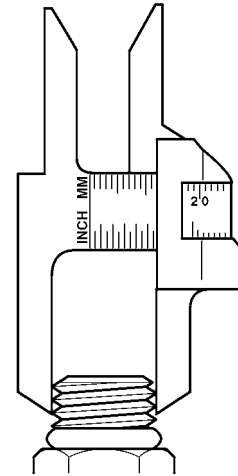
SOC FLAT HEAD 	0.56-12	106	53
	0.62-11	212	106
	0.75-10	375	187
	1.00-8	781	

b. Hoses and Fittings.

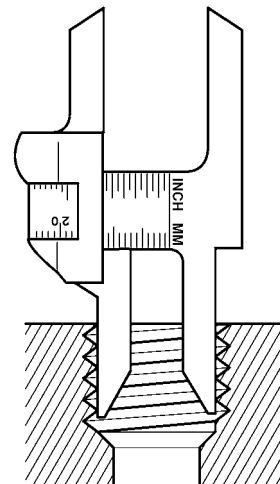
NOTE

Most fluid piping system sizes are measured by dash numbers. These are universally used abbreviations for the size of the component expressed at the numerator of the fraction with the denominator always being 16. For example, a -04 port is 4/16 or 1/4 inch. Dash numbers are usually nominal (in name only) and are abbreviations that make ordering of components easier.

- (1) Measure the I.D./O.D. with a caliper as shown.
- (2) Under the heading MALE THREAD O.D. and FEMALE THREAD I.D., match the measurements with the row in the table to determine proper torque.



**O.D.
(MALE THREADS)**



**I.D.
(FEMALE THREADS)**

TM 5-6675-348-13&P

- (3) To Find the sealing surface angle, use a protractor and measure the sealing surface parallel to the centerline of the fitting.

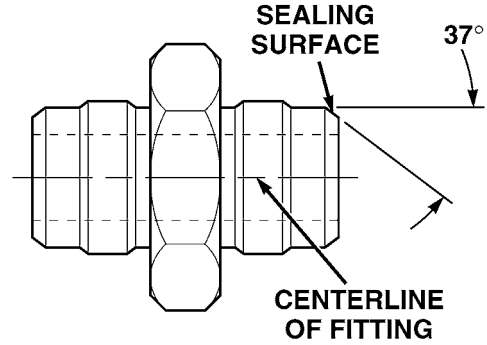


Table J-3. Torque Limits for Dry Fasteners

Size			Torque							
			SAE Grade No. 2		SAE Grade No. 5		SAE Grade No. 6 or 7		SAE Grade No. 8	
Dia. In.	Threads per In.	mm	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m
1/4	20	6.35	5	7	8	11	10	14	12	16
1/4	28	6.35	6	8	10	14	12	16	14	19
5/16	18	7.94	11	15	17	23	21	28	25	34
5/16	24	7.94	12	16	19	26	24	33	25	34
3/8	16	9.53	20	27	30	41	40	54	45	61
3/8	24	9.53	23	31	35	47	45	61	50	68
7/16	14	11.11	30	41	50	68	60	81	70	95
7/16	20	11.11	35	47	55	75	70	95	80	108
1/2	13	12.70	50	68	75	102	95	129	110	149
1/2	20	12.70	55	75	90	122	100	136	120	163
9/16	12	14.29	65	88	110	149	135	183	150	203
9/16	18	14.29	75	102	120	163	150	203	170	231
5/8	11	15.88	90	122	150	203	190	258	220	298
5/8	18	15.88	100	136	180	244	210	285	240	325
3/4	10	19.05	160	217	260	353	320	434	380	515
3/4	16	19.05	180	244	300	407	360	488	420	570
7/8	9	22.23	140	190	400	542	520	705	600	814
7/8	14	22.23	155	210	440	597	580	786	660	895
1	8	25.40	220	298	580	786	800	1085	900	1220
1	12	25.40	240	325	640	868	860	1166	1000	1356

Table J-3. Torque Limits for Dry Fasteners (Continued)

CAPSCREW HEAD MARKINGS			Torque							
Size			SAE Grade No. 2		SAE Grade No. 5		SAE Grade No. 6 or 7		SAE Grade No. 8	
Dia. In.	Threads per In.	mm	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m
1-1/8	7	28.58	300	407	800	1085	1120	1519	1280	1736
1-1/8	12	28.58	340	461	880	1193	1260	1709	1440	1953
1-1/4	7	31.75	420	570	1120	1519	1580	2142	1820	2468
1-1/4	12	31.75	460	624	1240	1681	1760	2387	2000	2712
1-3/8	6	34.93	560	759	1460	1980	2080	2820	2380	3227
1-3/8	12	34.93	640	868	1680	2278	2380	3227	2720	3688
1-1/2	6	38.10	740	1003	1940	2631	2780	3770	3160	4285
1-1/2	12	38.10	840	1139	2200	2983	3100	4204	3560	4827

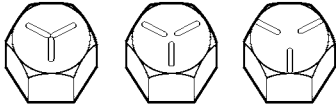
Table J-4. Torque Limits for Wet Fasteners

CAPSCREW HEAD MARKINGS			Torque							
Size			SAE Grade No. 2		SAE Grade No. 5		SAE Grade No. 6 or 7		SAE Grade No. 8	
Dia. In.	Threads per In.	mm	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m
1/4	20	6.35	4	6	6	8	8	11	9	12
1/4	28	6.35	5	7	7	9	9	12	10	14
5/16	18	7.94	8	11	13	18	16	22	18	24
5/16	24	7.94	9	12	14	19	18	24	20	27
3/8	16	9.53	15	20	23	31	30	41	35	47
3/8	24	9.53	17	23	25	34	30	41	35	47
7/16	14	11.11	24	33	35	47	45	61	55	75
7/16	20	11.11	25	34	40	54	50	68	60	81
1/2	13	12.70	35	47	55	75	70	95	80	108

Table J-4. Torque Limits for Wet Fasteners (Continued)

Size			Torque							
			SAE Grade No. 2		SAE Grade No. 5		SAE Grade No. 6 or 7		SAE Grade No. 8	
Dia. In.	Threads per In.	mm	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m
1/2	20		40	54	65	88	80	108	90	122
9/16	12	14.29	50	68	80	108	100	136	110	149
9/16	18		55	75	90	122	110	149	130	176
5/8	11	15.88	70	95	110	149	140	190	170	231
5/8	18		80	108	130	176	160	217	180	244
3/4	10	19.05	120	163	200	271	240	325	280	380
3/4	16		140	190	220	298	280	380	320	434
7/8	9	22.23	110	149	300	407	400	542	460	624
7/8	14		120	163	320	434	440	597	500	678
1	8	25.40	160	217	440	597	600	814	680	922
1	12		170	231	480	651	660	895	740	1003
1-1/8	7	25.58	220	298	600	814	840	1139	960	1320
1-1/8	12		260	353	660	895	940	1275	1080	1464
1-1/4	7	31.75	320	434	840	1139	1100	1492	1360	1844
1-1/4	12		360	488	920	1248	1320	1790	1500	2034
1-3/8	6	34.93	420	570	1100	1492	1560	2115	1780	2414
1-3/8	12		460	624	1260	1709	1780	2414	2040	2776
1-1/2	6	38.10	560	760	1460	1980	2080	2820	2360	3200
1-1/2	12		620	841	1640	2224	2320	3146	2660	3607

CAPSCREW HEAD MARKINGS



Manufacturer's marks may vary. These are all SAE Grade 5 (3-line).

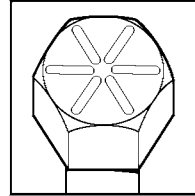
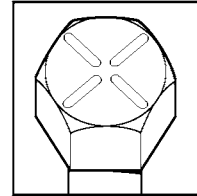
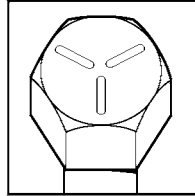
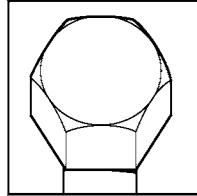


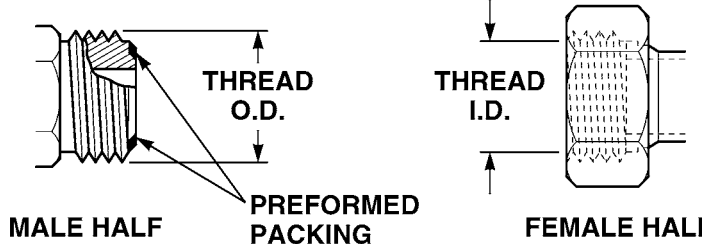
Table J-5. Torque Limits for 37-Degree Flare Hose Connections

INCH SIZE	DASH NO.	THREAD SIZE	TORQUE LB-FT	TORQUE N•M
1/4	04	7/16-20	11-12	15-16
3/8	06	9/16-18	18-21	24-28
1/2	08	3/4-16	26-39	35-53
5/8	10	7/8-14	57-62	77-84
3/4	12	1 1/16-12	79-87	107-118
7/8	14	1 3/16-12	83-91	113-123
1	16	1 5/16-12	108-112	146-152
1-1/4	20	1 5/8-12	127-133	172-180
1-1/2	24	1 7/8-12	158-167	214-226
2	32	2 1/2-12	245-258	332-350

Table J-6. Torque Limits for 45-Degree Flare Hose Connections

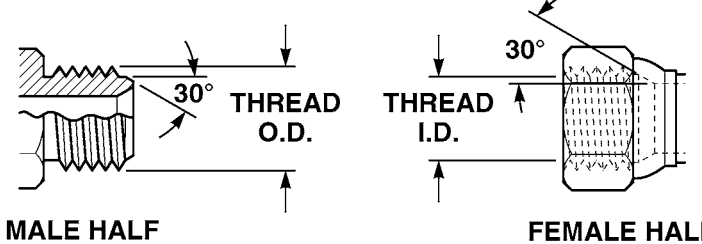
INCH SIZE	DASH NO.	THREAD SIZE	TORQUE LB-FT	TORQUE N•M
1/4	04	7/16-20	8-9	11-12
3/8	06	5/8-18	18-21	24-28
1/2	08	3/4-16	36-38	49-51
5/8	10	7/8-14	52-54	70-73
3/4	12	1 1/16-14	71-74	96-100

Table J-7. Torque Limits for ORS Preformed Packing Face Seal Hose Connections



INCH SIZE	DASH NO.	THREAD SIZE	TORQUE LB-FT	TORQUE N•M
1/4	04	9/16-18	10-12	14-16
3/8	06	11/16-16	18-20	24-27
1/2	08	13/17-17	32-35	43-47
5/8	10	1-14	46-50	62-68
3/4	12	1 3/16-12	65-70	88-95
1	16	1 7/16-12	108-113	146-153
1 1/4	20	1 11/16-12	127-133	172-180
1 1/2	24	2-12	158-167	214-226

Table J-8. Torque Limits for NPSM Swivel Connections



INCH SIZE	DASH NO.	THREAD SIZE	TORQUE LB-FT	TORQUE N•M
1/2	02	1/8-27	3-4	4-5
1/4	04	1/4-18	10-11	14-15
3/8	06	3/8-18	16-18	22-24
1/2	08	1/1-14	25-27	34-37
3/4	12	3/4-14	46-48	62-65
1	16	1-1 1/2	80-83	108-113
1 1/4	20	1 11/16-12	127-133	172-180
1 1/2	24	1 1/2-11/2	160-164	217-222
2	32	2-11/2	170-174	231-236

APPENDIX K

MANDATORY REPLACEMENT PARTS

Section I. INTRODUCTION

K-1. SCOPE.

This appendix lists all mandatory replacement parts required for performance of Unit, Direct, and General Support maintenance of Laser Leveling Equipment. It authorizes the requisitioning, issue, and disposition of consumable repair parts. All consumable repair parts listed in the maintenance task are listed here for ease or reference.

K-2. EXPLANATION OF COLUMNS (SECTION II).

a. Column (1) - Item No.

This number is assigned to the entry in the listing and is referenced in the narrative task box to identify the part [e.g., Clamp (Item 12, Appendix K)].

b. Column (2) - Nomenclature.

Indicates the Federal item name and, if required, a description to identify the item.

c. Column (3) - Part Number.

This is the vendor number assigned to the item.

d. Column (4) - National Stock Number.

This is the National Stock Number assigned to the item; use it to request or requisition the item.

Section II. MANDATORY REPLACEMENT PARTS

Table K-1. Mandatory Replacement Parts - Gradio®

(1) Item No.	(2) Nomenclature	(3) Part Number	(4) National Stock Number
1	Kit, Voltage Protection	121022	
2	Label, Warning, Welding/Jump Starting	111741	
3	Mount, MM2E Manual Mast, Dozer	201476	
4	Mount, RM2E Rigid Mast, Scraper	209254	

Table K-2. Mandatory Replacement Parts - Blade Pro®

(1) Item No.	(2) Nomenclature	(3) Part Number	(4) National Stock Number
1	Base Mounting Block	0355-8620	
2	Kit, Voltage Protection	121022	
3	Label, Caution, Rotation Sensor	0355-7470	
4	Label, Chart, Conversion	0790-8510	
5	Label, Warning, Welding/Jump Starting	111741	
6	Plate, Tracer/Mast Mount	0791-8820	


Table K-3. Mandatory Replacement Parts - Bucket-Pro™

(1) Item No.	(2) Nomenclature	(3) Part Number	(4) National Stock Number
1	Label, Warning, Welding/Jump Starting	111741	
2	Ring, Arm Sensor Mounting	0389-6380	
3	Ring, Boom Sensor Mounting	0389-4400	

By Order of the Secretary of the Army:

PETER J. SCHOOMAKER
General, United States Army
Chief of Staff

Official:


SANDRA R. RILEY
Administrative Assistant to the
Secretary of the Army
0516605

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PAGE NO.	COLM NO.	LINE NO.	FEDERAL STOCK NUMBER	REFERENCE NO.	FIGURE NO.	ITEM NO.	TOTAL NO. OF MAJOR ITEMS SUPPORTED	RECOMMENDED ACTION

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ITEM NO.	PAGE NO.	PARA-GRAPH	LINE NO.*	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES AND REASON <i>(Provide exact wording of recommended changes, if possible.)</i>	
<i>* Reference to line numbers within the paragraph or subparagraph.</i>							
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THE METRIC SYSTEM AND EQUIVALENTS

LINEAR MEASURE

1 Centimeter = 10 Millimeters = 0.01 Meters = 0.3937 Inches
 1 Meter = 100 Centimeters = 1000 Millimeters = 39.37 Inches
 1 Kilometer = 1000 Meters = 0.621 Miles

SQUARE MEASURE

1 Sq Centimeter = 100 Sq Millimeters = 0.155 Sq Inches
 1 Sq Meter = 10,000 Sq Centimeters = 10.76 Sq Feet
 1 Sq Kilometer = 1,000,000 Sq Meters = 0.386 Sq Miles

WEIGHTS

1 Gram = 0.001 Kilograms = 1000 Milligrams = 0.035 Ounces
 1 Kilogram = 1000 Grams = 2.2 Lb
 1 Metric Ton = 1000 Kilograms = 1 Megagram = 1.1 Short Tons

CUBIC MEASURE

1 Cu Centimeter = 1000 Cu Millimeters = 0.06 Cu Inches
 1 Cu Meter = 1,000,000 Cu Centimeters = 35.31 Cu Feet

LIQUID MEASURE

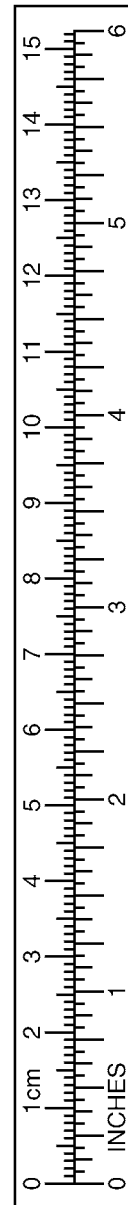
1 Milliliter = 0.001 Liters = 0.0338 Fluid Ounces
 1 Liter = 1000 Milliliters = 33.82 Fluid Ounces

TEMPERATURE

$5/9 (^{\circ}\text{F} - 32) = ^{\circ}\text{C}$
 212^o Fahrenheit is equivalent to 100^o Celsius
 90^o Fahrenheit is equivalent to 32.2^o Celsius
 32^o Fahrenheit is equivalent to 0^o Celsius
 $9/5 \text{ C}^{\circ} + 32 = \text{F}^{\circ}$

APPROXIMATE CONVERSION FACTORS

<u>TO CHANGE</u>	<u>TO</u>	<u>MULTIPLY BY</u>
Inches	Centimeters	2.540
Feet	Meters	0.305
Yards	Meters	0.914
Miles	Kilometers	1.609
Square Inches	Square Centimeters	6.451
Square Feet	Square Meters	0.093
Square Yards	Square Meters	0.836
Square Miles	Square Kilometers	2.590
Acres	Square Hectometers	0.405
Cubic Feet	Cubic Meters	0.028
Cubic Yards	Cubic Meters	0.765
Fluid Ounces	Milliliters	29.573
Pints	Liters	0.473
Quarts	Liters	0.946
Gallons	Liters	3.785
Ounces	Grams	28.349
Pounds	Kilograms	0.454
Short Tons	Metric Tons	0.907
Pound-Feet	Newton-Meters	1.356
Pounds per Square Inch	Kilopascals	6.895
Miles per Gallon	Kilometers per Liter	0.425
Miles per Hour	Kilometers per Hour	1.609
<u>TO CHANGE</u>	<u>TO</u>	<u>MULTIPLY BY</u>
Centimeters	Inches	0.394
Meters	Feet	3.280
Meters	Yards	1.094
Kilometers	Miles	0.621
Square Centimeters	Square Inches	0.155
Square Meters	Square Feet	10.764
Square Meters	Square Yards	1.196
Square Kilometers	Square Miles	0.386
Square Hectometers	Acres	2.471
Cubic Meters	Cubic Feet	35.315
Cubic Meters	Cubic Yards	1.308
Milliliters	Fluid Ounces	0.034
Liters	Pints	2.113
Liters	Quarts	1.057
Liters	Gallons	0.264
Grams	Ounces	0.035
Kilograms	Pounds	2.205
Metric Tons	Short Tons	1.102
Newton-Meters	Pound-Feet	0.738
Kilopascals	Pounds per Square Inch	0.145
Kilometers per Liter	Miles per Gallon	2.354
Kilometers per Hour	Miles per Hour	0.621



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