E160 OPERATION MANUAL

ELLIOTT
EQUIPMENT COMPANY

INTRODUCTION

Do not operate this aerial device until you have read and thoroughly understand this manual, the accompanying Association of Equipment Manufacturers "**SAFETY MANUAL FOR OPERATING AND MAINTENANCE PERSONNEL**", all decals on the aerial device and you have been properly trained by an experienced, qualified aerial device operator. The information in these manuals is a guide to assist qualified personnel in safe operation and maintenance of this aerial device and is not a substitute for training, experience and common sense.

If there is a question on application and/or operation, contact the Product Safety and Reliability Department at Elliott Equipment Company. If an Elliott Aerial device is involved in a personal injury or property damage incident notify the Product Safety and Reliability Department as soon as possible. Have the model and serial number and details of the incident recorded prior to the factory.

Elliott Equipment Company
4427 South 76th Circle
Omaha, NE 68127-1806
Ph. 402-592-4500 FAX 402-592-4553
e-mail info@elliottequip.com
www.elliottequip.com

⚠ DANGER

Always refer to ANSI/SIA A92.2 standards for safe operation, inspection and maintenance of this aerial device. Federal, state and local laws, rules and regulations along with safety codes and insurance requirements take precedence over any information in this manual.
See the OSHA 1926.1400 regulation for correct, safe operation near power lines, hand signals and personnel qualification requirements.

READ, UNDERSTAND AND FOLLOW ALL SAFETY LABELS
BEWARE OF OVERHEAD POWER LINES
UNDERSTAND AND NEVER ATTEMPT EXCEEDING AERIAL DEVICE LOAD CHARTS
NEVER EXCEED PLATFORM CAPACITY AND AREAS OF OPERATION

This manual must be retained with this boom truck for use by subsequent operating personnel.

ELLIOTT EQUIPMENT COMPANY

WARRANTY

Subject to the terms and conditions of this warranty, Elliott Equipment Company ("Elliott") hereby warrants all equipment manufactured by Elliott ("Equipment") to be free from defects in material and workmanship for a period of one year. There are no express or implied warranties, including the warranty of merchantability and fitness for a particular purpose, covering component parts or accessories manufactured or modifications made by someone other than Elliott.

All Equipment shall have a limited one-year warranty ("one-year warranty"), effective from the date that the Equipment is shipped from Elliott and subject to the terms and conditions contained herein. Elliott's sole obligation under the one-year warranty shall be the replacement of the defective part(s), but specifically excludes paint. This one-year warranty is limited to the original purchaser of equipment from Elliott or from an authorized Elliott distributor only and is not transferable to any other person or entity.

In addition to the one-year warranty, the following structural components shall have a lifetime parts-only warranty from the date of shipment from Elliott: Subframe, Turrets and Structural Components of all steel booms ("lifetime warranty"). Elliott's sole obligation under the lifetime warranty is replacement of the defective part(s), but specifically excluding any labor or other costs incurred. This lifetime warranty for structural components excludes hydraulic and electrical components, bed and body components, chassis, jibs, outriggers and platform. This lifetime warranty also specifically excludes any other parts or components, including without limitation seals, gaskets, hydraulic components and exterior coatings. All replacement parts are original equipment parts from Elliott. In the event ownership of the Equipment is transferred to a person or entity other than the original purchaser of the Equipment, the lifetime warranty shall terminate.

The lifetime warranty and one-year warranty as set forth herein apply only to Equipment shipped from Elliott after January 1, 2012.

EXCLUSIONS: No warranty claims shall be valid unless Elliott is notified in writing of the defect within a reasonable time following its discovery. The one-year warranty and lifetime warranty are valid only if an annual service inspection is performed and documented by an authorized Elliott distributor. The one-year warranty and lifetime warranty shall not apply with respect to any claimed defect which in Elliott's sole judgment has arisen from repair, alteration, damage during shipment, accident, negligence, failure to perform routine maintenance, overloading or misuse, including without limitation, an operator's failure to follow the instructions issued with the equipment. The one-year warranty and lifetime warranty are void if any modifications are made to the Equipment.

Elliott reserves the right to make changes in design or construction of its equipment at any time without obligating itself to make such changes on equipment previously manufactured.

LIMITATION OF LIABILITY: ELLIOTT'S LIABILITY FOR ANY LOSSES AND DAMAGES RESULTING FROM ANY CAUSE WHATSOEVER, INCLUDING WITHOUT LIMITATION, ELLIOTT'S NEGLIGENCE OR FROM DAMAGED OR DEFECTIVE EQUIPMENT, IRRESPECTIVE OF WHETHER SUCH DEFECTS ARE DISCOVERABLE OR LATENT, SHALL IN NO EVENT EXCEED THE PURCHASE PRICE OF THE PARTICULAR EQUIPMENT TO WHICH LOSSES OR DAMAGES ARE CLAIMED, OR AT THE ELECTION OF ELLIOTT, THE REPAIR OR REPLACEMENT OF THE DEFECTIVE EQUIPMENT. IN NO EVENT SHALL ELLIOTT BE LIABLE FOR ANY SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES INCLUDING WITHOUT LIMITATION COMMERCIAL LOSSES, LOST PROFITS OR COSTS OF ANY KIND OR FOR ANY DAMAGES FOR WHICH BUYER MAY BE LIABLE TO OTHER PERSONS.

DISCLAIMER: THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, AND IS ALSO IN LIEU OF ANY OTHER OBLIGATIONS ON THE PART OF ELLIOTT. No agent, employee or representative of Elliott may bind Elliott to any other warranty. In the event any provision of the warranty is for any reason held ineffective, the remaining provisions shall remain full and intact. In particular, the remedy of replacement provided for herein is the exclusive remedy for breach of the one-year warranty and lifetime warranty.

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SAFETY AND OPERATION

1.1 SAFETY RESPONSIBILITIES

Safety is more than reading and following proper operating instructions or procedures. Safety is achieved by having the appropriate state of mind at all times while operating or working around this equipment. Having a positive attitude towards safety is the most important factor in accident and equipment failure prevention.

Any individual who will operate, supervise, rig loads, service, or work near this boom truck shall read and understand this manual prior to operation. Failure to read this manual is a misuse of this boom truck. Death or serious injury can result from the misuse or improper maintenance of this boom truck.

It is your responsibility to read and understand this safety manual before operating this machine. Remember that **YOU** are the key to safety. Good safety practices not only protect you, but also protect the people around you. Study this manual and make it a working part of your safety program. Keep in mind that this manual is written only for this specific type of machine. Practice all other usual and customary safe working precautions, and above all:

REMEMBER – SAFETY IS UP TO YOU

YOU CAN PREVENT SERIOUS INJURY OR DEATH

Why is **SAFETY** important to **YOU**?

3 BIG REASONS

- Accidents **DISABLE** and **KILL**
- Accidents **COST**
- Accidents **CAN BE AVOIDED**

Your safety, along with the safety of all personnel involved with this boom truck, is of utmost concern to Elliott Equipment Company during the design and manufacture of this boom truck. This manual has been developed with the safety of all personnel that work around, with, or operated this equipment as our primary goal.

It is your responsibility to know and understand this specific requirements and hazards that exist. It is also your responsibility to know and understand all government regulations that apply to the work being performed with this boom truck. You shall make these items known to all personnel working with this equipment or in the area, so that everyone can take the necessary and required safety precautions. Failure to head these instructions can result in death or serious injury.

It is your responsibility to operate and maintain your boom truck with skill, good judgment, and caution. Following recognized safety procedures will help you avoid accidents. Modifications to any part of this boom truck can create a safety hazard and therefore shall not be made without written approval from Elliott Equipment Company. Use only Elliott factory approved parts to maintain this equipment. If this boom truck is rebuilt or remounted, mounting procedures, re-testing, and re-certification are required in accordance to instructions provided by Elliott Equipment Company.

Safety is dependent on all people associated with this boom truck. The overall condition of the equipment, maintenance and inspection procedures are just as important as safe operating procedures and a positive attitude

towards safety. All of these procedures properly applied will significantly reduce the likelihood of an accident or equipment failure.

1.2 RESPONSIBILITIES PER ANSI/SIA A92.2

7. Responsibilities of Dealers and Installers

7.1 General Responsibilities. Each dealer or installer as applicable shall comply with the requirements of this section.

7.2 Vehicle Specifications. Each dealer or installer, or both, who sells an aerial device shall inform the owner or user, or both, of the manufacturer's minimum vehicle specifications.

7.3 Vehicle Weight Distribution. The installer shall be responsible for the weight distribution of the completed mobile unit in accordance with the requirements of the aerial device and the applicable regulations. Allowance shall be made for the weight of readily removable tools and material specified by the user.

7.4 Manuals. Upon delivery of the equipment to the owner or user, the dealer or installer shall provide the manuals as required by Paragraph 6.4 of this standard and manuals for auxiliary equipment added by the installer.

7.5 Installations. The installer shall comply with Sections 5 and 6 of this standard relating to proper installation and shall follow the instructions of the manufacturer. In the event the original manufacturer no longer exists, and equivalent entity may provide these instructions. The installer of an aerial device shall, before the mobile unit is placed in operation, perform stability tests in accordance with the requirements of 4.5.1 and 4.5.2, the operational and visual tests in accordance with the requirements of 6.6.1 and 6.6.2 and the appropriate electrical tests required in 5.4.3 of this standard. The installer shall, when installing an aerial device on a chassis which is a highway vehicle, comply with all requirements of the applicable Federal Motor Vehicle Safety Standards in effect at the time of installation. Certification as a manufacturer (alteration, intermediate or final) of a motor vehicle under the Federal Motor Vehicle Safety Standards is required. The travel height of the mobile unit shall be posted in a location that is readily visible to the vehicle operator. For insulated aerial devices, the installer shall assure conformance to the Qualification test requirements of 5.3.2 by either obtaining certification of the test and performing a periodic test after installation, or by performing the Qualification test.

7.6 Quality Assurance. The installer shall have a documented quality assurance program which will ensure compliance with this standard.

7.7 Welding. All welds made by the installer, whose failure could result in motion of the platform(s) shall meet the Structural Welding Code AWS DI.I-98 and AWS DI.2-98. The installer shall establish applicable welding quality assurance procedures for all weldments.

7.8 Training. The dealer or installer shall offer training or training materials that aid owners and users in the operation, inspection, testing and maintenance of the aerial device. This training shall be offered initially and subsequently on request.

7.8.1 Dealer or Installer as User. Whenever a dealer or installer directs personnel to operate an aerial device (inspecting, sales demonstrations, or any form of use), the dealer or installer shall assume the responsibilities of users as specified in Section 9 of this standard. All personnel authorized to operate the aerial device shall have been trained.

8. Responsibilities of Owners

8.1 General Responsibilities. Each owner shall comply with the requirements of this section. The following responsibilities pertain to the owner's inspection, testing, maintenance, modification, training, and transfer of ownership. These activities shall be performed by qualified person(s).

8.2 Inspection and Testing Classifications.

8.2.1 Initial Inspection and Test. Prior to initial use, all new or modified mobile units shall be inspected and tested to ensure compliance with the provisions of this standard. Verification by the manufacturer, the installer or an equivalent entity(s), meets this requirement.

8.2.2 Regular Inspection and Tests. The inspection procedure for mobile units is divided into two classifications based upon the intervals at which inspections and tests shall be performed. Intervals shall be set by the owner in accordance with the manufacturer's recommendations. Such intervals are dependent upon component function and exposure to wear, deterioration and other agents which adversely affect component life. Two classifications are designated:

(1) Frequent Inspection and Test: Daily to monthly intervals.
(2) Periodic Inspection and Test: One to twelve month intervals.

8.2.3 Frequent Inspection and Test. Items determined by the owner in accordance with the manufacturer'' recommendations for each specific aerial device shall be inspected for defects. The following tests and inspections shall be performed by the operator once daily, prior to first use:

(1) Operating controls and associated mechanisms for conditions interfering with proper operation.
(2) Visual and audible safety devices for malfunction.
(3) Hydraulic or pneumatic systems for observable deterioration or excessive leakage.
(4) Fiberglass and other insulating components for visible damage or contamination.
(5) Missing or illegible operational and instructional markings.
(6) Electrical systems of / or related to the aerial device for malfunction, signs of excessive deterioration, dirt and moisture accumulation.
(7) Visual inspection of bolts, pins, and other fasteners for loose, deformed or missing fasteners and other locking devices.

Any suspected items shall be carefully examined or tested and a determination made by a qualified person as to whether they constitute a safety hazard. All unsafe items shall be replaced or repaired before use.

8.2.4 Periodic Inspection or Test. An inspection of the mobile unit shall be performed at the intervals defined in 8.2.2 depending upon its activity, severity of service, and environment, or as specifically indicated below. (These inspections shall include the requirements of 8.2.3):

(1) Structural members for deformation, cracks or corrosion.
(2) Parts, such as pins, bearings, shafts, gears, rollers, locking devices, chains, chain sprockets, wire and synthetic ropes, and sheaves for wear, cracks or distortion.
(3) Hydraulic and pneumatic relief valve settings.
(4) Hydraulic system for proper oil level.
(5) Hydraulic and pneumatic fittings, hoses, and tubing for evidence of leakage, abnormal deformation or excessive abrasion.
(6) Compressors, pumps, motors, and generators for loose fasteners, leaks, unusual noises or vibrations, loss of operating speed, and excessive heating.
(7) Hydraulic and pneumatic valves for malfunction and visible cracks in the external valve housing, leaks, and sticking spools.
(8) Visually inspect any vacuum prevention systems and verify function of such systems on Category "A" aerial devices.
(9) Hydraulic and pneumatic cylinders and holding valves for malfunction and visible damage.
(10) Hydraulic and pneumatic filters for cleanliness and the presence of foreign material in the system indicating other component deterioration.
(11) Electrical systems and components for deterioration or wear including those not readily visible on a frequent inspection.
(12) Performance test of all boom movements.
(13) Condition and tightness of bolts and other fasteners.
(14) Welds as specified by the manufacturer.
(15) Legible and proper identification, operational, and instructional markings.

(16) If the aerial device is rated an insulated device, the electrical insulating components and system(s) shall be thoroughly inspected for lack of cleanliness and other conditions that compromise insulation. Then these components and system(s) shall be tested for compliance with the rating of the aerial device in accordance with one of the applicable methods and procedures as outlined in section 5.4.3 of this standard:

(a) If the aerial device is used for AC bare hand work, the unit shall undergo a 60 Hz test as shown in Table 2 at least every three years;

(b) If the aerial device is used for DC bare hand work, the unit shall undergo a DC test as shown in Table 2 at least every three years;

(c) After repair or modification of any component that crosses the insulating system(s), or the repair or replacement of an insulating component(s), the unit shall be dielectrically tested in accordance with section 5.4.3;

(d) An insulated replacement boom shall be tested to insure conformance to 5.3.3 by the supplier;

(e) Bare-hand work units shall be tested as shown in Table 1 after any major repair to the insulated boom or any insulated boom replacement.

Any suspected items shall be carefully examined or tested and a determination made by a qualified person as to whether they constitute a safety hazard. All unsafe items shall be replaced or repaired before use.

8.3 Inspection and Test Records.

(1) Items to be inspected shall be designated to the operator or other authorized person making frequent inspections. Records of frequent inspections need not be made. However, where a safety hazard is found, it shall be reported in writing to a person responsible for the corrective action and that report and a record of the correction shall be maintained for five years, or as required by applicable regulations.

(2) Written, dated and signed reports and records shall be made of periodic inspections and tests and retained for a period of five years or as required by applicable regulations.

8.4 Maintenance. Maintenance and frequency of maintenance shall be determined by the owner in accordance with the manufacturer's recommendations.
Welding repairs of components or welds, designated as critical in the manufacturer's manual, shall be made in accordance with the manufacturer's recommendations. Should the original manufacturer no longer exist an equivalent entity may determine the required procedure.

8.4.1 Maintenance Training. The owner shall train their maintenance personnel in inspection and maintenance of the aerial device in accordance with the manufacturer's recommendations and Section 8 of this standard.

8.5 Modifications. No modifications or additions which affect the stability, mechanical, hydraulic, or electrical integrity or the safe operation of the aerial device shall be made without the written approval of the manufacturer. If such modifications or changes are made, the capacity, operation, and maintenance instruction markings shall be changed accordingly. In no case shall the safety factors be reduced below those specified in this standard or below the manufacturers design safety factors, whichever are greater. Should the original manufacturer no longer exist, an equivalent entity may approve required modification.

8.6 Weight Distribution. Changes in loading or additions made to the mobile unit after the final acceptance that affect weight distribution shall meet applicable regulations by governmental agencies. In no case shall axle loads of the fully loaded vehicle exceed the Gross Axle Weight Ratings (GAWR) assigned by the manufacturer. Note: Any change in weight distribution may adversely affect stability.

8.7 Transfer of Ownership. When a change in ownership of an aerial device occurs, it shall be the responsibility of the seller to provide the manufacturer's manual(s) for that aerial device to the purchaser. It is the responsibility of the purchaser to notify the manufacturer of the unit

model and serial number and the name and address of the new owner within 60 days.

8.8 Markings. The markings on the aerial device shall not be removed, defaced, or altered. All missing or illegible markings shall be promptly replaced.

8.9 Parts. When parts or components are replaced they shall be identical in specification and function to the original aerial device parts or components or shall provide an equal or greater factor of safety.

8.10 Safety Bulletins. Owners shall comply with safety related bulletins as received from the manufacturer, dealer or installer.

8.11 Manuals. The owner shall insure that the operating manual(s) is stored on the mobile unit.

8.12 Training, Retraining, and Familiarization of Operators.

8.12.1 Owner as a Renter or Lessor. When an owner functions as a renter or lessor he shall have the same responsibilities as specified under Section 11 of this standard.

8.12.2 General Training. Only personnel who have received general instructions regarding the inspection, application and operation of aerial devices, including recognition and avoidance of hazards associated with their operation, shall operate an aerial device. Such items covered shall include, but not necessarily be limited to, the following issues and requirements:

(1) The purpose and use of manuals.
(2) That operating manuals are an integral part of the aerial device and must be properly stored on the vehicle when not in use.
(3) A pre-start inspection.
(4) Responsibilities associated with problems or malfunctions affecting the operation of the aerial device.
(5) Factors affecting stability.
(6) The purpose of placards and decals.
(7) Workplace inspection.
(8) Applicable safety rules and regulations, such as Part 4, ANSI C2-1997, National Electrical Safety Code (applies to utility workers as defined in ANSI C2). The above standard is an example; other industries using aerial devices have safety rules pertinent to that industry.
(9) Authorization to operate.
(10) Operator warnings and instructions.
(11) Actual operation of the aerial device. Under the direction of a qualified person, the trainee shall operate the aerial device for a sufficient period of time to demonstrate proficiency in the actual operation of the aerial device.
(12) Proper use of personal fall protection equipment.

8.12.3 Retraining. The operator shall be retrained, when so directed by the user, based on the user's observation and evaluation of the operator.

8.12.4 Familiarization. When an operator is directed to operate an aerial device he/ she is not familiar with, the operator, prior to operating, shall be instructed regarding the following items and issues:

(1) The location of the manuals.
(2) The purpose and function of all controls.
(3) Safety devices and operating characteristics specific to the aerial device.

9. Responsibility of Users.

9.1 General Responsibilities. Each user shall comply with the requirements of this section.

9.2 Personnel. Only trained and authorized personnel shall be permitted to operate the aerial device.

9.3 Training, Retraining, and Familiarization of Operators.

9.3.1 General Training. Only personnel who have received general instructions regarding the inspection, application and operation of aerial devices, including recognition and avoidance of hazards associated with their operation, shall operate an aerial device. Such items covered shall include, but not necessarily be limited to, the following issues and requirements:

(1) The purpose and use of manuals.
(2) That operating manuals are an integral part of the aerial device and must be properly stored on the vehicle when not in use.
(3) A pre-start inspection.
(4) Responsibilities associated with problems or malfunctions affecting the operation of the aerial device.
(5) Factors affecting stability.
(6) The purpose of placards and decals.
(7) Workplace inspection.
(8) Applicable safety rules and regulations, such as Part 4, ANSI C2-1997, National Electrical Safety Code. (Applies to utility workers as defined in ANSI C2). The above standard is an example; other industries using aerial devices have safety rules pertinent to that industry.
(9) Authorization to operate.
(10) Operator warnings and instructions.
(11) Actual operation of the aerial device. Under the direction of a qualified person, the trainee shall operate the aerial device for a sufficient period of time to demonstrate proficiency in the actual operation of the aerial device.
(12) Proper use of personal fall protection equipment

9.3.2 Retraining. The operator shall be retrained, when so directed by the user, based on the user's observation and evaluation of the operator.

9.3.3 Familiarization. When an operator is directed to operate an aerial device he/she is not familiar with, the operator, prior to operating, shall be instructed regarding the following items and issues:

(1) The location of the manuals.
(2) The purpose and function of all controls.
(3) Safety devices and operating characteristics specific to the aerial device.

9.4 Application. The employer and assigned operator shall insure that the aerial device is used only for intended applications as defined in the operating manual, and that recognized safety practices are observed.

9.5 Mobile Operation. Before and during driving, the driver shall:

(1) Avoid traveling on any surface that adversely affects vehicle stability.
(2) Maintain a safe distance from obstacles and overhead lines.
(3) Maintain communications between the driver and the operator.
(4) Under all travel conditions, the driver shall limit travel speed in accordance with conditions of the ground surface, congestion, and slope.

9.6 Alterations. Altering or disabling of safety devices, guards, or interlocks if so equipped shall be prohibited.

9.7 Bare-Hand Work. For bare-hand work, a Category "A" aerial device shall be used.

9.8 Lower Controls. The lower controls of aerial devices shall not be used for continuous operation with personnel in the platform.

10. Responsibilities of Operators

10.1 General Responsibilities. Each operator shall comply with the requirements of this section.

10.2 Operation. During operation of the aerial device all platform occupants shall use appropriate fall protection connected to the aerial device at the platform position.

10.3 Work Platform. The operator shall not use railings, planks, ladders or any other device in or on the work platform for achieving additional working height or reach.

10.4 Brakes. The vehicle parking brake(s) shall be set at all times that the boom is elevated except when the aerial device is being used in accordance with 9.5.

10.5 Loading. Any loading which includes a horizontal load shall be avoided unless the mobile unit is designed for that application.

10.6 Observations. Observations during operation for any defects shall be conducted on an ongoing basis.

10.6.1 Pre-start Inspection. Items determined by the owner in accordance with the manufacturer's recommendations for each specific aerial device shall be inspected for defects prior to each day's operation. The following tests and inspections shall be performed by the operator once daily, prior to first use:

(1) Operating controls and associated mechanisms for conditions interfering with proper operation.
(2) Visual and audible safety devices for malfunction.
(3) Hydraulic or pneumatic systems for observable deterioration or excessive leakage.
(4) Fiberglass and other insulating components for visible damage or contamination.
(5) Missing or illegible operational and instructional markings.
(6) Electrical systems of / or related to the aerial device for malfunction, signs of excessive deterioration, dirt and moisture accumulation.
(7) Visual inspection of bolts, pins, and other fasteners for loose, deformed or missing fasteners and other locking devices. Any suspected items shall be carefully examined or tested and a determination made by a qualified person as to whether they constitute a safety hazard. All unsafe items shall be replaced or repaired before use.

10.7 Worksite. Before the aerial device is used the worksite shall be surveyed for hazards such as:

(1) Untamped earth fills.
(2) Ditches.
(3) Dropoffs and floor obstructions.
(4) Debris.
(5) Overhead obstructions and electrical conductors.
(6) Weather conditions.
(7) Presence of unauthorized persons.

10.8 Precautions. Before and during each use the operator shall:

(1) Check for overhead obstructions and electrical conductors.
(2) Insure that the load on the platform and / or load lifting devices are in accordance with the manufacturer's rated capacity.
(3) Insure that outriggers and stabilizers are used if the manufacturer's instructions require their use.
(4) Insure that guardrails are properly installed, and the gates are closed.
(5) Use outrigger pads when necessary to provide firm footing.

10.9 Mobile Operation. Before engaging in mobile operation the operator shall determine that the aerial device is specifically designed for mobile operation.

10.10 Personnel. Only trained and authorized personnel shall be permitted to operate the aerial device.

10.11 Training, Retraining, and Familiarization of Operators.

10.11.1 General Training. Only personnel who have received general instructions regarding the inspection, application and operation of aerial devices, including recognition and avoidance of hazards associated with their operation, shall operate an aerial device. Such items covered shall include, but not necessarily be limited to, the following issues and requirements:

(1) The purpose and use of manuals.
(2) That operating manuals are an integral part of the aerial device and must be properly stored on the vehicle when not in use.
(3) A pre-start inspection.
(4) Responsibilities associated with problems or malfunctions affecting the operation of the aerial device.
(5) Factors affecting stability.
(6) The purpose of placards and decals.
(7) Workplace inspection.
(8) Applicable safety rules and regulations, such as Part 4, ANSI C2-1997, National Electrical Safety Code (applies to utility workers as defined in ANSI C2). The above standard is an example: other industries using aerial devices have safety rules pertinent to that industry.
(9) Authorization to operate.
(10) Operator warnings and instructions.
(11) Actual operation of the aerial device.

Under the direction of a qualified person, the trainee shall operate the aerial device for a sufficient period of time to demonstrate proficiency in the actual operation of the aerial device.

(12) Proper use of personal fall protection equipment.

10.11.2 Retraining. The operator shall be retrained, when so directed by the user, based on the user's observation and evaluation of the operator.

10.11.3 Familiarization. When an operator is directed to operate an aerial device he/she is not familiar with, the operator, prior to operating, shall be instructed regarding the following items and issues:

(1) The location of the manuals.
(2) The purpose and function of all controls.
(3) Safety devices and operating characteristics specific to the aerial device.

11. Responsibilities of Renters, Lessors or Lessees

11.1 General Responsibilities. Each renter or lessor or lessee shall comply with the requirements of the applicable section or sections below.

11.1.1 Lessor or Lessee as Dealer or Installer. When a lessor or lessee uses the aerial device as a dealer or installer he shall have the same responsibilities as specified under Section 7 of this standard.

11.1.2 Lessor or Lessee as Owner. When a lessor or lessee uses the aerial device as an owner he shall have the same responsibilities as specified under Section 8 of this standard.

11.1.3 Lessor or Lessee as User. When a lessor or lessee uses the aerial device as a user he shall have the same responsibilities as specified under Section 9 of this standard.

11.1.4 Lessor or Lessee as Operator. When a lessor or lessee uses the aerial device as an operator he shall have the same responsibilities as specified under Section 10 of this standard.

11.2 Ownership Duties. The renter or lessor shall carry out the duties of ownership specified in this standard which are not assigned to the renting entity or lessee as the user.

11.3 Obligations. Upon delivery each renter or lessor of an aerial device shall provide the operators manual and the ANSI/SIA A92.2-xxxx Manual of Responsibilities for dealers, owners, users, operators, lessors and lessees of Vehicle Mounted Elevating and Rotating Aerial Devices. These manuals shall be stored on the mobile unit.

11.4 Training. The renter or lessor shall offer training or training materials that aid the renting entity or lessee in the operation, inspection, testing and maintenance of the aerial device. This training shall be offered initially and subsequently on request.

11.4.1 General Training. Only personnel, who have received general instructions regarding the inspection, application and operation of aerial devices, including recognition and avoidance of hazards associated with their operation, shall operate an aerial device. Such items covered shall include, but not necessarily be limited to, the following issues and requirements:

(1) The purpose and use of manuals.
(2) That operating manuals are an integral part of the aerial device and must be properly stored on the vehicle when not in use.
(3) A pre-start inspection.
(4) Responsibilities associated with problems or malfunctions affecting the operation of the aerial device.
(5) Factors affecting stability.
(6) The purpose of placards and decals.
(7) Workplace inspection.
(8) Applicable safety rules and regulations, such as Part 4, ANSI C2-1997, National Electrical Safety Code (applies to utility workers as defined in ANSI C2). The above standard is an example; other industries using aerial devices have safety rules pertinent to that industry.
(9) Authorization to operate.
(10) Operator warnings and instructions.
(11) Actual operation of the aerial device. Under the direction of a qualified person, the trainee shall operate the aerial device for a sufficient period of time to demonstrate proficiency in the actual operation of the aerial device.
(12) Proper use of personal fall protection equipment.

11.4.2 Familiarization. When an operator is directed to operate an aerial device he/she is not familiar with, the operator, prior to operating,

shall be instructed regarding the following items and issues:

(1) The location of the manuals.
(2) The purpose and function of all controls.
(3) Safety devices and operating characteristics specific to the aerial device.

11.5 Communications. In the event the manufacturer or installer provides the renter or lessor manuals, bulletins, or other materials for the information of the user of an aerial device, the renter or lessor shall pass them on to the user without any undue delay.

1.3 PLATFORM SAFETY WARNINGS

DANGER

FAILURE TO OBEY FOLLOWING WILL RESULT IN DEATH OR SERIOUS INJURY

- TRUCK MUST BE SECURELY PARKED WITH PARKING BRAKE APPLIED, TRANSMISSION IN NEUTRAL AND AERIAL DEVICE PROPERLY STABILIZED PRIOR TO OPERATION.
- TO AVOID TIP-OVER, OUTRIGGERS (WHEN SO EQUIPPED) MUST BE PROPERLY EXTENDED ON A SOLID LEVEL SURFACE. USE GROUND BOARDS IF NOT ON SOLID SURFACE.
- OPERATE ALL CONTROLS SLOWLY FOR A SMOOTH PLATFORM MOTION TO MAKE SURE CONTROLS RETURNED TO NEUTRAL AFTER DESIRED OPERATION.
- CREW MUST USE PROPER PERSONAL AND OTHER PROTECTIVE EQUIPMENT.
- NEVER LOAD BEYOND RATED CAPACITY.
- NEVER OPERATE AERIAL DEVICE WITH PERSONNEL UNDER BOOM OR LOAD.
- KEEP AT LEAST (3) WRAPS OF LOADLINE ON WINCH DRUM WHEN SO EQUIPPED.
- NEVER MOVE THE TRUCK UNTIL THE BOOMS, OUTRIGGERS AND WHEN SO EQUIPPED AUGER AND WINCH LINE ARE IN A PROPERLY STOWED POSITION AND SECURED.
- REFER TO THE OPERATIONS MANUAL FOR COMPLETE INSTRUCTIONS. IF MISSING, REPLACE MANUALS.

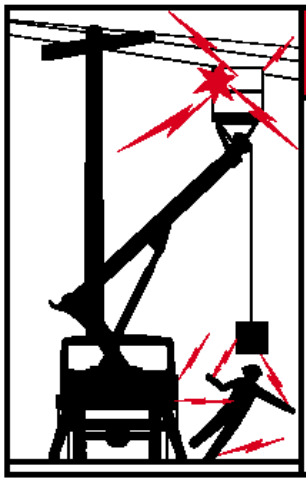
DO NOT PAINT OVER ANY LABELS 1003360 111193

DANGER

FALLING FROM PLATFORM WILL RESULT IN DEATH OR SERIOUS INJURY

PLATFORM PERSONNEL MUST WEAR BODY HARNESS WITH A LANYARD ATTACHED TO ANCHOR PROVIDED. PLATFORM DOOR, OR OPENING CHAIN, MUST BE SECURELY LATCHED.

DO NOT PAINT OVER ANY LABELS 1002300 011397



DANGER

ELECTROCUTION HAZARD
THIS MACHINE IS NOT INSULATED
DEATH OR SERIOUS INJURY
WILL RESULT FROM CONTACT WITH OR INADEQUATE CLEARANCE TO ELECTRICAL POWER LINES AND APPARATUS

- MAINTAIN SAFE CLEARANCE FROM ELECTRICAL POWER LINES IN ACCORDANCE WITH APPLICABLE GOVERNMENT REGULATIONS. ALLOW FOR BOOM, ELECTRICAL LINE AND LOADLINE SWAY.
- THIS MACHINE DOES NOT PROVIDE PROTECTION FROM CONTACT WITH OR PROXIMITY TO AN ELECTRICALLY CHARGED POWER LINE.

DO NOT PAINT OVER ANY LABELS 1001470 081792

DANGER

AN UNTRAINED OPERATOR SUBJECTS HIMSELF AND OTHERS TO DEATH OR SERIOUS INJURY
YOU MUST NOT OPERATE THIS MACHINE UNLESS

- YOU HAVE BEEN TRAINED IN THE SAFE OPERATION OF THIS MACHINE.
- YOU HAVE READ, UNDERSTAND AND FOLLOW THE SAFETY AND OPERATING RECOMMENDATIONS CONTAINED IN THE MACHINE MANUFACTURERS MANUALS, YOUR EMPLOYER'S WORK RULES AND APPLICABLE GOVERNMENT REGULATIONS.
- YOU ARE SURE THE MACHINE IS OPERATING PROPERLY AND HAS BEEN INSPECTED AND MAINTAINED IN ACCORDANCE WITH THE MANUFACTURERS MANUALS.
- YOU ARE SURE THAT ALL SAFETY SIGNS, GUARDS, AND OTHER SAFETY FEATURES ARE IN PLACE AND IN PROPER CONDITION.

DO NOT PAINT OVER ANY LABELS 1001 130 040794

1.4 JIB SAFETY

When Deploying or stowing the jib on this aerial device, always follow the instructions instruction found in this manual. The proper procedures can be found in Sections 1.8.1 for jib deployment and 1.8.2 for stowing of the jib. Read and follow these safety guidelines when using the jib.

A) The anti-two-block switch weight and cord must be attached to the jib when deployed.
B) Do not lift load with the boom tip when the jib is pinned on the boom tip.
C) Load Chart Interpretation with boom at full extension
   1) Operate with jib by radius when main boom is fully extended. If necessary, increase boom angle to maintain loaded radius.
   2) When radius is between points listed on capacity chart, the load shown at the next longer radius shall be used.
D) Load Chart Interpretation with boom not at full extension.
   1) Operate with jib by boom angle when main boom is not fully extended. Do not exceed rated jib capacities at any reduced boom lengths.
   2) When angle is between points listed on capacity chart, the load shown at next lower boom angle shall be used.

E) Ensure jib is stowed correctly.
   1) **Removal of swing-around pins, 'C' without proper installation of stow pin 'A' and jib-swing pin 'B', may allow jib to fall.**
   b. Extending boom with jib stowed and failure to remove swing pins 'C', will damage boom and/or jib.
F) Only attempt to swing jib to working or stowed position when boom is horizontal, stow pin 'A' and jib-swing pin 'B' are removed and swing pins 'C' are in place. Jib could swing uncontrollably if boom is not horizontal.
G) Crane shall be fully set up according to proper set-up procedures outlined previously when stowing or unstowing jib.
H) Operate boom and turn functions very slowly and carefully when using jib since jibs can increase boom length by 50%.
I) Area where jib swings around must be clear of obstructions and power lines when stowing and unstowing jib.
J) Use safety glasses when pounding pins with hammer.
K) Do not extend/retract boom unless boom is horizontal when stow pin ‘A’ and jib-swing pin ‘B’ are removed during stowing or unstowing procedures.
L) Always put spring clips in pins to ensure that they will stay in place.
M) When the jib is stowed, the boom can not be fully retracted if a boom tip attachment option is installed.
N) For manually extendable jib options:
   1) Extension retaining pin ‘E’ must always be installed before operation.
   2) All swing around (stow and unstowing) operations shall be done with jib retracted and pinned.
   3) Extendable section may slide out of 1st section jib when pin ‘E’ is removed. Keep personnel clear of area.

⚠ DANGER

Visually inspect all pin positions to assure jib is fully retracted into side stow brackets, jib stow attachment is secure, and all pins and spring clips are in their proper locations. Failure to properly secure the jib during stowing and erecting may allow the jib to fall. Serious personal injury or death could result.

Always have at least one, if not both of the following in place at all times:

- **Side stow bracket completely engaged into stow hook with stow pin 'A' properly in place.**
- **Both pins 'C1' in upper and lower jib holes properly in place through mating holes in boom tip.**

1.5 ROAD TRANSPORT

1) Make sure outriggers/stabilizers are retracted and removable pads stowed-if applicable. Always retract optional front bumper stabilizer before retracting outriggers and stabilizers.
2) Make sure platform auto-leveling is shut off and that the platform stow arrows are aligned.
3) Secure the load line, headache ball or hook block to travel attach point.
4) Boom must be in boom rest and retracted to the green indicator stripe.
5) Secure all items on the truck bed.
6) Disengage the PTO.
7) Inflate tires to proper pressure.
8) Release park brake.
9) Know the weight of the vehicle and items transported on deck. Do not exceed axle limits and bridge load limits.

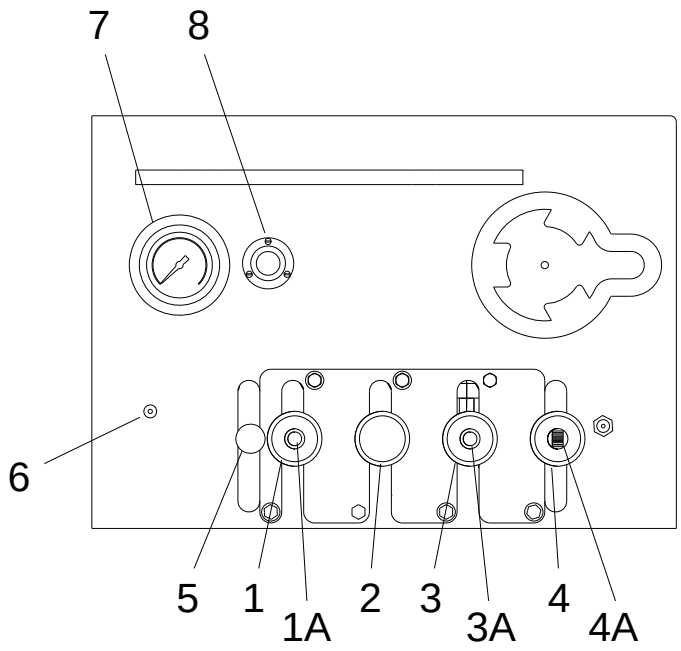
Know overall height and make sure there is clearance before entering underpasses and other overhead obstructions.

1.6 ON-SITE SETUP

1) Position the vehicle in an area free of overhead restrictions. Check capacity chart for picks required and position the aerial device in the proper place to complete the task safely.
2) Maintain a clearance of at least 10 feet (3.05M) between any part of the aerial device, load line or load and any electrical line carrying up to 50,000 volts. One additional foot (.30M) clearance is required for every additional 30,000 volts or less. Set ground markers in place to be used as a reference to assist in making sure the aerial device and load maintain minimum clearances required. Power lines and load lines deflect in wind and additional clearance must be provided. If the electrical line voltage is unknown, contact the utility and obtain the voltage prior to operation. All overhead wires must be considered energized until the electrical utility representative verifies that they are not and the wires are visibly grounded.
3) A qualified signal person shall be assigned to monitor the distance from the aerial device and load to energized power lines, and warn when approaching the minimum safe distance. Use non-conductive tag lines.
4) The aerial device must be set up on a firm, level surface with adequate support for outrigger/stabilizer loads. Thin concrete, hot asphalt and partially frozen ground may not support outrigger loads. Use cribbing to assist in distributing loads.
5) Always set the park brake and disengage the transmission.

6) Use a signal person to set the outriggers safely if not visible and avoid a crushing hazard.
7) Extend outriggers first so aerial device is level from side to side and raise vehicle front tires clear of the ground, but keep minimum distance above the ground especially on units that do not have a front stabilizer. Level aerial device using the bubble levels. Then extend stabilizers so aerial device is level from front to rear and rear tires are off ground. After the aerial device is level side-to-side and front-to-back, extend the front stabilizer (if equipped with option) until firm contact is made with the ground. Operating out of level will drastically reduce stability.
8) Run all controls and safety devices, including the anti-two block system, through a cycle prior to lifting loads.
9) Operate control levers and engine speed smoothly to avoid sudden starts and stops, which could cause loads to swing.
10) Do not side load the boom. Side loading can result in sudden structural failure or tipping.
11) Side loading occurs when rapidly starting and stopping swing operations, operating out of level, dragging or pulling loads sideways or operating in high winds.
12) Always position the boom head and loadline directly over the load before lifting and lift slowly to avoid swinging the load. Never drag a load or push down with the boom. When at or near maximum rated load tighten the loadline with the winch and then boom the load off the ground to keep the load from swinging to an increased radius due to boom deflection.
13) Always remember the load lifted includes the load weight, the hook block/headache ball weight, slings, and applicable options on the boom. When operating between boom lengths or radii on the load rating chart, use the next lower rated capacity.
14) Keep the load as close to the ground as possible.
15) Do not lift loads if wind can create a hazard. Winds aloft can be much stronger than at the ground.
16) Use multi-part rope reeving when required. Keep at least three full wraps of rope on the winch drum at all times. In some multi-parted cases, the hook block cannot be lowered to the ground if the boom tip is too high before all rope is unspooled from the winch.
17) Always keep space between the hook block and boom head when winching up or extending the boom to avoid two-blocking. **Do not rely on the two block system to eliminate two blocking.**
18) Do not allow anyone to ride the loadline, hook or load.
19) Only use Elliott approved personnel baskets attached to the boom or jib for lifting personnel.
20) Do not operate the aerial device if the anti-two block safety system is inoperative.
21) Do not operate the aerial device if the Load Moment Limiter/Load Moment Indicator System installed on the aerial device is inoperative.

1.7 OPERATING CONTROLS



Power Take-Off (PTO)
Located in the truck cab. Refer to truck manuals for operating instructions. PTO must be engaged to provide power to aerial device functions. Refer to truck manuals for operating instructions. ***CAUTION****: Driving truck with PTO engaged may damage hydraulic pump.*

Master Switch – Emergency Stop Switch
Located in the truck cab. Switch Master Switch to "ON" position, to operate aerial device.

Remote Control Switch
Located in the truck cab. On units equipped with remote controls, this switch activates the remote controls. Set the switch to the "ON" position to activate the remote controls. Set this position to the "OFF" position to turn remotes off. See operating instructions in the "Optional Remote Controls" section of this manual.

1.7.1 Boom Controls

1) **Swing Control Lever**
   Push forward - "RIGHT" position- Turret swings right - Clockwise
   Pull back - "LEFT" position – Turret swings left – Counterclockwise

1A) **Horn Button**
   Located on top of Swing control lever handle. Push in to activate horn.

2) **Boom Telescope Control Lever**
   Push forward -"OUT" position – Extends Boom Sections
   Pull back - "IN" position – Retracts Boom Sections.

3) **Winch Control Lever**
   Push forward -"DOWN" position – Winch pays out cable lowers load.
   Pull back - "UP" position – Winch winds up cable, raises load.

3A) **Winch Burst of Speed Switch**
   Located on top of Winch control lever handle. Depress button – High Speed winch operation.

4) **Boom Control Lever**
Push forward - “DOWN” position – Lowers boom.
Pull back - “UP” position – Raises boom

4A) **Truck Throttle Control Switch**
Located on top of Boom control lever handle. This switch can be used to control the truck engine throttle. To increase truck engine speed press and release. This speed varies due to differences in truck transmissions and engine sizes. To decrease engine speed, press and release.

5) **Option Valve Section**. Push down or pull forward to activate options hydraulically connected to option section

6) **Truck Start Switch**
This is a momentary switch used to start or stop the truck engine. Holding the switch in the start position, activates the starter. Release the switch as soon as the engine starts. Activate and hold the switch in the Stop direction to shut the truck off. Once the engine stops completely stops running, release the switch. If this switch is released while engine is still turning over, the truck will restart.

7) **Hyd. System Pressure Gauge**
Located inside control valve enclosure. Indicates Maximum pressure (0-3000 PSI) in the Winch and Function circuits. Does not display pressure in the swing circuit.

8) **Bubble Level**
Master Level located on subbase top plate, adjustable levels located at each outrigger control station. Once a week, operator shall verify that bubble located at control stations match the master level. Adjust levels in control stations if necessary. Use to level aerial device.

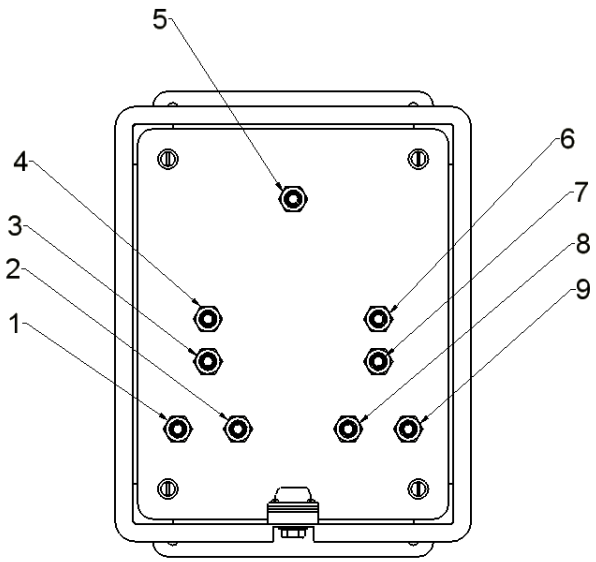
9) **Boom Angle Indicators**
Located on either side of base boom- indicates the angle of the boom (in degrees) above or below horizontal.
NOTE: For main boom, do not exceed the operating radius for the rated loads on the chart.

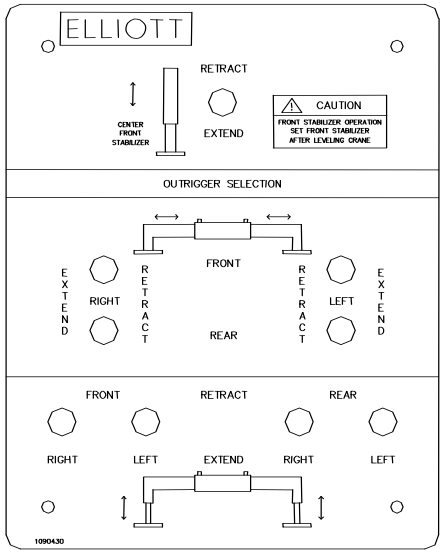
10) **Boom Length Indicators**
Located on either side of the first moving boom section. The letters correspond with the letters on the load chart.

11) **LMI (Load Moment Indicator) & Anti-Two Block Control**
See LMI Manufacturer manual for set-up and operation information. Set for proper boom/jib configuration prior to operation. LMI manufacturer manual is included with this manual. See table of contents for page number.

12) **Anti-Two block and LMI alarm**
If a two block or overload condition exists, the alarm horn will sound; telescope out, winch up and boom down will be disabled. Immediately correct this condition to prevent tipping or structural damage. Lowering the load to ground and/or retracting the boom will resolve the problem.

1.7.2 Outrigger Controls





***NOTE**: When deploying outriggers, always set the beams to either full or mid-span prior to lowering outrigger jacks. Always be sure to use correct load chart based on outrigger span. When stowing/raising outriggers, always raise outrigger jacks prior to retracting beams. Always set center front stabilizer last and retract first when stowing.*

1) **Right Front Outrigger Jack Switch** – Activate switch up or down to raise or lower right front outrigger jack.
2) **Left Front Outrigger Jack Switch** – Activate switch up or down to raise or lower left front outrigger jack.
3) **Right Rear Outrigger Beam Switch** – Activate switch left or right to extend or retract right rear outrigger beam.
4) **Right Front Outrigger Beam Switch** – Activate switch left or right to extend or retract right front outrigger beam.
5) **Center Front Stabilizer Switch** – Activate switch up or down to raise or lower center front stabilizer. This stabilizer should always be lowered last and raised first.
6) **Left Front Outrigger Beam Switch** – Activate switch left or right to retract or extend left front outrigger beam.
7) **Left Rear Outrigger Beam Switch** – Activate switch left or right to retract or extend left rear outrigger beam
8) **Right Rear Outrigger Jack Switch** – Activate switch up or down to raise or lower right rear outrigger jack.
9) **Left Rear Outrigger Jack Switch** – Activate switch up or down to raise or lower left rear outrigger jack.

***NOTE**: Left and right are based on operator's left and right as he stands at outrigger control box facing the front of the truck.*

1.7.3 Platform/Remote Controls

⚠ DANGER

DANGER ELECTROCUTION HAZARD
This aerial platform is not insulated unless insulated jib is properly deployed. (See Jib deployment procedures in section 1.8 of this manual) The remote control provides no protection against electrocution hazards. Do not operate near live electrical power lines unless insulated jib is properly deployed. All warnings in the Safety & Operation Section of this manual and on the aerial device relative to operating and safety procedures and power line clearances must be observed when using the aerial device remote controls.

In order to maintain a safe machine, a regular function check of the platform/radio control system is necessary. This check shall include verifying all safety features are operational before using this system. **Controls are equipped to be connected to hard wired communication cable or be used as radio remote controls.**

Never allow anyone to operate the system until the operator has read all instructions and has become completely familiar with the total remote control system. In the event any unexplained, unpredicted, or incorrect operation occurs, immediately shut down the complete system and investigate. This includes shutting down all electronics, hydraulics, PTO's and engines. Never resume operation unto the problem has been corrected.

When not using the remote controls, switch the transmitter off by pressing the Emergency Stop Button. Verify that the button locks itself in, and then make sure the remote control power switch is switched to the off position. This will prevent inadvertent operation of the aerial device by activation of the transmitter joysticks.

Operation
If the truck is running when the remotes are switched on, the truck engine will shut off and the truck will need to be restarted using the remote controls. This can be done by following the instructions found later in this section. This remote control system is designed for use either single or multiple functions at once and is fully proportional. See joystick and switch designations found in the transmitter section of this text for specifics on operation of each joystick and switch.

Aerial device and Option Function Joysticks: This transmitter is equipped with seven single axis joysticks for the following boom functions; boom swing, telescope, spare, spare, aux winch, main winch and boom lift and eight toggle switches to operate the following functions; Transmitter power/Enable/Calibrate, Truck Start/Stop, Operation control Range, Emergency Pump, Aux Winch, Main winch Speed, LMI / ATB function cutout Override and Main Winch disable, and engine speed.

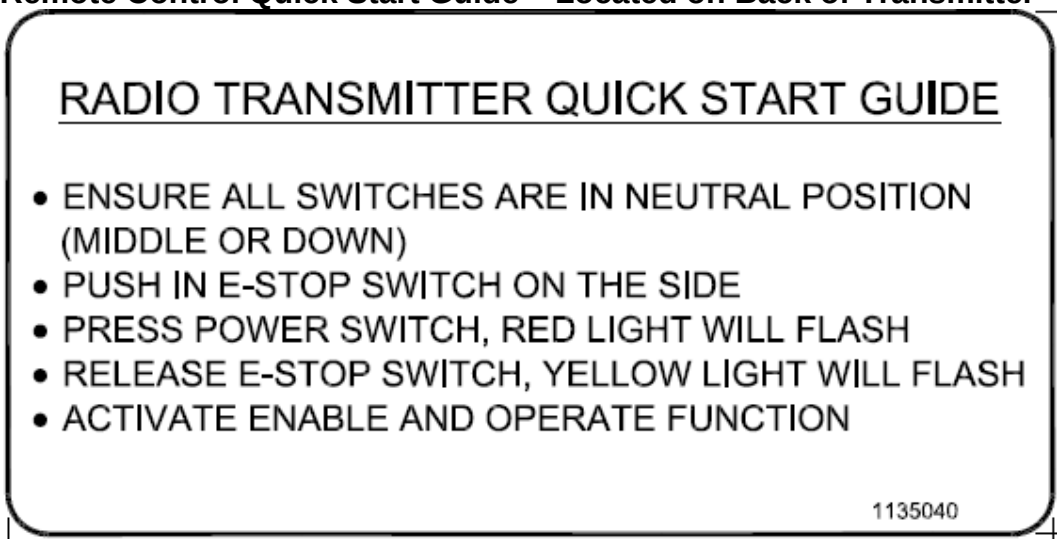
When the joystick is in the center position, the function is inactive. Moving the joystick from the center position initiates function movement. The speed of the function is increased proportionally with the movement of the joystick farther from the center position. The speed of the function is also decreased proportionally with the movement of the joystick back towards the center position. For smooth boom &

platform operation slowly meter the joystick away from the center position. Multiple functions can be operated simultaneously with this system. The layout of the joysticks and switches on the transmitter are shown in the pictures that follow. Refer to these pictures and the descriptions of each joystick/switch operation below the drawing.

The proportional joysticks can be calibrated to the operator's preference by following calibration procedures found in the component operator's manual in section 4.2 of this manual.

Platform/Radio Remote Control Transmitter

Remote Control Quick Start Guide – Located on Back of Transmitter



Remote Control Receiver and Communication Modules

LMI Display on Transmitter

Elliott remote controls provide the operator with the same load and capacity information to the operator using the remote controls as if they were operating from the operator's cap or platform. This provides the operator in the platform or at the hook point with boom length, angle and load radius information along with allowable load and actual load values

Switch Label

Joystick Label

Indicator Panel

Indicator Panel lights are from left to right: Battery/Pendant, Active, E-Stop. For complete information on interpreting these lights, see section 4.2 of this manual.

Complete Remote Control System Manufactures Manual is included with this manual in section 4.2. Refer to this section for complete troubleshooting, calibration, and communication information.

Powering up the transmitter.
To start using the remote controls, this sequence must be followed to power up the transmitter for use. These procedures are also located on a decal on the bottom side of the transmitter.

1) Ensure all switches and joysticks are in the neutral position. Any two position toggle switches need to be in the lower position. (Transmitter will not power up if the switches are not in neutral position).

2) Select and release the Power switch in the “ON/Horn” direction.
The Red, Emergency Stop light will flash quickly.

3) Release the Emergency Stop (Red button on side of transmitter) by rotating clockwise.
The yellow (Active) light on the transmitter will begin to flash.

Power, ON/Enable, Horn, Calibrate Button
This pushbutton switch needs to be depressed before operating any of the joysticks. The horn will sound momentarily when the button is pushed to alert personnel in the working area

that aerial device movement is about to begin. Any time the transmitter is inactive, the enable will stay active for 15 seconds, then this switch needs to be activated again.

Start/Stop Switch
This is a momentary switch used to start or stop the truck engine. Holding the switch in the start position, within 5 seconds of pressing the enable button, activates the starter. Release the switch as soon as the engine starts. Activate and hold the switch in the Stop direction to shut the truck off. Once the engine stops completely stops running, release the switch. If this switch is released while engine is still turning over, the truck will restart.

Emergency Stop Button (Red pushbutton on side of transmitter)
Press this button down to stop remote operation and to the truck engine. When the emergency stop button is pushed down completely, it locks itself in the depressed state. To release the emergency stop button, turn the button clockwise and the button will pop back out allowing the transmitter to operate again. If this button is depressed, the transmitter will not function.

Control Range Switch
With this switch set to High, full activation of the joystick will move the valve spool to its maximum flow position. Setting this switch to Low, full movement of the joystick will move the control valve spool approximately 50% of the spool travel. Setting this switch at Low does not necessarily provide half speed of the function. The operator can toggle back and forth between these options based on load or proximity of the aerial device to other objects.

Emergency Pump Switch
This momentary switch can be used to operate the Emergency by holding in either direction. To operate the unit with the emergency pump, hold this switch and activate desired functions.

Aux Winch (Optional)
This button is used to turn on or off the optional aux winch. If this switch is in the center/neutral position, the aux winch joystick is active, selecting the “HIGH” position activates the high speed winch feature. Selecting the “DISABLE” position de-activates the aux winch.

Winch
This button is used to select the speed of the main winch. turn on for “HIGH” speed winch operation, off for “LOW” normal winch operation.

Override / Winch Disable
This switch turns on or off the main winch, and provides an override of the LMI / ATB function lockout. To disable the main winch, select this switch to the “WINCH DISABLE” position. To override the LMI / ATB function cutout, select this switch to the “OVERRIDE” position.

Engine Speed Switch
Activate momentary toggle switch to change engine speed between High Idle and Idle.

Boom Swing Joystick
This joystick operates the boom rotation system.
Push forward - “CW” position to swing boom clockwise.

Pull back - “CCW” position to swing boom counter clockwise.

Boom In/Out Joystick
This joystick operates the boom telescoping system.

Push forward -“OUT” position to extend boom.
Pull back - “IN” position to retract boom

Aux Winch Joystick (Optional)
This joystick operates the optional aux winch. To pay out winch line or lower load, activate this joystick in the “DOWN” direction. To reel in winch line or raise load, activate this joystick in the “UP” direction.

Winch Joystick
This joystick operates the main winch. To pay out winch line or lower load, activate this joystick in the “DOWN” direction. To reel in winch line or raise load, activate this joystick in the “UP” direction.

Boom Up/Down Joystick
This joystick operates the boom lift cylinder.

Push forward - “DOWN” position – Lowers boom.
Pull back - “UP” position – Raises boom

1.8 JIB OPERATION

The anti-two-block switch weight and cord must be attached to the jib when deployed.
Do not lift load with the boom tip when the jib is pinned on the boom tip.
a. Operate with jib by radius when main boom is fully extended. If necessary, increase boom angle to maintain loaded radius.

b. When radius is between points listed on capacity chart, the load shown at the next longer radius shall be used.
a. Operate with jib by boom angle when main boom is not fully extended. Do not exceed rated jib capacities at any reduced boom lengths.

b. When angle is between points listed on capacity chart, the load shown at next lower boom angle shall be used.
Ensure jib is stowed correctly.
a. Removal of swing-around pins, 'C' without proper installation of stow pin 'A' and jib-swing pin 'B', may allow jib to fall.
b. Extending boom with jib stowed and failure to remove swing pins 'C', will damage boom and/or jib.
Only attempt to swing jib to working or stowed position when boom is horizontal, stow pin 'A' and jib-swing pin 'B' are removed and swing pins 'C' are in place. Jib could swing uncontrollably if boom is not horizontal.
Crane shall be fully set up according to proper set-up procedures outlined previously when stowing or unstowing jib.
Operate boom and turn functions very slowly and carefully when using jib since jibs can increase boom length by 50%.
Area where jib swings around must be clear of obstructions and power lines when stowing and unstowing jib.
Use safety glasses when pounding pins with hammer.
Do not extend/retract boom unless boom is horizontal when stow pin ‘A’ and jib-swing pin ‘B’ are removed during stowing or unstowing procedures.
Always put spring clips in pins to ensure that they will stay in place.
When the jib is stowed, the boom can not be fully retracted if a boom tip attachment option is installed.
For manually extendable jib options:
Extension retaining pin ‘E’ must always be installed before operation.
All swing around (stow and unstowing) operations shall be done with jib retracted and pinned.
Extendable section may slide out of 1st section jib when pin ‘E’ is removed.
Keep personnel clear of area.

1.8.1 Deployment Procedure

Using boom telescope function, fully retract boom.
Using lift function, lower boom to allow for easier access to jib deployment pins ‘C1’ and ‘C2’.
Install pins ‘C1’ in upper and lower jib ears. Install retainer spring clips. These pins will be used as a pivot point to swing jib into the deployed position.
Locate the stowed position of pins ‘C2’. If in jib attachment holes or boom sheave case jib holes, remove pins from storage location.
Remove jib-swing pin ‘B’ from top ear of jib.
Remove stow pin ‘A’ from ramp/side stow bracket assembly on jib.
Attach tag line to sheave case end of jib.
Using lift function, raise boom to a horizontal position.
Using telescope function, slowly extend boom approximately one foot. This will pull the jib out of the stow bracket.

⚠ CAUTION

Use Caution during this step. The jib is free to swing away from the boom upon boom extension.

Using tag line, swing jib into deployed position.
Remove cable keeper pins from boom sheave case and jib. Remove hook block. Pivot jib slightly to allow for loadline to be removed from boom sheave case. Remove loadline from boom sheave case and place in an area to minimize possible damage.
Pivot jib into place, visually aligning the upper 'C2' pin holes. Install upper 'C2' pin and spring clip. A slight hammer strike may be necessary to install pins. Always use proper eye protection during this step.
Install lower 'C2' pin and spring clip. A slight hammer strike may be necessary to install pins. Always use proper eye protection during this step.
Using winch function, unspool enough loadline to reeve loadline over jib sheave case. Keep slight tension on loadline to avoid bird caging of loadline on winch drum.
Route loadline over jib sheave and install keeper. Install line bock to end of loadline.
Remove anti-two-block weight/chain assembly from boom tip switch and install on jib top switch. Be certain to use keeper provided with switch.
Install jib swing pin 'B' and spring clip into jib ears.
Remove tag line from jib sheave case.
For manually extendable jibs, pull extension retention pin 'E', and extend second section out by pulling on sheave case. The second section jib, as it extends, will hit a mechanical stop that allows for extension pin 'E' installation. Install pin and spring clip.

1.8.2 Stowing Procedure

Using lift function, lower boom so that jib tip is close to the ground.
For manually extendable jibs, pull extension retention pin and fully retract extendable 2nd section jib into the 1st section.
Reinstall extension retention pin through the 1st and 2nd section jib assembly and install spring clip.
Remove loadline from jib sheave case. Place loadline in area to avoid possible damage from stow procedure.
Move anti-two-block weight assembly to boom tip switch.
Attach tag line to sheave case end of jib.
Remove spring clips from pins 'C2' on both upper and lower jib ears.
Remove pins 'C2' from upper and lower jib ears. Co not remove 'C1' pins at this time. 'C1' pins will be used as a pivot point to swing jib into stowed position. A slight hammer strike may be necessary to remove pins. Always use proper eye protection during this step.
Using lift function, raise boom to a horizontal position.
Using telescope function, extend boom approximately 1 foot.
Using tag line, slowly swing jib into stow position (parallel with 1st section boom). Pins 'C1' are the jib pivot points during this operation.

⚠ CAUTION

Use Caution when swinging jib to avoid unnecessary impact with 1st section.

Install jib-swing pin 'B' with spring clip through jib ear and boom sheave case holes. This pin will keep the jib assembly in line (parallel) with the 1st section boom. Jib swing pin 'B' does not retain the jib in its stowed position on the 1st section boom.
Using boom telescope function, slowly retract boom. The ramp/side stow bracket assembly on the side of the 1st section jib will engage the hook on the side of the 1st section boom, first lifting the jib and then engaging the jib side stow bracket and the boom hook completely upon full retraction of the boom.
Install stow pin 'A' with spring clip into the ramp/side stow bracket assembly on the jib. Complete engagement of stow brackets and proper installation of pin 'A' is critical for secure jib stow attachment.
Remove pins 'C1' from upper and lower jib ears. A slight hammer strike may be necessary to remove pins. Always use proper eye protection during this step.

⚠ DANGER

Reinstall loadline over boom sheave case.

Visually inspect all pin positions to assure jib is fully retracted into side stow brackets, jib stow attachment is secure, and all pins and spring clips are in their proper locations. Failure to properly secure the jib during stowing and erecting may allow the jib to fall. Serious personal injury or death could result.

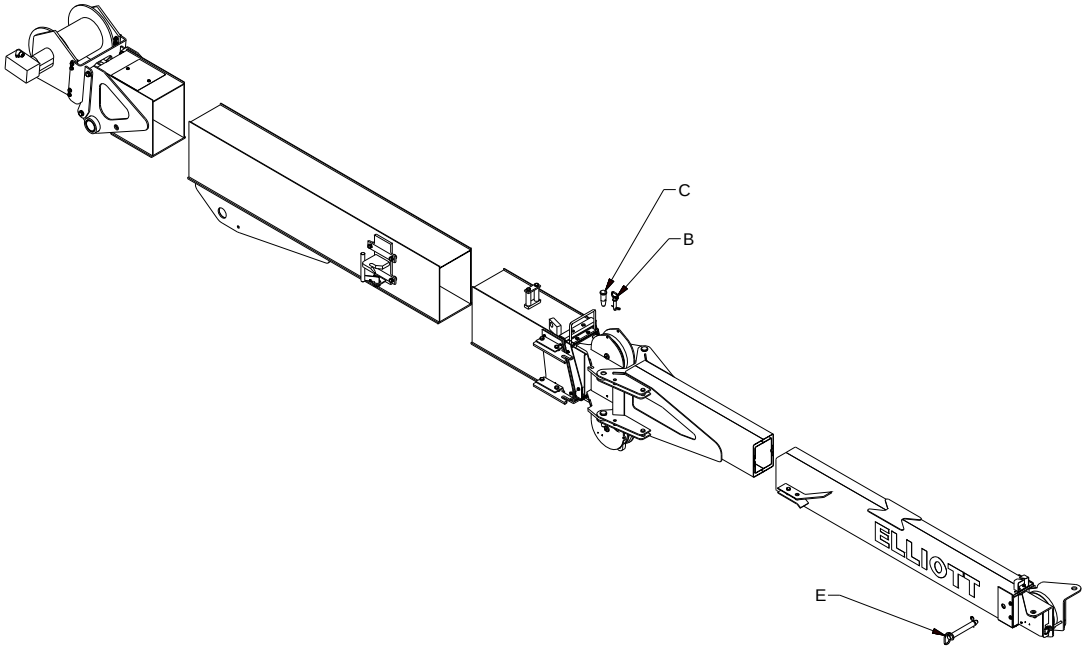
Always have at least one, if not both of the following in place at all times:
Side stow bracket completely engaged into stow hook with stow pin 'A' properly in place.
Both pins 'C1' in upper and lower jib holes properly in place through mating holes in boom tip.

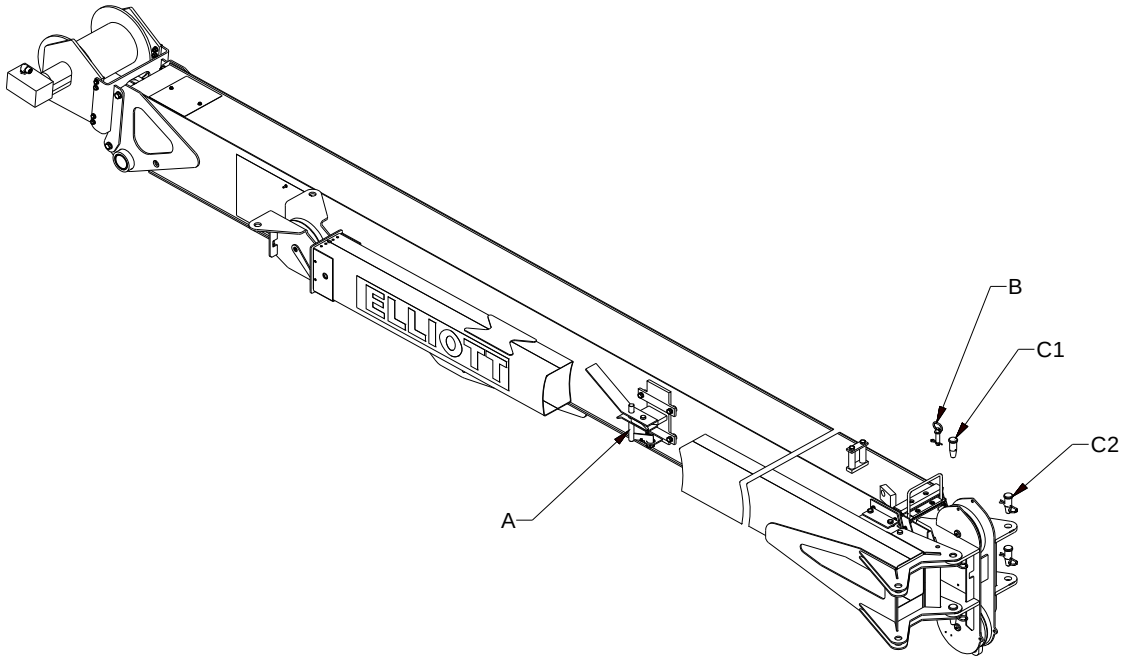
1.8.3 Jib Maintenance

Lubricate sheave pin on jib with grease gun containing chassis grease weekly.
Check for free rotation of jib sheave daily when using jib.
Lubricate jib sheave case pivot pin with grease gun containing chassis grease monthly.

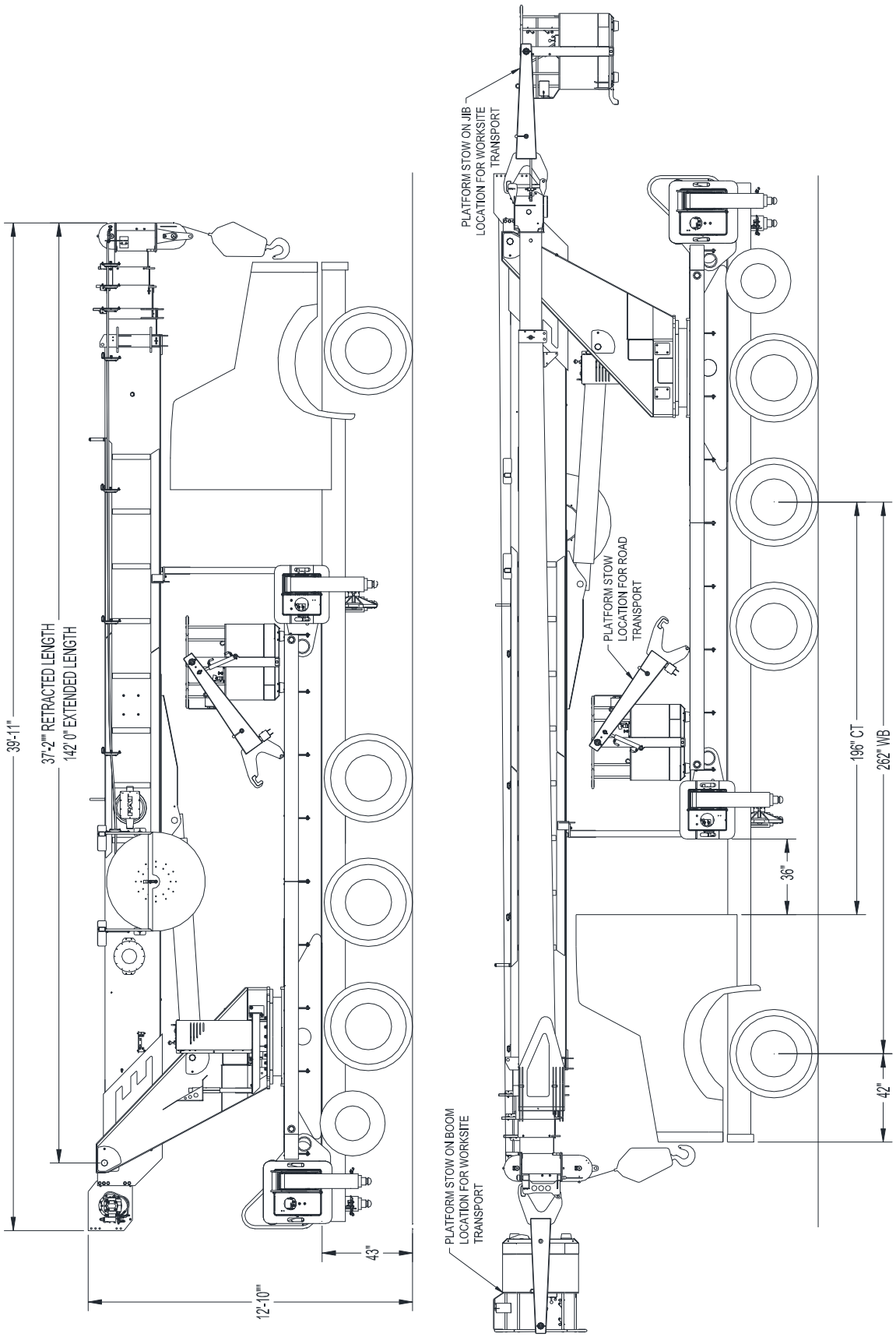
1.8.4 Jib removal

Should jib removal from the boom become necessary, proceed as follows:
Unstow and swing jib into position on the boom tip according to steps 1-10 in the preceding jib deployment section.
Support and raise the jib at its balance point and remove the two swing around pins. Jib is now free of boom.
To install, proceed in reverse order of removal.


C
B
ELLIOTT
E


ELLIOTT
B
C1
C2
A

1.9 Presentation Drawing



1.10 LOAD CHARTS

1.10.1 Material Handling – Main Boom

ELLIOTT EQUIPMENT COMPANY

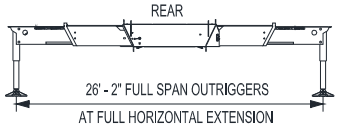
MODEL E160

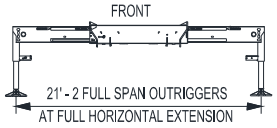
MAIN BOOM LOAD RATINGS WITH FULLY EXTENDED OUTRIGGERS LMI MODES: HOOK - w/BSKT & HOOK - NoBSKT

MAIN BOOM LOAD RATINGS WITH BASKET ATTACHED LMI MODE: HOOK - w/BSKT

LOAD RATINGS IN lbs WITH OUTRIGGERS AND STABILIZERS EXTENDED

LOAD RADIUS IN FEET	LOADED BOOM ANGLE	35-ft	LOADED BOOM ANGLE	A 47-ft	LOADED BOOM ANGLE	B 61-ft	LOADED BOOM ANGLE	C 74-ft	LOADED BOOM ANGLE	D 88-ft	LOADED BOOM ANGLE	E 101-ft	LOADED BOOM ANGLE	F 115-ft	LOADED BOOM ANGLE	G 128-ft	LOADED BOOM ANGLE	H 142-ft	
7	75.4	30,000																	
8	73.2	30,000																	
10	71.0	30,000	76.7	26,200															
12	67.3	30,000	74.3	26,200	79.1	26,200													
15	61.7	30,000	70.5	26,200	76.3	25,900	79.5	22,200											
20	50.9	27,500	63.6	25,700	71.4	20,700	75.7	19,200	78.7	14,900									
25	38.1	19,000	56.0	19,200	66.3	20,000	71.5	17,400	75.2	12,500	77.8	10,300							
30	19.3	14,000	47.8	14,300	60.6	17,850	67.2	14,750	71.7	10,900	75.0	9,400	77.5	7,700	79.3	6,500			
35			38.0	11,000	54.5	11,200	62.8	11,400	68.1	10,500	72.0	8,400	75.0	6,800	77.0	5,700	79.1	3,500	
40			25.2	8,600	48.0	8,800	58.0	9,040	64.4	9,000	68.8	8,000	72.2	6,000	74.9	5,000	77.0	3,500	
45					40.7	7,100	52.9	7,300	60.6	7,350	65.6	7,400	69.8	5,200	72.6	4,400	74.8	3,500	
50					31.9	5,700	47.3	5,800	56.5	5,900	62.3	6,000	67.0	5,100	70.1	4,000	72.7	3,000	
55					19.8	4,700	41.2	4,750	52.3	4,850	59.1	4,900	64.2	4,800	67.6	3,400	70.5	2,700	
60							34.9	3,850	48.0	3,900	55.5	4,000	61.2	4,000	65.0	3,300	68.3	2,400	
65							26.4	3,050	43.0	3,100	51.8	3,250	58.1	3,200	62.4	3,200	65.9	2,300	
70							12.9	2,350	37.3	2,450	47.6	2,550	55.0	2,500	59.7	2,500	63.6	2,200	
75									30.8	1,850	43.1	1,950	54.6	1,950	56.9	2,000	61.2	2,100	
80									22.5	1,300	38.2	1,400	47.8	1,450	54.0	1,450	58.7	1,550	
85											32.7	950	43.8	1,050	50.8	1,150	56.2	1,150	
90											26.1	600	39.6	700	47.4	780	53.5	780	
95															43.8	450	50.7	450	
	0	12,100	0	7,100	0	4,000	0	2,200	0	900									
		950		700		550		450		400		350		300		250		200	DEDUCTIONS FOR STOWED EXTENDABLE JIB (lbs)
LMI MODE: HOOK - NoBSKT		600		600		600		600		600		600		600		600		600	ADDITIONAL CAPACITY WHEN PLATFORM IS DETACHED (lbs)





ELLIOTT EQUIPMENT CO. SUPPLIED LOADLINE EQUIPMENT DEDUCTIONS:

DOWNHAUL WEIGHT.....225 lbs
ONE SHEAVE BLOCK.....424 lbs
TWO SHEAVE BLOCK.....592 lbs
THREE SHEAVE BLOCK.....639 lbs
FOUR SHEAVE BLOCK.....762 lbs
AUXILIARY SHEAVE.....100 lbs

DO NOT PAINT OVER ANY LABELS 1179860 110812

1.10.2 Range Diagram – Main Boom

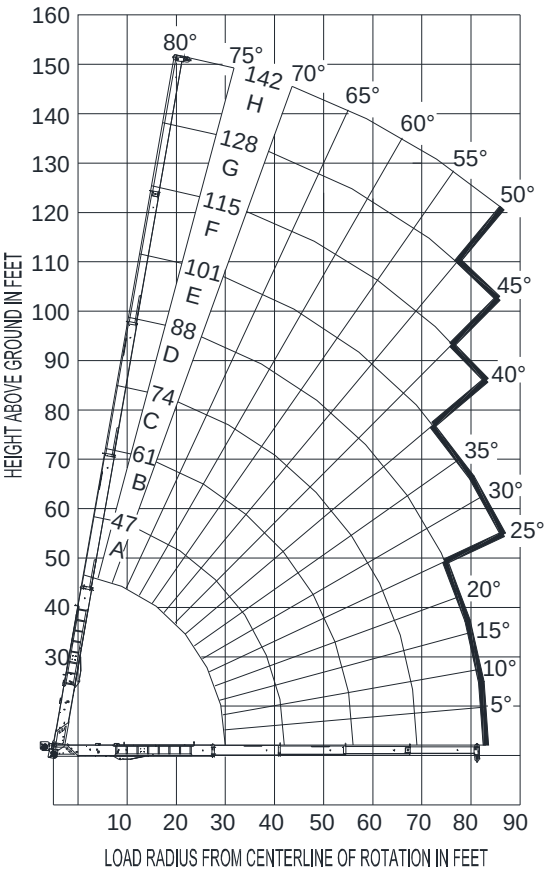
ELLIOTT EQUIPMENT COMPANY

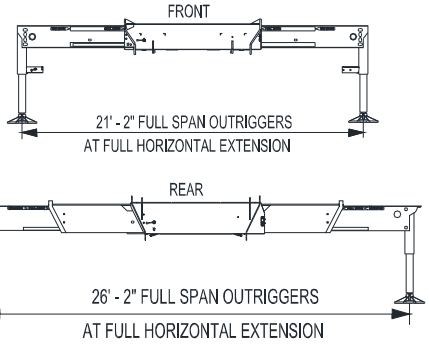
MODEL E160

RANGE DIAGRAM WITH FULLY EXTENDED OUTRIGGERS

LMI MODES: HOOK - w/BSKT & HOOK - NoBSKT

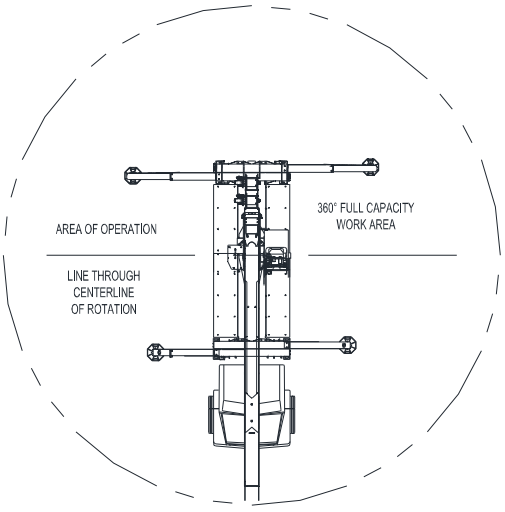
RANGE DIAGRAM WITH FULL SPAN OUTRIGGERS





NOTE:

1. Operate jib by radius when main boom is fully extended. Increase boom angle if necessary to maintain load radius.
2. When boom is retracted, operate jib by boom angles. Do not exceed any rated jib capacities at reduced boom lengths.
3. Boom load ratings are based on loaded boom radius. Loaded boom angles are given as reference only.
4. Personnel handling is allowed only with full span outriggers.



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1.10.3 Material Handling - Jib

ELLIOTT EQUIPMENT COMPANY

MODEL E160

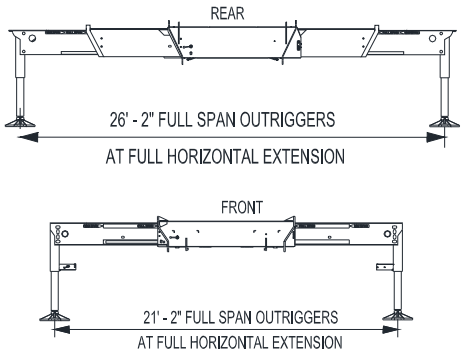
JIB LOAD RATINGS WITH FULLY EXTENDED OUTRIGGERS

LMI MODES: 32' JIBRET & 55' JIBEXT

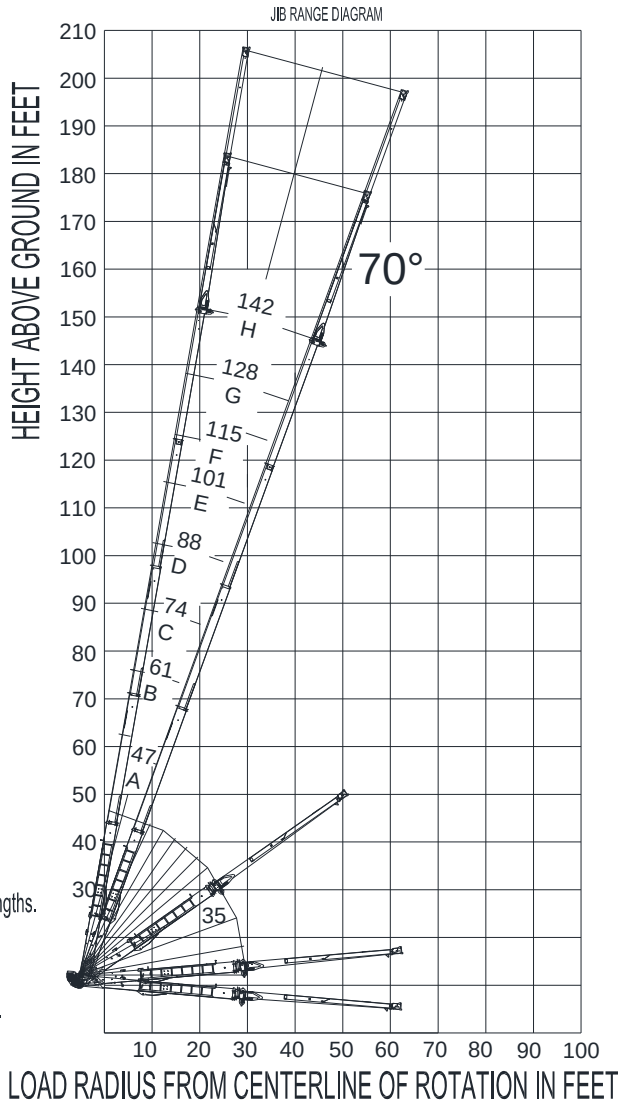
32'-55' TWO SECTION JIB

LOAD RADIUS IN FEET	LOADED BOOM ANGLE	32-ft JIB 360°	LOAD RADIUS IN FEET	LOADED BOOM ANGLE	55-ft JIB 360°
33	80	1,400	40	80	900
50	75	1,400	59	75	900
65	70	450	76	70	300
LMI MODE: 32' JIB RET			LMI MODE: 55' JIB EXT		

DO NOT OPERATE JIB IN WINDS EXCEEDING 15MPH



NOTE:
1. Operate jib by radius when main boom is fully extended. Increase boom angle if necessary to maintain load radius.
2. When boom is retracted, operate jib by boom angles. Do not exceed any rated jib capacities at reduced boom lengths.
3. Boom load ratings are based on loaded boom radius. Loaded boom angles are given as reference only.
4. Personnel handling is allowed only with full span outriggers.



DO NOT PAINT OVER ANY LABELS 1179860 110812

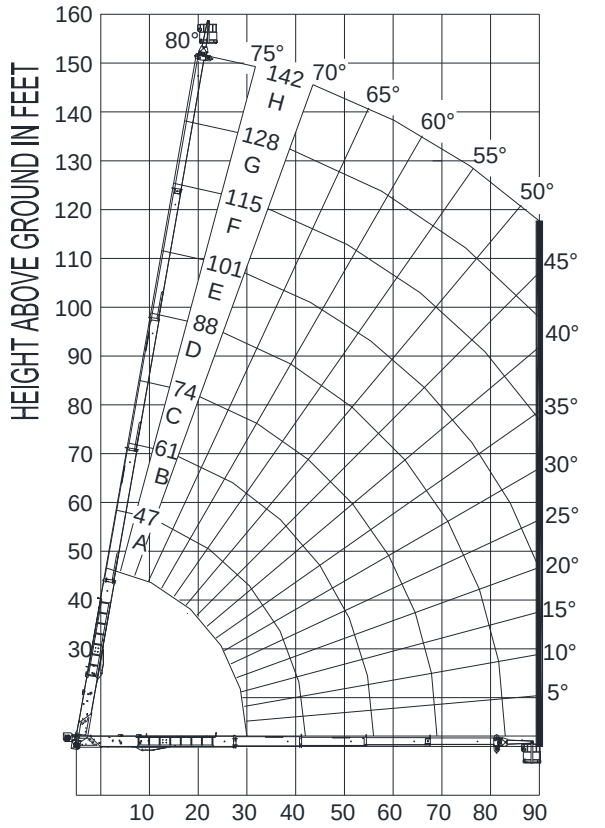
1.10.4 Platform Range Diagram – 600 lb. Main Boom

ELLIOTT EQUIPMENT COMPANY

MODEL E160

BOOM RANGE DIAGRAM WITH PLATFORM ATTACHED — LMI MODE: BSKT - MAINBM

LOAD RADUIS IN FEET	LOADED BOOM LENGTH	LOADED BOOM ANGLE
90	90	0
90	101	26.1
90	115	39.6
90	128	47.4
90	142	53.5



PERSONNEL 600 LBS MAX

USE OUTRIGGERS AT ALL TIMES

NOTE:
1. Personnel handling is allowed only with full span outriggers.
2. Boom load ratings are based on loaded boom radius. Loaded boom angles are given as reference only.

DO NOT PAINT OVER ANY LABELS 1179860 110812

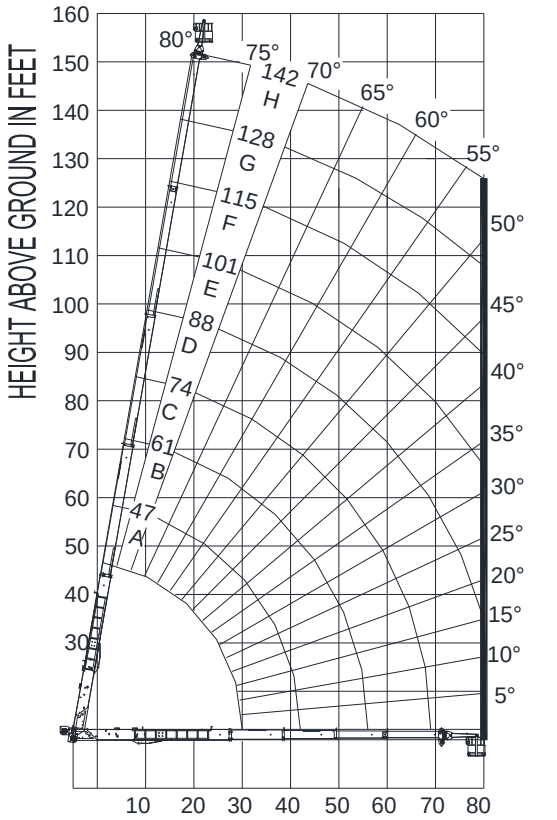
1.10.5 Platform Range Diagram – 1200 lb. Main Boom

ELLIOTT
EQUIPMENT COMPANY

MODEL E160

BOOM RANGE DIAGRAM WITH PLATFORM ATTACHED — LMI MODE: BSKT - MAINBM

LOAD RADUIS IN FEET	LOADED BOOM LENGTH	LOADED BOOM ANGLE
80	80	0
80	88	22.5
80	101	38.2
80	115	47.8
80	128	54.0
80	142	58.7



PERSONNEL 1200LBS MAX

USE OUTRIGGERS AT ALL TIMES

NOTE:
1. Personnel handling is allowed only with full span outriggers.
2. Boom load ratings are based on loaded boom radius. Loaded boom angles are given as reference only.

DO NOT PAINT OVER ANY LABELS 1179860 110812

1.10.6 Platform Range Diagram – 600 lb Jib Retracted

ELLIOTT EQUIPMENT COMPANY

MODEL E160

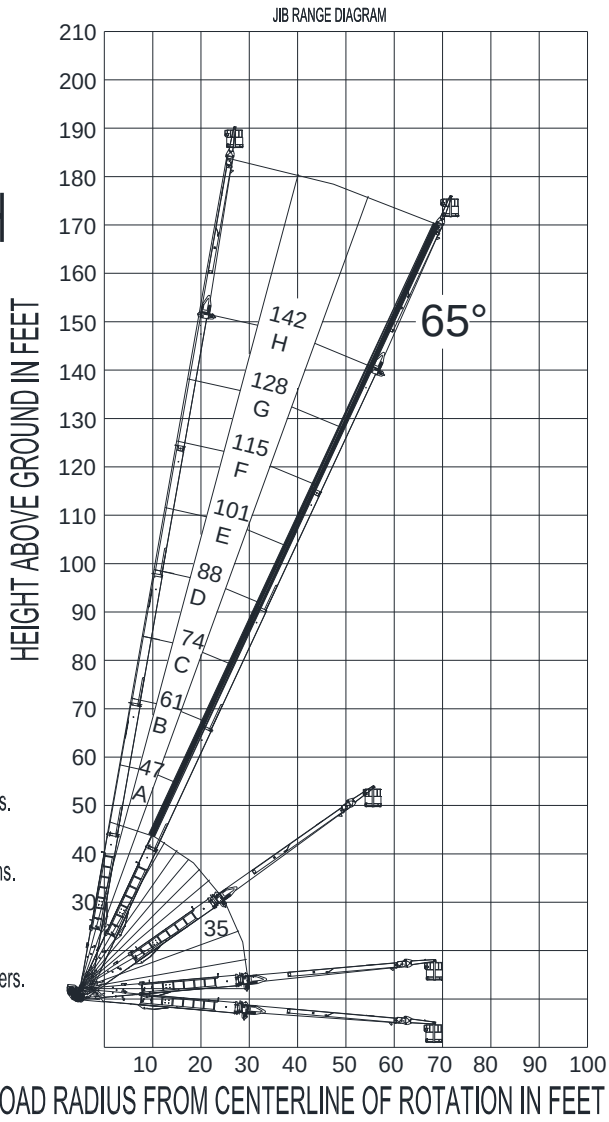
2 PIECE FULLY RETRACTED JIB RANGE DIAGRAM WITH PLATFORM ATTACHED

LMI MODE: BSKT - JIBRET

PERSONNEL 600LBS MAX

DO NOT OPERATE JIB IN WINDS EXCEEDING 15MPH

USE OUTRIGGERS AT ALL TIMES



NOTE:
1. Operate jib by radius when main boom is fully extended. Increase boom angle if necessary to maintain load radius.
2. When boom is retracted, operate jib by boom angles. Do not exceed any rated jib capacities at reduced boom lengths.
3. Boom load ratings are based on loaded boom radius. Loaded boom angles are given as reference only.
4. Personnel handling is allowed only with full span outriggers.

DO NOT PAINT OVER ANY LABELS 1179860 110812

1.10.7 Platform Range Diagram – 600 lb Jib Extended

ELLIOTT EQUIPMENT COMPANY

MODEL E160

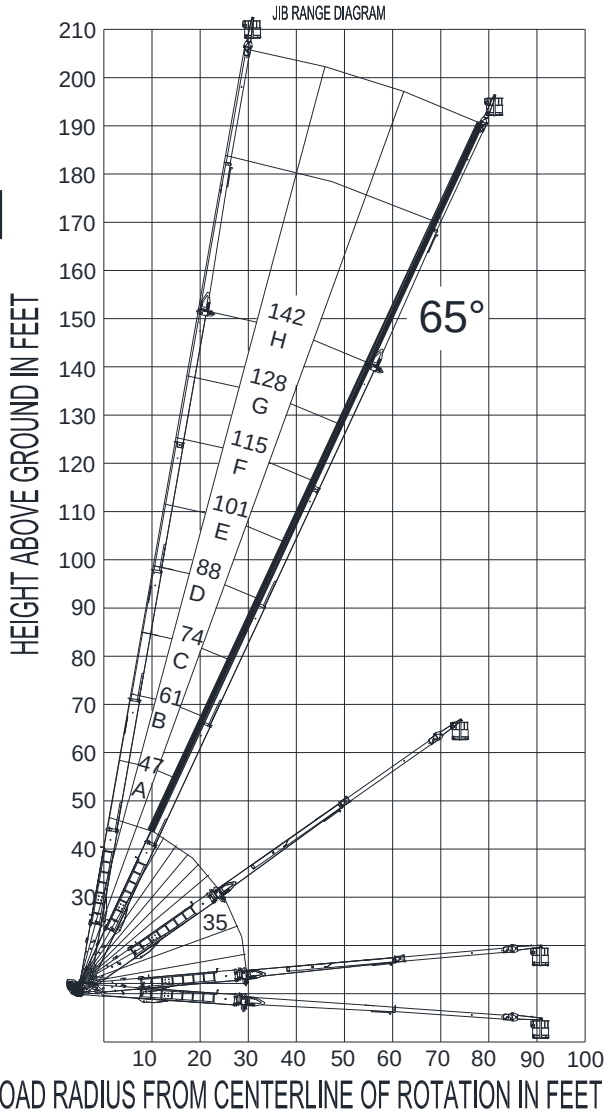
2 PIECE FULLY EXTENDED JIB RANGE DIAGRAM WITH PLATFORM ATTACHED

LMI MODE: BSKT - JIBEXT

PERSONNEL 600LBS MAX

DO NOT OPERATE JIB IN WINDS EXCEEDING 15MPH

USE OUTRIGGERS AT ALL TIMES



NOTE:
1. Operate jib by radius when main boom is fully extended. Increase boom angle if necessary to maintain load radius.
2. When boom is retracted, operate jib by boom angles. Do not exceed any rated jib capacities at reduced boom lengths.
3. Boom load ratings are based on loaded boom radius. Loaded boom angles are given as reference only.
4. Personnel handling is allowed only with full span outriggers.

DO NOT PAINT OVER ANY LABELS 1179860 110812

1.10.8 Platform Range Diagram – 1200 lb Jib Retracted

ELLIOTT EQUIPMENT COMPANY

MODEL E160

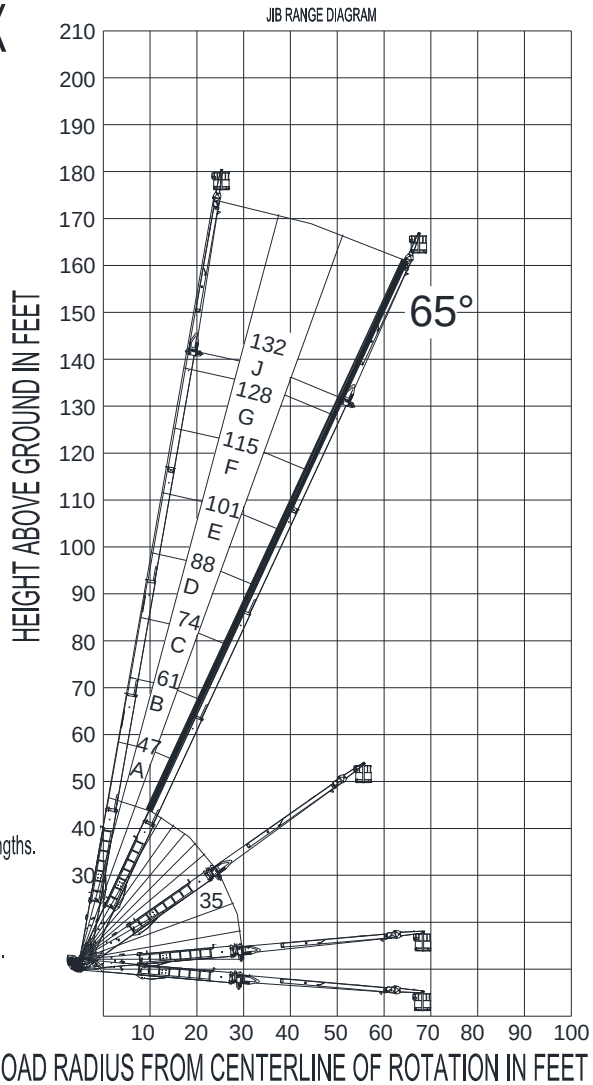
2 PIECE FULLY RETRACTED JIB RANGE DIAGRAM WITH PLATFORM ATTACHED

LMI MODE: BSKT - JIBRET

PERSONNEL 1200LBS MAX

DO NOT OPERATE JIB IN WINDS EXCEEDING 15MPH

USE OUTRIGGERS AT ALL TIMES



NOTE:
1. Operate jib by radius when main boom is fully extended. Increase boom angle if necessary to maintain load radius.
2. When boom is retracted, operate jib by boom angles. Do not exceed any rated jib capacities at reduced boom lengths.
3. Boom load ratings are based on loaded boom radius. Loaded boom angles are given as reference only.
4. Personnel handling is allowed only with full span outriggers.

DO NOT PAINT OVER ANY LABELS 1179860 110812

1.10.9 Platform Range Diagram – 1200 lb Jib Extended

ELLIOTT EQUIPMENT COMPANY

MODEL E160

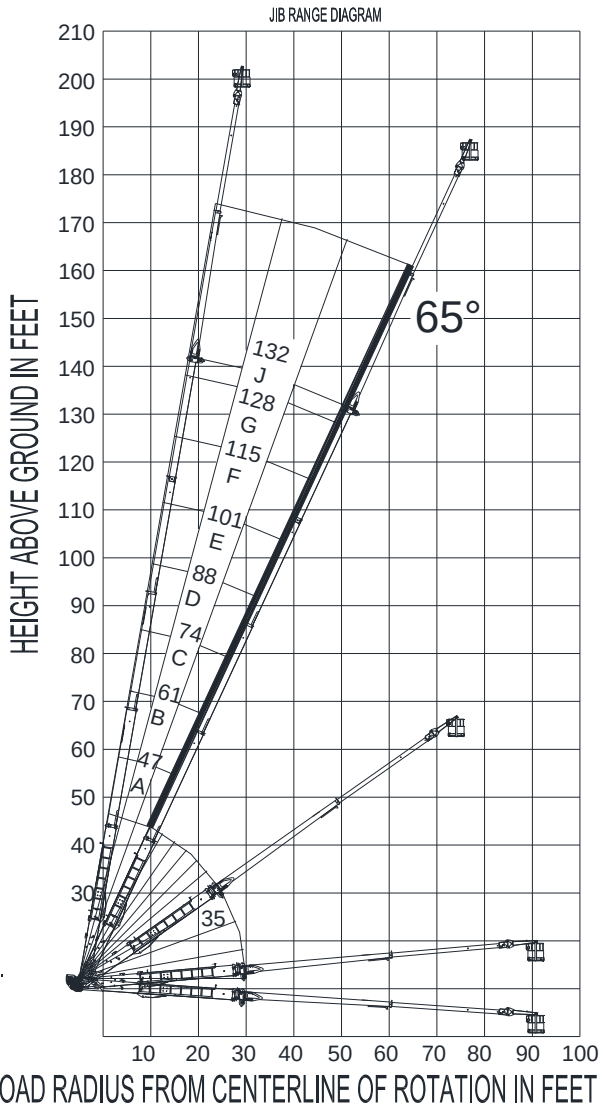
2 PIECE FULLY EXTENDED JIB RANGE DIAGRAM WITH PLATFORM ATTACHED

LMI MODE: BSKT - JIBEXT

PERSONNEL 1200LBS MAX

DO NOT OPERATE JIB IN WINDS EXCEEDING 15MPH

USE OUTRIGGERS AT ALL TIMES



NOTE:
1. Operate jib by radius when main boom is fully extended. Increase boom angle if necessary to maintain load radius.
2. When boom is retracted, operate jib by boom angles. Do not exceed any rated jib capacities at reduced boom lengths.
3. Boom load ratings are based on loaded boom radius. Loaded boom angles are given as reference only.
4. Personnel handling is allowed only with full span outriggers.

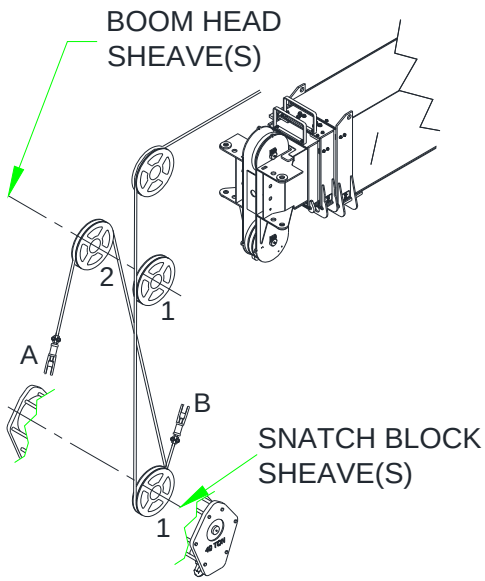
DO NOT PAINT OVER ANY LABELS 1179860 110812

1.10.10 Load Line Rigging

ELLIOTT EQUIPMENT COMPANY

MODEL E160

PARTS OF LINE



1-3 PARTS OF LINE

NOTICE:
- DO NOT DEADHEAD LINE BLOCK AGAINST BOOM TIP WHEN EXTENDING BOOM.
- KEEP AT LEAST 5 WRAPS OF LOADLINE ON THE WINCH DRUM AT ALL TIMES.
- USE ONLY 5/8" DIAMETER ROPE, AS SPECIFIED, WITH THE PROPER BREAKING STRENGTH LISTED.
- ANTI-TWO-BLOCK SYSTEM MUST BE IN GOOD OPERATING CONDITION BEFORE OPERATING CRANE. SEE OPERATION & SAFETY MANUAL.

PARTS OF LINE	SHEAVE(S) ON BOOM HEAD	SHEAVE(S) ON SNATCH BLOCK	5/8" - AMSTEEL BLUE ROPE 50,000-lbs. BREAKING STRENGTH
1	1	A	10,000 lbs
2	1 B	1	20,000 lbs
3	1 2	1 A	30,000 lbs

A-DEAD END FOR ODD PARTS OF LINE
B-DEAD END FOR EVEN PARTS OF LINE

DO NOT PAINT OVER ANY LABELS 1179860 110812

1.11 REQUIRED INSPECTIONS

Government regulations and Elliott Equipment Company require the following inspections. It is the responsibility of the operator to not operate this boom truck until the appropriate inspections have been performed, documented, and any necessary repairs are made. Failure to perform and record these inspections shall be considered misuse of the equipment and could void warranty consideration. It is the responsibility of the operator or employer to maintain accurate inspection records for the periodic inspections. The owner shall maintain a record of the results of the inspections for each boom truck and it's optional equipment. These records shall be kept in a location accessible to the operator.

⚠ CAUTION

Be sure the unit is in an area free of overhead obstructions and power lines.

1.11.1 Daily Inspection

1) Perform all items required in a standard walk around vehicle inspection in accordance with US DOT Commercial vehicle requirements. Perform daily inspection of truck per manufacturer's recommendations. Verify that the loaded vehicle does not exceed the Gross Vehicle Weight Rating, Gross Axle Weight Ratings or exceed state law ratings.
2) Inspect the unit's underside for structural damage and hydraulic leaks.
3) Check all hydraulic hoses, particularly those that flex in normal operation for any scuffing, cuts or wear marks.
4) Check the turret, pedestal and boom for cracked welds, loose or broken bolts and damaged or missing parts. Verify all guards and covers are in place.
5) Perform the daily lubrication per the "Lube Chart".
6) Check that oil level is at proper level
7) Check oil filter condition by reading dirty filter gauge on filter housing. This needs to be checked while engine is running and PTO is engaged.
8) Inspect the wire rope for wear and damage, check for corrosion, kinking, crushing, cuts, and slippage of clamps at wedge socket.
9) Check for proper wire rope spooling on the winch drum and proper reeving. Make sure all sheaves turn freely.
10) Make sure the load line is correctly fastened to the hook block/headache ball.
11) Make sure the hook block/headache ball latch works properly.
12) Check slings, chains, etc. for damage or wear.
13) Check that the Lift Capacity Charts and all other decals are in place and readable.
14) Check proper operation of all aerial device functions.
15) Check boom proportioning. Verify all sections start and stop simultaneously.
16) Check all control mechanisms for maladjustment that could interfere with proper operation.
17) Verify that all control mechanisms when released to the neutral position all functions stop.

18) Make sure all control mechanisms are free of excessive wear and are not contaminated by lubricants or other foreign matter.

19) Check the hook block/headache ball for excessive wear and overload. Check for cracks, spread side plates, elongated holes, bent tie bolts etc.

20) Test the ATB system. With the engine running and PTO engaged, raise the ATB weight and make sure the alarm sounds and the winch up, telescope out, and lift down functions are disabled. Refer to the ATB manufacturer's operator manual for additional daily inspection procedures.

21) Test the Load Moment Indicator (LMI) by picking a known weight load and slowly move it toward an overload condition per the Capacity Chart. When the overload position is reached, the alarm should sound and the telescope out, lift down, and winch up functions should be disabled. All other functions should operate.

22) Check proper operation of horn, start/stop switch, etc.

23) If supplied, clean oil cooler core for proper heat transfer.

⚠ CAUTION

Be sure the unit is in an area free of overhead obstructions and power lines.

1.11.2 Weekly Inspection

1) Perform the daily and weekly lubrication per the "Lube Chart".
2) Perform the "Daily Check List".
3) Check the winch drum and sheaves for cracks, wear and damage.
4) Make sure the boom angle indicator is working.
5) Check boom lift and outrigger holding valves for proper operation.
6) Verify winch brake stops and holds load. Check at rated line capacity.
7) Verify owner's manual is with unit. If manual is not present and cannot be located, either print new manual from CD provided, or provide serial number to Elliott Dealer to order replacement manual immediately.

⚠ CAUTION

Be sure the unit is in an area free of overhead obstructions and power lines.

1.11.3 Monthly Inspection

1) Perform the daily, weekly and monthly lube services.
2) Perform the "Daily Check List" and "Weekly Check List".
3) Check the boom and all structural components-especially welds-for deformation, cracks, corrosion and other forms of damage.
4) Inspect full length of wire rope for damage and excessive wear. See wire rope maintenance section for details.

⚠ CAUTION

Hook must be replaced if throat opening is 15 percent more than when new or if bent/twisted more than 10 percent from original configuration.

5) Check the wire rope attachment at the wedge socket for damage and/or loose parts.
6) Check wiring for damage, dirt accumulation, loose connections etc.
7) Check hydraulic hoses for wear on outside surfaces and leakage at connections.
8) Check hydraulic pump for loose bolts, leaks, noise and vibration.
9) Check the hydraulic valves for leaking.
10) Check the hydraulic cylinders for drifting due to holding valve failure, rod seal leakage, weld joint leaks, visual damage.
11) Check foot throttle engine speed.
12) Check all pins for proper installation and retention.
13) Check boom wear pad retention bolts.
14) Adjust the tension on the extend and retract cables in the boom.

⚠ CAUTION

Be sure the unit is in an area free of overhead obstructions and power lines.

The items listed below should be inspected on a periodic basis, with the interval to be determined by the amount and serverity of the operation of the unit. This inspection should be performed at least once every twelve monthes and shall be performed by a competant individual or a government or private agency recognized by the U.S. Department of Labor.

1.11.4 Periodic Inspection

1) Perform all lube services.
2) Perform the “Daily”, ”Weekly”, ”Monthly”, and “Semiannual Checklist”.
3) Check all fasteners and retighten. Check torque of all bolts on “Bolt Torque” chart.
4) Check the relief valve settings per the hydraulic schematic.
5) Check for worn, cracked, or distorted parts such as pins, bearings, shafts, gears, rollers and locking devices.
6) Test lift and outrigger cylinders for drift from possible internal leakage.
7) Check PTO drive line or direct mounted pump for proper alignment, lubrication, and tightness.
8) Check Rotation bearing and gearbox mounting bolts for proper torque. See “Bolt Torque” chart for appropriate torque values.
9) Check mounting bolts, except “huck-bolts” for proper torque. See “Bolt Torque” chart for appropriate torque values.
10) Check all “huck-bolts” for damage and tightness.
11) Inspect all electrical wires and connections for wear, cuts, deterioration, etc. Replace as required.
12) Check condition of extend and retract cables for wear or damage.
13) Re-shim the boom wear pads as required. Replace worn or damaged wear pads as required.
14) Check boom angle and boom length indicators for accuracy throughout entire operating range.
15) Check LMI system for inaccuracies. Perform this check by lifting load of know weight and measuring boom angle and radius.

1.12 AMSTEEL BLUE ROPE USAGE, INSPECTION AND RETIREMENT

INDUSTRIAL

Rope Selection, Usage, and Retirement

ROPE SELECTION Select the Right Rope for the Job

The use of rope for any purpose subjects it to friction, bending, and tension. All rope hardware, sheaves, rollers, capstans, cleats, and knots are, in varying degrees, damaging to the rope. It is important to understand that rope is a moving, working strength member, and, even under ideal conditions, it will lose strength during use in any application. Maximizing the safety and rope performance begins with selecting the right rope, managing its strength loss through optimal handling practices, and retiring it from service before it creates a dangerous situation. Ropes are serious working tools, and when used properly they will give consistent and reliable service. The cost of replacing a rope is extremely small when compared to the physical damage or injury to personnel a worn out rope can cause.

THIS BULLETIN COVERS THE FOLLOWING TOPICS:

Selecting a rope involves evaluating a combination of factors. Some of these factors are straightforward like comparing rope specifications. Others are not easily quantified, like color preference or how a rope feels in your hand. Cutting corners, reducing sizes, or strengths on an initial purchase creates unnecessary replacements, potentially dangerous conditions, and increases long term costs. Fiber and construction being equal, a larger rope outlasts a smaller rope because of the greater surface wear distribution. Similarly, a stronger rope outlasts a weaker one because it will be used at a lower percentage of its break strength with less chance of being overstressed. The following issues should be considered in your rope selection:

STRENGTH

When given a choice between ropes, select the strongest of any given size. A load of 200 pounds represents 2% of the strength of a rope with a breaking strength of 10,000 pounds. The same load represents 4% of the strength of a rope that has a breaking strength of 5,000 pounds. The weaker rope is having to work harder and as a result will have to be retired sooner. Braided ropes are stronger than twisted ropes of the same size and fiber type.

Note carefully the quoted breaking strengths of the various Samson products. These are average breaking strengths. Published breaking strengths are determined by standard cordage testing and do not cover conditions such as sustained loads or shock loading. These strengths are attained under laboratory conditions. Remember also, that this is a breaking strength — not a recommended working load.

ELONGATION

It is well accepted that ropes with more elongation under load will give you better load control — a big help at complicated job sites. However, ropes with lower elongation that are shock loaded, like a lowering line, can fail without warning even though it appears to be in good shape. Low elongating ropes should be selected with the highest possible strength. Both twisted ropes and braided ropes are suitable for rigging. Twisted rope has lower strength and more stretch. Braided rope has higher strength and lower stretch.

SHOCK LOADING

Working loads as described herein are not applicable when rope has been subjected to shock loading. Whenever a load is picked up, stopped, moved, or swung there is an increased force caused by the dynamic nature of the movement. The force increases as these actions occur more rapidly or suddenly, which is known as "shock loading." Synthetic fibers have a memory and retain the effects of being overloaded or shock loaded. A rope that has undergone shock loading can fail at a later time even though it is loaded within the working load range.

Examples of applications where shock loading occurs include: ropes used as a tow line, picking up a load on a slack line, or using rope to stop a falling object. In extreme cases, the force put on the rope may be two, three, or more times the normal load involved. Shock loading effects are greater on a low elongation rope such as polyester than on a high elongation rope such as nylon, and greater on a short rope than on a long one.

For example, the shock load on a winch line that occurs when a 5,000 lb object is lifted vertically with a sudden jerk may "weigh" 30,000 lb under the dynamic force. If the winch line is rated in the 30,000-lb break-strength range, it is very likely to break.

Where shock loads, sustained loads, or where life, limb, or valuable property is involved, it is recommended that an increased working load factor be used.

It is recommended that a lower working load factor be selected with only expert knowledge of conditions and professional estimates of risk, if the rope has been inspected and found to be in good condition, and if the rope has not been subject to shock loads, excessive use, elevated temperatures, or extended periods under load.

For dynamic loading applications that involve severe exposure conditions, or for recommendations on special applications, consult the manufacturer.

TECHNICAL REFERENCE

Rope Selection

FIRMNESS

Select ropes that are firm and round and hold their shape during use. Soft or mushy ropes will snag easily and abrade quickly causing accelerated strength loss. Because the fibers are in a straighter line, which improves strength but compromises durability, loose or mushy rope will almost always have higher break strengths than a similar rope that is firm and holds its shape.

CONSTRUCTION AND ABRASION

It is important to choose the right rope construction for your application, because it effects resistance to normal wear and abrasion. Braided ropes have a round, smooth construction that tends to flatten out somewhat on a bearing surface. This distributes the wear over a much greater area, as opposed to the crowns of a 3-strand or, to a lesser degree, an 8-strand rope.

WORKING LOADS

Working loads are the loads that a rope is subjected to in everyday activity. For rope in good condition with appropriate safeties, in nonlifting applications and under normal service conditions, working loads are based on a percentage of the breaking strength of new and unused rope of current manufacture.

Working load factors vary in accordance with the different safety practices and policies of each user. However when used under normal conditions, our general recommendation, and one that is fairly well accepted in the industry, is a minimum 5:1 working load factor. Thus, your maximum workload should be approximately 1/5th, or 20%, of the quoted breaking strength. This factor provides greater safety and extends the service life of the winch line.

Normal working loads do not cover dynamic conditions such as shock loads or sustained loads, nor do they cover where life, limb, or valuable property are involved. In these cases, a lower working load must be used. A higher working load may be selected only with expert knowledge of conditions and professional estimates of risk; if the rope has been inspected and found to be in good condition; and if the rope has not been subject to dynamic loading (such as sudden drops, snubs, or pickups), excessive use, elevated temperatures, or extended periods under load.

Assume that you have seven identical ropes, each with a 30,000 lb breaking strength and you work these ropes daily with each rope lifting a different load, as shown in Table 1.

Table 1 shows that the higher the working load factor, the greater the service life and the lower the replacement factor. Therefore, the working load factor directly reflects the economy of the purchase.

TABLE 1. WORKING LOADS FOR SEVEN ROPES WITH BREAKING STRENGTHS OF 30,000 LB.

	Breaking Strength	Working Load*	Working Load Factor	Number of Lifts
1	30,000 lb	5,000 lb	6:1	1,000
2	30,000 lb	6,000 lb	5:1	750
3	30,000 lb	7,500 lb	4:1	500
4	30,000 lb	10,000 lb	3:1	300
5	30,000 lb	15,000 lb	2:1	100
6	30,000 lb	20,000 lb	1.5:1	25
7	30,000 lb	27,300 lb	1.1:1	5

Relative values only. The higher the working load factor the greater the service life, and, of course, the lower the replacement factor. Thus, a working load factor also directly reflects an economy factor; if you always lifting the same weight, then the stronger the rope, the higher the working load factor, and the longer the rope will last.

IMPORTANT NOTE: It is important to note that many industries are subject to state and federal regulation on workload limits that supersede the manufacturer's recommendation. It is the responsibility of the rope user to be aware of and adhere to these laws and regulations.

ROPE CLASS

All Samson ropes are categorized for splicing and testing purposes as a Class I or Class II construction.

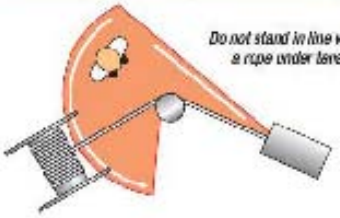
Class I ropes are produced with non high modulus fibers that impart the strength and stretch characteristics to the rope, which have tenacities of 15 grams/denier (gpd) or less and a total stretch at break of 6% or greater. Class I ropes are produced with traditional fibers such as: polypropylene or polyethylene), nylon, and polyester.

Class II ropes are produced with high modulus fibers that impart the strength and stretch characteristics to the rope which have tenacities greater than 15 grams/denier (gpd) and a total stretch at break of less than 6%. Typical Class II ropes are produced with: HMPE (Dyneema®), HMPP (Innegra®S), aramid (Technora®), LCP (Vectran®), and PBO (Zylon®).

Both Class I and Class II ropes can be produced in various rope constructions such as: 3 strand, 8 strand, 8x3 strand, 12-strand, double braids, or core-dependent braids.

TECHNICAL REFERENCE

Use the Rope Properly **Rope Handling/Usage**

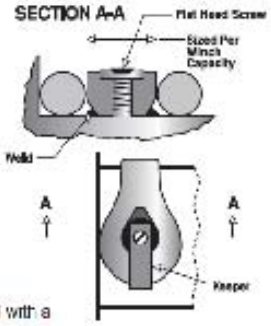


DANGER TO PERSONNEL

Persons should be warned against the serious danger of standing in line with a rope under tension. Should the rope part, it may recoil with considerable force and speed. In all cases where any such risks are present, or where there is any question about the load involved or the condition of use, the working load should be substantially reduced and the rope properly inspected before every use.

ATTACHING LINE TO A WINCH DRUM

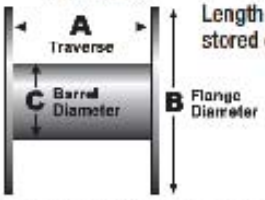
There are various methods of attaching a winch line to a winch drum: using a wedge or plug and set screw in the main body of the drum, or using a "U" bolt through the side of the flange. Another method involves welding a round plug to the winch drum. The soft eye at the end of the winch line is placed over the plug and held in place with a flat keeper. The attachment method should not have a sharp edge that will cut the line under load. If possible, it is advisable to have an eye splice in both ends of the winch line so that it can be reversed in the event of damage to one end, however, this is not always possible, depending upon the method of attachment to the winch drum and whether or not a closed thimble is spliced into the eye. If an eye is not used at the drum end, then this end should be tightly whipped with a strong twine.



ROPE CAPACITY OF A WINCH DRUM

Effect of rope diameter on drum capacity.

The formula for determining the length of rope that will fit on a winch drum is:



$$\text{Length to be stored (feet)} = \frac{A(B^2 - C^2)}{15.3\ (\text{rope dia.})^2}$$

(Where A, B, C, and rope diameter are expressed in inches and length (L) is expressed in feet.)

EFFECT OF ROPE DIAMETER ON DRUM CAPACITY

Rope Diameter	Feet on Drum
1/2"	510'
5/8"	325'
3/4"	225'
7/8"	165'
1"	125'
1-1/8"	100'

(values based on a 7-foot drum)

AVOID ALL ABRASIVE CONDITIONS

All rope will be severely damaged if subjected to rough surfaces or sharp edges. Chocks, bills, winches, drums, and other surfaces must be kept in good condition and free of burrs and rust. Pulleys must be free to rotate and should be of proper size to avoid excessive wear.

WINDING ONTO A WINCH

LEVEL WINDING: Using the appropriate amount of tension, wind the rope evenly, without spaces across the drum of the winch. The next level should wind over the previous layer of rope and follow the valley between turns on the previous level. This pattern is followed for all layers of rope, with each layer of turns slightly offset from the layer below.

LEVEL WINDING

CROSS WINDING *First Cross*

CROSS WINDING *Second Cross*

CROSS WINDING *Level Layer*

CROSS WINDING: When the rope is placed under load it can dive, or push into, the previously wrapped level below it. To avoid diving, cross winding is recommended.

When cross winding, start with two layers of level wound rope using the appropriate back tension. At the end of the second layer, pull the rope quickly across the drum, allow it to wind one full turn at the side of the drum, then quickly pull it back to the opposite side of the drum. This will force the rope to cross in the middle and form a barrier that will prevent the rope from diving into the lower layers of the drum when placed under load. Follow the cross wound layer with two layers of level wound turns, then form another cross. Repeat this pattern until the length of rope is fully spooled onto the winch.

WINDING ROPE ON THE WINCH DRUM

The first layer (wrap) around the winch drum should be put on closely and tightly. The initial winding tension (load) should be approximately 50 pounds. This will prevent subsequent wraps from slipping down between turns when tension is applied. Samson winch lines tend to self level. Important: Samson recommends at least four wraps* always be left on winch drum.

***IMPORTANT NOTE: Due to their low coefficient of friction AmSteel® and AmSteel®-Blue lines must be worked with at least eight wraps on the drum at all times.**

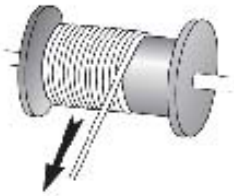
TECHNICAL REFERENCE

Rope Handling/Usage Use the Rope Properly

DIELECTRIC PROPERTIES

Based on rope industry practices, dielectric property testing is conducted on clean, new rope samples and holds true only under such ideal conditions. Dirt, grease, foreign matter, and moisture (including humidity) will alter the nonconductivity/conductivity of any synthetic rope or material. No rope manufacturer can attest to a rope's dielectric properties under actual operating conditions.

REMOVING ROPE FROM A REEL OR COIL



Synthetic fiber ropes are normally shipped on reels for maximum protection while in transit. The rope should be removed from the reel by pulling it off the top while the reel is free to rotate. This can be accomplished by passing a pipe through the center of the reel and jacking it up until the reel is free from the deck. Rope should never be taken from a reel lying on its side. If the rope is supplied on a coil, it should always be uncoiled from the inside so that the first turn comes off the bottom in a counter-clockwise direction.

ROPE STORAGE: COILING, FLAKING, AND BAGGING

Great care must be taken in the stowage and proper coiling of 3-strand ropes to prevent the natural built-in twist of the line from developing kinks and hockles. Braided ropes on the other hand have no built in twist and are far more resistant to kinking. Even if kinks do develop, they cannot develop further into hockles.

Hockled Rope

Three-strand and braided ropes should be coiled in a clockwise direction (or in the direction of the lay of the rope) and uncoiled in a counter clockwise direction to avoid kinks. An alternate and perhaps better method is to flake out the line in a figure eight. This avoids putting twist in the line in either direction and lessens the risk of kinking.

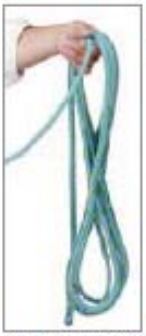


Figure Eight Flaking

Coiling — Twisted Rope

Bagging is the most common method of storing braided or twisted climbing lines. The rope is allowed to fall into its natural position without deliberate direction.

EYE SPLICES

The standard eye splice cannot be pulled out under tension, however, it can be pulled out by hand when the winch line is in a relaxed state. To prevent such tampering, it is recommended that lock stitching or light seizing be applied to the base or throat of the splice.

Lock stitching may also prove advantageous on some splices to prevent no-load opening due to mishandling. The material required is one bit length of nylon whipping twine approximately the same size diameter as the strands in the rope you are lock stitching. The strands cut from the rope you are lock stitching may also be used, but whipping twine is preferable. You may download lock stitch instructions from our website SamsonRope.com or call customer service to receive them by mail.

Eye splices at the end of winch lines (if not put in at the factory) should be done in strict accordance with the steps and procedures outlined in Samson splicing instructions. These splicing methods can be easily learned and executed by line crews and shop personnel. Splicing instruction assistance is available through the Samson Technical Representative in your area. Splicing Training Kits, manuals, and tools can be ordered through your local Samson Distributor or direct from the factory. Instructions are also available online at SamsonRope.com.

KNOTS

While it is true that a knot reduces rope strength, it is also true that a knot is a convenient way to accomplish rope attachment. The strength loss is a result of the tight bends that occur in the knot. With some knots, ropes can lose approximately 50% of their strength, however, this number can be higher or lower based on rope construction and fibers used. It is vital that the reduction in strength by the use of knots be taken into account when determining the size and strength of a rope to be used in an application. To avoid knot strength reduction, it is recommended that a rope be spliced according to the manufacturer's instructions. Splice terminations are used in all our ropes to determine new and unused tensile strengths. Therefore, whenever possible, spliced terminations should be used to maximize the rope strength for new and used ropes.

USE OF SLINGS WITH WINCH LINES

The winch line itself should not be used as a choker to pick up a pole or other objects. The hook attached on the end of the winch line can cut deeply into the rope itself. We recommend a separate line, sling or strap be used as the choker and not the winch line itself.

SHARP CUTTING EDGES

Samson winch lines should not be exposed to sharp edges and surfaces such as metal burrs on winch drums, sheaves, shackles, thimbles, wire slings, etc. Our winch lines are made from synthetic fibers and, as such, can be cut or damaged by sharp edges. When installing winch lines on old truck units, great care must be exercised to assure that the rope is not coming in contact with hardware that has been scored and chewed by previously used wire lines. Sheaves, shackles, thimbles, etc., should be replaced in most cases. Other metal surfaces should be carefully examined and dressed if necessary.

ABRASION PROTECTION OF LINE

With their outer jacket of polyester, Stable Braid, Amsteel® II, Viviator SK8, and Dragon II have a relatively high degree of resistance to abrasion and melting. However, all synthetics are subject to melting if subjected to enough friction and heat, therefore, such practices as surging on a gypsy-head winch, hard rendering around poles, or over cross-arms, etc., should be avoided whenever possible.

TECHNICAL REFERENCE

Use the Rope Properly **Rope Handling/Usage**

TEMPERATURE

Friction can be your best friend or worst enemy if it is not managed properly. Friction takes place anytime two surfaces come in contact. Mild friction, sometimes referred to as grip is a good characteristic, especially in winching applications. However friction creates heat, the greater the friction, the greater the heat buildup. Heat is an enemy to synthetic fiber and elevated temperatures can drastically reduce the strength and/or cause rope melt-through.

High temperatures can be achieved when shocking ropes on a cable or running over stuck or non-rolling sheaves or rollers. Each rope's construction and fiber type will yield a different coefficient of friction (resistance to slipping) in a new or used state. It is important to understand the operational demands, and take into account the size of the rope, construction, and fiber type to minimize heat buildup.

Never let ropes under tension rub together or move relative to one another. Enough heat to melt the fibers can buildup and cause the rope to fail quickly; as if it had been cut with a knife.

Be aware of areas of heat buildup and take steps to minimize them. Under no circumstances let any rope come in contact with an exhaust muffler or any other hot object. The strength of a used rope can be determined by testing, but often the rope is destroyed in the process so the ability to determine the retirement point before it fails in service is essential. That ability is based on a combination of education in rope use and construction along with good judgment and experience. Remember, you almost always get what you pay for in the form of performance and reliability.

TABLE 2. THE CRITICAL AND MELTING TEMPERATURES FOR SYNTHETIC FIBERS.

FIBER TYPE	CRITICAL TEMP.	MELTING TEMP.
HMPE	150° F	300° F
Polypropylene	250° F	330° F
Nylon	325° F	425° F
Polyester	350° F	480° F
Aramid	520° F	930° F*

*While the term "melting" does not apply to this fiber, it does undergo extreme degradation in these temperatures, and they char.

STRENGTH DEGRADATION FROM ULTRAVIOLET LIGHT

Prolonged exposure of synthetic ropes to ultraviolet (UV) radiation from sunlight causes varying degrees of strength degradation.

Polyester fibers are the least affected by UV exposure, and the resulting strength degradation of exposed fibers is negligible. Nylon is more susceptible to strength loss due to ultraviolet rays, but with both polyester and nylon, the degree of susceptibility to UV damage is dependent on the type of fiber and the various UV inhibitors with which the fiber manufacturer treats them (i.e., Samsonex coating).

Polyolefin and PBO fibers are severely affected by ultraviolet exposure, especially in their natural, undyed, and/or uncovered states.

HARMFUL CHEMICALS

Certain chemicals can break down synthetic fibers. Sulfuric acids, alkalis, and chlorinate hydrocarbons over 100° F should be avoided, while strong cleaning agents or bleaches may be harmful. If you are unsure about the effect of a specific chemical, contact our customer service department for more information.

AVOID SHOCK LOADING

Shock loading of any line—synthetic, natural, or wire—produces a drastically different set of physical properties and results as compared with normal loading. Shock loading is a jerking or snatching of a line, or a very sudden change in tension such as from a relaxed state or low load to one of high load. A sudden drop of of a platform from as short a distance as four inches actually doubles the rope's load. Similarly, an overwrap "falling off" the winch drum can result in a shock load. This results in accelerated wear of the rope.

FATIGUE

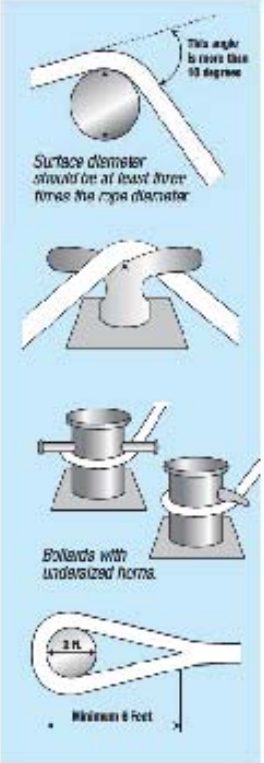
Synthetic fibers have memory: they remember and retain the effects of being overloaded and shock loaded. This why winch line procedures are so important in reducing the danger of shock loading, which prolongs the life of the rope and reduces premature down grading. If there is reason to believe that a line has been shock loaded above its recommended working load, it should be logged. If a number of these instances occur, the line should be inspected and rotated.

END-FOR-ENDING

It is recommended that every winch line be rotated end for end on a periodic basis. This will vary high stress and wear points and extend useful life. The recommended end for ending period is six months, at which time visual inspection and washing can also be done.

TECHNICAL REFERENCE

Bending Radius Sizing the Radius of Bitts, Fairleads, and Chocks



BENDING RADIUS

Any sharp bend in a rope under load decreases its strength substantially and may cause premature damage or failure. In sizing the radius of bitts, fairleads and chocks for best performance, the following guidelines are offered.

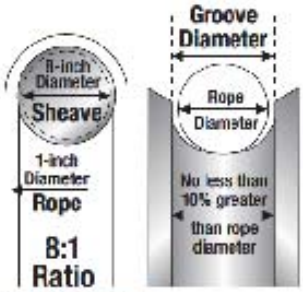
Where a rope bends more than 10 degrees around bits or chocks, or is bending across any surface, the diameter of that surface should not be less than 3 times the diameter of the rope. Stated another way, the diameter of the surface should be at least 3 times the rope diameter. A 4-to-1 ratio (or larger) would be better yet because the durability of the rope increases substantially as the diameter of the surface over which it is worked increases.

On a cleat when the rope does not bend radially around, the barrel of the cleat can be one half the rope circumference (minimum).

The ratio of the length of an eye splice to the diameter of the object over which the eye is to be placed (for example, bollard, bitt, cleat, etc.) should be a minimum 3 to 1 relationship and preferably 5-to-1. In other words, if you have a bollard 2 feet in diameter the eye splice should be 6 or 10 feet in length. By using this ratio the angle of the 2 legs of the eye splice at its throat will not be so severe as to cause a parting or leaning action at this point (thimbles are normally designed with a 3 to 1 ratio).

BOOM-SHEAVE RECOMMENDATIONS

To assure maximum efficiency and safety, sheaves for braided ropes should be no less than eight times the rope diameter. The sheave groove diameter should be no less than 10% greater than the rope diameter. The sheave groove should be round in shape. Sheaves with "V" shaped grooves should be avoided, as they tend to pinch and damage the rope through excessive friction and crushing of the rope fibers. Sheave surfaces should be kept smooth and free of burrs and gouges. Bearings should be maintained to ensure smooth rotation.



Twisted / Plaited:
10 times rope diameter

Braided:
8 times rope diameter

Coatings and Finishes

SAMTHANE

Samthane coatings are a family of abrasion resistant coatings specifically formulated for specific rope constructions and their applications. The advantages of Samthane coatings and some of the common coatings are outlined below.

ADVANTAGES:

- *Improved service life*
- *Reduced snagging*
- *Enhanced abrasion resistance*
- *Protection from contamination*
- *Reduced cutting damage*
- *Color coding for identification*

SAMTHANE (TYPE A)

A spliceable coating used on polyester double braids, Samthane Type A greatly enhances abrasion resistance and makes splicing used rope much easier. It is available in a variety of colors for easy identification, tracking line in service, keying colors to specific operations, etc. Splicing core on ropes coated with Type A uses the same tools and techniques for splicing uncoated rope. Coating adds approximately 3% to 5% to the weight of the line.

SAMTHANE (TYPE F)

Samthane Type F is a spliceable coating specially formulated for nylon/polyester blend ropes and the cores of many Class II core-dependent double braids. The physical properties of Samthane Type F are the same as for Samthane Type A coating. Coating adds approximately 3% to 5% to the weight of the line.

SAMTHANE (TYPE C)

A non spliceable jacketing type coating, Samthane Type C is usually applied to specific sections of a line that will be subjected to extreme abrasion. The coating is very tough, with excellent resistance to cutting and chafing. It is usually applied to a thickness of 1/8" or more, which has a stiffening effect on the rope. This coating is applied to prespliced ropes and may also be used for thimble encapsulation.

SAMTHANE (TYPE S)

Samthane Type S is a spliceable coating used on high performance, olefin, and polyester fiber ropes. This coating adds firmness and greatly improves wear life. The coating adds approximately 3% to 5% to the weight of the line.

TECHNICAL REFERENCE

Retire the Rope when it's Time **Rope Inspection & Retirement**

One question frequently asked is "When should I retire my rope?" The most obvious answer is before it breaks. But, without a thorough understanding of how to inspect it and knowing the load history, you are left making an educated guess. Unfortunately, there are no definitive rules nor are there industry guidelines to establish when a rope should be retired because there are so many variables that affect rope strength. Factors like load history, bending radius, abrasion, chemical exposure or some combination of those factors, make retirement decisions difficult. Inspecting your rope should be a continuous process of observation before, during, and after each use. In synthetic fiber ropes, the amount of strength loss due to abrasion and/or flexing is directly related to the amount of broken fiber in the rope's cross section. After each use, look and feel along every inch of the rope length inspecting for abrasion, glossy or glazed areas, inconsistent diameter, discoloration, and inconsistencies in texture and stiffness.


New rope


Used rope


Severely abraded rope

VISUAL INSPECTION

The load bearing capacity of double braid ropes, such as Stable Braid, is divided equally between the inner core and the outer cover. If upon inspection, there are cut strands or significant abrasion damage the rope must be retired because the strength of the entire rope is decreased.

Core-dependent double braids such as Ultra-Tech have 100% of their load-bearing capacity handled by the core alone. For these ropes, the jacket can sustain damage without compromising the strength of the load bearing core. Inspection of core dependent double braids can be misleading because it is difficult to see the core. In the case of 12-strand single braids such as AmSteel® and AmSteel®-Blue, each of the 12-strands carries approximately 8.33%, or 1/12th, of the load. If upon inspection, there are cut strands or significant abrasion damage to the rope, the rope must be retired or the areas of damage removed and the rope repaired with the appropriate splice.


Inspect for pulled strands

ABRASION

When a 12 strand single braid rope, such as AmSteel® Blue, is first put into service, the outer filaments of the rope will quickly fuzz up. This is the result of these filaments breaking, which actually forms a protective cushion and shield for the fibers underneath. This condition should stabilize, not progress. If the surface roughness increases, excessive abrasion is taking place and strength is being lost. When inspecting the rope, look closely at both the inner and outer fibers. When either is worn, the rope is obviously weakened.

Open the strands and look for powdered fiber, which is one sign of internal wear. Estimate the internal wear to estimate total fiber abrasion. If total fiber loss is 20%, then it is safe to assume that the rope has lost 20% of its strength as a result of abrasion.

As a general rule for braided ropes, when there is 25% or more wear from abrasion, or the fiber is broken or worn away, the rope should be retired from service. For double braid ropes, 50% wear on the cover is the retirement point, and with 3 strand ropes 10% or more wear is accepted as the retirement point.


Inspect for internal abrasion.

DISCOLORATION

With use, all ropes get dirty. Be on the lookout for areas of discoloration that could be caused by chemical contamination. Determine the cause of the discoloration and replace the rope if it is brittle or stiff.

INCONSISTENT DIAMETER

Inspect for flat areas, bumps, or lumps. This can indicate core or internal damage from overloading or shock loads and is usually sufficient reason to replace the rope.

INCONSISTENT TEXTURE

Inconsistent texture or stiff areas can indicate excessive dirt or grit embedded in the rope or shock load damage and is usually reason to replace the rope.


Compare surface yarns with internal yarns

RESIDUAL STRENGTH

Samson offers customers residual strength testing of our ropes. Penocic testing of samples taken from ropes currently in service ensures that retirement criteria are updated to reflect the actual conditions of service.


Compressed areas

GLOSSY OR GLAZED AREAS

Glossy or glazed areas are signs of heat damage with more strength loss than the amount of melted fiber indicates. Fibers adjacent to the melted areas are probably damaged from excessive heat even though they appear normal. It is reasonable to assume that the melted fiber has damaged an equal amount of adjacent unmelted fiber.

TECHNICAL REFERENCE

SINGLE BRAID Rope Inspection & Retirement Checklist

Single Braids

Inspection and Retirement Checklist*

Any rope that has been in use for any period of time will show normal wear and tear. Some characteristics of a used rope will not reduce strength while others will. Below we have defined normal conditions that should be inspected on a regular basis.

If upon inspection you find any of these conditions, you must consider the following before deciding to repair or retire it:

- *the length of the rope,*
- *the time it has been in service,*
- *the type of work it does,*
- *where the damage is, and*
- *the extent of the damage.*

In general, it is recommended to:

- *Repair the rope if the observed damage is in localized areas.*
- *Retire the rope if the damage is over extended areas.*

*REFERENCES Cordage Institute International, *International Guideline CI2001-04, Fiber-Rope Inspection and Retirement Criteria: Guidelines to Enhance Durability and the Safer Use of Rope*, 2004.

COMPRESSION *Not a permanent characteristic* ☐

WHAT
- Visible sheen
- Stiffness reduced by flexing the rope
- Not to be confused with melting
- Often seen on winch drums

CAUSE
- Fiber molding itself to the contact surface under a radial load

CORRECTIVE ACTION
Flex the rope to remove compression

PULLED STRAND *Not a permanent characteristic* ☐

WHAT
- Strand pulled away from the rest of the rope
- Is not cut or otherwise damaged

CAUSE
- Snagging on equipment or surfaces

CORRECTIVE ACTION
Work back in to rope

REDUCED VOLUME *Repair or retire* ☐

WHAT
- 25% reduction

CAUSE
- Abrasion
- Sharp edges and surfaces
- Cyclic tension wear

MELTED OR GLAZED FIBER *Repair or retire* ☐

WHAT
- Fused fibers
- Visibly charred and melted fibers, yarns, and/or strands
- Extreme stiffness
- Unchanged by flexing

CAUSE
- Exposure to excessive heat, shock load, or a sustained high load

DISCOLORATION/DEGRADATION *Repair or retire* ☐

WHAT
- Fused fibers
- Brittle fibers
- Stiffness

CAUSE
- Chemical contamination

INCONSISTENT DIAMETER *Repair or retire* ☐

WHAT
- Flat areas
- Lumps and bumps

CAUSE
- Shock loading
- Broken internal strands

ABRASION INSPECTION PROCEDURES

Internal abrasion can be determined by pulling one strand away from the others and looking for powdered or broken fiber filaments. (ABOVE)

To determine the extent of outer fiber damage from abrasion, a single yarn in all abraded areas should be examined. The diameter of the abraded yarn should then be compared to a portion of the same yarn or an adjacent yarn of the same type that has been protected by the strand crossover area and is free from abrasion damage. (LEFT)

TECHNICAL REFERENCE

Rope Inspection & Retirement Checklist DOUBLE BRAID

Double Braids

Inspection and Retirement Checklist*

Any rope that has been in use for any period of time will show normal wear and tear. Some characteristics of a used rope will not reduce strength while others will. Below we have defined normal conditions that should be inspected on a regular basis.

If upon inspection you find any of these conditions, you must consider the following before deciding to repair or retire it:

> *the length of the rope,*
> *the time it has been in service,*
> *the type of work it does,*
> *where the damage is, and*
> *the extent of the damage.*

In general, it is recommended to:

> *Repair the rope if the observed damage is in localized areas.*
> *Retire the rope if the damage is over extended areas.*

*REFERENCES Cordage Institute International, *International Guideline CGI001-04, Fiber Rope Inspection and Retirement Criteria: Guidelines to Enhance Durability and the Safer Use of Rope, 2004.*

DOUBLE BRAID vs. CORE-DEPENDENT

Double braid ropes consist of a cover or jacket braided over a seperately braided core. Samson produces two types of double braided ropes: standard double braids and core-dependent double braids.

The strength of standard double braid ropes is shared between the cover and the core. Damage to the cover also usually affects the core and ultimately the strength of the rope.

In core-dependent double braids, the core is the strength member and carries the entire load. Damage to the cover of a core-dependant double braid may not compromise strength of the rope.

Inspection of both standard double braids and core-dependent double braids is essential to determining whether the rope can be repaired or if it needs to be retired.

CUT STRANDS

DOUBLE BRAID: *Repair or retire*
CORE-DEPENDENT: *May not affect strength*

WHAT
> Three or more adjacent cut strands

CAUSE
> Abrasion
> Sharp edges and surfaces
> Cyclic tension wear

REDUCED VOLUME

DOUBLE BRAID: *Repair or retire*
CORE-DEPENDENT: *May not affect strength*

WHAT
> 60% volume reduction

CAUSE
> Abrasion
> Sharp edges and surfaces
> Cyclic tension wear

MELTED OR GLAZED FIBER

Repair or retire

WHAT
> Fused fibers
> Visibly charred and melted fibers, yarns, and/or strands
> Extreme stiffness
> Uncharged by flexing

CAUSE
> Exposure to excessive heat, shock load, or a sustained high load

DISCOLORATION/DEGRADATION

Repair or retire

WHAT
> Fused fibers
> Brittle fibers
> Stiffness

CAUSE
> Chemical contamination

INCONSISTENT DIAMETER

Repair or retire

WHAT
> Flat areas
> Lumps and bumps

CAUSE
> Shock loading
> Broken internal strands

TECHNICAL REFERENCE

Elastic Elongation | Components of Stretch

Elongation (Stretch)

ELASTIC ELONGATION (EE)

Elastic elongation refers to the portion of stretch or extension of a rope that is immediately recoverable after the load on the rope is released. The rope's tendency to recover is a result of the fiber(s) rather than the rope construction. Each type of synthetic fiber inherently displays a unique degree of elasticity. Relatively speaking, high performance fiber has extremely low elasticity as compared to nylon fiber.

ELASTIC HYSTERESIS

Elastic hysteresis refers to a recoverable portion of stretch or extension over a period of time after a load is released. In measuring elastic recovery, it is the portion that occurs immediately when a load is removed. However, a remaining small percentage of elastic recovery occurs gradually over a period of hours or days. Elastic hysteresis is measured in a length/time scale.

PERMANENT EXTENSION (PE) AFTER RELAXATION

Permanent extension after relaxation refers to the portion of extension that prevents the rope from returning to its original length due to construction deformation, such as compacting of braid and helical changes, and some plastic deformation of the yarn fibers.

PE WHILE WORKING

Permanent extension while working is the amount of extension that exists when stress is removed but no time is given for hysteretic recovery. It includes the nonrecoverable and hysteretic extension as one value and represents any increase in the length of a rope in a constant working situation, such as during repeated surges in towing or other similar cyclical operations. The percentage of PE over the working load range is generally in order of 4–6% for braided ropes and two to three times as much for plaited. However, it varies slightly with different fibers and rope constructions. In some applications, such as subsurface mooring or devices that demand precise depth location and measurement, allowances must be made for this factor.

CREEP

A material's slow deformation that occurs while under load over a long period of time. Creep is mostly nonreversible. For some synthetic ropes, permanent elongation and creep are mistaken for the same property and used interchangeably when in fact creep is only one of the mechanisms that can cause permanent elongation.

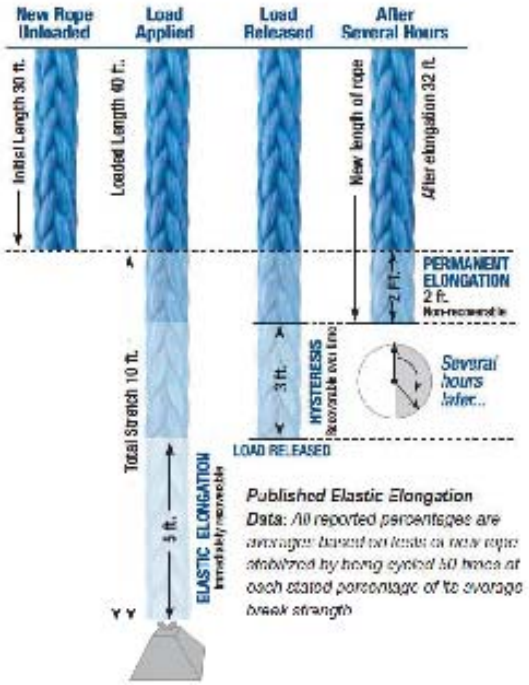
CONSTRUCTIONAL ELONGATION

The elongation of a loaded rope that results from compaction as the fibers and strands align and adjust.

SPLICE SETTING

The elongation of a spliced rope caused by the adjustment and settling of the strands in the splice.

Components of Stretch on a Loaded Rope



Published Elastic Elongation Data: All reported percentages are averages based on tests of new rope stabilized by being cycled 50 times at each stated percentage of its average break strength.

TECHNICAL REFERENCE

Fiber Characteristics | Rope Construction

Comparison of Fiber Characteristics

GENERIC FIBER TYPE	NYLON	POLYESTER	POLYPROPYLENE	HMPE	LCP	ARAMID	PBO
Tenacity (g/den)[1]	7.5 – 10.5	7 – 10	6.5	40 (SK-75)	23 – 26	28	42
Elongation[2]	15 – 20%	12 – 16%	10 – 22%	3.6%	3.3%	4.6%	2.5%
Coefficient of Friction[3]	12 – 16	12 – 16	15 – 22	05 – 07	12 – 16	12 – 16	18
Melting Point	425° – 490° F	480° – 500° F	330°	300° F	625° F	850° F *	1200° F *
Critical Temperature[4]	325° F	350° F	250°	150° F	300° F	520° F	750° F
Specific Gravity	1.14	1.38	.91	.98	1.40	1.39	1.56
Creep[5]	Negligible	Negligible	Application Dependent	Application Dependent	Negligible	Negligible	Negligible

* Dive temperature — does not melt

[1] **TENACITY** is the measurement of the resistance of fiber to breaking.

[2] **ELONGATION** refers to percent of fiber elongation at break.

[3] **COEFFICIENT OF FRICTION** is based on the rope's resistance to slipping.

[4] **CRITICAL TEMPERATURE** is defined as the point at which degradation is caused by temperature alone.

[5] **CREEP** is defined as a material's slow deformation that occurs while under load over a long period of time. Creep is mostly nonreversible. For some synthetic ropes, permanent elongation and creep are modeled for the same property and used interchangeably when in fact creep is only one of the mechanisms that can cause permanent elongation.

FIBER STRENGTH RETENTION AFTER CHEMICAL IMMERSION

(HMPE strength retention after 6-months immersion)

AGENT	HMPE
Sea Water	100%
Hydraulic Fluid	100%
Kerosene	100%
Gasoline	100%
Glacial Acetic Acid	100%
1 M Hydrochloric Acid	100%
5 M Sodium Hydroxide	100%
Ammonium Hydroxide (29%)	100%
Hypophosphite Solution (5%)	100%
Perchloroethylene	100%
10% Detergent Solution	100%
Bleach	91%

Rope Construction

All sizes stated are nominal diameters and do not reflect exact dimensions. Weights depicted are average net rope weights relaxed and standard tolerances are ± 5% unless agreed to in writing.

All Samson ropes are categorized for testing purposes as Class I or Class II ropes. Class I ropes are manufactured from polyolefin, nylon and or polyester fiber. Class II ropes are manufactured from high modulus fiber (i.e., Dyneema®, Vylon®, Technora®, Vectran®).

TECHNICAL REFERENCE

Published Strengths and Testing

Because our ropes are asked to perform in the real world, our published strengths and test results reflect as accurately as possible the conditions under which they are intended to be used. Since nearly all ropes in actual use are terminated with a splice, publishing unspliced strengths does not allow the customer to select the appropriate size and strength rope for his application, and to assure the utmost in safety and length of service life. Throughout this catalog, and wherever strengths are noted, all published data are for spliced ropes. This ensures that you are selecting sizes and strengths based on real world conditions. When comparing our data to other strengths, please ensure that spliced strengths are used.

TESTING METHODS AT SAMSON

Testing is a critical stage in the design and manufacture of new ropes, and in determining retirement criteria for used ropes. Samson has established test methods that comply with industry standard methods like CI 1500, with more stringent specifications and testing instructions to eliminate wide tolerances or generalized procedures. The result is more consistent, reliable data for our customers, and more accurate assessment of retirement criteria.

Samson R&D maintains the largest capacity testing machine for synthetic rope in the industry, capable of testing rope to failure up to 1.1 million pounds. The machine is fully computer controlled, provides automated cycle loading, and precise elongation measurements. All data is acquired, stored, calculations performed, and reports generated automatically.

1.1 million pound test machine

SAMSON'S TESTING METHODOLOGY COVERS:

- *Sampling of test specimens*
- *Determination of diameter*
- *Determination of lay/pitch, picks per inch*
- *Linear density*
- *Breaking force*
- *Initial elongation (unecycled elongation)*
- *Cycled elongation/ tension fatigue*
- *Wet testing*
- *Reporting procedures*
- *Stiffness*
- *Abrasion resistance*

SAMSON WAS ONE OF THE FIRST U.S. ROPE MANUFACTURERS TO RECEIVE ISO 9001 CERTIFICATION, A NATURAL PROGRESSION OF OUR EXISTING QUALITY

Assurance Program that incorporates:

- *Integrated product development and production software that translates engineering specifications into production orders for manufacturing*
- *Specialized production documents for processing high modulus fibers*
- *Standardized procedures for inspection, analysis, and testing of in-process product as well as finished goods*
- *Individual specifications for all products*

Based on our Quality Assurance Program, Samson has received product type approval certifications from:

ABS – American Bureau of Shipping
NK – Nippon Kaiji Kyokai
DNV – Det Norske Veritas
LR – Lloyds Register

Product certifications are available upon request with order placement. As a long standing active member of the Cordage Institute, Samson has been a major contributor in developing standards and specifications on behalf of the Cordage Institute.

samson
THE STRONGEST NAME IN ROPE

2090 Thornton Street
Ferndale, WA 98248

Phone: +1 800.227.7673
or +1 360.384.4669
Fax: +1 360.384.0572
SamsonRope.com

1.13 WIRE ROPE INSPECTION

All wire ropes should be thoroughly inspected at regular intervals. The longer it has been in service or the more severe the service, the more thoroughly and frequently it should be inspected. Be sure to maintain records of each inspection. A person who has learned through training or practical experience what to look for and who knows how to judge the importance of any abnormal conditions discovered should carry out inspections.

1.13.1 Typical Evidence of Wear and Abuse

A "birdcage" is caused by sudden release of tension and the resulting rebound of rope. These strands and wires will not be returned to their original positions. The rope should be replaced immediately.

This is localized wear over an equalized sheave. The danger here is that it's invisible during the rope's operation, and that's why you need to inspect this portion of an operating rope regularly. The rope should be pulled off the sheave during inspection and bent to check for broken wires.

This is a wire rope with a high strand -- a condition in which one or more strands are worn before adjoining strands. This is caused by improper socketing or seizing, kinks or dog-legs. It reoccurs every 6th strand in a 6 strand rope.

A kinked wire rope is shown here. It's caused by pulling down a loop in a slack line during handling, installation or operation. Note the distortion of the strands and individual wires. This rope must be replaced.

Here's a wire rope that has jumped a sheave. The rope "curled" as it went over the edge of the sheave. There are two types of breaks here: tensile "cup and cone" breaks and shear breaks that appear to have been cut on an angle.

Drum crushing is caused by small drums, high loads and multiple winding condition.

1.13.2 Replacement Criteria

1) No precise rules can be given for determining when to replace a wire rope. Replacement depends upon good judgment of a qualified inspector and comparison of data recorded on previous inspection reports. Any deterioration resulting in an appreciable loss of rope strength is sufficient cause for removal of the wire rope. Guidelines for replacement are listed below:
2) Six randomly distributed broken outer wires in one rope lay length or three broken outside wires in one strand of one rope lay length. Note: One rope lay length is the distance measured along a rope in which one strand makes one complete revolution around the rope core.
3) One broken outside wire at the point the wire contacts the core. The broken wire will have worked its way out of the rope structure and either protrude or loop out from the rope structure. Inspect this area of the wire rope for core damage.
4) Wear on one-third the original diameter of outside wires.
5) Kinking, crushing, bird caging, core protrusion or any other damage resulting in distortion of the rope structure.
6) Evidence of heat damage.
7) Severe Corrosion.
8) Reduction from the nominal diameter of more than the following limits.

a) 1/64 inch for rope diameters through 5/16 inch
b) 1/32 inch for rope diameters 3/8 through 1/2 inch
c) 3/64 inch for rope diameters 9/16 through 3/4 inch

9) Core failure. This type of damage is usually indicated by a reduction in the nominal diameter or an increase in rope lay length. If these conditions are noted, open up the wire rope and inspect the core. Replace the rope if the core is broken. See fig. 3 for a recommended method of opening the core.

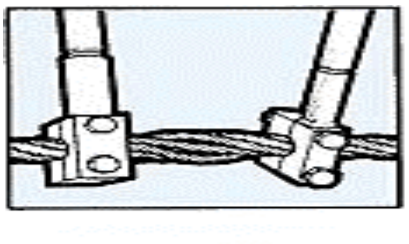
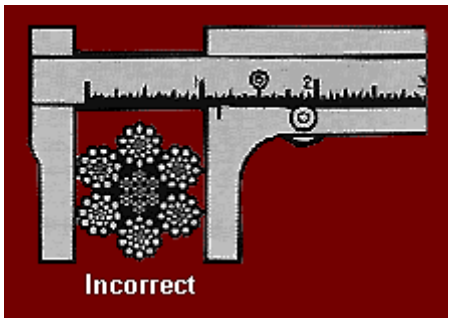
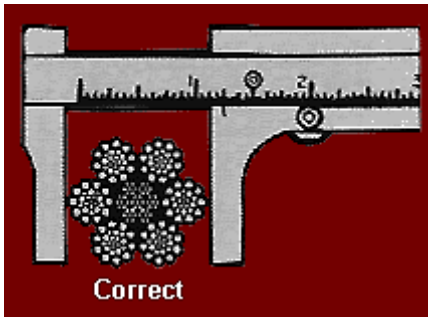


fig 3

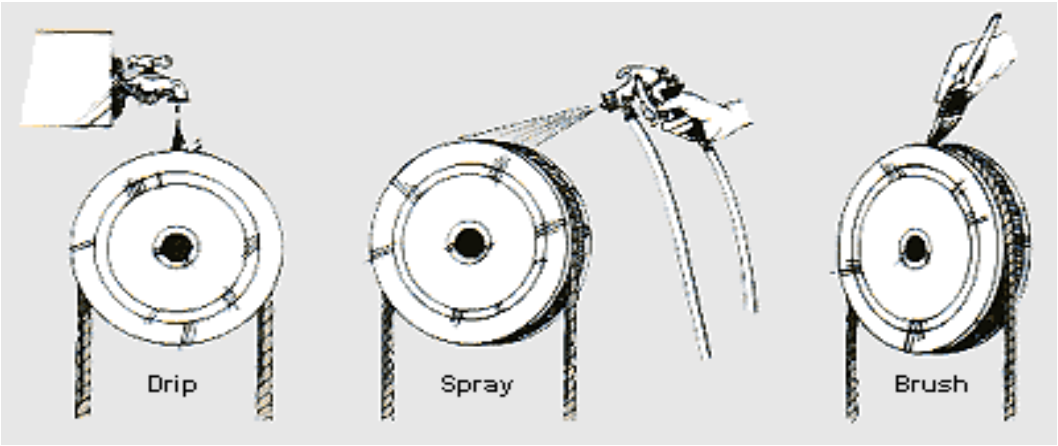




1.13.3 Lubrication

Wire rope is lubricated during manufacture so that the strands -- as well as the individual wires in the strands -- may move and adjust as the rope moves and bends. But no wire rope can be lubricated sufficiently during manufacture to last its entire life. That's why it's important to lubricate periodically throughout the life of the rope.
The surface of some ropes may become covered with dirt, rock dust or other material during their operation. This can prevent field-applied lubricants from properly penetrating into the rope, so it's a good practice to clean these ropes before lubricating.

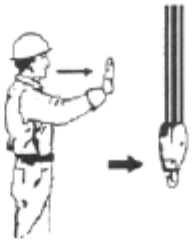
The lubricant you apply should be light-bodied enough to penetrate to the rope's core. You can normally apply lubricant by using one of three methods: drip it on rope, spray it on or brush it on. In all cases, you should apply it at a place where the rope is bending such as around a sheave. Apply it at the top of the bend because that's where the rope's strands are spread by bending and more easily penetrated. In addition, there are pressure lubricators available commercially. Your rope's service life will be directly proportional to the effectiveness of the method used and the amount of lubricant that reaches the rope's working parts.
A proper lubricant must reduce friction, protect against corrosion and adhere to every wire. It should also be pliable and not crack or separate when cold yet not drip when warm. Never apply heavy grease to the rope because it can trap excessive grit, which can damage the rope. Nor should you apply used "engine oil" because it contains materials that can damage th



1.14 HAND SIGNALS


EXTEND BOOM


DOG EVERYTHING


TRAVEL


RETRACT BOOM


EXTEND BOOM (ONE HAND)

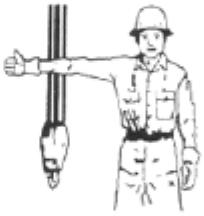

RETRACT BOOM (ONE HAND)

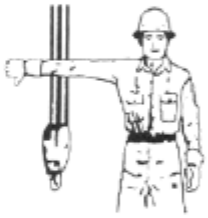

HOIST


LOWER

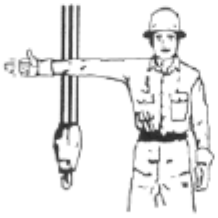

USE MAIN HOIST

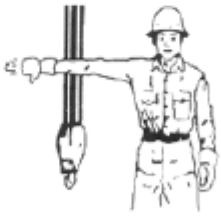

USE WHIP LINE

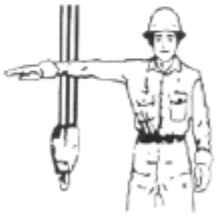

RAISE BOOM

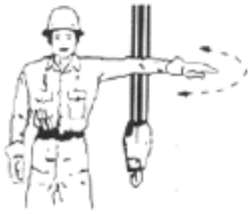

LOWER BOOM

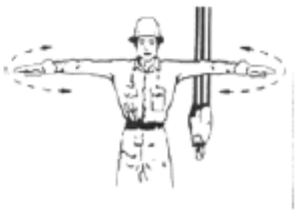

MOVE SLOWLY


RAISE THE BOOM & LOWER THE LOAD


LOWER THE BOOM & RAISE THE LOAD


SWING


STOP


EMERGENCY STOP

SPECIFICATIONS & SERVICE TOOLS

2.1 SPECIFICATIONS

Hydraulic System	Max FLOW GPM	FLOW L/min.		PRESSURE psi	PRESSURE MPa
Main Piston Pump 80cc	50	189		3500	24.1
			Standby	325	2.2

Pump Flows listed are at free flow condition (100 psi)

Platform System Pump .524cc	0.85 at 250 psi			1500	10.0

Functions	Relief Setting psi	Relief Setting MPa	FLOW GPM	FLOW L/min.	Operating Time seconds
Lift Up	3500	24.1	24	91	45 +/- 5
Lift Down	3500	24.1	11	42	35 +/- 5
Boom Extend	2700	18.6	30	114	
Boom Retract	2200	15.2	9	34	
Level Up	2500	17.2	30	114	
Level Down	2500	17.2	30	114	
Swing Left	2100	14.5	9	34	41 +/-5
Swing Right	2100	14.5	9	34	41 +/-5
Options-C1	2500	17.2	11	42	
Options-C1	2500	17.2	11	42	
Outriggers In/Out	2500	17.2			
Outriggers Up/Down	2500	17.2			
Front Stabilizer	2200	17.2			

Reservoir Capacity	143 Gallons
Filtration (Pressure)	5 Micron
Filtration (Return)	10 Micron

Winch System Performance

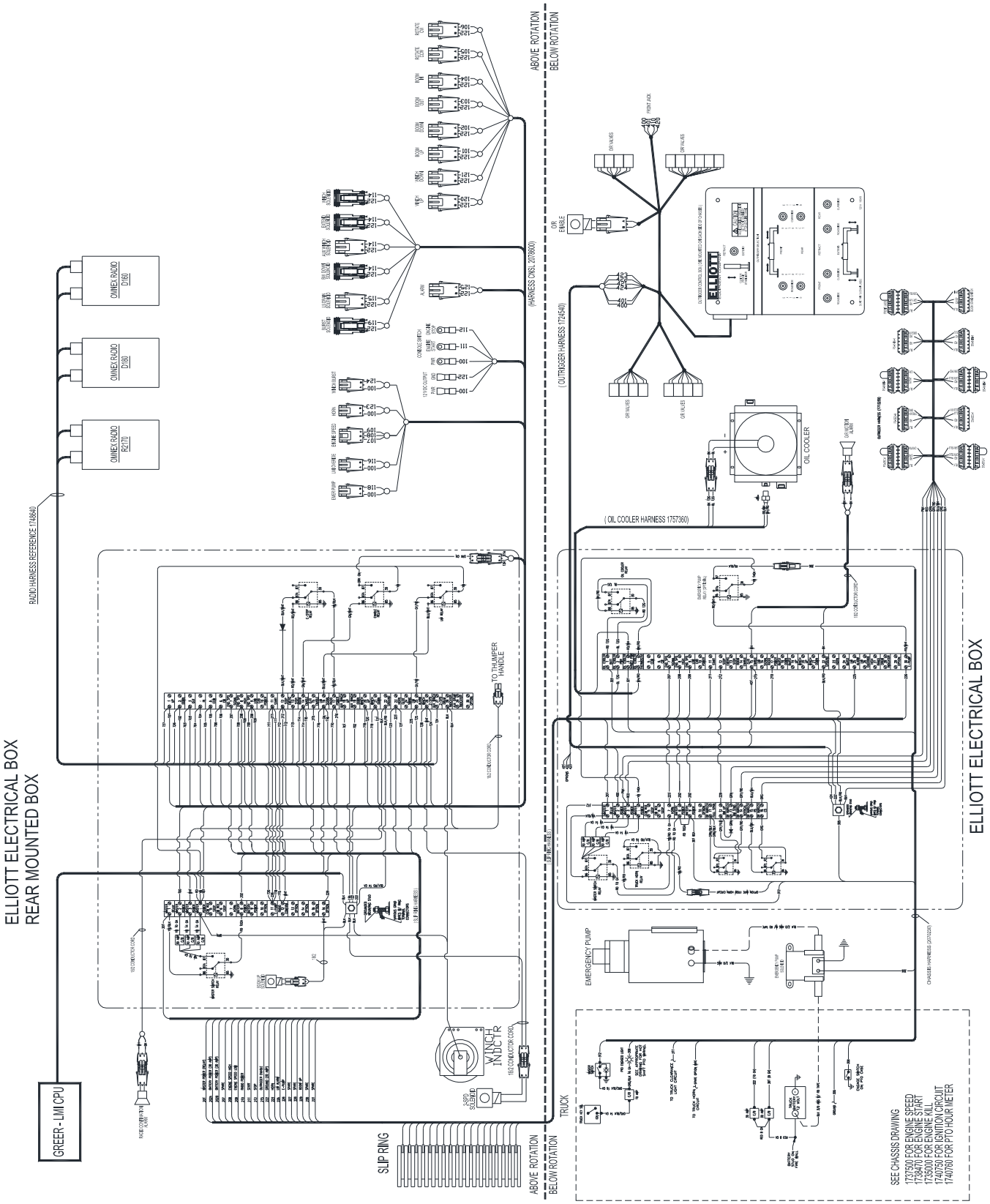
Line Pull	7100 Lbs.
Wire Rope	1/2" 6 x 37 IWRC EIPS
Breaking Strength	26,600 Lbs.
Cable Length	400 Lbs.

	Winch Line Pull		Line Speed	
Layer	Lb.	(kg)	fpm	(mpm)
1	7100	(3220)	105	(32)
2	7100	(3220)	116	(35)
3	7100	(3220)	128	(39)
4	7100	(3220)	139	(42)

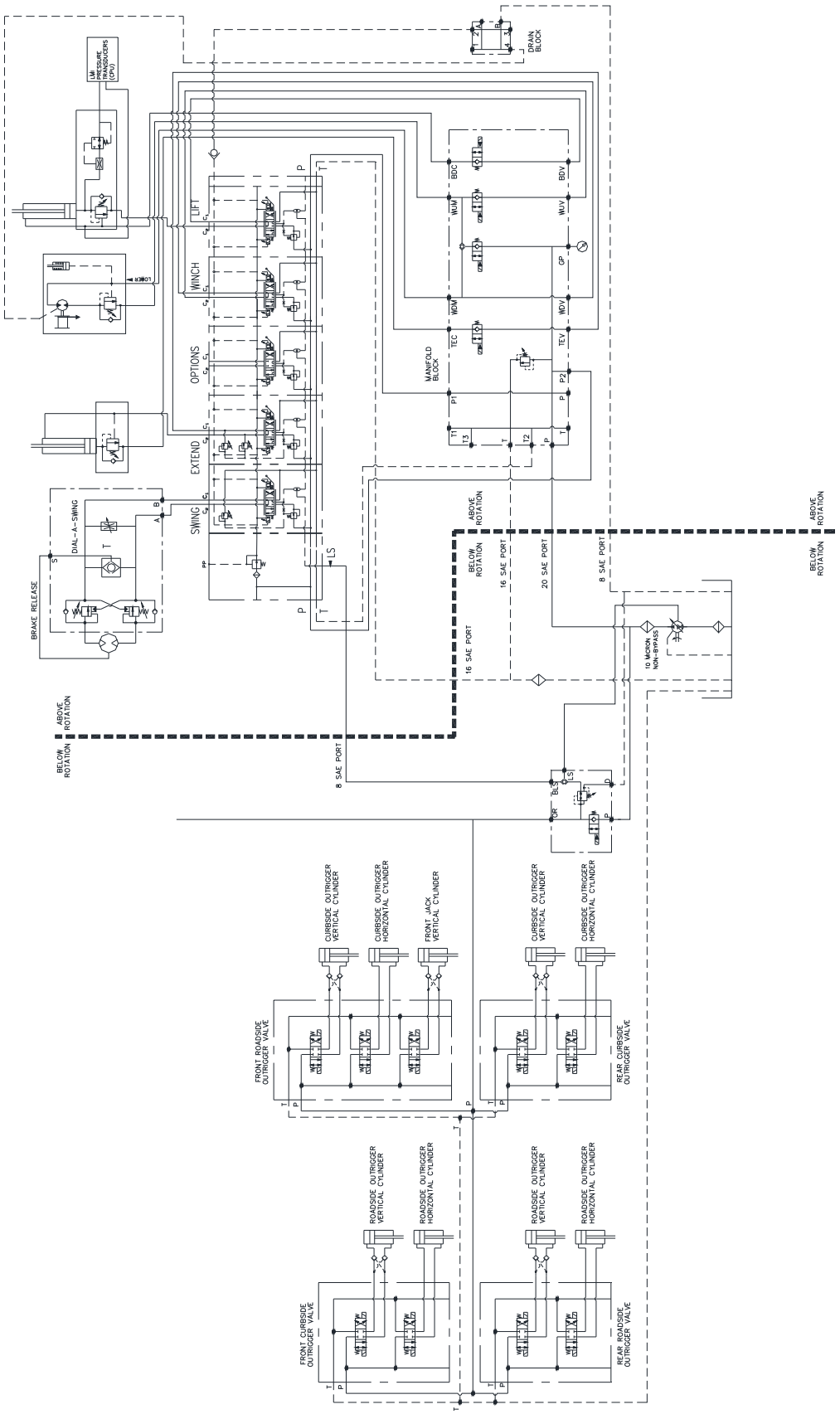
Reccomended Hydraulic Oil

Main System	MV Extreme Hydraulic Fluid	Elliott PN 3013677	165 gallons
Platform Leveling System	Low temp ISO 32 Synthetic	Elliott PN 3019364	2 gallons

2.2 ELECTRICAL SCHEMATIC (MAIN) (.PDF FILE ON CD)



2.3 HYDRAULIC SCHEMATIC (.PDF FILE ON CD)



MAINTENANCE

3.1 MAINTENANCE SAFETY

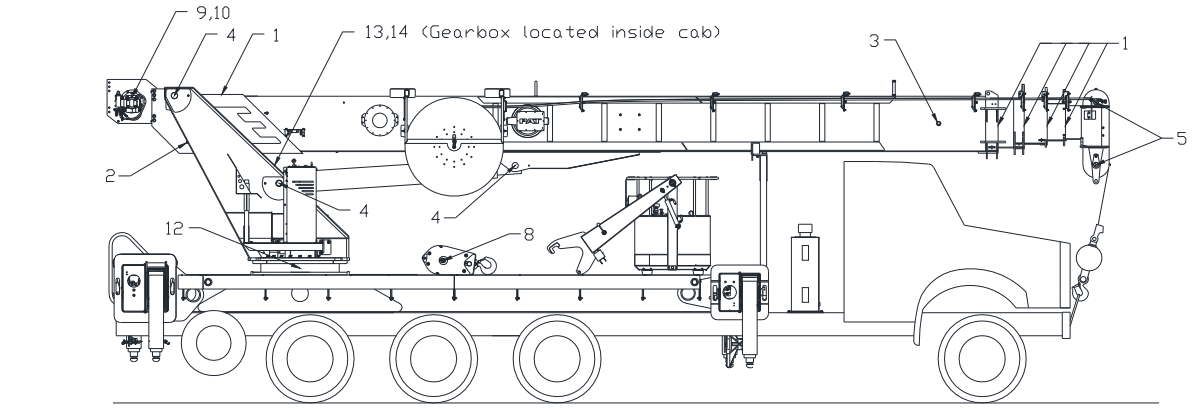
Perform the following safety steps whenever possible before maintaining or repairing the aerial device:

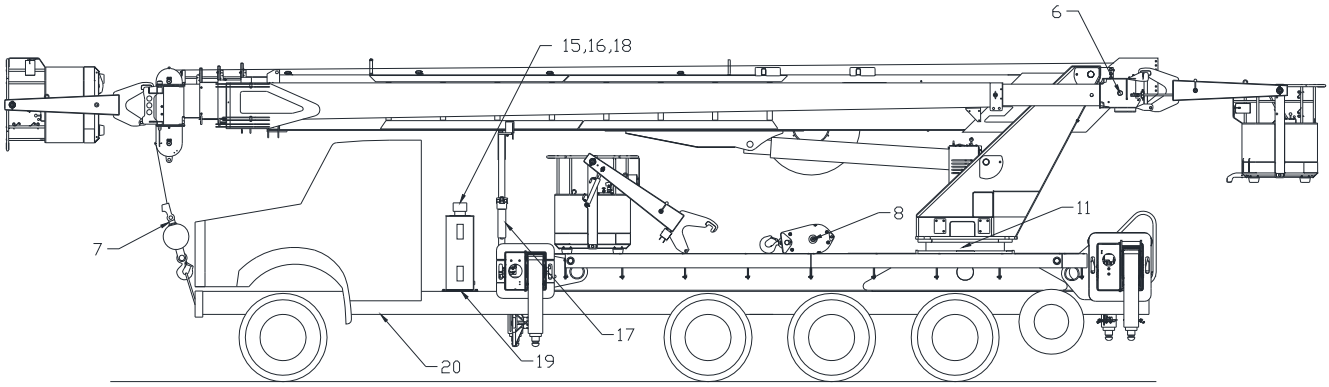
1) Apply the Parking brake.
2) Lower all loads to ground and disconnect.
3) Stow boom on rest if possible.
4) Move all controls to off position.
5) Disengage PTO and turn engine off.
6) Tag start controls warning personnel that aerial device is being serviced and must not be started.
7) Do not place hands or tools in openings in boom sections while engine is running or boom sections are moving.
8) Read and thoroughly understand all applicable instructions.
9) Pressurized oil can penetrate human skin causing serious injury. Do not use bare hands to check for hydraulic leaks.
10) Hydraulic oil is flammable. Keep open flames away.
11) Do not alter specified relief settings for hydraulic pressure.
12) Make sure boom, outriggers, etc. are securely blocked of resting on the ground before removing cylinders.
13) Know the weight of heavy objects and do not attempt to lift them.
14) Replace all guards and covers prior to returning the aerial device to service.
15) Never climb on turret, winch, or top of boom. Use ladder and/or manlift to obtain access to these areas.

3.2 CLEANLINESS

Long life of a aerial device's hydraulic components is dependent on keeping dirt out of the system. Whenever hydraulic lines are disconnected, clean the adjacent area as well as the point of disconnection. Immediately cap or plug openings to prevent entry of dirt. Clean all parts and cover to keep clean.
If evidence of foreign particles is found in the hydraulic system, flush the system. Inspect all sealing elements when disassembling and assembling hydraulic systems. Always install new O-rings on ORFS fittings when removing and reinstalling. Hoses should be installed so any bending is with natural curvature.

3.3 LUBRICATION





	Description	Lubricant	Procedure	Interval	Notes
1	Boom Wear Pads	Grease	Brush/Roller	Monthly	1
2	Boom Retract Sheaves	Grease	Gun	Weekly	2
3	Boom Extend Sheaves	Grease	Gun	Weekly	3
4	Boom & Lift Cylinder Pivot Pins	Grease	Gun	Weekly	4
5	Boom Head Sheaves	Grease	Gun	Weekly	
6	Jib Head Sheave	Grease	Gun	Weekly	
7	Hook Block/Headache Ball Swivel	Grease	Gun	Weekly	
8	Hook Block Sheave(Snatch Block)	Grease	Gun	Weekly	
9	Winch Brake	SAE 20W-20 Motor Oil	Check Level	Monthly	5
10	Winch Gearbox	SAE 90 EP Gear Lube	Check Level	Monthly	5
11	Swing Bearing Grease Fitting	Grease	Gun	Monthly	6
12	Swing Bearing Gear Teeth	Grease	Gun/Brush	Monthly	7
13	Swing Gearbox Pinion Bearing	Grease	Gun	Monthly	8
14	Swing Reducer Gearbox	SAE 90 EP Gear Lube	Check Level	Semi-annually	8
15	Hydraulic Oil Tank Fill	See Notes	Check Level	Daily	9
16	Hydraulic Oil Filter - Return			Daily	10
17	Hydraulic Oil Filter - Pressure				
18	Hydraulic Tank Breather			Semi-annually	
19	Suction Strainer			At Oil Change	
20	Pump Drive U-Joint or	Grease			
	Pump Drive Spling Shaft	Coupling Lube	Remove Pump		
		Spline Lubricant	and apply to		
			shaft		

3.3.1 Lubrication notes

1) Fully extend boom and apply a light coat of grease to sides and bottom of moving boom sections in area of wear pads.
2) Fully retract boom. Remove cover on top, rear of base boom and coat wear pads with grease. On 4 section booms-slightly extend as necessary to expose all pads to grease. Replace cover.

⚠CAUTION

Do not place hands or tools into opening when truck engine is running and/or boom sections are moving.

Retract sheaves on 1st moving section are accessible through holes in base boom when boom is fully retracted.

Do not place hands or tools into opening when truck engine is running and/or boom sections are moving.

3) Fitting is located on end of extend sheave pin on outboard end of telescope cylinder in boom. Extend boom to align holes in sides of mid and fly booms. Caution: Do not place hands or tools into opening when truck engine is running and/or boom sections are moving.
4) Grease fittings for the hoist cylinder pivots are on the middle of the cylinder end mounts. Boom pivot grease fittings are on the base boom pivot bushings and are accessible from the back of the boom.
5) See “Tulsa Winch Service Manual” for complete lubrication checking and oil changing directions.
6) The swing bearing race is lubricated from a remote grease fitting located on the top of the operator’s console on the driver’s side. Apply three or four pumps of grease, rotate 90 degrees and apply three of four more shots of grease. Repeat procedure through 360 degrees of operation.
7) Brush or spray grease on each gear tooth. Note: Swing cover must be removed.
8) See “Tulsa Winch Swing Drive Service Manual” for complete lubrication and oil changing directions.
9) When checking the level on the hydraulic tank, the boom must be retracted and stowed and all outriggers and stabilizers must be fully retracted. Add hydraulic oil as required to keep the level on the sight gauge between the high and low marks. Use high quality ISO Grade 32 hydraulic fluid with a viscosity index greater than 100.
10) Check daily and periodically throughout day. Replace the element when the gauge reading reaches 25 PSI with warm oil and the engine at high RPM. Note: The filter has a bypass that opens when the pressure exceeds 25 PSI. Operating the crane when the filter is bypassing may damage the pump, valves and hydraulic system. Replace at earlier intervals if required. Do not clean and reuse

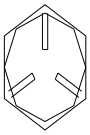
3.4 BOLT TORQUE

The torque values for fasteners are listed below. Make sure each fastener is the correct size and grade prior to torquing. Always use grade 8 nuts with grade 8 fasteners. Use hardened washers under screw heads and beneath nuts that are torqued. Make sure threads are clean and free of burrs. Semiannually check items #1-8. Use a calibrated torque wrench and recalibrate on a regular basis

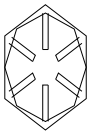
Tightening Torque

Coarse Threaded Fasteners				Fine Threaded Fasteners			
UNC Size	TPI	Grade 5 ft-lb.	Grade 8 ft-lb.	UNF Size	TPI	Grade 5 ft-lb.	Grade 8 ft-lb.
1/4	20	8	12	1/4	20	10	14
5/16	18	17	25	5/16	18	19	25
3/8	16	30	45	3/8	16	35	50
7/16	14	50	70	7/16	14	55	80
1/2	13	75	110	1/2	13	90	120
9/16	12	110	150	9/16	12	120	170
5/8	11	150	220	5/8	11	180	240
3/4	10	260	380	3/4	10	300	420
7/8	9	400	600	7/8	9	440	660
1	8	580	900	1	8	640	1000
1 1/8	7	800	1280	1 1/8	7	880	1440
1 1/4	7	1120	1820	1 1/4	7	1240	2000
1 3/8	6	1460	2380	1 3/8	6	1680	2720
1 1/2	6	1940	3160	1 1/2	6	2200	3560

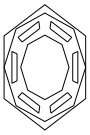
* Tolerance on Torque Values +/- 10%



GRADE 5 BOLT OR SCREW



GRADE 8 BOLT OR SCREW



GRADE 8 NUT

GRADE MARKINGS

3.5 CHANGING HYDRAULIC OIL

Drain and refill the hydraulic system every six months unless an alternate interval has been established by oil analysis.

1) Bring the oil to operating temperature by running the aerial device functions.
2) With all controls in neutral position, turn the truck engine off.
3) Remove the drain plug from the tank bottom. If the oil is extremely dirty or contaminated, crack open fittings at high points on the system to vent the lines. Be sure to retighten the fittings prior to starting the truck engine.
4) Thoroughly clean dirt from the access cover on the top of the tank and remove the cover.
5) Clean out any sediment inside the tank.
6) Remove the suction strainer. Soak in solvent and blow off with compressed air before reinstalling.
7) Reinstall the cover on the tank top, replace gasket as required.
8) Replace the filter element.
9) Replace the breather.
10) Clean metal particles from the drain plug and reinstall.
11) Fill the hydraulic tank to the proper level with approved, filtered hydraulic oil-use 10 micron filter.
12) Make sure the suction line shut off valve is open before starting the engine; otherwise the pump will cavitate and destroy itself.
13) Start the engine, engage the PTO and let the pump run a couple minutes with no load at low RPM.
14) Gradually increase speed and operate all functions. Operation may be sluggish or erratic as air is purged.
15) Once the functions are operating smoothly, stow the boom and outriggers and then stop the engine.
16) Fill the hydraulic tank to the full level on the sight gauge.

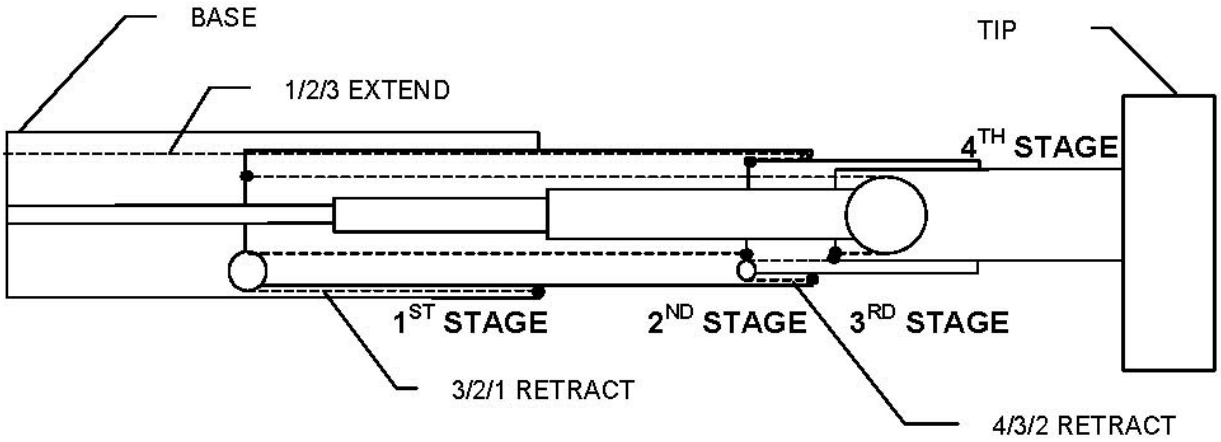
3.6 BUBBLE LEVEL ADJUSTMENT

Check the adjustment of the bubble levels on the control consoles monthly:

1) Extend outriggers and stabilizers and level the aerial device with the bubble level.
2) Raise the fully retracted boom to 80 degrees.
3) Place an accurate carpenter's level on either side of the turret top plate.
4) Adjust the outriggers and stabilizers so the aerial device is level from front to rear according to the carpenter's level.
5) Swing the boom 90 degrees over either side of the truck and adjust the outriggers and stabilizers so the aerial device is level according to the carpenter's level.
6) Repeat this procedure until the aerial device is level and needs no further adjustment. Note: Tires must be off the ground.
7) Check the bubble level at each console. Shim under the level base with washers at mounting screws as required until the bubble is centered in the circle. Retighten mounting screws.

3.7 FOUR SECTION BOOM OPERATION

THE BOOM SERVICE AND MAINTENANCE SECTION OF THIS MANUAL INCLUDES BOTH THE FOUR AND FIVE SECTION BOOM INFORMATION. USE APPROPRIATE INFORMATION FOR YOUR PARTICULAR BOOM LENGTH.



A rod-fed, two-stage double-acting cylinder, attached to the 1st, 2nd and 3rd boom sections, supports and propels the 2nd and 3rd boom sections. The extend cables attach to the base end of the 2nd boom section, are reeved around sheaves attached to the cylinder and attach to the base end of the 4th boom section, therefore providing support and extention of the 4th boom section. The 3rd section retract cables attach to the tip end of the 1st boom section, are reeved around sheaves attached to the 2nd boom section and attach to the base end of the 3rd boom section, therefore providing retraction of the 3rd boom section. The 4th section retract cables attach to the tip end of the 2nd boom section, are reeved around sheaves attached to the 3rd boom section, and attach to the base end of the 4th boom section, therefore providing retraction of the 4th boom section. A proportioning cable attached to the rear of the 1st section, reeved around a sheave at the tip of the 2nd section and anchored to the rear of the 3rd section maintain proper cylinder extension proportion, therefore maintaining equal boom section proportion. Detailed service and maintenance is required to insure smooth and proper operation. **Do not, under any circumstances, work at an elevated height without using proper fall protection as required by local, state or federal regulations**

3.7.1 Internal Cable Sheave Lubrication

NOTE: Observation through the sheave case for the extend sheaves and the winch mount for retract sheaves will visually determine the amount of grease necessary for proper lubrication. A slight amount of grease extrusion around the pin joint is adequate for proper lubrication.

Lubrication of the extend cable sheaves located on the boom tip end of the extend cylinder and the retract cable sheaves located on the inside rear of the 2nd and 3rd section and the extend cable sheave attached to the bottom of the top plate of the second section at the sheave case end of the boom are accomplished with the boom fully retracted. A grease zerk is located on each lubrication point.

3.7.2 Four Section Cable Tensioning

After boom reassembly or from time to time if interior proportioning cables appear loose, cable tensioning may be required. Tensioning must be done with the boom horizontal

1. Slightly tighten all cables. Then cycle the boom approx. 4 feet (120cm) out and in a few times to equalize the extend and retract cable/boom section sequence positioning.
2. Fully retract boom. Do not induce and hold hydraulic pressure. At full retraction, observing through the winch mount end of the boom, the second section should be bottomed on the extend cylinder butt plate, the third section should be bottomed on the thick vertical side plates welded to the inside of the second section, the fourth section should be bottomed on the thick vertical side plates welded to the inside of the third section.
3. It is important to achieve these boom section positions before torquing. If the boom sections do not bottom out as specified (boom is out of sequence), adjust cables to achieve proper section positioning. After proper section position has been established, a scribe mark on all the sections at the boom tip end to identify proper sections at the boom tip end to identify proper section position relative to each other may be helpful during the tensioning process.
4. Torque 4/3/2 retract cables to 7 ft-lb (9.5 N.m). Cable adjustment point is located at the sheave case end of the boom on the bottom of the 2nd section. Use the flats at the front of the cable ends to keep the cables from turning while torquing retainer nuts.
5. Torque large extend cables to 22 ft-lb (12.2 N.m). Cable adjustment point is located at the rear of the boom on the cable anchor located in the rear of the 2nd section.
6. Torque 3/2/1 retract cables to 9 ft-lb (12.2 N.m). Cable adjustment point is located at the sheave case end of the boom, on the bottom of the 1st section. Use the flats at the front of the cable ends to keep the cables from turning while torquing retainer nuts.
7. Torque 1/2/3 extend cable to 9 ft-lb (12.2N.m). Cable adjustment point is located at rear of boom on the winch crossbar spanning the 1st section.
8. Repeat steps 4,5,6 and 7, torquing the 4/3/2 retract cables to 14 ft-lb (19 N.m). Torque the large extend cables to 45 ft-lb (61 N.m). The 3/2/3 retract cables to 18 ft-lb (24 N.m) and the 1/2/3 extend cable to 18 ft-lb (24 N.m).
9. Cycle the boom fully, check that all the cables are torqued properly and that all sections are retracted completely, utilizing scribe marks or bottoming position of boom sections then add jam nuts to all cables. All threaded cable ends must be equipped with retainer nuts and jam nuts.

3.7.3 Four Section Boom Removal

Boom length	**Boom weight**
L115	9,500 lb (4318 kg)

1. Extend and set machine outriggers. Boom must be completely retracted and stowed in the boom rest.
2. If equipped, remove swing around jib according to procedures outlined in the “Safety & Operation” section.

3. Remove hook block or downhaul weight, wind up rope on winch drum and stow wedge socket on pegs provided on 1st section. Shut down truck engine.
4. Attach a lifting device to rod end of lift cylinder, remove boom lift cylinder pin keeper and pin from bottom of the 1st section boom. Lower lift cylinder to a suitable support.
5. Tag and disconnect extend cylinder lines and winch hydraulic lines. Cap all open lines and ports.
6. Attach a lifting device to provide even weight distribution and raise the boom until weight is removed from the boom pivot pin. Remove boom pivot pin keeper and boom pivot pin. Lift boom free of turret.

3.7.4 Boom Disassembly

For reference, the front of the boom refers to the sheave case end, the rear of the boom is the winch mount end. Left and right are viewed from rear to front.

If the boom is to be unpinned from the turret of the aerial device structure, please refer to the Boom Removal Procedure section in this book. If the required service procedure is to be performed on the boom while still pinned to the turret, please follow these directions.

Do not, under any circumstances, work at an elevated height without using proper fall protection as required by local, state or federal regulations.

1. Extend and set all outriggers and SFO.
2. Fully retract the boom and place in a horizontal position.
3. Winch removal optional.

3.7.5 Boom Disassembly Alternative

1. Gaining access through rear of boom, loosen cap screws retaining the keeper plates holding the extend cable anchor and retract cables in the rear of the 3rd section, remove keeper plates.
2. Extend boom 24 inches (60 cm). Loosen and remove the nuts which secure the extend cables to the cable anchor plate. Tag and disconnect hydraulic lines to the extend cylinder.
3. Drape extend cables inside boom and slide cable anchor plate out of the side of the winch mount if winch has been removed from boom.
4. Loosen and remove two cap screws, lockwashers and spacers which anchor the extend cylinder rod butt plate to the rear of the 1st section.
5. Loosen and remove two cap screws and lockwashers securing spacer bar to the inside top of the front of the 1st section. Remove spacer bar.
6. Loosen and remove four cap screws securing wear pads to the bottom of the 1st section. Removal of side wear pads is optional. Adequate clearance exists between adjoining section side pads for boom disassembly. If side pad removal is required, tag all pads, shims and corresponding locations for proper reassembly.
7. Support 2nd-3rd-4th assembly at the front with an appropriate lifting method. Raise the 2nd-3rd-4th assembly inside the 1st section to allow for front bottom pad removal. Remove bottom wear pads.
8. With the 2nd-3rd-4th assembly supported, slide assembly out of the 1st. Relocation of the sling point on the 2nd-3rd-4th assembly will be necessary for proper balancing of the assembly as it slides out of the

1st section. Keep tension on retract cables as the assembly is pulled out of the 1st to minimize the chance of retract cable damage.

9. Place 2nd-3rd-4th assembly on a suitable horizontal surface. Take care not to pinch or crush retract cables while lifting or supporting assembly.
10. Remove top rear wear pads on the 2nd section. They will lift off the cam plates easily. Do not remove or loosen the cap screws holding the cam plates to the section. This will affect side clearance during re-assembly.
11. Loosen and remove four cap screws securing the rear bottom wear pads on the 2nd section. This pad serves as a bottom and side pad as well as the retract cable keeper under the retract sheaves. Removal of this pad will allow the retract cables to uncoil off the retract sheaves. Place retract cable ends in a location to minimize the possibility of damage.
12. Loosen and remove six cap screws securing retract sheave pin and retract sheaves to 2nd section. Remove sheaves and pins.
13. Loosen and remove two cap screws functioning as upper retract cable keepers. Remove retract cables.
14. Loosen and remove two cap screws securing lock bar to the extend cylinder collar. This bar constrains the vertical movement of the extend cylinder. Remove bar.
15. Loosen cap screws retaining extend cable anchor to back of the 4th section. Total removal of the cap screws will allow the cable anchor to be completely disassembled, backing cap screws out approximately .50 inch (12mm) will allow the anchor assembly to slide rearward out of the section as the extend cylinder is removed.
16. Support extend cylinder with an appropriate lifting device and pull the extend cylinder out of the boom while keeping the extend cables tensioned slightly by hand to minimize the possibility of damage to the cables. Pull cylinder to within 3 feet (91mm) of complete removal from the boom sections.
17. Reach into the rear of the 4th section and pull the extend cable anchor out from its retaining pocket on the bottom of the 4th section. A slight angle applied to the anchor as it is being pulled to the rear will permit easier removal through the 2nd and 3rd sections.
18. Remove the extend cylinder from the boom. Do not allow the sheaves to fall off the pin on the end of the extend cylinder. Remove extend cables. Place cylinder and cables in suitable area to prevent possible damage.
19. Loosen and remove two cap screws, cable guide, wear pad and spacer bar from the front top of the second section.
20. Loosen and remove four cap screws attaching the bottom pad plate to the second section. Slightly lift third section and remove pad plate.
21. Slide 3rd section out of 2nd section. Removal of side pads is optional, as the side pads have adequate clearance for boom disassembly. If removal of side pads is required, tag all shims, pads and corresponding locations for proper re-assembly.
22. Loosen and remove two cap screws, cable guide wear pad and spacer bar from the front top of the third section.
23. Loosen and remove four cap screws attaching the bottom pad plate to the third section. Slightly lift 4th section and remove pad plate.
24. Slide 4th section out of 3rd section. Removal of side pads is optional, as

the side pads have adequate clearance for the boom disassembly. If removal of the side pads is required. Tag all shims, pads and corresponding locations for proper reassembly.

25. Loosen and remove all remaining cap screws and wear pads from sections.

3.7.6 Additional Maintenance, Disassmbled Boom

1. Clean all boom sections and inspect for wear, dents, bent or crooked boom sections, gouged metal, broken welds or any abnormal conditions. Repair or replace as required.
2. Inspect all sheaves for excessive groove wear or abnormal rim wear. Replace as required.
3. Inspect all sheave bearings for excessive wear or cut inner liner material. If installed bearing diameter is .015 inch (.38 mm) larger than pin diameter, bearing must be replaced. Any cut or gouge which causes the bearing liner to lose strands is cause for bearing replacement.
4. Clean and inspect all cable assemblies according to wire rope inspection procedures in this section. Pay particular attention to any wire breakage at the end connections. Replace cable assemblies as required. Lubricate all cable assemblies as required. Lubricate all cable assemblies before reinstalling them in boom.
5. Inspect all sheave pins for nicks, gouges or pitting due to rust in the bearing surface area. Replace if any damage is evident.
6. Inspect all zerks and grease paths in pins to ensure proper grease flow. Clean and replace as required.
7. Replace all lubricating plugs in all wear pads.

3.7.7 Four Section Boom Assembly

Note: Do not use Loctite on any cable threaded ends. Always use the locknut and nut provided.

When initially assembling threaded ends of cables, thread the first on past the flat in the cables so adjustment can be made later.

1. Assemble sheaves into 4th section sheave case. Top sheave is to be installed to the left hand side of the boom with the spacer to the right hand side.
2. Attach rear wear pads on bottom of 4th section. Using Loctite 242 blue, Loctite all wear pad mounting cap screws.
3. Install 4th boom section into 3rd section. Slide together approximately 5 feet (150cm).
4. Assemble bottom front wear pads for 3rd section. Attach pads to pad plate.
5. Using appropriate lifting device, lift 4th section to allow for wear pad/pad plate installation in front of 3rd. Install wear pad/pad plate assembly. Slide sections together within 12 inches (30cm) of full retraction.
6. Install cable guide and upper spacer to front of 3rd section.
7. Install front side wear pads with appropriate shims, between 4th and 3rd sections. If boom has been disassembled and no sections have been replaced, use same shim quantity and location as was previously used. If locations are in question, refer to shim calibration section in this book. Slide boom sections completely together.
8. Assemble top rear wear pads to the top of the 4th boom section with the cam plates and install through the winch mount end of the boom. Install cap screw through holes in outer boom sections. The wear pads on each side at the top/rear of the boom can be adjusted over a range of 3/16 inch (4.8mm) by rotating, end for end, the wear pad and plate or the wear pads and plate independently. This is possible because the holes in these parts are offset from the center. The holes are .06 inch (1.5mm) off center in the plate and .03 inch (.8mm) off center in the wear pad. Various combinations of rotation of these parts allow the adjustment.
9. Uncoil 4/3/2 retract cable assemblies and insert button end into anchors in back of the 4th section. Place uncoiled cable in area that will minimize the potential for damage.
10. Uncoil 3/2/1 retract cable assemblies and insert button end into cable anchor pockets in back of the 3rd section. Place uncoiled cable in area that will minimize the potential for damage. Assemble retract sheaves and retract sheaves and retract sheave pins in rear of 3rd section. Coat surfaces of bearings and keeper plates with grease before assembly.
11. Place retract cables anchored to 4th over the top of the retract sheaves on the 3rd. Install keeper cap screw above sheave to hold retract cables in place.
12. Reeve cables over retract sheave and install keeper/wear pad to bottom rear of 3rd section. This pad acts as a side pad, bottom pad and a cable retainer. Loctite rear wear pad hardware on bottom of 3rd with Loctite 242 blue. Loctite all wear pad mounting cap screws.
13. Loop the 1/2/3 extend cable in half and place it on the top of the 3rd section with the loop end towards the sheave case end and the

threaded and button end towards the rear of the section.

14. Install clamp plate and cap screws with the button end of the cable installed in the anchor slot on the rear top of the 3rd section.
15. Place sheave pin and sheave for the 1/2/3 extend cable in position on the sheave case end of the boom, inside the loop of cable.
16. Install 3rd and 4th section boom assembly into 2nd section. Slide together approximately 5 feet (150 cm). Use caution as retract cables and upper extend cable attached to the 4th-3rd section assembly slide into the 2nd section to prevent damage or crossing of cables.
17. Assemble bottom front wear pads for 2nd section. Attach pads to pad plate.
18. Using appropriate lifting device, lift 3rd and 4th section assembly to allow for wear pad/pad plate installation in front of 2nd. Install wear pad/pad plate assembly. Slide sections together within 12 inches (30cm) of full retraction.
19. Install cable guide and spacer to top of 2nd section.
20. Install front side wear pads with appropriate shims between 3rd and 2nd sections. If boom has been disassembled and no sections have been replaced, use same shim quantity and location as was previously used. If locations are in question, refer to shim calibration section n this book. Slide sections fully together.
21. Assemble top rear wear pads to the top of the 3rd boom section with the cam plates and install through the winch mount end of the boom. Install cap screw through holes in outer boom sections.
    The wear pads on each side at the top/rear of the boom can be adjusted over a range of 3/16 inch (4.8mm) by rotating, end for end, the wear pad and plate or the wear pads and plate independently. This is possible because the holes in these parts are offset from the center. The holes are 0.06 inch (1.5mm) off center in the plate and .03 inch (.8mm) off center in the wear pad. Various combinations of rotation of these parts allow the adjustment. Plates function as rear side clearance adjustment.
22. Position sheave and sheave pin located in cable loop on top of 3rd to allow cap screw installation through top plate of 2nd. Install cap screws and torque to specification, clamping sheave pin and sheave to the bottom of the 2nd section.
23. Assemble retract sheaves, retract sheave pins and cable keeper plates in rear of 2nd section. Coat surfaces of bearings with grease and assemble extend sheaves on sheave pin.
24. Place retract cables anchored to 3rd over top of retract sheaves attached to rear of 2nd. Install keeper cap screw above sheave to hold retract cables in place.
25. Reeve cables over retract sheave and install keeper/wear pad to bottom rear of 2nd section. This pad acts as a side pad, bottom pad and a cable retainer.
26. Assemble exterior extend cylinder components. Install and center sheave pin case end of extend cylinder. Install bearings into extend cable sheaves. Coat surface of bearings with grease and assemble extend sheaves on sheave pin.
27. Wrap approximately 10 feet (300cm) of each diameter 2/3/4 extend cable around extend sheaves and install 4th section extend cable anchor around cables at button end. Do not tighten cap screws clamping anchor together completely. These cap

screws if tightened completely will not allow cable anchor to install into 4th section.

28. Install wear pad over extend cylinder sheave side plates. This serves as a wear pad to keep the end of the extend cylinder centered in the boom, as well as an extend cable retainer.
29. Slide extend cylinder/extend cables into 2nd-3rd-4th boom assembly enough to assemble extend cable anchor into bottom rear of 4th section. Be aware of extend cable location when inserting cylinder into boom sections, inadvertent crushing or other damage to cables will warrant replacement.
30. Tighten cap screws clamping extend cable anchor together. This will also lock anchor in place in the anchor cutouts in the 4th section.
31. Visually verify that the extend cables are properly routed on their sheaves and continue to slide with the extend cylinder and cables into the boom sections. Keep extend cables supported and slightly tensioned during insertion of cylinder to maintain proper cable placement.
32. As the extend cylinder nears complete insertion into the 2nd-3rd-4th section assembly, adjust the height of the cylinder to allow the cylinder anchor collars to access the cylinder keeper cutouts in the doubler plates on the sides of the 2nd and 3rd sections.
33. Drop the cylinder down into the vertical cutouts in the doubler plates on the sides of the 2nd and 3rd sections. Cylinder length or boom section placement may have to be adjusted to allow cylinder collars to drop into their proper position.
34. Install lock bar and cap screws to the extend cylinder collar in the 3rd section.
35. Install large extend cable anchor into anchor cutouts in the doubler plates in the rear of the 2nd by routing extending cables through the anchor and the small cable over the anchor. Slide anchor fully into cutout.
36. Install keeper plates and hardware. This keeper plate retains both the horizontal movement of the extend anchor and the vertical movement of the extend cylinder.
37. Install 2nd-3rd-4th section boom assembly into 1st section boom, use caution when sliding sections together, 3rd retract cables must maintain their position to prevent damage, do not let boom rest on cables. Damage will result.
38. Assemble bottom front wear pads for 1st section.
39. Using appropriate lifting device, lift 2nd-3rd-4th section assembly to allow for wear pad installation in front of 1st. Install wear pads. Slide sections together within 12 inches (30cm) of full retraction.
40. Install upper spacer to front of 1st section.
41. Install front side wear pads with appropriate shims between 2nd and 1st sections. If boom has been disassembled and no sections have been replaced, use same shim quantity and location as was previously used. If locations are in question, refer to shim calibration section in this book.
42. Push boom together until extend cylinder butt plate makes contact with the rear cylinder anchor plates in the rear of the 1st section. Install spacers, washers and cap screws, attaching cylinder to 1st section boom. If cylinder is misaligned with anchor points, cylinder butt plate can be rotated to achieve proper alignment (holding valve up, parallel with boom top plate).

43. Assemble top rear wear pads to the top of the 2nd boom section with the cam plates and install through the winch mount end of the boom. Install cap screws through holes in out boom sections.

    The wear pads on each side at the top/rear of the boom can be adjusted over a range of 3/16 inch (4.8mm) by rotating, end for end, the wear pad and plate or the wear pads and plate independently. This is possible because the holes in these parts are offset from the center. The hole are 0.06 inch (1.5mm) off center in the plate and 0.03 inch (.8mm) off center in the wear pad. Various combinations of rotation of these parts allow the adjustment.
44. Install thick winch attachment bar into the mount. This bar anchors the extend cable.
45. Install the threaded ends of the small extend cables through hole in center of the winch mount attachment assembly.
46. Slightly tighten all cables. Cycle boom slowly to assure proper operation before torquing cables. Refer to the "Four Section Cable Tensioning" section to properly torque the cables in the extend system. Cables must be torqued to proper specifications for proper boom operation.
47. Install winch and anti-two block system.

3.7.8 Four and Five Section Top/Bottom Pad Replacement – Assembled Boom

Inspect top and bottom wear pads periodically for signs of abrasion or excessive wear. Excessive is defined as 3/16 of an inch (4.8mm) from the original pad thickness, top rear pad thickness .75 inch (19mm), bottom front 1st section 1 inch (25mm), bottom front 2nd and 3rd section .44 inch (13mm). Uneven pad wear of 3/32 inch (2mm) from side to side on the wear pad would be considered excessive as well. If any of these conditions exist, the top and bottom pads can be replaced without complete disassembly of the boom.

3.7.9 Top Pad Replacement

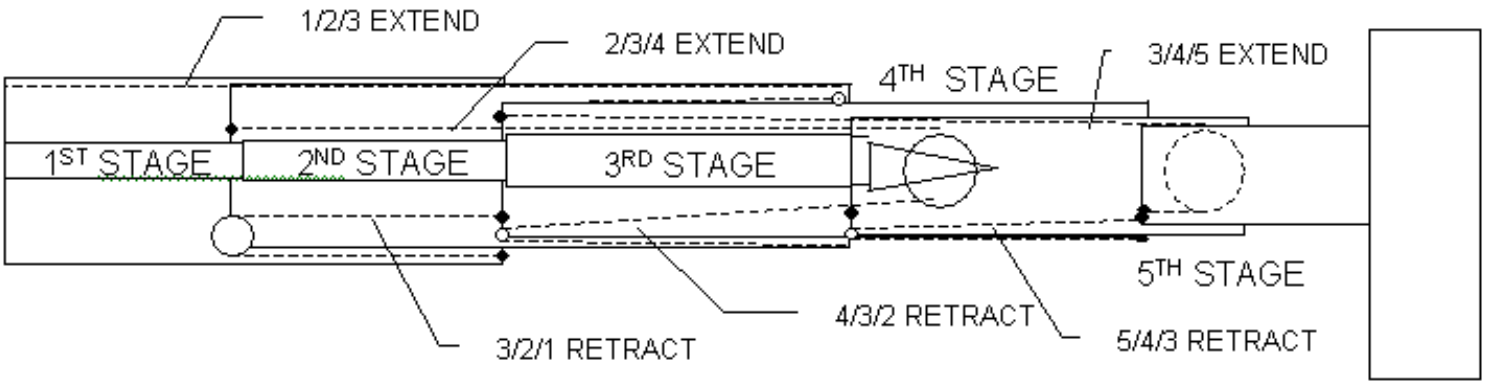
Pad maintenance on the four or five section can be made easier by removal of the winch. Additional clearance can be achieved on the four section by loosening the large extend cables and removing the extend cable anchor located in the 2nd section.

1) Retract boom completely.
2) Remove cap screws through access holes on top rear of sections.
3) Remove wear pads, shims and cam plates from the rear of the boom through open winch mount end.
4) Note all pad locations and tags accordingly.
5) Inspect pads for wear using previously mentioned inspection criteria.
6) Install new pads through winch mount end of boom. See top pad adjustment procedure for proper pad and section position.
7) Torque retainer cap screws to 75 lb-ft (100 N-M). Failure to properly torque cap screws will cause loss of preload, allowing pad cam to rotate and cause excessive side clearance between sections.

3.7.10 Front Bottom Pad Replacement

1) Extend boom approximately 4 feet (120cm) out.
2) Remove cable guides and upper spacer bars from front of boom sections.

3) Loosen and remove hex nuts on retract cables on the front of the 1st and 2nd sections.
4) Using an appropriate lifting device, sling around the 4th and 5th depending on configuration section boom and lift it up until weight is removed from the bottom pads in the front of the interior sections.
5) Loosen and remove the cap screws holding the pad doubler plates in the front of the sections. Remove plates. Remove pads from these plates. Note all pad locations and tag accordingly.
6) Inspect pads for wear using previously mentioned inspection criteria.
7) Install new pads on plates or boom sections. Reassemble plates in boom in proper locations.



3.8 FIVE SECTION BOOM OPERATION

A two-stage, rod fed, double-acting cylinder is attached to and supports the 1st, 2nd and 3rd stage boom sections. The 3/4/5 extend cables attach to the base of the 3rd stage boom, are reeved around sheaves at the tip of the 4th stage boom and attach to the base and support the 5th stage boom. The 5/4/3 retract cables are attached to the base of the 5th stage boom, are reeved around sheaves at the base of the 4th stage boom and attach to the tip of the 3rd stage boom. The 2/3/4 extend cables attach to the base of the 2nd stage boom, are reeved around sheaves at the tip of the 3rd stage cylinder and attach to the base and support the 4th stage boom. The 4/3/2 retract cables are attached to the base of the 4th stage boom, are reeved around sheaves at the base of the 3rd stage. Boom and attach to the tip of the 2nd stage boom. The 1/2/3 extend cables attach to the base of the 1st stage boom, are reeved around sheaves at the tip of the 2nd stage boom and attach to the base of the 3rd stage boom. The 3/2/1 retract cables attach to the base of the 3rd stage boom, are reeved around sheaves at the base of the 2nd stage boom and attach to the tip of the 1st stage boom.

The 3/2/1 retract cables directly oppose the 1/2/3 extend cables to ensure that the 2nd and 3rd stage booms extend and retract equally at all times. The 4/3/2 retract cables directly oppose the 2/3/4 extend cables to ensure that the 3rd and 4th stage booms extend and retract equally at all times. The 5/4/3 retract cables directly oppose the 3/4/5 extend cables to ensure that the 4th and 5th stage booms extend and retract equally at all times.

3.8.1 Five Section Boom Service

3.8.2 Boom Removal

Length	Boom Weight*
E160	16,540 lb (7502 kg)
L140	10,300 lb (4682 kg)
32'/55' Jib	2150 lb (975 kg)

1. Extend and set machine outriggers and front stabilizer. Boom must be completely retracted and stowed in boom rest over front of truck.
2. If equipped, remove swing around jib according to procedures outlined in the "Safety and Operation" section.
3. Remove hook block or downhaul weight, wind up rope on winch drum and stow wedge socket becket on pegs provided on 1st section. Shut down truck engine.
4. Attach a lifting device to rod end of lift cylinder, remove boom lift cylinder pin keeper and pin from bottom of 1st section boom. Lower lift cylinder rod end to the deck.
5. Tag and disconnect extend cylinder lines and winch hydraulic and electric lines. Cap all openings.

Attach a lifting device to provide even weight distribution and raise the boom until weight is removed from the boom pivot pin. Remove boom pivot pin keeper and boom pivot pin. Lift boom free of turret.

3.8.3 Five Section Boom Maintenance

Do not, under circumstances, work at an elevated height without using proper fall proctection as required by local, state or federal regulations.

3.8.4 Internal Cable Sheave Lubrication

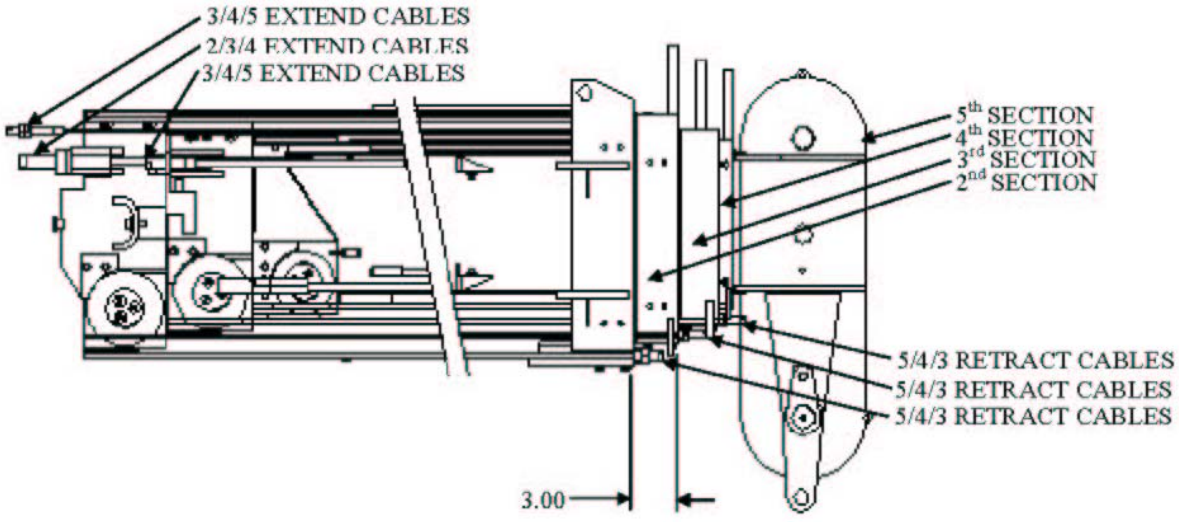
NOTE: Observation through the sheave case for the extend sheaves and the winch mount for retract sheaves will visually determine the amount of grease necessary for proper lubrication. A slight amount of grease extrusion around the pin joint is adequate for proper lubrication.

Lubrication of the extend cable sheaves located on the boom tip end of the extend cylinder and the retract cable sheaves located on the inside rear of the 2nd, 3rd and 4th section and the extend cable sheave attached to the bottom of the top plate of the 2nd section at the sheave case end of the boom, are accomplished with the boom in its fully retracted position. A grease zerk is located on each lubrication end.

3.8.5 Five Section Cable Tensioning

After boom reassembly or from time to time if interior proportioning cables appear loose, cable tensioning may be required. Tensioning must be done with boom horizontal. Proceed as follows:

1) Cycle boom approximately 8 ft (243cm) out and in a few times (2 feet (60cm) per section).
2) Fully retract boom. At full retraction the base of the 2nd boom bottoms out in the base of the 1st section boom, the base of the 3rd section bottoms out in the base of the 2nd bottom, the base of the 4th section boom bottoms out in the base of the 3rd section boom and the base of the 5th section boom bottoms out in the base of the 4th section boom. Marks should be scribed on the side plates along the front edge of each upper wear pad Indicating where each section bottoms out. This will aid the mechanic during the cable tensioning procedure. When the cables are torqued (tensioned) properly, the boom sections should extend/retract proportionally and bottom out at the same time during retract.
3) Tighten the 5/4/3 retract, 3/4/5 extend, 4/3/2 retract, 2/3/4 extend, 3/2/1 retract and 1/2/3 extend cables (in order listed) to remove slack from the cables and to achieve proper sequencing of bottoming out base of booms. To reach the 3/4/5 extend cables boom must be extended out approximately 18 inches (45cm), 4.50 inches (11.43cm) per stage and tightened through openings in the 1st and 2nd section booms.



4) Torque the 5/4/3 retract cables to ft-lb (8.13 N.m) each. Use the flats at the front of the cable ends to keep the cables from rotating while torquing. These cables are located at the bottom tip of the 3rd section boom.
5) Torque the 3/4/5 extend cables to 15 ft-lb (20.37 N.m) each. These cables are located at the top base of the 3rd stage boom. (Reference Step #3 for access to the 3/4/5 extend cables.)
6) Torque the 4/3/2 retract cables to 7 ft-lb (9.5 N.m). Use the flats at the front of the cable ends to keep the cables from rotating while torquing. These cables are located at the bottom tip of the 2nd section boom.
7) Torque the 2/3/4 extend cables to 20 ft-lb (27 N.m) each. These cables are located at the top base of the 2nd section boom. (Reference step #3 for access to the 2/3/4 extend cables).
8) Torque the 3/2/1 retract cables to the 9ft-lb (12 N.m). Use the flats at the front of the cable ends to keep the cables from rotating while torquing. These cables are located at the bottom tip of the 1st section boom.
9) Torque the 1/2/3 extend cables to 7 ft-lb (9.5 N.m) each. These cables are located at the top of the 1st section boom winch bar.
10) Check to ensure that boom sections are all bottoming out simultaneously as in Step 2. If not, proceed as follows:
    a) If the second section is bottoming out first, equally loosen the 1/2/3 extend cables and tighten the 3/2/1 retract cables. This will cause the second section boom to bottom laer but will also cause the 3rd, 4th and 5th sections to bottom out sooner.
    b) If the 3rd section is bottoming out first, equally loosen the 3/2/1 retract cables and tighten the 1/2/3 extend cables. This will cause the 3rd, 4th and 5th sections to bottom later and the 2nd section boom to bottom sooner.
    c) If the 4th section is bottoming out first, equally loosen the 4/3/2 retract cables and tighten 2/3/4 extend cables. This will cause the 4th and 5th sections to bottom out later and the 2nd and 3rd sections to bottom out sooner.
    d) If the 5th section is bottoming out first, equally loosen the 5/4/3 retract cables and tighten the 3/4/5 extend cables. This will cause the 5th section to bottom out later and the 2nd, 3rd and 4th sections to bottom out sooner.
11) Cycle the boom a few feet out and in. Check to ensure that all sections are bottoming out simultaneously. Repeat step 10 as required.
12) Repeat Steps 4 through 9. Torque the 5/4/3 retract cables to 12 ft-lb (16.26 N.m). Torque the 3/4/5 extend cables to 30 ft-lb (40 N.m). Torque the 4/3/2 retract cables to 14 ft-lb (19 N.m). Torque the 2/3/4 extend cables to 45 ft-lb (61 N.m). Torque the 3/2/1 retract cables to 18 ft-lb (24 N.m) Torque the 1/2/3 extend cables to 14 ft-lb (19 N.m).
13) Cycle boom fully, check that all cables are torqued properly and that all sections are bottoming out simultaneously. Repeat Step 10 as required then add locknuts to all cables. Each threaded cable end must have two nuts locked together.

3.8.6 Five Section Boom Disassembly

For reference, front is sheave case end, rear (base) is winch mount end, left and right are viewed from rear to front.
Do not, under any circumstances, work at an elevated height without using proper fall protection as required by local, state and federal regulations.
Steps 1 through 3 apply to a boom that is to be disassembled with the 1st

section and jib (if equipped) left on crane.

1) Extend and set all outriggers and SFO.
2) Fully retract boom and place it in a horizontal position.
3) Tag and disconnect the hydraulic lines to the telescope cylinder. Cap all lines and fittings.
4) Loosen and remove the fasteners attaching the extend cylinder butt plate to the base of the 1st section boom.
5) Mark the location of the hex nuts which secure the 1/2/3 extend cables to the cable anchor. Remove hex nuts and washers from 1/2/3 extend cables. Leave the cable ends draped inside the boom.
6) Attach a sling or chain to the front of the 2nd section boom, pull the 2nd, 3rd, 4th and 5th assembly out of the 1st section approximately 12 inches (30cm). Remove front upper spacer bar from 1st section. Remove the tag the four side wear pads and shims from the front of the 1st section. Suspend 2nd, 3rd, 4th and 5th assembly off of bottom pads.
7) Remove 4 capscrews which retain the lower front pad plate to the 1st section. Remove pad plate. Remove upper back wear pads and cam plates from 2nd section. Pull the retract cables out and keep retract cables taut while pulling the 2nd, 3rd, 4th and 5th assembly out of the 1st section. Support the base end of the 2nd as it exits the 1st stage boom.
8) Place 2nd-3rd-4th-5th on a suitable horizontal surface. Take care not to damage the retract cables while lifting or supporting the 2nd-3rd-4th-5th assembly.
9) Remove lower L-pads, retract cables and retract cable retaining capscrews from rear of 2nd section. Remove retract cable retaining plates from the rear of the 3rd section. Remove 3/2/1 retract cables from anchor pocket in 3rd section.
10) Remove retaining capscrews from cylinder anchor channels in the rear of the 2nd section. Remove upper top wear pads and cam plates from upper rear of the 3rd section.
11) Remove cable guide and upper spacer bar/cable retainers from the front top of the 2nd section. Attach a sling or chain to the tip of the 3rd section boom and pull the 3rd-4th-5th assembly out of the 2nd approximately 12 inches (30cm). Suspend the 3rd section off of the lower wear pads.
12) Remove capscrews retaining 1/2/3 extend sheaves to the top plate of the 2nd section, this will allow the sheaves, pins and extend cables to lay on the top plate of the 3rd section.
13) Remove 4 capscrews which retain the lower front pad plate to the 2nd section. Remove pad plate. Remove and tag four side wear pads with shims from front of 2nd section. Pull the retract cables out and keep retract cables taut while pulling the 3rd-4th-5th assembly out of the 2nd section. Support the base end of the 3rd as it exits the 2nd section boom.
14) Place 3rd-4th-5th assembly on a suitable horizontal surface. Take care not to damage the retract cables while lifting or supporting the 3rd-4th-5th assembly. Remove 1/2/3 extend cables from the top of the 3rd section by removing the anchor plates and capscrews at the rear of the section, place cables in a area to avoid damage.
15) Remove lower L-pads, retract cables and retract cable retaining capscrews from rear of 3rd section. Remove retract cable retaining plates from the rear of the 4th section. Remove 4/3/2 retract cables from the anchor pocket in the 4th section.

16) Remove lock bar and hardware from extend cylinder collar anchor pocket in the 3rd section. Lifting the butt plate end of the cylinder up will disengage the cylinder from its anchor pockets in the 3rd section. Slowly pull cylinder out of the 3/4/5 assembly. Keep 2/3/4 extend cables taut and in position to avoid damage as cylinder exits boom assembly. Remove 2/3/4 extend cable anchor in the 4th section as the end of the cylinder nears the anchor position.
17) Place cylinder assembly on suitable horizontal surface. Take care not to damage the extend cables while lifting or supporting the cylinder assembly. The cables can be disassembled from the cylinder at this time by removing the tapered wear pads on the front of the cylinder assembly and routing the cables through the access opening made by removing the pad. After tapered pads are removed use caution as the sheave pin and sheaves can move forward from the lock position into the assembly position, allowing pin and sheaves
18) Remove cable guide and upper spacer bar from the front top of the 3rd section. Loosen and remove hex nuts from threaded ends of 5/4/3 extend cables at rear of 3rd section. Remove top rear wear pads and cam plates from top of 4th section.
19) Attach a sling or chain to front of the 4th section boom and pull the 4th-5th assembly out of the 3rd approximately 12 inches (30cm). Suspend the 4th section off of the lower wear pads.
20) Remove 4 capscrews which retain the lower front pad plate to the 3rd section. Remove pad plate. Remove and tag four side wear pads with shims from the front of the 3rd section. Pull the retract cables out and keep retract cables taut while pulling the 4th-5th assembly out of the 3rd section. Support the base end of the 4th as it exits the 3rd section boom.
21) Place 4th-5th assembly on a suitable horizontal surface. Take care not to damage the retract cables while lifting or supporting the 4/5 assembly.
22) Remove lower L-pads, retract cables and retract cable keeper from rear of 4th section, coil 5/4/3 retract cables inside of 5th section. Remove upper top wear pads and cam plates from upper rear of 5th section.
23) Remove cable guide and upper spacer bar from the front of the 4th section. Remove side wear/cable retainer pads from front of 4th section, leave 3/4/5 extend sheaves and 3/4/5 extend cables in place.
24) Attach sling or chain to the front of the 5th section boom and pull the 5th section out of the 4th until there is approximately 36 inches (90cm) of the 5th still inserted in the 4th, use caution to keep 3/4/5 extend cables from damage as boom sections slide apart, if possible keep tension on 3/4/5 extend cables from the base end of the 4th boom section during this procedure.
25) Lift 5th section off the lower pads and remove pads and hardware. Remove 3/4/5 extend sheaves and hardware.
26) Slide 5th section completely out of 4th. Support the base end of the 5th as it exits the 4th section boom. Place 5th section boom on a suitable horizontal surface.
27) Remove cable retainers and hardware from side anchor locations on the 5th section. Remove 3/4/5 extend and 5/4/3 retract cables from anchor points in the side of the 5th section, place in suitable area to avoid damage.
28) Remove loadline sheaves by removing retainers and lightly tapping on sheave pin while removing sheaves and spacers until

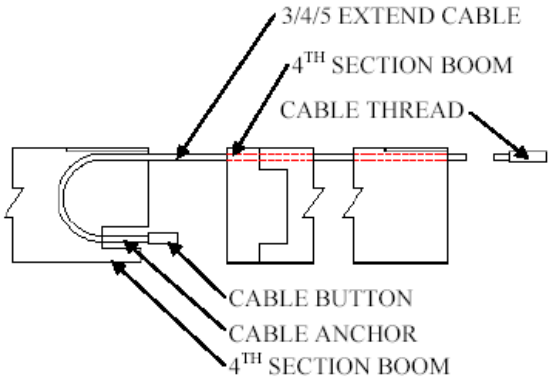
29) all sheaves are removed from boom sheave case.

3.8.7 Additional Maintenance, Disassembled Boom

1) Clean all boom sections and inspect for wear, dents, bent or crooked boom sections, gouged metal, broken welds or any abnormal conditions. Repair or replace as required.
2) Inspect all sheaves for excessive groove wear or abnormal rim wear. Replace as required.
3) Inspect all sheave bearings for excessive wear or cut inner liner material. If installed bearing diameter is .015 inch (.38mm) larger than pin diameter, bearing must be replaced. Any cut or gouge which causes the bearing liner to lose strands is cause for bearing replacement.
4) Clean and inspect all cable assemblies according to wire rope inspection procedures in this section. Pay particular attention to any wire breakage at the end connections. Replace cable assemblies as required. Lubricate all cables assemblies as required. Lubricate all cable assemblies before reinstalling them in boom.
5) Inspect all sheave pins for nicks, gouges or pitting due to rust in the bearing surface area. Replace if any damage is evident.
6) Inspect all zerks and grease paths in pins to ensure proper grease flow. Clean and replace as required.

3.8.8 Five Section Boom Assembly

1) Assemble sheaves into 5th section sheavecase. Top sheave is to be installed to the left hand side of the boom with the spacer to the right hand side.
2) Attach rear wear pads to the bottom of the 5th section. Using Loctite 242 blue, Loctite all wear pad mounting capscrews.
3) Position 5th section boom in front of the 4th section boom ready to slide together. Route 3/4/5 extend cables through 4th section boom with the threaded end of the cable at the rear of the 4th section and the button end out the front, loop the front button end of the 3/4/5 cable beyond its anchor point on the 5th section and install button end into 5th section boom.
4) Install 5/4/3 retract cable button end into anchor point in 5th section and



install keeper plate and capscrews, keeper plate will lock both the extend and retract cables in place. Coil 5/4/3 retract cables temporarily into 5th section.
5) Install 5th section into 4th section approximately 3 feet (100cm). Take care not to damage 3/4/5 extend cables. They should be laying on the extended lip of the bottom plate of the 5th section.
6) Install 3/4/5 extend sheave pins and bearings into the 3/4/5 extend sheaves. Install wear plugs into the holes on each side of the extend sheaves. Loop 3/4/5 extend cables around the 3/4/5 extend sheaves and slide the sheaves between the 4th and 5th boom sections, make certain the grease hole in the pin is orientated correctly before attaching pin to 4th section. Install countersunk

capscrews attaching 3/4/5 extend sheave pins to 4th section.

7) Raise the 5th section against the top of the 4th and install the bottom wear pads between the 4th and 5th, lower 5th section onto pads.
8) Install side wear pads with appropriate shims on front side inside of the 4th section boom. Install upper spacer bar and cable guide with wear pad and related hardware on the top of the 4th section. Shim according to calibration instructions or as pads were originally removed and tagged.
9) Push the 5th section completely inside the 4th section until it bottoms out on the doubler plates in the rear of the 4th, keep 3/4/5 extend cables tight when installing section. A scribe mark on the 5th at full retraction will aid in cable tensioning for proper boom sequence later.
10) Uncoil 5/4/3 retract cables out of the 5th section, assemble 4th section retract sheaves and pins into the inside of the 4th section rear, using proper hardware and Loctite 242, reeve cable over sheave installing upper keeper capscrew and lower rear pad, this pad serves as a cable keeper, lower pad and side pad for the rear of the section.
11) Install 4/3/2 retract cable button end into anchor point in 4th section and install keeper plate and capscrews. This keeper plate is installed temporarily to keep the button ends in place during this phase of the assembly, it will need to come back out during cylinder and 2/3/4 extend cable installation. Coil 4/3/2 retract cables temporarily into 5th section.
12) Assemble top rear wear pads with the cam plates to the top of the 5th section. The wear pad on each side of the top/rear of the boom can be adjusted over a range of 3/16 inch (4.8mm) by rotating, end for end, the wear pad and plate or the wear pads and plate independently. This is possible because the holes in these parts are offset from the center. The holes are .06 inch (1.5mm) off center in the plate and .03 inch (.8mm) off center in the wear pad. Various combinations of rotation of these parts allow this adjustment.
13) Pull threaded ends of 5/4/3 retract cable, now under the 4th section, towards front of boom.
14) Position 4th-5th section in front of 3rd section, ready for assembly. Route 5/4/3 retract cables to allow easy cable movement as the sections slide together.
15) Slide 4th-5th section into 3rd boom section approximately 36 inches (90cm) keep 4th-5th sections suspended to avoid damage to 5/4/3 retract cables.
16) Assemble bottom wear pads on 3rd section pad plate, raise 4th-5th section high enough in 3rd to allow plate with pads to slide between the sections, place retract cables in the grooves in the bottom pad plate, as boom sections are slid together, retract cables will pull through these grooves, use appropriate hardware and fasten pad plate to the bottom plate of the 3rd section.
17) Install a nut on the threaded ends of the 5/4/3 retract cables, to keep the cable ends from pulling through the anchor as the sections are pushed together.
18) Push the 4th-5th section inside the 3rd section, until it is within 36 inches (90cm) of full insertion.
19) Install side wear pads with appropriate shims on front inside of the 3rd section boom. Install upper spacer bar and cable guide with wear pad and related hardware on the top to the 3rd section. Shim according to calibration instructions, or as pads were originally removed and tagged.

20) Slide 4th-5th section inside 3rd until the end of the 4th section hits against the doubler bars in the 3rd section. Use caution as the 5/4/3 retract cable threaded end gets close to the grooves in the lower front pad plate, adjust as necessary to allow proper placement. A scribe mark on the 4th section at full retraction will aid in cable tensioning for proper boom sequence later.
21) Assemble top rear wear pads with the cam plates to the top of the 4th section. See step #11 for pad installation detail.
22) Uncoil 4/3/2 retract cables out of the 5th section, assemble 3rd section retract sheaves and pins into the inside of the 3rd section rear, using proper hardware and Loctite 242, reeve cable over sheave installing upper keeper capscrew and lower rear pad, this pad serves as a cable keeper, lower pad and side pad for the rear of the section.
23) Pull threaded end of 4/3/2 retract cables, now under the 3rd section, toward front of boom.
24) Assembly step #22 completes the 5/4/3 boom section stage, at this point the hydraulic extension cylinder and related cables and components are inserted into the 3rd-4th-5th section assembly starting with step #24.
25) Support extension cylinder in a workable location and install the 3 extend sheaves in the sheave case end of the cylinder, orientate the pin so that the bearing grease holes are on the unloaded side of the pin (towards cylinder butt plate).
26) Install 3 - 2/3/4 extend cables over sheaves by placing button end through opening between the sheave and the front double tapered plate on the cylinder. After the cables are in place, install the plastic tapered cylinder pads on the top bottom shelves of the cylinder sheavecase, these pads when secured in place act as cable retainers as well as wear pads, again apply Loctite and jam nuts in these locations.
27) Pull the 3 button ends through the extend cylinder sheavecase until there is enough slack to install the 2/3/4 extend cable anchor, install cable anchor on extend cables, keep capscrews clamping on the two halves of the anchor together just tight enough to not let the cables escape from their positions, this will allow easier assembly into the 4th section anchor point.
28) Drape 2/3/4 extend cables that come off top of the sheaves in an area to avoid damage, preferably on the top of the top of the extend cylinder, this will put them in their approximate location as the cylinder is installed into the 5th/4th/3rd boom assembly.
29) Slide extend cylinder into the 3rd-4th-5th boom assembly approximately 36 inches (90cm). Raise cylinder up at an angle slightly to allow easier access to the 2/3/4 extend cable anchor in the rear of the 4th section. Install 2/3/4 extend cable anchor and cable ends into the anchor point. Install keeper plates over the retract cable ends these keepers are shaped to retain the 2/3/4 anchor as well as the retract cable ends. Tighten capscrews holding the two halves of the 2/3/4 anchor assembly together.
30) Lower extend cylinder to a position parallel with the 3rd/4th/5th boom assembly and slowly push the cylinder into the 3rd/4th/5th boom assembly until the cylinder collar makes contact with the 3rd section rear vertical doubler plates. Monitor 2/3/4 extend cable location as cylinder slides into boom sections to avoid damaging cables.
31) Raise extend cylinder up to allow cylinder collar to slide through and align with the anchor pocket on the

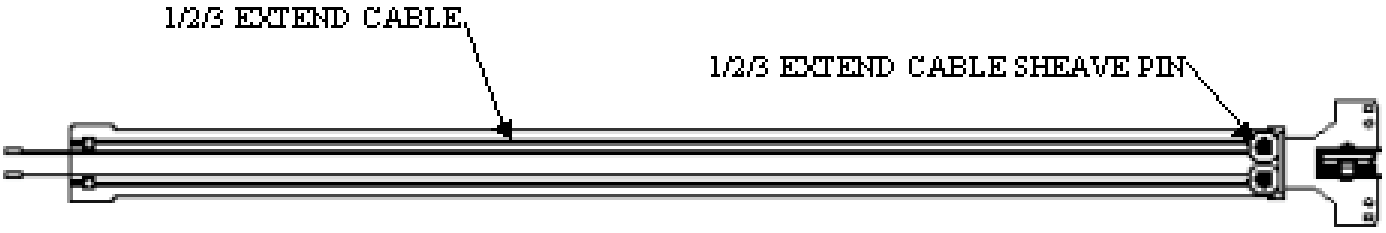
back of the 3rd, lower cylinder, collar will move down into cylinder anchor pocket, if properly positioned over pocket. Assemble lock bar and proper hardware to the cylinder collar, this will retain the cylinder into the anchor pocket.

32) Attach button end of 1/2/3 small extend cables into anchor point on the rear top plate of the 3rd section, a thin plate on the bottom and a thicker anchor plate on the top of the 3rd section top are required for proper cable retention, assemble with proper hardware and Loctite 242.

33) Lay 1/2/3 extend cables on the top of the 3rd section with the proper sheaves and pins that eventually will attach to the top plate of the 2nd section. Arrange cables per illustration (see figure 1).

34) The 3rd/4th/5th and cylinder assembly is now ready to assemble into the 2nd section boom.

35) Slide 3rd/4th/5th and cylinder assembly is now ready to assemble into the 2nd section boom approximately 36 inches (90cm) keep the 3rd/4th/5th and cylinder assembly suspended to avoid damage to the 4/3/2 retract cables.



TOP VIEW OF 3RD SECTION

FIGURE 1

36) Assemble bottom wear pads on 2nd section pad plate, raise 3rd/4th/5th and cylinder assembly high enough in the 2nd to allow pad plat with pads to slide between the sections, place retract cables in the grooves in the bottom pad plate, as the boom sections are slid together, retract cables will pull through these grooves, use appropriate hardware and fasten the pad plate to the bottom of the 2nd section.
37) Install nuts on the threaded ends of the 4/3/2 retract cables, to keep the cable ends from pulling through the anchor as the sections are pushed together.
38) Push the 3rd/4th/5th and cylinder assembly inside the 2nd section, until it is within 36 inches (90cm) of full insertion.
39) Install side wear pads with appropriate shims on the front inside of the 2nd section, shim according to calibration instructions, or as pads were originally removed and tagged. Assemble 1/2/3 extend cable sheaves and pins with the appropriate hardware to the 2nd section top plate, assemble cable keeper/spacer bar plates to 2nd section, install cable guide and wear pad to the top of the 2nd section.
40) Slide the 3rd/4th/5th and cylinder assembly into the 2nd section until the extend cylinder collar bottoms out in its anchor pocket in the rear of the 2nd section or the 3rd section side plates bottom out on the doubler plates on the rear of the 2nd section. Use caution as the 4/3/2 retract cable threaded ends get close to the grooves in the lower front pad plate, adjust as necessary to allow proper placement.
41) Cylinder length adjustment may be necessary to properly position cylinder collar in the anchor pocket with the 3rd section side plates bottoming out on the doublers in the rear of the 2nd. A hydraulic power source may have to be utilized to adjust the cylinder length. Install appropriate hardware fastening the extend cylinder collar to the cylinder mounting channels in the rear of the 2nd section boom. A scribe mark on the 3rd section at full retraction will aid in cable tensioning for proper boom sequence later.
42) Assemble top rear wear pads with the cam plates to the top of the 3rd section. See step #11 for pad installation detail.
43) Assemble 3/2/1 retract cable button ends into anchor points in the rear of the 3rd section. Install keeper plates and capscrews. Assemble with Loctite 242.
44) Assemble 2nd section retract sheaves and pins into the inside of the 2nd section using proper hardware and Loctite 242, reeve 3/2/1 retract cables, anchored to 3rd, over sheaves attached to 2nd section and install upper keeper capscrew and lower rear pad, this pad serves as a cable keeper, lower pad and side pad for the rear of the section.
45) Pull threaded ends of 3/2/1 retract cables, now under the 2nd section, towards the front of the boom.
46) Suspend assembled boom sections, position of extend cylinder butt plate is holding valve down, rotate rod assembly to achieve proper orientation, place retract cables to avoid damage, and slide assembled boom sections into the 1st section approximately 36 inches (90cm). Keep boom assembly suspended to avoid damage to the retract cable.
47) Assemble bottom wear pads on the 2nd section pad plate, raise the 2nd/3rd/4th/5th and cylinder assembly high enough in 1st to allow plate with pads to slide between the sections, place retract cables in the grooves in

the bottom pad plate, as the boom sections are slid together, retract cables will pull through these grooves, use appropriate hardware and fasten pad plate to the bottom plate of the 1st section.

48) Install nuts on the threaded ends of the 3/2/1 retract cables, to keep the cable ends from pulling through the anchor as the sections are pushed together.

49) Push the 2nd/3rd/4th/5th and cylinder assembly inside the 1st section, until it is within 36 inches (90cm) of full insertion.

50) Install the side wear pads with the appropriate shims on the front inside of the 1st section. Install upper spacer bar with appropriate hardware to the inside top of the 1st. Shim according to calibration instructions, or as pads were originally removed and tagged.

51) Slide the 2nd/3rd/4th/5th and cylinder assembly into the 1st section until the extend cylinder butt plate contacts the back plate of the winch mount. Use caution as the holding valve nears the winch mount back plate, the holding valve nears the winch mount back plate, the holding valve to back plate clearance requires the butt plate to be level, with the holding valve down. Use caution as the 3/2/1 retract cable threaded ends get close to the grooves in the lower front pad plate, adjust as necessary to allow proper placement.

52) Install proper hardware retaining extend cylinder butt plate to the 1st section winch mount.

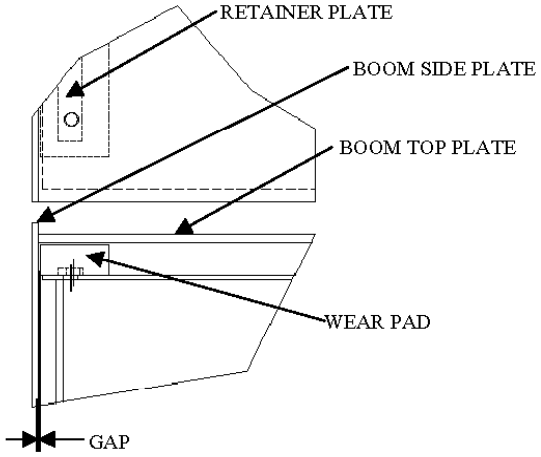
53) Assemble top rear wear pads with the cam plates to the top of the 2nd section. See step #11 for pad installation detail.

54) Install cable guides, angle pendulum, winch and anti-two block system, see anti-two block system description and installation instructions.

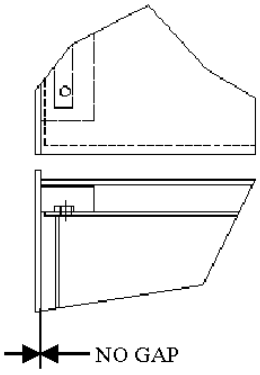
3.8.9 Top Wear Pad Adjustment

1) With the boom fully retracted, located the inner boom section horizontally in the outer boom section its riding in, a pry bar used to manipulate the side to side position of the section can be used. It is often difficult to pry the verymost inner sections over.
2) Extended boom straightness is critical in proper boom operation. The extended boom straightness required is a deviation of .50 inch (13mm) or less from the theoretical centerline of the boom. A stringline from the center of the winch to the middle of the sheavecase on the last section will provide a theoretical centerline. The top rear pads should be adjusted accordingly to provide proper clearances to achieve a straight extended boom.
3) Assemble the top/rear wear pads and plates. The top/rear wear pads on this boom are adjustable to account for lateral tolerances that occur during the manufacturing process of the boom sections.
4) The wear pad on each side at the top/rear of the boom can be adjusted over a range of 3/16 inch (4.8mm) by rotating, end for end, the wear pad and plate or the wear pads and plate independently. This is possible because the holes in these parts are offset from the center. The holes are .06 inch (1.6mm) off center in the plate and .03 inch (.8mm) off center in the wear pad. Various combinations of rotation of these parts allow the adjustment.
5) Once the boom is located, the wear pad and plate combinations can be inserted into the space between the boom sections and aligned over the holes in the sections. If the holes in the plate are not centered over the holes in the sections, the wear pads

and plates have to be removed and adjusted either towards or away from the side plate of the next larger section until the holes will align. When properly aligned the wear pad should be tight against the side plate of the out boom section and the extended boom should be straight to previously mentioned specifications.



Needs adjustment. The capscrews can not be installed and there is a gap between the wear pad and side plate of the larger boom section



Properly aligned and adjusted wear pad. The holes in the retainer plate are concentric with the threaded holes in the smaller boom section and the wear pad is tight against the side plate of the larger boom section. When wear pads are properly aligned and adjusted, install capscrew and torque to 75 ft-lb (100N.m)

FOUR AND FIVE SECTION TOP/BOTTOM PAD REPLACEMENT – ASSEMBLED BOOM

Inspect top and bottom wear pads periodically for signs of abrasion or excessive wear. Excessive is defined as 3/16 of an inch (4.8mm) from the original pad thickness, top rear pad thickness .75 inch (19mm), bottom front 1st section 1 inch (25mm), bottom front 2nd and 3rd section .44 inch (13mm). Uneven pad wear of 3/32 inch (2mm) from side to side on the wear pad would be considered excessive as well. If any of these conditions exist, the top and bottom pads can be replaced without complete disassembly of the boom.

3.8.10 Top Pad Replacement

Pad maintenance on the four or five section can be made easier by removal of the winch. Additional clearance can be achieved on the four section by loosening the large extend cables and removing the extend cable anchor located in the 2nd section.

8) Retract boom completely.
9) Remove capscrews through access holes on top rear of sections.
10) Remove wear pads, shims and cam plates from the rear of the boom through open winch mount end.
11) Note all pad locations and tags accordingly.
12) Inspect pads for wear using previously mentioned inspection criteria.
13) Install new pads through winch mount end of boom. See top pad adjustment procedure for proper pad and section position.
14) Torque retainer capscrews to 75 lb-ft (100 N.m). Failure to properly torque capscrews will cause loss of preload, allowing pad cam to rotate and cause excessive side clearance between sections.

3.8.11 Front Bottom Pad Replacement

8) Extend boom approximately 4 feet (120cm) out.
9) Remove cable guides and upper spacer bars from front of boom sections.
10) Loosen and remove hex nuts on retract cables on the front of the 1st and 2nd sections.
11) Using an appropriate lifting device, sling around the 4th and 5th depending on configuration section boom and lift it up until weight is removed from the bottom pads in the front of the interior sections.
12) Loosen and remove the capscrews holding the pad doubler plates in the front of the sections. Remove plates. Remove pads from these plates. Note all pad locations and tag accordingly.
13) Inspect pads for wear using previously mentioned inspection criteria.
14) Install new pads on plates or boom sections. Reassemble plates in boom in proper locations.

3.9 TROUBLESHOOTING

1) BOOM EXTENDS DURING TRANSPORTATION:
Check for oil leaks. Clean or replace holding valve and check setting. Rebuild cylinder and replace seals.

2) BOOM CREEPS BACK AFTER BEING EXTENDED:
As hydraulic oil cools it is normal for it to retract in the telescope cylinder and let the boom creep in slightly. If the creep continues, check for leaks first. Then clean and/or replace the holding valve and check the setting. Finally, remove the telescope cylinder and rebuild it replacing the seals.

3) **BOOM TELE OUT, WINCH UP AND BOOM DOWN ARE NOT WORKING:**
If these are the only functions not working, check to see if the boom head is two blocked. Next check the load per the Capacity Chart to make sure it is not an overload. Then refer to the LML and Anti-Two Block operator's manual for trouble shooting this system. Also check the wiring from the system to the solenoid valves and the operation of the valves to make sure they are not jammed.

4) **BOOM DEFLECTS EXCESSIVELY-UP/DOWN OR SIDE TO SIDE-WHEN PICKING LOAD:**
Wear pads are not shimmed properly. Re-shim wear pads per section in manual.

5) **BOOM OPERATING SLOWLY OR NOT PICKING LOAD:**
Check for leaks and damaged hose. Check relief valve settings. Reset as required. Check flow from pump. Replace as required.

6) BOOM CHATTERS WHEN EXTENDING OR RETRACTING:
Lubricate the boom sections and sheaves per the lubrication directions. Check wear pads for proper adjustment and wear.

7) BOOM DOES NOT SEQUENCE PROPERLY:
Adjust the Extend/Retract boom cables per the manual.

8) **WINCH LIFTS LOAD, BUT HAS NO CONTROL ON LOWERING OR HOLDING THE LOAD:**
Excessive back pressure on the brake causing it to partially release:
Back pressure must not exceed 150 PSI. Check the pressure on the return line and remove any restrictions if pressure is too high.
Brake return springs broken or brake discs worn or damaged: Disassemble the brake and replace worn parts in brake.
Clutch slipping: Improper oil can cause the clutch to slip. Drain the winch and refill with oil per the vendor's specifications. Also, the clutch may be damaged or worn. Disassemble the winch and replace faulty parts.

9) **WINCH WILL NOT RAISE LOAD:**
Check Capacity Chart to make sure load is not an overload. Check LML/Anti-two block system to make sure it is functioning properly and not locking out the system. Check system pressure relief and reset as required. Check pump flow and repair/replace pump as required.

10) WINCH WILL NOT LOWER LOAD OR LOWERS ERRATICALLY:
The winch brake should fully release between 340-400 PSI. Clean and replace the hose as required. Disassemble the winch and replace faulty parts as required.

11) SWING INOPERATIVE OR ERRATIC:

- Swing park brake should fully release at 400 PSI. Replace hose and rebuild as required. Erratic behavior may be caused by improper backlash between the gears.

- Check for loose swing drive gear box and readjust the backlash as required.
- Check for worn or damaged teeth on the gears or wear in slew ring bearings. Rebuild swing box and replace slew bearing as required.

12) SWING BRAKE DOES NOT HOLD:

Brake return springs probably broken or brake discs worn or damaged. Disassemble the brake and replace faulty parts.

13) OUTRIGGER/STABILIZER BEAM WILL NOT EXTEND OR MAKES EXCESSIVE NOISE WHEN EXTENDING:

- On outriggers-first grease pads.
- check for worn pads allowing mounting bolts to bind.
- Check system relief pressure.
- Check cylinder for leaks and worn seals.
- Check pump for flow.

14) OUTRIGGER/STABILIZER CREEPS IN UNDER LOAD:

Clean holding valve and check relief setting. Replace as required.

15) OIL CONTAMINATION PROBLEMS:

- Water in oil (milky)
- Filter plugged (dirty)
- Metal particles (mechanical failure)
- Oil discolored or has burned odor (overheating)
- Oil foaming due to low oil, water in oil, air leak in suction, kinked hose or worn pump shaft seal

16) PUMPING PROBLEMS:

- Suction line plugged-clean and check.
- Ball valve closed-open valve
- Air leak in pump suction-replace suction line
- Dirt in pump-flush system & rebuild pump
- Worn pump-repair or replace
- Relief valves not properly adjusted-check and adjust valves
- Dirty or collapsing hoses-replace
- Worn cylinders or motors-rebuild/replace.

17) SYSTEM OPERATES SLOWLY OR ERRATICALLY:

- Air in system-check suction line for leaks and oil level in tank
- Cold oil-run system and make sure oil is warm.
- Pump damaged-repair
- Dirt in relief valve-clean/replace
- Restriction in suction line-clean and replace
- Ball valve closed-open valve
- Oil viscosity too high-replace with proper oil
- Low oil supply
- Valve plugged-clean valve orifices
- Oil leak-tighten fitting/replace hoses as required

18) PUMP MAKES NOISE:

- Low oil
- Oil viscosity too high
- Pump speed too fast
- Suction plugged
- Ball valve closed
- Dirt in pump
- Tank breather plugged
- Air in oil
- Worn pump bearings
- Broken Pump parts

19) OIL OVERHEATING:

- Operator holds control lever in position too long-oil dumps over relief valve generating excess heat
- Using incorrect oil
- Low oil
- Dirty oil
- Engine running too fast
- Incorrect relief valve settings
- Internal oil leakage in valves, cylinders, motors
- Restriction in pump suction line
- Ball valve closed
- Control valve stuck partially open
- Heat not radiating properly from hydraulic tank, oil lines and cooler
- Excessive operation of winch

3.9 TROUBLESHOOTING

20) BOOM EXTENDS DURING TRANSPORTATION:
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As hydraulic oil cools it is normal for it to retract in the telescope cylinder and let the boom creep in slightly. If the creep continues, check for leaks first. Then clean and/or replace the holding valve and check the setting. Finally, remove the telescope cylinder and rebuild it replacing the seals.

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- Check pump for flow.

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- Ball valve closed-open valve
- Oil viscosity too high-replace with proper oil
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- Valve plugged-clean valve orifices
- Oil leak-tighten fitting/replace hoses as required

37) PUMP MAKES NOISE:

- Low oil
- Oil viscosity too high
- Pump speed too fast
- Suction plugged
- Ball valve closed
- Dirt in pump
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- Air in oil
- Worn pump bearings
- Broken Pump parts

38) OIL OVERHEATING:

- Operator holds control lever in position too long-oil dumps over relief valve generating excess heat
- Using incorrect oil
- Low oil
- Dirty oil
- Engine running too fast
- Incorrect relief valve settings
- Internal oil leakage in valves, cylinders, motors
- Restriction in pump suction line
- Ball valve closed

- Control valve stuck partially open
- Heat not radiating properly from hydraulic tank, oil lines and cooler
- Excessive operation of winch

COMPONENT SERVICE MANUALS

4.1 Winch Service Manual – Tulsa 1500W

Tulsa Winch

TWG Tulsa Winch Group A DOVER COMPANY

Model 1500W Service Manual

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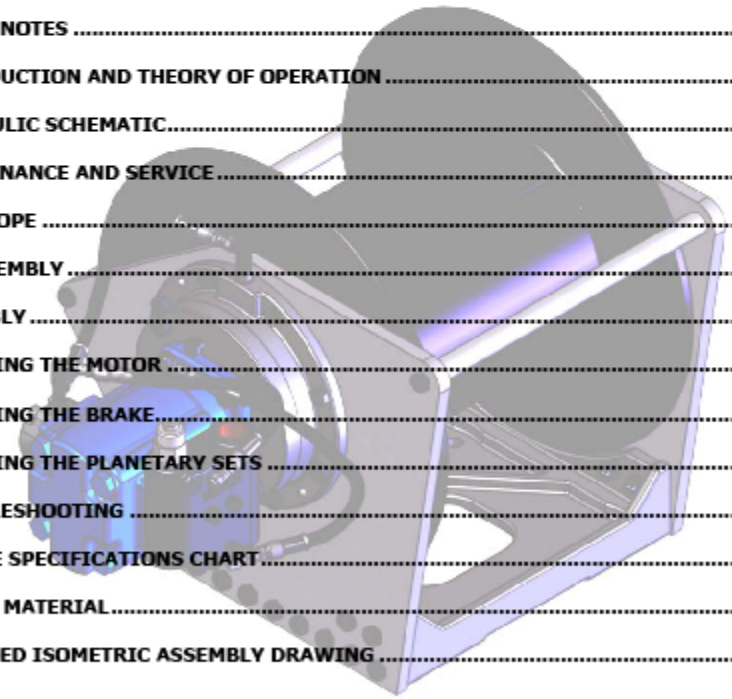

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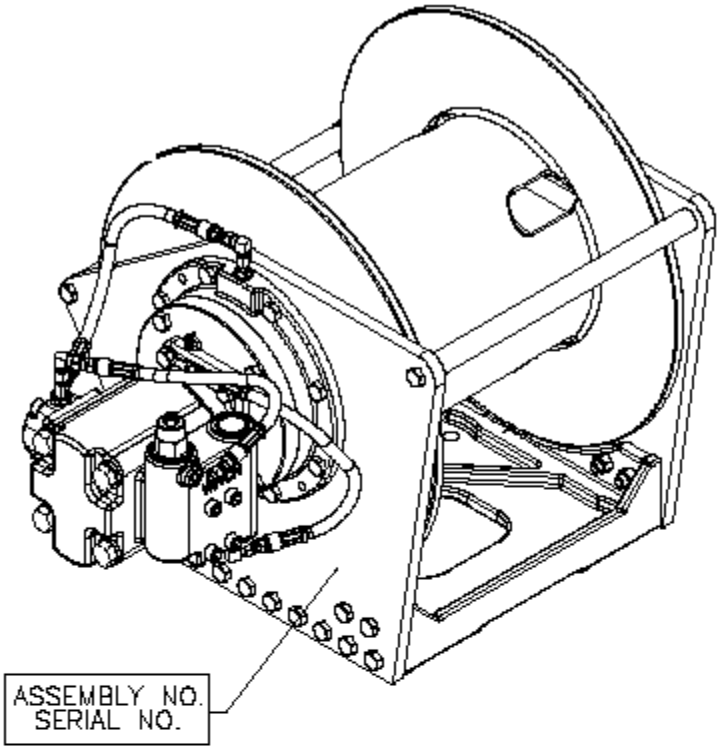


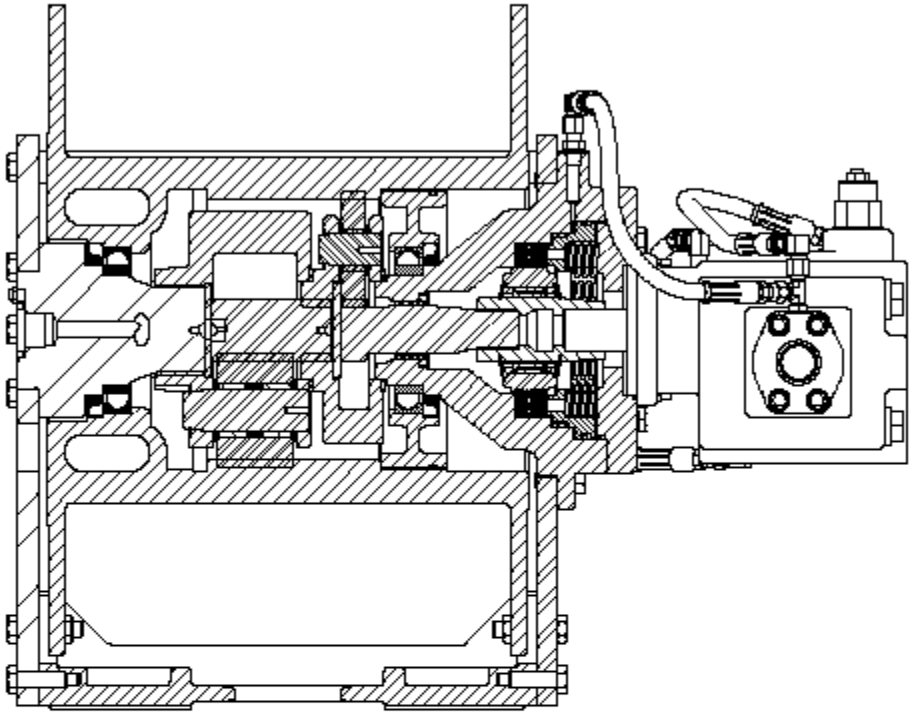
WARNING

FAILURE TO HEED THE FOLLOWING WARNINGS MAY RESULT IN SERIOUS INJURY OR DEATH!

- Operators must be trained in the proper, safe operation of the hoist.
- Hoists are **not** to be used to lift, raise, or move people. If your task involves lifting or moving people, you **must** use the proper equipment, not this hoist.
- Cable anchors on hoists are not designed to hold the rated load of the hoist. You must keep at least five (5) wraps of cable on the drum to ensure that the cable doesn't come loose.
- Stay clear of suspended loads and of cable under tension. A broken cable or dropped load can cause serious injury or death.
- Avoid shock loads. This type of load imposes a strain on the hoist many times the actual weight of the load and can cause failure of the cable or the hoist.
- Make sure that all equipment, including the hoist and cable, are maintained properly.

2

INTRODUCTION AND THEORY OF OPERATION



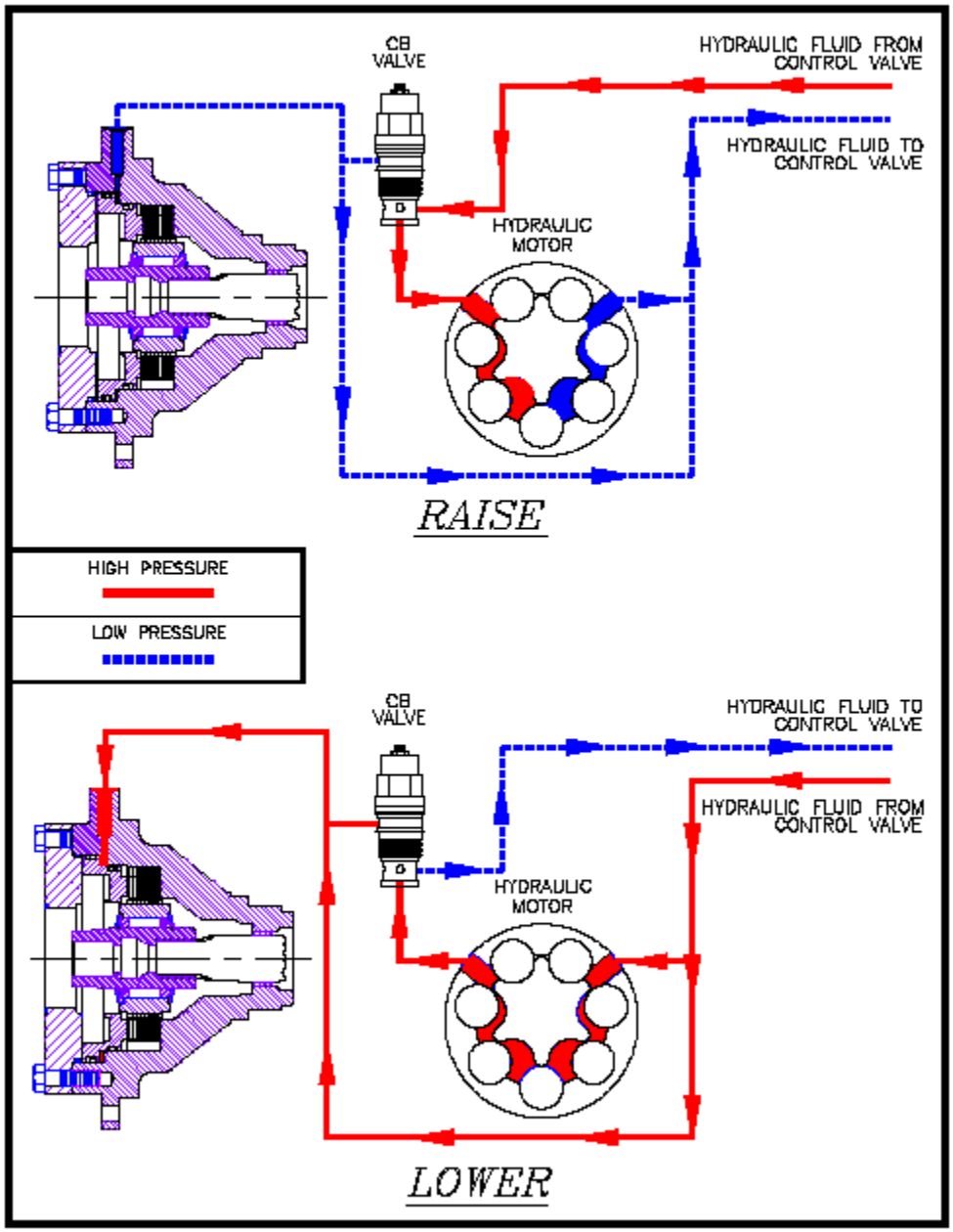
The planetary hoist is designed to utilize a geroler, gear, or piston motor, driving through a multiple-disc oil brake, through a pair of planetary gearsets to the cable drum.

The multiple-disc oil brake is spring applied and hydraulically released through a port in the brake housing. During inhaul, the brake is not released, since the load is driven through a one-way cam clutch, bypassing the brake. When the load comes to a stop, the cam clutch locks up and the brake prevents the load from moving.

During payout, a brake valve is used to prevent the load from moving faster than desired. This brake valve partially blocks the main line from the motor back to the directional control valve, allowing only a limited amount of hydraulic fluid through the motor. The brake valve is then modulated by sensing pressure on the other main line, the line from the directional control valve to the motor. Additionally, any time there is sufficient pressure (225 PSI ±10%) to modulate the brake valve; this same pressure releases the brake.

3

HYDRAULIC SCHEMATIC



4

MAINTENANCE AND SERVICE

For safe and consistent operation of TULSA WINCH hoists, swing drives, and winches, a regular program of preventive maintenance is strongly recommended. Regular oil changes with the correct oil for the ambient temperature conditions and an annual inspection of the wear components will help ensure a long life for your planetary geared products.

Maintenance Scheduling

The owner is to ensure proper inspection intervals, in compliance with the API RP 2D Section 4 requirements or the ANSI B30.5, 5-2.3, and will review hoist usage categories on a periodic basis. A Qualified Inspector should perform all maintenance and inspections.

- For hoists in occasional use, less than 10 hours per month, API RP 2D recommends a pre-use inspection and an annual 12-month inspection based on average use over a quarter.
- For hoists in moderate use, more than 10 but less than 50 hours per month, API RP 2D recommends a pre-use inspection, quarterly inspection, and an annual 12-month inspection based on average use over a quarter.
- For hoists in heavy use, more than 50 hours per month, API RP 2D recommends a pre-use inspection, monthly inspection, quarterly inspection, and an annual 12-month inspection.

Oil Level Maintenance

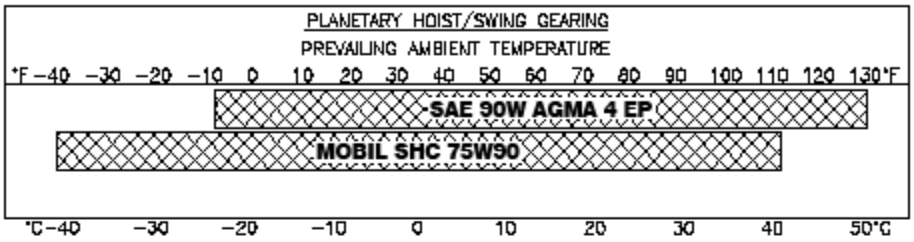
Tulsa Winch recommends that the oil level in the gearbox and brake housing be checked and adjusted as part of the pre-use inspection. If the oil level drops frequently or oil leakage is detected during an inspection, maintenance should be performed to correct any problems.

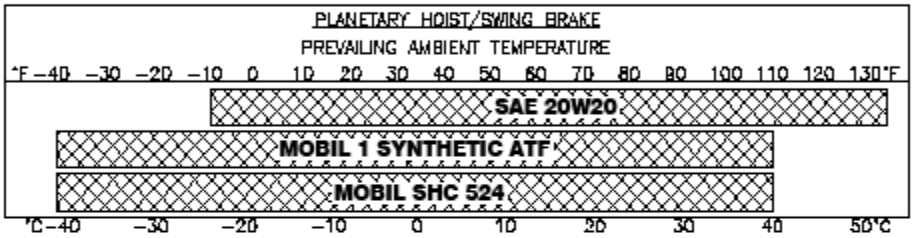
Oil Change Interval

The oil in the gearbox and brake sections should be changed every **1000 hrs** or **6 months** of usage.

5

RECOMMENDED OIL





All oils must meet MIL-PRF2105E. Substitution from a reputable manufacturer is allowed as long as type and grade are maintained.

OIL CAPACITY	
GEARBOX	1.00 QT
BRAKE	.25 QTS

WARNING

Do not use EP type gear lubes in the brake section of this winch. EP lubes may prevent the clutch from locking up, which, in turn causes the load to fall, resulting in property damage, personal injury, or death.

The hydraulic system should use only high quality hydraulic fluid from reputable suppliers. These oils should contain additives to prevent foaming and oxidation in the system. All hoist hydraulic systems should be equipped with a return line filter capable of filtering 10 micron particles from the system.

Hoists are shipped from the factory with SAE 90 Extreme Pressure (EP) gear lube in the gearbox and lightweight non-EP oil in the brake section. This oil and gear lube should be satisfactory for operation in ambient temperatures from -10º F (-23º C) to +130º F (+55º C).

OIL CHANGE

Gearbox oil is drained by first removing the drain plug *(Item 33)* by rotating the drum so that the plug is visible through the lower hole in the side plate *(Item 50) (See Fig 1)*. Screw in a piece of 1" pipe to allow the oil to drain, and then with a hex wrench remove the drain plug located inside of the 1" pipe *(See Fig. 2)*. Examine the used oil for signs of significant metal deposits and then dispose of it in a proper manner. Remove the 1" pipe.

Rotate the drum so that the port is visible through the upper hole in the side plate. With a hex wrench, remove the fill plug *(Item 33)* located in the center of the output shaft *(Item 32)*. Install a 1" pipe with elbow through the hole in the output shaft. Fill the gearbox with 1.00 quart of EP-90 oil. Remove the pipe and elbow then replace the plugs *(Items 31 & 33)*. *See the Oil Chart on page 6 of this manual for the recommended oil type and grade for your application.*

Drain the brake section by removing the drain plug *(Item 40)* under the motor along with the vent *(Item 30)* above the motor *(See Fig. 4)*. Inspect the oil for signs of metallic particles and/or burning and reinstall the drain plug. Fill with ¼ quart of non-EP oil and reinstall the vent *(Item 30). See Oil Chart Pg. 6 this manual for recommended oil type and grade for your application.*

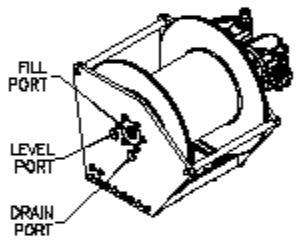


FIG 1

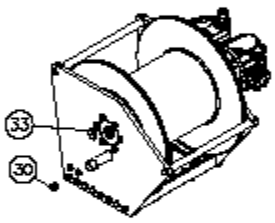


FIG 2

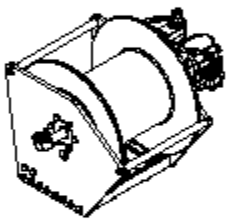


FIG 3

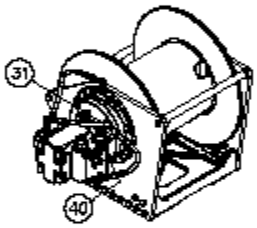
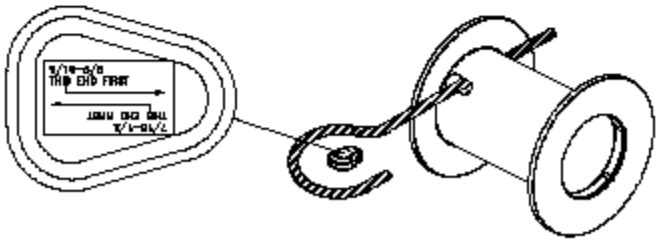


FIG 4

WIRE ROPE

Wire rope should be installed as shown in the drawing below. Note that the wedge will satisfy cable diameters from 7/16" to 5/8", depending on how it is installed in the cable drum.



DISASSEMBLY

1. Drain the oil from the gearbox and brake sections using the instructions on page 7.

2. Stand the hoist on its end with the motor pointing up.

3. Disconnect the tubing or hose connected to the brake housing *(Item 21)*. Remove the motor and counterbalance valve assembly from the hoist by removing the capscrews *(Item 51)* and washers *(Item 52)*. *See Servicing The Motor section on page 10 for motor and counterbalance valve disassembly.*

4. Remove the brake subassembly from the hoist by removing eight capscrews *(Item 9)* holding the brake housing to the side plate *(Item 1)*. Reinstall two of these capscrews into the two extra tapped holes and tighten them evenly until the brake housing comes loose from the side plate. *See Servicing The Brake section on page 11 for brake repair.*

5. Remove the side plate *(Item 1)* by removing twelve capscrews *(Item 2 & 60)* and two nuts *(Item 61)*.

6. Lift the bearing carrier *(Item 26)* out of the drum *(Item 5)*. Inspect the bearing *(Item 28)* for signs of pitting or spalling and if necessary, replace the bearing and seal *(Item 7-5)*.

7. Remove the thrust washer *(Item 6)* and input sun gear *(Item 8)* from the input planet gearset *(Item 36)*. Inspect for damage and replace if needed.

8. Remove the input planet gearset *(Item 36)* from the drum. Inspect the gearset for wear and repair as needed. *See Servicing The Planetary Set section on page 13 for disassembly and repair.*

9. Remove the thrust washer *(Item 6)* and output sun gear *(Item 16)*. Inspect for damage and replace if needed.

10. Remove the output planet gearset *(Item 4)* from the cable drum. Inspect the gearset for wear and repair as needed. *See Servicing The Planetary Set section on page 13 for disassembly and repair.*

11. Remove the drum *(Item 5)* by lifting straight up and off of the output shaft *(Item 32)*. Inspect the gear teeth for excessive wear and replace if necessary. Inspect the bearing *(Item 28)* for signs of spalling or pitting and, if necessary, replace the bearing and seal *(Item 7-5)*.

12. Inspect the retaining ring *(Item 3)* on the output shaft to ensure that it is still in the groove and is not bent, and replace if necessary.

13. Inspect the shaft *(Item 32)* for wear or damage and, if necessary, remove it from the side plate *(Item 50)* by removing six capscrews *(Item 9)*.

ASSEMBLY

1. Thoroughly clean all parts. Replace those that show wear or damage.

2. Inspect the drum *(Item 5)* for structural integrity and the gear teeth for excessive wear, then replace if necessary.

3. Attach the output shaft *(Item 32)* to the side plate *(Item 50)* with six capscrews *(Item 9)*, making sure the vent *(Item 30)* is oriented properly, then torque them to specification *(see Torque Specifications Chart on page 15 of this manual)*.

4. Install the retaining ring *(Item 3)* onto the shaft *(Item 32)*.

5. Attach the base *(Item 12)* and rods *(Item 43)* to the side plate *(Item 50)* with twelve capscrews *(Items 2 & 60)* and two nuts *(Item 61)*. Torque to specification *(see Torque Specifications Chart on page 15 of this manual)*.

6. If necessary, install a new bearing *(Item 28)* and oil seal *(Item 7-5)* into the drum.

7. Lay the unit down so that the rods *(Item 43)* and base *(Item 12)* are pointing up. Set the drum *(Item 5)* onto the shaft *(Item 32)* being careful not to damage the seal *(Item 7-5)*, seating the drum on the bearing *(Item 28)*.

8. Install the output planet gearset *(Item 4)* into the drum *(Item 5)*, making sure it's installed correctly onto the output shaft *(Item 32)*.

9. Put a light coating of grease on the thrust washer *(Item 6)* to keep it in place. Install the thrust washer into the output gearset *(Item 4)*, and then insert the output sun gear *(Item 16)*. The slot in the sun gear must be installed facing the output shaft.

10. Install the input planet gearset *(Item 36)* into the drum *(Item 5)*, making sure it's installed correctly onto the output sun gear *(Item 16)*.

11. Put a light coating of grease on the thrust washer *(Item 6)* to keep it in place. Install the thrust washer into the input gearset *(Item 36)*, and then insert the input sun gear *(Item 8)*.

12. Install a new o-ring *(Item 7-10)* and, if necessary, a new bearing *(Item 28)* and seal *(Item 7-5)* into the bearing carrier *(Item 26)*. Grease the o-ring and seal and install the bearing carrier into the drum.

13. Position the side plate *(Item 1)* on top of the base *(Item 12)* and rods *(Item 43)*. Attach the side plate with twelve capscrews *(Items 2 & 60)* and two nuts *(Item 61)*. Torque to specification *(see Torque Specifications Chart on page 15 of this manual)*.

14. Install the brake subassembly into the side plate *(Item 1)*, making sure that the pilot of the brake housing aligns with the bearing *(Item 28)* and seal *(Item 7-5)* in the bearing carrier *(Item 26)* and that the holes for the motor are in the correct orientation. Also, make sure that the level and vent plugs in the cover are properly oriented. Install eight capscrews *(Item 9)* and torque them to specification (*see Torque Specifications Chart on page 15 of this manual*).

15. Install a new o-ring *(Item 7-1)* on the face of the motor and re-install the motor/counterbalance valve assembly. Install the capscrews *(Item 51)* and washers *(Item 52)* and torque them to specification *(see Torque Specifications Chart on page 15 of this manual)*.

16. Reconnect the tubing or hose to the brake housing *(Item 21)*.

17. Fill both the gearbox and the brake section with the proper amount and type of lubricants as instructed in the *Recommended Oil* section on page 6 of this manual.

SERVICING THE MOTOR

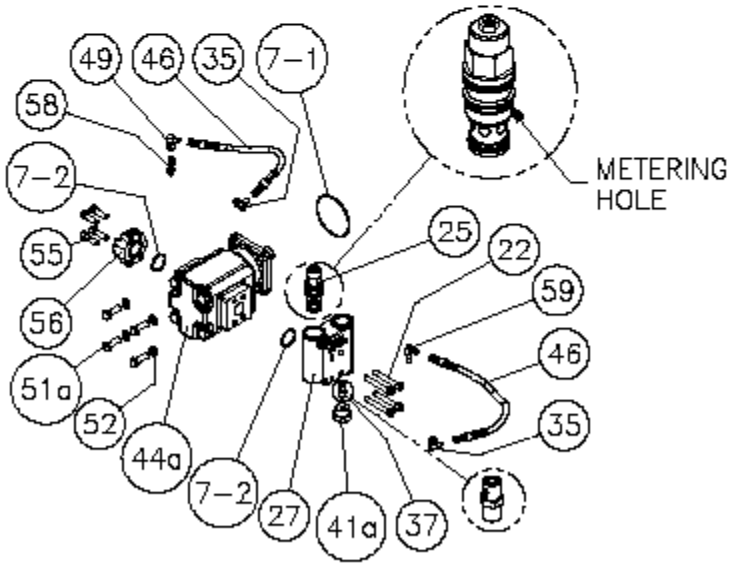
1. Tag tubing or hoses for proper re-installation and remove them from the motor assembly.

2. Remove the counterbalance block *(Item 27)* from the motor.

3. Remove the counterbalance valve *(Item 25)* from the block and inspect the small metering hole located on the side of the valve to make sure it is not obstructed. Also, inspect the o-rings (*Item 7-2)* for damage and replace if necessary.

4. Remove the fitting *(Item 41)* and inspect the check valve *(Item 37)* to make sure it is working properly. The check valve should be installed as shown, with the arrow facing into the block.

5. Motors and counterbalance valves are not serviceable in the field. Return them to an authorized dealer for service.



SERVICING THE BRAKE

1. Evenly remove the four capscrews *(Item 11)* holding the brake cover *(Item 20)* in place. Spring pressure will raise the cover as the capscrews are loosened. Remove the cover from the brake housing.

2. Remove the springs *(Item 24)* from the piston and check the free height. Each spring should measure at least 1.200 inches with no force on them.

3. Remove the brake piston *(Item 10)* by installing two pieces of 3/8"-16NC all-thread in the bottom of two spring pockets. Using jam nuts, screw the all-thread pieces in evenly until the piston is clear of the housing. An alternate way of removing the piston is to use a portable power unit or shop air to slowly pressurize the brake cavity until the piston is out of the bore.

4. Remove the brake driver/clutch assembly *(Items 13, 14, 15, 17, 34, and 38)* from the brake housing *(Item 21)*.

5. Remove the stator plates *(Item 19)* and friction discs *(Item 18)* from the brake housing and check them for excessive wear, then replace if necessary. Additionally, check the top stator plate for scoring caused by the removal tools and polish if necessary. Friction discs should measure no less than 0.055 inches thick and stator plates should measure no less than 0.064 inches thick.

6. If necessary, with a hook wire or pry bar, remove the seal *(Item 7-5)* from the brake housing.

7. Examine the bushing *(Item 39)* in the brake housing for wear and, if worn, replace it.

8. If the brake housing *(Item 21)* is removed from the hoist, examine the journal on the brake housing where the seal *(Item 7-5)* runs for wear. If severely worn, replace the brake housing.

9. Carefully disassemble the brake driver/clutch and note the side in which the markings on the clutch *(Item 34)* are facing. The clutch assembly must be re-assembled with the markings facing the proper direction in order for the hoist to function properly. Inspect the surface on the input and brake drivers *(Items 13 & 38)* where the clutch *(Item 34)* runs. If there is any pitting or spalling on the drivers then both it and the clutch must be replaced.

10. Re-assemble the driver/clutch assembly, making sure that the clutch is installed properly.

11. Install a new seal *(Item 7-6)* into the brake housing. If the brake housing is removed from the hoist, temporarily install the input sun gear *(Item 38)* into the brake housing and slide the driver/clutch assembly onto the sun gear spline.

12. Install the stator plates *(Item 19)* and friction discs *(Item 18)* into the brake housing starting with a stator and alternating friction discs and stator plates. There is one more stator plate than friction disc so you will finish with a stator plate.

13. After installation, check the brake stack-up to make sure that the dimensions are within the tolerance shown in Fig 5. If your measurement is greater than shown, either some friction discs and stator plates have been left out, or the friction discs are worn beyond acceptable tolerances. If your measurement is less than shown, too many plates or discs have been inserted or they are not seated properly.

14. Coat the new o-rings and backup rings *(Items 7-3, 7-7, 7-8, & 7-9)* with light oil and install onto the piston *(Item 10)*. *See Fig. 5 for proper o-ring/backup ring installation.*

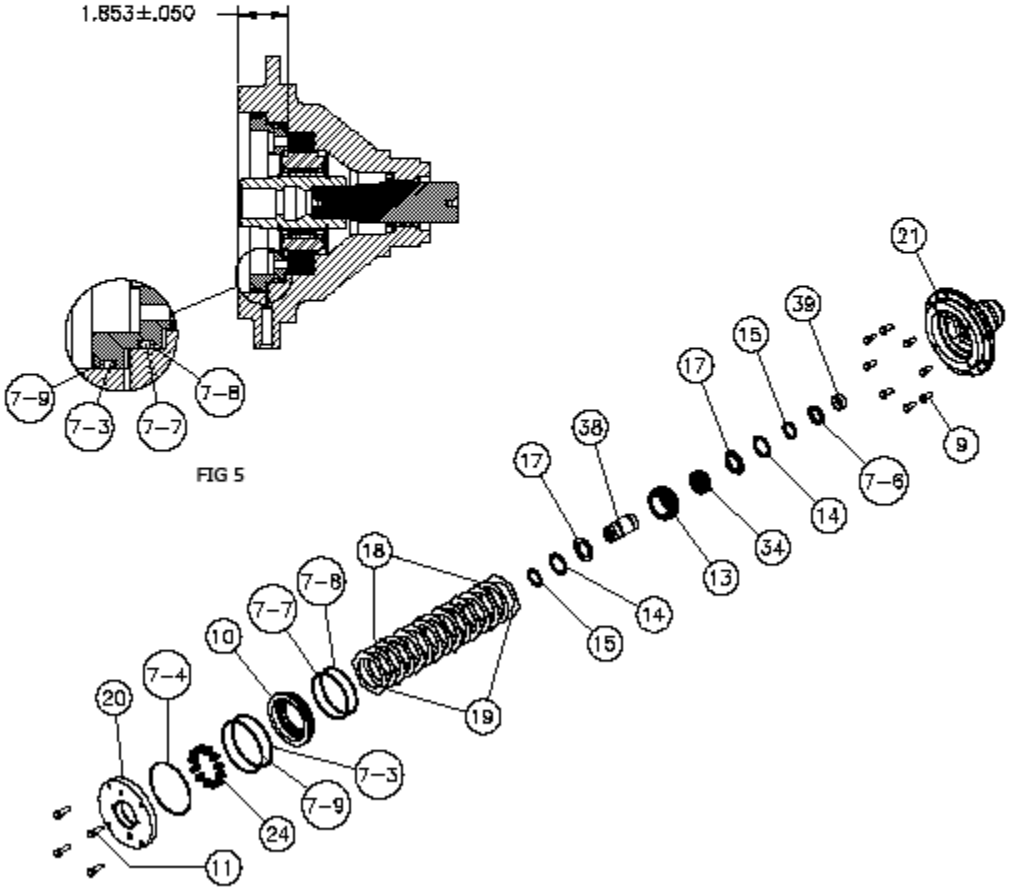
15. Carefully install the piston *(Item 10)* into the brake housing *(Item 21)* and gently tap it down until it is seated.

16. Install the springs *(Item 24)* into the spring pockets of the piston. If working in a horizontal position, coat the bottom of each spring with chassis lube to keep it in position.

17. Coat the new o-ring *(Item 7-4)* with light oil and install it into the groove on the brake cover *(Item 20)*.

18. Install the cover *(Item 20)* onto the brake housing *(Item 21)* and draw it down evenly, alternating between opposite capscrews. Make sure that the cover is aligned properly with the brake housing in order to correctly orient the motor and vent/drain plugs.

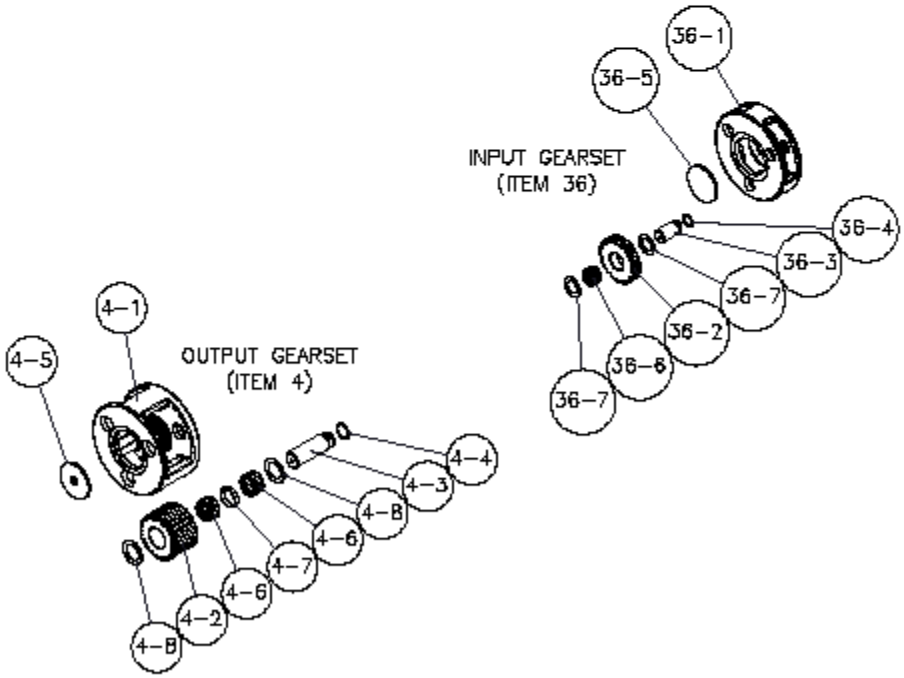
19. Check the brake release with a portable hydraulic pump. Full release should be obtained at 225 PSI ±10%.



12

SERVICING THE PLANETARY SETS

1. Remove the retaining rings from the planet pins.
2. Remove the pins from the carrier by carefully tapping them out.
3. Remove the planet gears, washers and bearings from the carrier.
4. Inspect the pins, bearings, and gear bores for evidence of wear and replace if necessary.
5. On output planet gearsets, note that two bearings with a spacer between them are used.
6. Before reassembly, be sure to insert the thrust plate into the carrier.
7. To reassemble, be careful to line up the planet pins with the thrust washers and bearings then press the knurled part of the pin into the carrier. If the pins are not lined up properly, the washers can be shattered during the pressing operation.
8. Replace the retaining rings onto the planet pins.



13

TROUBLESHOOTING

Hoist won't hold load

Possible Solutions:

1. There is excessive back pressure in the hydraulic system. Check the system for line restrictions and reduce the back pressure.
2. The brake discs are worn. Replace the brake discs. Friction discs should measure no less than 0.055 inches thick and the stator plates should measure at least 0.068 inches thick.
3. The brake clutch is slipping due to wear of either driver and/or clutch. Inspect the driver components for wear and replace if necessary.

Hoist unable to lift load

Possible Solutions:

1. The relief valve setting may be too low to allow proper lifting. Increase the relief pressure setting.
2. The load being lifted may be more than the winches rating. Verify weight and reduce the load or re-rig it to increase mechanical advantage.

Hoist unable to lower load

Possible Solutions:

1. The hoses or tubes have been installed incorrectly. Check hose routing and correct any errors *(see page 4 for hydraulic schematic).*
2. The counterbalance valve cartridge may have a plugged metering hole *(see page 10 for location of metering hole).* Remove the cartridge and clean it.

Oil leaks from motor-side vent

Possible Solutions:

1. The motor shaft seal may have failed. Replace the seal and reduce the back pressure if that was a cause of the seal failure.
2. The brake pistons o-ring seals may have failed. Service the brake section and replace any worn parts found.

TORQUE SPECIFICATIONS CHART

		Dry	Plated	Lubricated	Dry	Plated	Lubricated
		SAE Grade 5	SAE Grade 5	SAE Grade 5	SAE Grade 8	SAE Grade 8	SAE Grade 8
Nominal	Size	Torque *(Ft-Lbs)	Torque *(Ft-Lbs)	Torque *(Ft-Lbs)	Torque *(Ft-Lbs)	Torque *(Ft-Lbs)	Torque *(Ft-Lbs)
1/4	20	8	6	5	12	9	7
1/4	28	10	7	6	14	10	8
5/16	18	17	13	10	25	18	15
5/16	24	19	14	11	27	20	16
3/8	16	31	23	19	44	33	26
3/8	24	35	26	21	49	37	30
7/16	14	49	37	30	70	53	42
7/16	20	55	41	33	78	58	47
1/2	13	76	57	45	106	80	64
1/2	20	85	64	51	120	90	72
9/16	12	109	82	65	153	115	92
9/16	18	122	91	73	172	129	103
5/8	11	150	113	90	212	159	127
5/8	18	170	128	102	240	180	144
3/4	10	266	200	160	376	282	226
3/4	16	297	223	178	420	315	252
7/8	9	430	322	258	606	454	364
7/8	14	474	355	284	668	501	401
1	8	644	483	386	909	682	545
1	14	721	541	433	1019	764	611
1-1/8	7	794	596	475	1288	966	772
1-1/8	12	890	668	534	1444	1083	866
1-1/4	7	1120	840	672	1817	1363	1090
1-1/4	12	1241	930	745	2012	1509	1207

T = BOLT TORQUE (LB. FT.) **T = (KWD) / 12**

K = TORQUE COEFFICIENT (K = **0.20 DRY** **K = 0.15 PLATED** **K = 0.12 LUBRICATED)**

W = PRELOAD TENSION

D = NOMINAL BOLT SIZE (IN.) *** ALL TORQUE VALUE TOLERANCES ARE ± 5%**

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BILL OF MATERIAL

SEQ	QTY	P/N	DESCRIPTION	NOTES
1a	1	42489	SIDE PLATE	BRAKE SIDE (SEE PICTORAL FOR IDENTIFICATION) CONTACT FACTORY IF SIDE PLATE ISN'T SHOWN
1b	1	42767	SIDE PLATE	
1c	1	42536	SIDE PLATE	
1d	1	43301	SIDE PLATE	
1e	1	4263	SIDE PLATE	
2	20	29792	CAPSCREW	
3	1	29973	RETAINING RING	
4	1	4370	OUTPUT GEARSET	
4-1	1	42248	CARRIER	
4-2	3	42244	PLANET GEAR	
4-3	3	41747	PLANET PIN	
4-4	3	41716	RETAINING RING	
4-5	1	44067	THRUST PLATE	
4-6	6	41717	BEARING	
4-7	3	41739	SPACER	
4-8	6	939249	WASHER	
5a	1	42251	DRUM	
5b	1	42260	DRUM	
5c	1	42455	DRUM	
6	2	41722	THRUST WASHER	
7a	1	4321	SEAL KIT	FOR SINGLE SPEED MOTOR
7b	1	4339	SEAL KIT	FOR 81525001 ASSEMBLY (NO MOTOR)
7c	1	4372	SEAL KIT	FOR TWO SPEED MOTOR
8	1	42250	INPUT SUN GEAR	
9	14	20524	CAPSCREW	
10	1	42942	BRAKE PISTON	
11	4	10381	CAPSCREW	
12a	1	42488	BASE	FOUR MOUNTING HOLES
12b	1	43023	BASE	TWO MOUNTING HOLES
13	1	43453	BRAKE DRIVER	
14	2	41723	RACE	
15	2	26980	RETAINING RING	
16	1	44066	OUTPUT SUN GEAR	
17	2	41743	BUSHING	
18	7	32765	FRICTION DISC	
19	8	42148	STATOR PLATE	
20a	1	42015	BRAKE COVER	SAE 4-BOLT "B" MOTOR MOUNT
20b	1	42456	BRAKE COVER	SAE 2-BOLT "C" MOTOR MOUNT
20c	1	43419	BRAKE COVER	SAE 4-BOLT "C" MOTOR MOUNT
21	1	43423	BRAKE HOUSING	
22	4	42263	CAPSCREW	
24	12	42230	BRAKE SPRING	
25	1	41867	COUNTERBALANCE VALVE	
26	1	42289	BEARING CARRIER	
27	1	42029	COUNTERBALANCE BLOCK	
28	2	34550	BEARING	
29	1	41756	CABLE THIMBLE	
30	2	13050	BREATHER	
31	1	41879	O-RING PLUG	
32	1	43424	SHAFT	
33	1	41719	O-RING PLUG	
34	1	41759	CLUTCH	
35	2	42089	90 DEGREE ADAPTER	
36	1	4185	INPUT GEARSET	
36-1	1	42528	CARRIER	
36-2	3	42245	PLANET GEAR	

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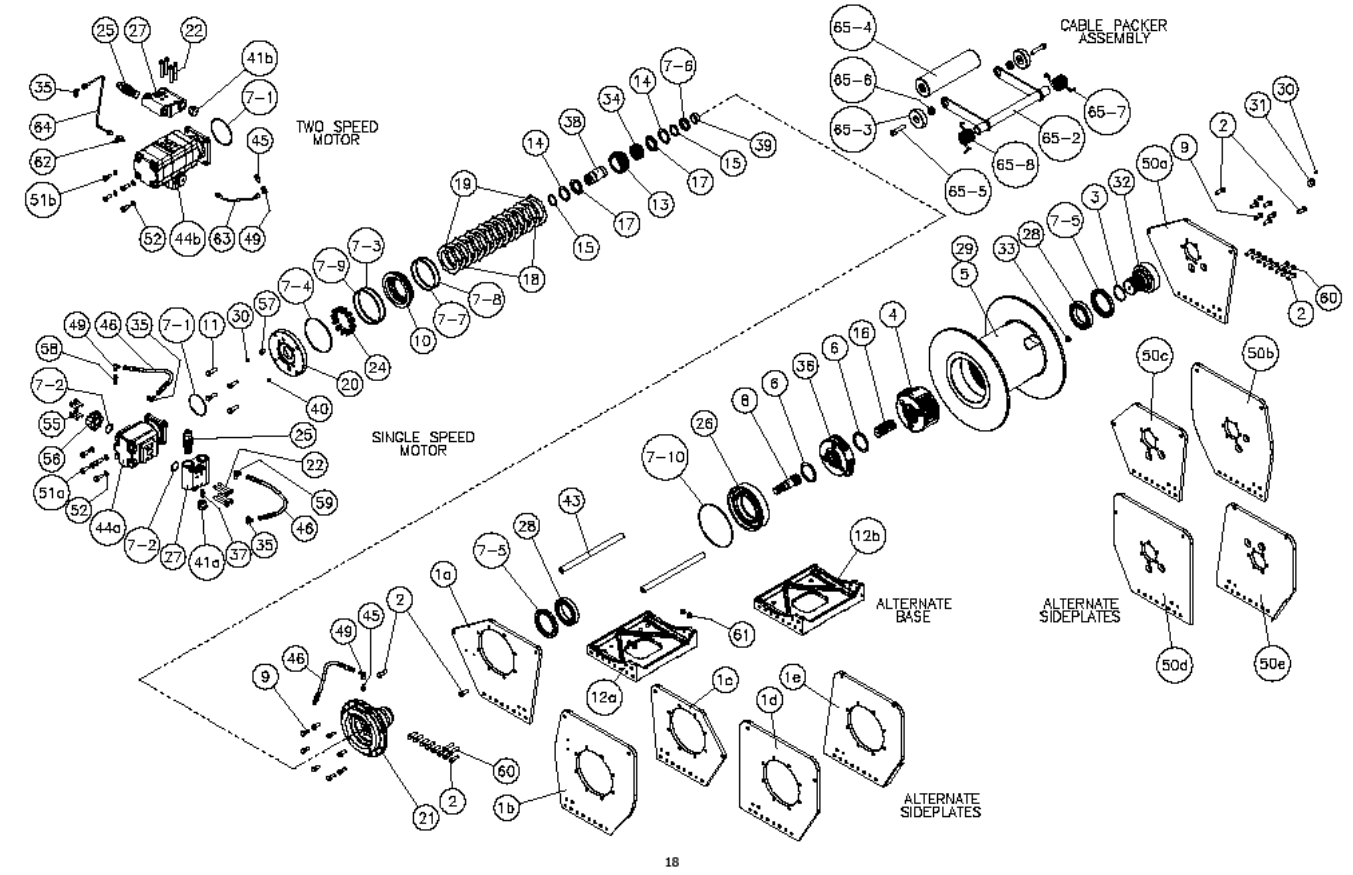
SEQ	QTY	P/N	DESCRIPTION	NOTES
36-3	3	41760	PLANET PIN	
36-4	3	41715	RETAINING RING	
36-5	1	41769	THRUST PLATE	
36-6	3	30484	BEARING	
36-7	6	28771	WASHER	
37	1	42223	CHECK VALVE	
38	1	44852	INPUT DRIVER	
39	1	32445	BUSHING	
40	1	41307	O-RING PLUG	
41	1	42225	O-RING PLUG	
43	2	42134	SUPPORT ROD	
44a	1	42022	SINGLE SPEED MOTOR	
44b	1	43624	TWO SPEED MOTOR	
45	1	41838	STRAIGHT ADAPTER	
46	3	42030	HOSE ASSEMBLY	
49	2	41873	SWIVEL ADAPTER	
50a	1	44542	SIDE PLATE	OUTPUT SHAFT SIDE (SEE PICTORAL FOR IDENTIFICATION) CONTACT FACTORY IF SIDE PLATE ISN'T SHOWN
50b	1	44843	SIDE PLATE	
50c	1	44840	SIDE PLATE	
50d	1	44860	SIDE PLATE	
50e	1	4514	SIDE PLATE	
51	4	28060	CAPSCREW	
52	4	20518	LOCKWASHER	
55	4	40546	CAPSCREW	
56	1	42211	FLANGE	
57	1	12208	BUSHING	
58	1	42209	FITTING TEE	
59	1	42259	ELBOW	
60	4	20311	CAPSCREW	
61	4	20267	NUT	
62	1	42438	BRANCH TEE	
63	1	43400	TUBING	
64	1	42256	TUBING	
65	1	4183	CABLE PACKER	
65-1	2	42515	BEARING	
65-2	1	42485	PACKER ARM	
65-3	2	42418	ROLLER	
65-4	1	42421	ROLLER	
65-5	2	42517	CAPSCREW	
65-6	2	42516	BEARING	
65-7	1	42425	LEFT SPRING	
65-8	1	42533	RIGHT SPRING	

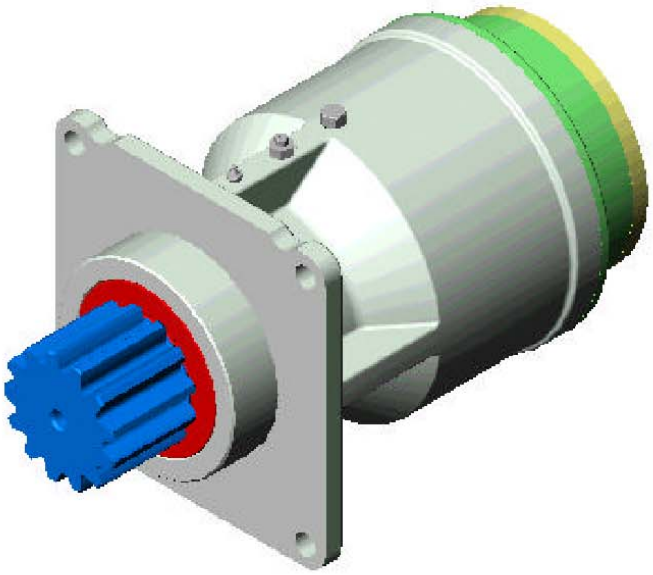
EXPLODED ISOMETRIC ASSEMBLY DRAWING



4.2 Swing Drive Service Manual – Tulsa 6036S

Tulsa Winch

5200 SERIES
6000 SERIES
SWING DRIVE
SERVICE MANUAL



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Rev-1

This manual will primarily assist in disassembly and assembly procedures of major components for all 52 & 60 series Swing Drives. Item numbers, indicated in parentheses throughout this manual, refer to the Tulsa Winch Model 52 and 60 series exploded assembly drawing located in the back of this manual.

LUBRICATION AND MAINTENANCE

Manufacturer recommends changing oil after first 50 hours of operation. Oil should be changed at 500-hour intervals thereafter. All gearboxes require GL-5 grade EP 80/90 gear oil for lubrication. Some units may be equipped with a grease fitting for lubrication of the output shaft bearings (pinion up applications). The shaft bearings should be greased sparingly at every 50 operating hours with a lithium or GP bearing lube. In pinion down applications, gearbox oil will lubricate Shaft bearings.

OIL CAPACITIES:

	52	**60**
Pinion up:	70 Ounces	128 Ounces
Pinion down:	88 Ounces	100 Ounces

DISASSEMBLY PROCEDURE

FOR 52 & 60 SERIES SWING DRIVES

1. Remove drive from vehicle and drain gearbox lubricant by removing the drain plug (**31**).

2. Remove the motor from the motor adapter (**30**).

3. Remove the brake assembly from the gear housing assembly (**7**) by removing eight hexhead capscrews (**18**). NOTE: Notice the position of the brake port in conjunction with the drain and fill holes in the housing for reassembly.

4. Inspect the brake housing o-ring (**14**) for damage. Replace if necessary.

5. Separate the motor adapter (**30**) from the brake housing (**15**) by removing eight capscrews (**32**). NOTE: Notice the position of the motor mounting hole in relation to the brake release port for re-assembly. CAUTION: The motor adapter is spring-loaded and the capscrews should be loosened in a sequence that will allow an even load distribution on the motor adapter.

6. Inspect the motor adapter o-ring (**29**) for damage. Replace if necessary.

7. Remove the six springs (**33**), piston (**25**), and brake driver (**27**) from brake housing (**15**). NOTE: On 52 series swingdrives notice the position of the dowel-pin hole in piston with respect to the brake release port for re-assembly. NOTE: A port-a-power can be used to assist in the removal of piston by slowly pressurizing the brake release port until piston clears the top of housing (**15**).Remove stator plates (**19**) and friction discs (**20**) from the brake housing (**15**). Inspect stator plates for excessive grooving or burn spots. Also, inspect friction discs for wear. Replace as required. *(Ref. Fig. 1)*

8. Inspect the piston o-rings (**22** & **23**) and the back-up rings (**21** & **24**) for damage, replace if necessary. *(Ref. Fig. 2)*

9. If applicable remove 2nd piston (**36**) from the brake housing (**15**), inspect o-rings

(**37** & **38**) and back-up rings (**39** & **40**) for damage, replace if necessary. *(Ref. Fig. 2)* On 52 series swingdrive inspect bearing (**41**) & seal (**42**) in brake housing (**15**) replace if necessary.

10. Remove race (**12**) from input planet set (**13**).

11. Remove input planet set (**13**) from gear housing (**7**) by pulling straight up and out of the housing.

12. Remove retaining ring (**13.4**), press out the planet pins (**13.3**), remove the planet gear (**13.2**), and needle bearings (**13.5**), inspect for unusual wear. Replace as required.

13. Remove race (**12**) from output planet set (**10**).

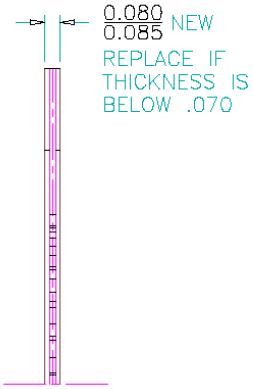
14. Remove the output sun gear (**11**), from the output planet carrier **(10.)**. Lift the output planet set out of the housing **(7)**.

15. Remove the retaining ring (**10.4**). Press out the planet pins (**10.3**); remove the planet gear (**10.2**) and needle bearings (**10.5**). Inspect for unusual wear. Replace as required.

16. Remove bearing lock nut (**35**) and lock washer (**34**).

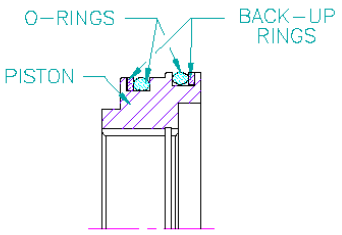
17. Remove the pinion shaft (**1**) from the housing (**7**) inspect the pinion shaft, seal, and bearing for wear and replace if necessary. Remove the inboard bearing (**9**) and inspect for wear.

18. Remove outboard seal (**2**) and bearing (**3**) Inspect for wear and replace if necessary.



FRICTION DISK (WITHOUT WEAR)

(FIG 1)



O-RING INSTALLATION

(FIG 2)

ASSEMBLY PROCEDURE

FOR 5200 & 6000 SERIES SWING DRIVES

1. Press the inboard and outboard bearing cup (**4** & **8**) into the gear housing (**7**) if replaced.

2. Grease pack the bearing cones (**9** & **3**) with EP-2 before installation.

3. Install the outboard cone (**3**) into the outboard cup (**4**). Press the seal (**2**) into the gear housing (**7**) from the outboard side.

4. Slide the output pinion (**1**) into the housing (**7**) from the outside.

5. Install the inboard bearing cone (**9**).

6. Apply Loc-Tite to pinion shaft and locknut.

7. Install the bearing lockwasher (**34**) then the bearing locknut (**35**). Torque locknut to 100 Ft. Lbs. Loosen and rotate pinion 90 degrees, re-torque locknut to 100 Ft. Lbs. (repeat this process 4 times) then re-tighten locknut to 100 Ft. Lbs. If the locknut is between tabs on the lockwasher always tighten until tabs align with slots in locknut. Secure locknut by bending tabs on lockwasher so that it engages locknut to prevent locknut from backing off. NOTE: Install a 5/8-11 bolt into the end of the pinion shaft on the outboard side and check the rolling torque. Preload of the bearing torque should be 75-85 In. Lbs.

8. Install the output carrier (**10**) into the gear housing (**7**). Install sun gear (**11**) and then the race (**12**) into output carrier (**10**).

9. Install the input carrier section (**13**) with race (**12**).

10. Assemble the brake section by first installing the o-ring (**14**) on the brake housing (**15**). Install eight capscrews (**18**) to the brake housing (**15**) and torque to 10 ft. lbs. NOTE: Notice the position of the brake port in conjunction with the drain and fill holes in the housing.

11. If applicable install piston (**36**) into brake housing (**15**). NOTE: Apply a slight film of oil on the o-rings and back-up rings before installation.

12. Insert the brake driver (**27**) into the assembled brake housing (**15**).

13. Install the stator plates (**19**) and friction disks (**20**) starting with one stator plate and alternating between friction disk and stator plate until six stator plates and five friction disks are used. NOTE: Soak friction disk in EP-90 oil before installation.

14. Carefully press the assembled piston (**25**) into the brake housing (**15**), taking care not to damage the o-rings. NOTE: Notice the position of the dowel pin hole in piston with the brake release port for correct assembly.

15. Install six springs (**33**) into the holes in the piston (**25**).

16. Mount the motor adapter (**30**) to the brake housing (**15**) with eight capscrews (**32**) checking to make sure the roll pin (**26**) is in line with the dowel hole in piston (**25**). NOTE: Notice the position of the motor mounting hole in relation to the brake release port for correct re-assembly.

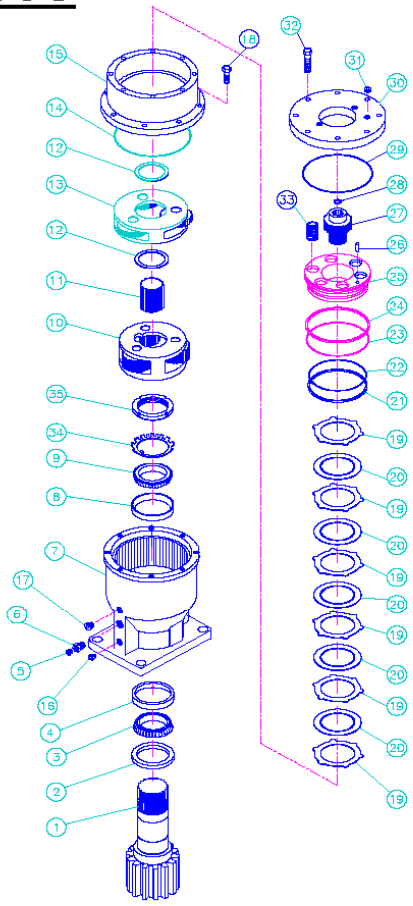
17. Mount the motor to the adapter (**30**).

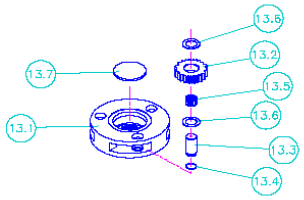
18. Fill the gearbox to desired level with EP-90 gear lube.

5200S

1	1	43379	SHAFT, OUTPUT, PINION
2	1	43382	SEAL, OIL
3	1	34773	CONE, BEARING
4	1	34772	CUP, BEARING
5	1	13050	BREATHER
6	1	42752	ADAPTER
7	1	43378	HOUSING, GEAR
8	1	43381	CUP, BEARING
9	1	43380	CONE, BEARING
10	1	4171	GEAR SET, OUTPUT
11	1	42303	GEAR, SUN, OUTPUT
12	2	41722	RACE
13	1	4170	GEAR SET, INPUT
14	1	939452	O-RING
15	1	42680	HOUSING, BRAKE
16	1	21128	FITTING, GREASE ZERK
17	1	939487	PLUG, O-RING
18	8	20522	CAPSCREW
19	6	42111	PLATE, STATOR
20	5	33564	DISC, FRICTION
21	1	42675	RING, BACK-UP
22	1	42672	O-RING
23	1	32186	O-RING
24	1	42337	RING, BACK-UP
25	1	42697	PISTON, BRAKE
26	1	27590	PIN
27	1	42683	DRIVER, BRAKE
28	1	41994	RING, RETAINING
29	1	33094	O-RING
30	1	42682	COVER, BRAKE
31	1	42392	PLUG, O-RING
32	8	939261	CAPSCREW
33	6	41718	SPRING, BRAKE
34	1	42333	LOCKWASHER, BEARING
35	1	42332	LOCKNUT, BEARING

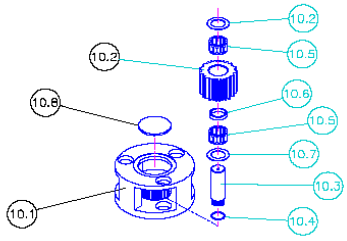
PART NO. TAKEN FROM 81631





GEAR SET (ITEM 13 ABOVE)

13.1	1	42323	CARRIER, INPUT
13.2	3	42304	GEAR, PLANET, INPUT
13.3	3	41760	PIN, PLANET
13.4	3	41715	RING, RETAINING
13.5	3	30484	BEARING, NEEDLE
13.6	6	28771	RACE
13.7	1	41769	PLATE



GEAR SET (ITEM 10 ABOVE)

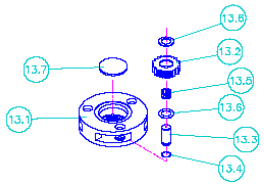
10.1	1	42324	CARRIER, OUTPUT
10.2	3	42306	GEAR, PLANET
10.3	3	41747	PIN, PLANET
10.4	3	41716	RING, RETAINING
10.5	6	41717	BEARING
10.6	3	41739	SPACER
10.7	6	939249	RACE
10.8	1	41769	PLATE

4

6000S

1	1	42796	SHAFT, OUTPUT, PINION
2	1	42330	SEAL, OIL
3	1	42329	CONE, BEARING
4	1	34771	CUP, BEARING
5	2	13050	BREATHER
6	2	12208	BUSHING, PIPE
7	1	42857	HOUSING, GEAR
8	1	33115	CUP, BEARING
9	1	42331	CONE, BEARING
10	1	4171	GEAR SET, OUTPUT
11	1	42303	GEAR, SUN, OUTPUT
12	2	41722	RACE
13	1	4170	GEAR SET, INPUT
14	1	939452	O-RING
15	1	42897	HOUSING, BRAKE
16	1	42305	GEAR, SUN, INPUT
17	0	OMIT	OMIT
18	8	939261	CAPSCREW
19	6	42148	PLATE, STATOR
20	4	32765	DISC, FRICTION
21	1	42336	RING, BACK-UP
22	1	42335	O-RING
23	1	32186	O-RING
24	1	42337	RING, BACK-UP
25	1	42307	PISTON, BRAKE
26	1	29043	RING, RETAINING
27	1	42327	DRIVER, BRAKE
28	1	41994	RING, RETAINING
29	1	33094	O-RING
30	1	42712	COVER, BRAKE
31	2	939487	PLUG, O-RING
32	8	30078	CAPSCREW
33	6	41718	SPRING, BRAKE
34	1	42333	LOCKWASHER, BEARING
35	1	42332	LOCKNUT, BEARING
36	1	42898	PISTON, BRAKE
37	0	OMIT	OMIT
38	0	OMIT	OMIT
39	0	OMIT	OMIT
40	0	OMIT	OMIT
41	1	42632	BEARING
42	1	11637	SEAL, OIL

PART NO. TAKEN FROM B1459

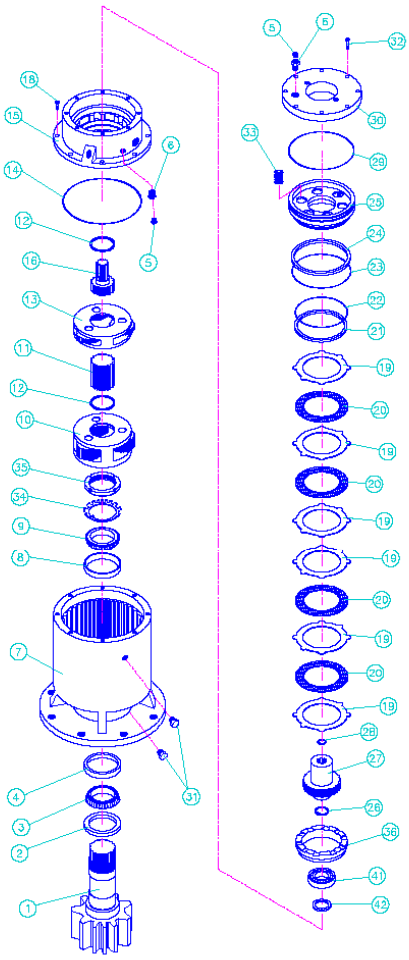


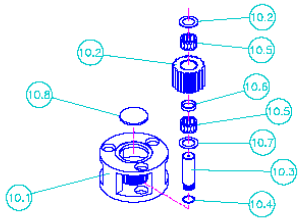
GEAR SET (ITEM 13 ABOVE)

13.1	1	42323	CARRIER, INPUT
13.2	3	42304	GEAR, PLANET, INPUT
13.3	3	41760	PIN, PLANET
13.4	3	41715	RING, RETAINING
13.5	3	30484	BEARING, NEEDLE
13.6	6	28771	RACE
13.7	1	41769	PLATE

GEAR SET (ITEM 10 ABOVE)

10.1	1	42324	CARRIER, OUTPUT
10.2	3	42306	GEAR, PLANET
10.3	3	41747	PIN, PLANET
10.4	3	41716	RING, RETAINING
10.5	6	41717	BEARING
10.6	3	41739	SPACER
10.7	6	939249	RACE
10.8	1	41769	PLATE





5

4.3 LMI Operator's Manual – Greer Insight

Introduction

The GREER INSIGHT System is designed for use as an aid to crane operation.

Do not use this system in place of a properly trained operator who is knowledgeable in safety guidelines, crane capacity information, and the crane manufacturer's specifications.

This manual describes the operation of the GREER INSIGHT, (hereinafter referred to as "the system"). Please read, understand, and follow the contents and instructions contained within this manual.

Table of Contents

OUTLINE OF OPERATION

System Components

- Display Unit
- Computer Unit
- Pressure Transducers
- Reeling Drum with Length and Angle Sensors
- Anti-Two-Block Switches
- Cables
- Installation/Operator Manuals
- Audible Alarm

The system is intended to aid the crane operator by monitoring the load and indicating an approach to an overload or a two-block condition. Crane functions are monitored by means of multiple sensors. The system compares the load suspended below the boom head, to the crane capacity chart stored within the computer's memory. At approach to overload, the system warns an operator by means of audible and visual alarms. The system may be configured to cause crane function kick-out by sending a signal to function disconnect solenoids.

The operator is provided with a display of:

- Rated Capacity
- Actual Load
- Bar graph showing Actual Load vs. Rated Capacity
- Radius of the Load
- Boom Angle
- Main Boom Length
- Working Area

BOOM ANGLE SENSOR

The boom angle is measured by means of a potentiometer/pendulum assembly. This sensor provides a voltage proportional to boom angle. The sensor is mounted inside the cable reeling drum assembly.

EXTENSION SENSOR

The extension sensor provides a voltage proportional to the extension of the boom.

PRESSURE TRANSDUCERS

There are two pressure transducers which measure the pressure in the boom hoist cylinder.

ANTI-TWO BLOCK (A2B)

A switch monitors the approach of the hookblock or overhaul ball to the boom head. The switch is held in the normal position until the hookblock or overhaul ball raises a weight that is mounted around the hoist rope. When the weight is raised it causes the switch to open. The resultant switch open signal is sent to the computer via the reeling drum, this results in the A2B alarm operating and a corresponding function kick-out.

FUNCTION KICK-OUT

Electrically operated hydraulic solenoids disconnect the control lever functions for boom hoist lower, telescope out and winch up whenever an overload A2B or other FKO level condition occurs.

OPERATOR PROGRAMMABLE ALARMS

These alarms, when properly set by the operator, define the working range for a particular work area. The operator can set minimum and maximum angle, maximum height and/or maximum length.

AREA ALARM

This alarm defines a "virtual wall" working area. This wall is defined by setting two points. Both set points and area alarms may be set simultaneously.

POWER UP SELF TEST

Image 1
Power Up Self Test Screen

Immediately following electrical power up, the system executes a System self-test which lasts for approximately 10 seconds. During this time the display shows the rating chart number, units in use, and load.

Image 2
The Startup Screen

Immediately following power up self test, the startup screen will appear. During this time, crane motions are disabled by the system function kickout. Selecting the button adjacent to "PRESS TO CONTINUE" will acknowledge the home display message and allow the system to start normal operation.

Note: Not all applications will have this screen. In such applications the Home display will be shown with no need to select "CONTINUE."

SYSTEM SETUP

Image 3
Home Display

Note: The Configuration Display may be accessed from the Home Display by selecting the Configuration button shown above.

The system has the capability of remembering all data previously set. When removing power to the system, and re-powering, the settings remain intact until reset by the operator.

THE CONFIGURATION DISPLAY

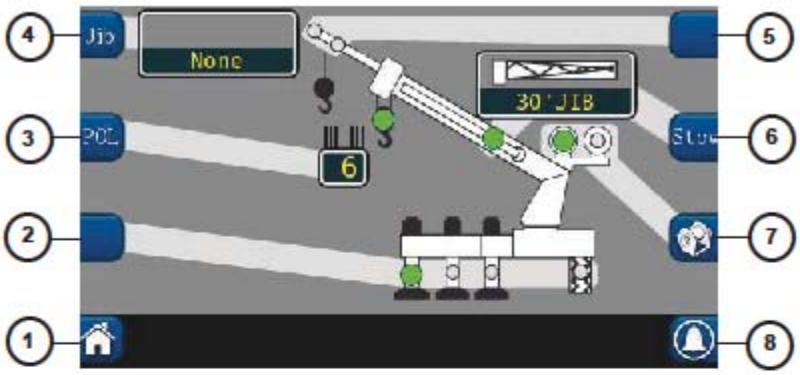


Image 4
The Configuration Display

The Configuration Display gives a pictorial representation of the current set up of the system. Each shaded area contains a group of one or more green indicators and a button which is pressed to change the setup selection. In groups where there are multiple options, green indicators illuminate one at a time to indicate the selection. Once the configuration is complete, press the Home button to go to the Home display.

Please see the following table, (Table 1 Configuration Display) for a description of the referenced numbers outlined in (Image 4).

Note: The graphic above is only a representation of the system. Therefore, the shaded areas may vary in configuration depending upon application.

Note: Always check the point of lift and parts of line upon selection of the winch.

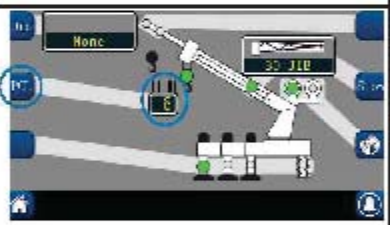
WARNING!

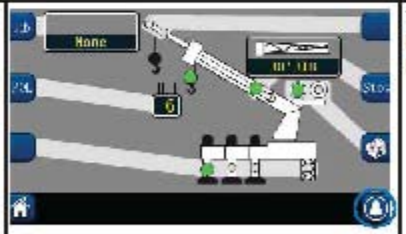
THE DISPLAYED LOAD AND CAPACITY ARE BASED UPON THE CURRENT SELECTED POINT OF LIFT. NEITHER THE GREER INSIGHT SYSTEM, NOR THE CRANE CAPACITY CHART ALLOWS FOR LIFTING FROM MORE THAN ONE HOOK AT A TIME.

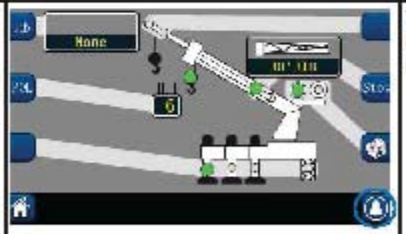
TABLE 1

CONFIGURATION DISPLAY

Note: Options may vary, depending upon the equipment being used.

Reference Number	Image	Description
1		The **Home** button will return the user to the Home display.
2		The **Outrigger / Tire** selections are made by pressing the button shown. *Note: Some models of cranes will not have the option of selecting different outrigger positions.*
3		The **Parts of Line (POL),** button selects the current Parts of Line. Pressing the **(POL)** button will increment the **POL.** When the maximum parts of line for the equipment being used is reached, the indicator will rollover to one **POL.**
4		The **Jib Options** may be selected by pressing the jib button multiple times to scroll through jib options. If there aren't any options available, the display will show **"None."** *Note: The jib must be stowed before it is erected.*

Reference Number	Image	Description
5		The **Pick Long, Pick Short, Pick Main** selections are dependent upon the model of crane being used.
6		The **Stow (Stowed Jib)**, group contains one green indicator. This will illuminate when the jib is stowed on the boom. Press the Stow button multiple times to scroll through jib options. If there aren't any options available, the display will show **"None"**.
7		The **Winch** group contains two green indicators, which indicate the selection of Front or Rear winch. *Note: If the crane is equipped with two winches, always select the winch to be used for the lift, prior to selecting the parts of line selections for each winch.*
8		The **Operator Alarms** may be accessed by pressing the corresponding alarm button.

Reference Number	Image	Description
5		The **Pick Long, Pick Short, Pick Main** selections are dependent upon the model of crane being used.
6		The **Stow (Stowed Jib)**, group contains one green indicator. This will illuminate when the jib is stowed on the boom. Press the Stow button multiple times to scroll through jib options. If there aren't any options available, the display will show **"None"**.
7		The **Winch** group contains two green indicators, which indicate the selection of Front or Rear winch. *Note: If the crane is equipped with two winches, always select the winch to be used for the lift, prior to selecting the parts of line selections for each winch.*
8		The **Operator Alarms** may be accessed by pressing the corresponding alarm button.

THE HOME DISPLAY

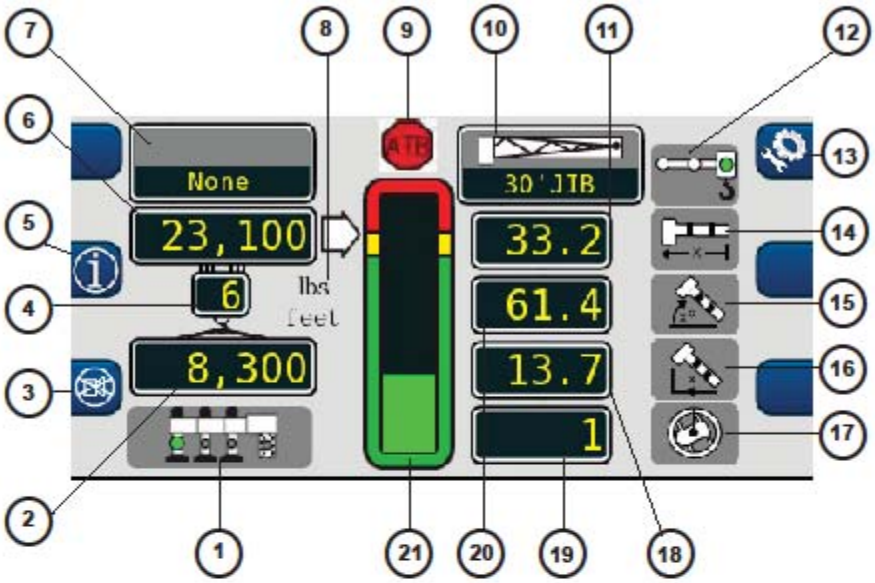
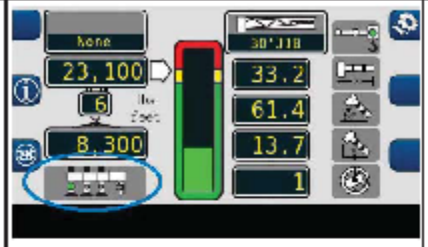
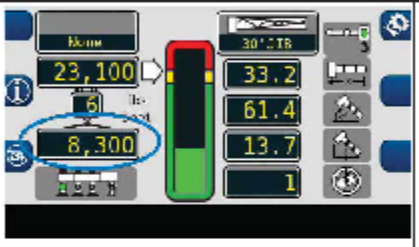
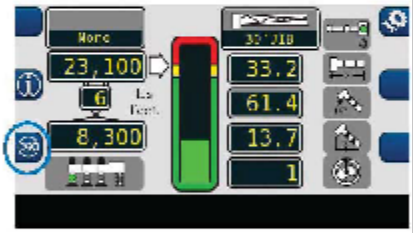
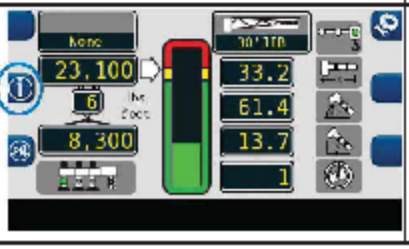
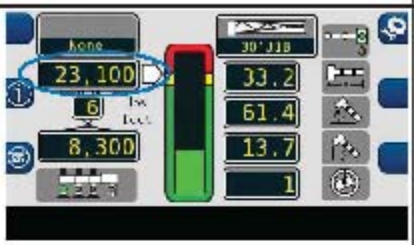
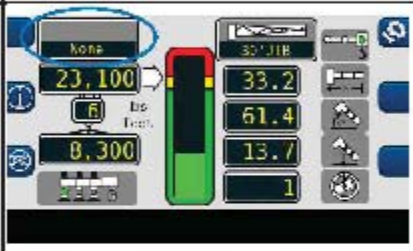
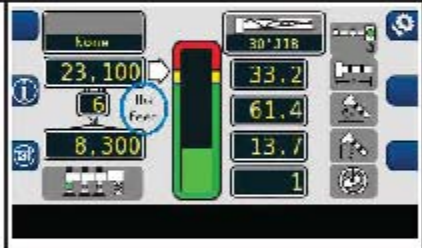
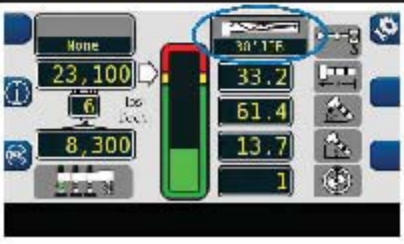
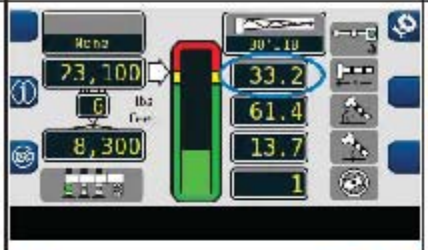
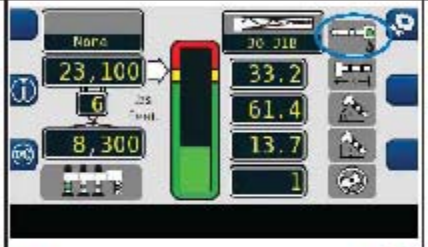
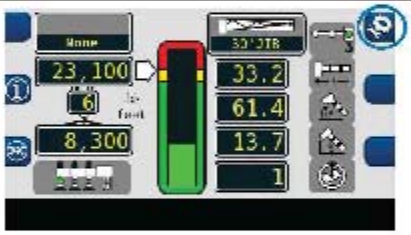
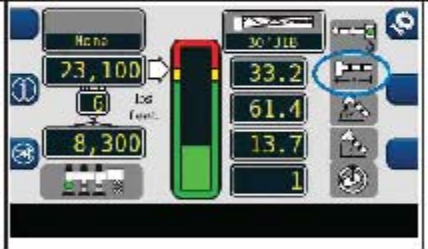
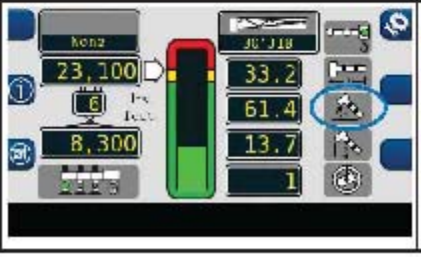


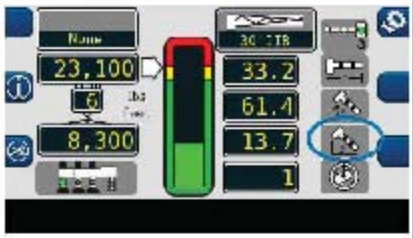
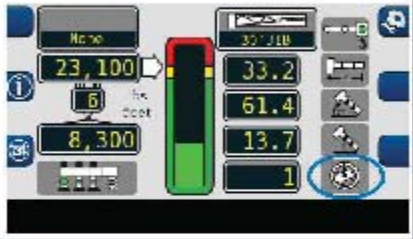
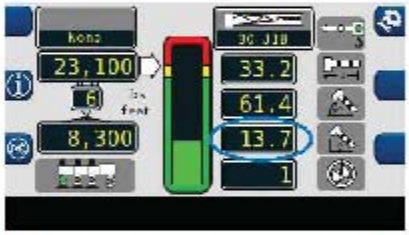
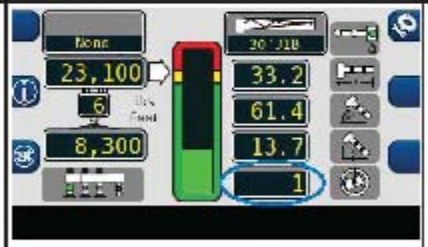
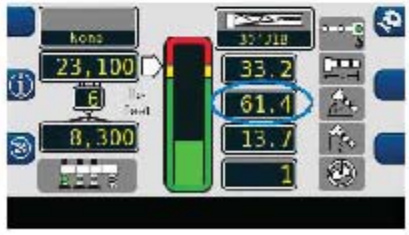
Image 5
The Home Display

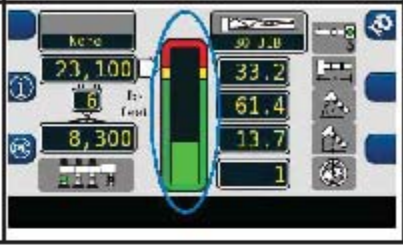
TABLE 2
HOME DISPLAY

Reference Number	Image	Description
1		The **Outrigger / Tires** setting contains four green indicators. They indicate the selection of tires, full, intermediate, and retracted outriggers. The user must make the outrigger/ tires selection from the Configuration display. *Note: Outrigger / Tire selections are dependent upon the model of the crane being used. A particular model may have one selection etc.*
2		The **Actual Load** value displays the total load, including slings, etc., suspended below the lifting point.
3		The **Cancel Alarm Button** is used to silence the audible alarm. Pressing this button once will cancel an audible alarm generated by the following conditions: Overload A2B Alarm Operator Programmable Alarm The audible alarm remains cancelled until the condition which caused the alarm has been resolved.
4		The **Parts of Line** display shows the amount of line chosen for the configuration selected. It is adjustable from the Configuration screen.
5		The **Information** button displays system generated messages regarding the software versions of the equipment and fault codes. When the information button is pressed, the data is displayed as long as the button is held.

Reference Number	Image	Description
6		The **Rated Capacity** display shows the maximum rated capacity of the machine in the current configuration.
7		The **Erected Jib** display shows the jib options selected for the machine. If there are no jib options available, the display will show **"None."**
8		The **System** has the capability of showing units of measurement in Metric or Imperial units.
9		The **Anti-Two Block** indicator illuminates when the A2B limit switch detects approach to a two-block condition.
10		The **Jib Stowed** display shows the jib that has been stowed from the configuration screen. The length and the offset of the jib in use is also shown in the Home display.

Reference Number	Image	Description
11		The **Boom Length** is indicated in the box shown to the left. This shows the length of the main boom from the boom foot pin to the sheave pin of the main boom head machinery. This measurement can be shown in either Imperial or Metric units.
12		The **Pick Points**, Pick Long, Pick Short, Pick Main. The pick selection is made from the Configuration display screen.
13		The **Configuration Button** may be selected to return to the Configuration display screen. 
14		The **Boom Length** symbol is shown to the right of the length of the boom display.
15		The **Boom Angle** symbol is shown to the right of the boom angle display.

Reference Number	Image	Description
16		The corresponding **Load Radius** symbol is shown to the right of the boom angle display.
17		The corresponding **Swing Angle** of the boom symbol is indicated in the box shown to the left.
18		The **Load Radius** of the boom is indicated in the box shown to the left. The radius display shows the radius of the load. Radius is defined as the horizontal distance from the centerline of rotation to the centerline of the lifting point.
19		The **Swing Angle** of the boom is indicated in the box shown to the left.
20		The **Boom Angle** display indicates in degrees, the angle of the main boom relative to horizontal.

Reference Number	Image	Description
21		The **Bar Graph** indicates the actual load vs. the rated capacity of the equipment being used.

SYSTEM SETUP

Cancel Alarm Button

The cancel alarm button is used to silence the audible alarm. Pressing this button once will cancel an audible alarm which has occurred as a result of either an: Overload, A2B Alarm, or Operator Programmable Alarm.

The audible alarm remains cancelled until the condition which caused the alarm has been resolved.

SYSTEM SETUP

Reset Function Kick-Out

When the machine is to be rigged, it may be necessary to put the boom in a position which could cause function kick-out. In this situation, it would be necessary to use the bypass, (cancel alarm button).

The cancel alarm button is also used to reset the function kick-out relay when it is necessary to bypass the function disconnects. Pressing and holding the cancel alarm button for 5 seconds resets the relay. At this time, a second beep is heard confirming the bypass. Should a different alarm condition occur while the relay is overridden, the new alarm will cause the controls to disconnect again. When the condition which caused the alarm is no longer present, the function disconnect relay will reset to the normal condition.

WARNING!

WHEN THE FUNCTION DISCONNECT RELAY IS RESET BY MEANS OF THE CANCEL ALARM BUTTON, THERE IS NO LONGER PROTECTION AGAINST THE CONDITION THAT CAUSED THE FUNCTION KICK-OUT.

OPERATOR PROGRAMMABLE ALARMS

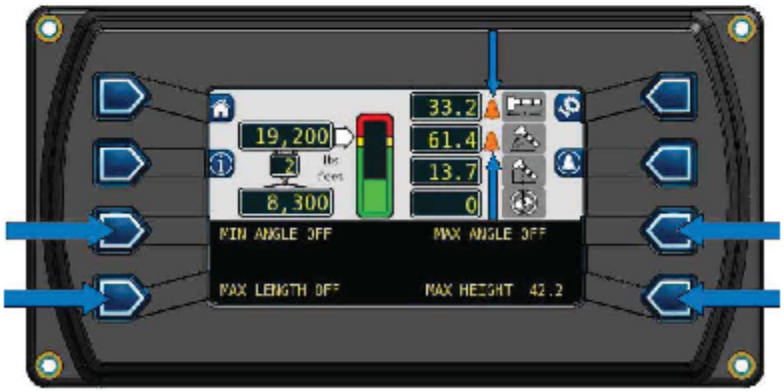
Setting the Operator Alarms

Access to the operator alarms from the main working screen is gained by first pressing the configuration button, and then pressing the operator alarm button. The information screen will show the current status of the operator alarms.

There are four buttons to the left and right of the home display screen. Each button relates to the alarm to which it is pointing.

In addition, each button also operates as a toggle switch. If the alarm to be set is OFF, pressing the button will turn the alarm ON. If the alarm to be set is ON, pressing the button will turn the alarm OFF.

There are several operator alarms available. When operator alarms are set, the orange alarm will appear. An example is shown below:



OPERATOR PROGRAMMABLE ALARMS

Setting Minimum Boom Angle Alarm

1. Move the boom to the desired minimum angle, in this example, 57.9 °.
2. Press the button pointing to the MIN ANGLE OFF.
3. The display will show the desired minimum angle, in this example 57.9 °.

4. Pressing the MIN ANGLE button again, will cancel the alarm, and the display will read: MIN ANGLE OFF.

Setting Maximum Boom Angle Alarm

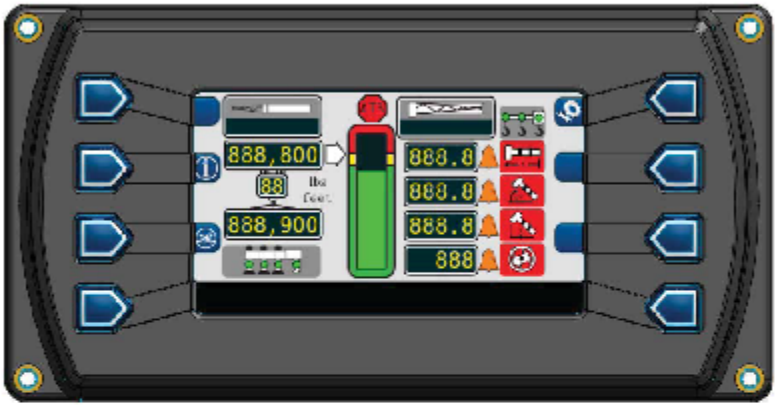
1. Move the boom to the desired maximum angle, in this example, 61.4 °.
2. Press the button pointing to the MAX ANGLE OFF.
3. The display will show the desired maximum angle, in this example 61.4 °.

4. Pressing the MAX ANGLE button again, will cancel the alarm, and the display will read: MAX ANGLE OFF.

OPERATOR PROGRAMMABLE ALARMS

Setting the Minimum and Maximum Boom Angle Alarm

If the boom travels past the given boom angle, length, height, or swing point, the operator alarms will be triggered. This will result in the red indicators illuminating, followed by an intermittent tone. The display will show a warning message similar to the display shown below:



OPERATOR PROGRAMMABLE ALARMS

Setting the Maximum Boom Length Alarm

1. Move the boom to the desired maximum length, in this example, 33.2 °.
2. Press the button pointing to the MAX LENGTH OFF.
3. The display will show the desired maximum length, in this example 33.2 °.

4. Pressing the MAX LENGTH button again, will cancel the alarm, and the display will read: MIN ANGLE OFF.

Setting Maximum Tip Height Alarm

1. Move the boom to the desired maximum height, in this example, 42.2 °.
2. Press the button pointing to the MAX HEIGHT OFF.
3. The display will show the desired maximum height, in this example 42.2 °.

4. Pressing the MAX HEIGHT button again, will cancel the alarm, and the display will read: MAX HEIGHT OFF.

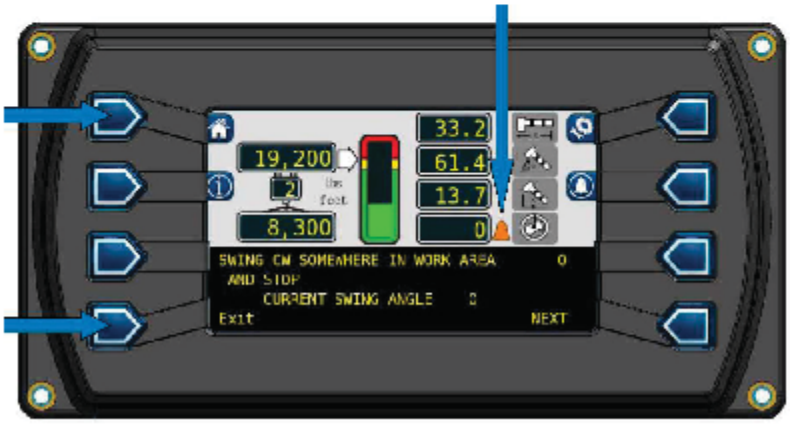
OPERATOR PROGRAMMABLE ALARMS

Setting the Swing and Work Area Alarms

Access to the operator alarms from the main working screen is gained by pressing the configuration button, and subsequently pressing the operator alarm button twice. By doing so, the display will show the current status of the swing and work area alarms.

The lower buttons of the display correspond to the alarms displayed. If the alarm to be set is OFF, pressing the corresponding button will turn the alarm ON. If the alarm is ON, pressing the corresponding button once again will turn the alarm OFF.

When the operator alarms have been set, the operator alarm icon will appear next to the corresponding pictograph as shown below.



Note: Press the operator alarm button in order to cycle through various user programmable alarms. Press the home button to return to the main screen. Exit may be chosen at any time.

OPERATOR PROGRAMMABLE ALARMS

Setting the Swing and Work Area Alarms

To access the swing and work area alarms from the main working screen, press the operator alarm button twice.

On equipment where the swing sensor is housed in the swing drive, the following screen will appear. Otherwise, for equipment having the swing sensor housed in a collector column, this screen will be disregarded.

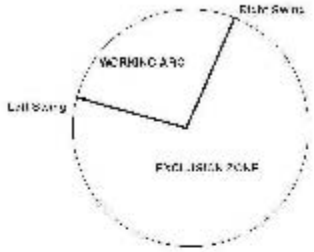
1. Press the key adjacent to the "SET SWING AND/OR WORK AREA ALARMS?".

2. Press the key adjacent to the "SET LEFT AND RIGHT SWING ALARMS? SET WORKING AREA ALARM?".

OPERATOR PROGRAMMABLE ALARMS

Setting the Swing and Work Area Alarms

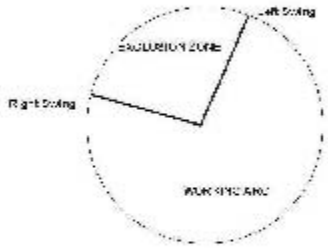
WORKING ARC AND EXCLUSION ZONE



Swing alarms define a working arc and an exclusion zone by two set points. The following diagram illustrates the working arc and exclusion zone.

- A left swing alarm is activated when swinging to the left.
- A right swing alarm is activated when swinging to the right.
- In this example, the working arc is the smaller piece of the pie.

WORKING ARC AND EXCLUSION ZONE



- A left swing alarm is activated when swinging to the left.
- A right swing alarm is activated when swinging to the right.
- In this example, the working arc is the larger piece of the pie.

WARNING!

THE OPERATOR DEFINED SWING ALARM IS A WARNING DEVICE. ALL CRANE FUNCTIONS REMAIN OPERATIONAL WHEN ENTERING THE OPERATOR DEFINED EXCLUSION ZONE.

OPERATOR PROGRAMMABLE ALARMS

Setting the Left and Right Swing Alarms

Note: In order for the swing alarms to function properly both alarms must be set. If the procedure is aborted prior to setting both points it will default to "OFF."

To set a new swing area, the left and right points must be reset.

1. Press the keys adjacent to "Left Swing" and "Right Swing." Doing so, will show them as "OFF."

2. Next, rotate the boom to the left swing point and press the key adjacent to the "Left Swing," to set the value.

3. Press the key adjacent to NEXT to continue.

OPERATOR PROGRAMMABLE ALARMS

Setting the Left and Right Swing Alarms (Continued),

4. Move the boom to the middle of the swing area and press the key adjacent to "Set."

5. Press the key adjacent to "Next."

6. Rotate the boom to the right swing point and press the key adjacent to "OFF."

OPERATOR PROGRAMMABLE ALARMS

Setting the Left and Right Swing Alarms (Continued),

7. Press the key adjacent to "FINISHED" to complete the routine.

OPERATOR PROGRAMMABLE ALARMS

Swing Alarm Condition

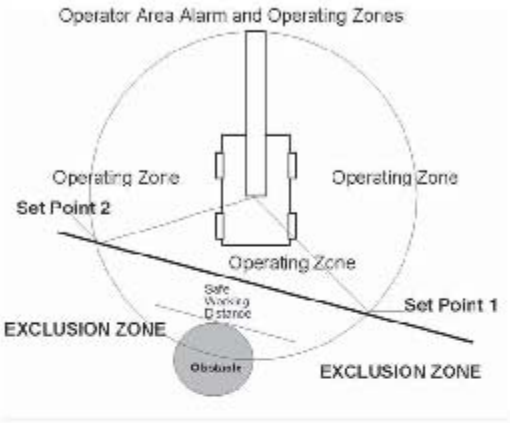
If the swing travels past either set point by one degree an alarm condition will occur. The red overload indicator will illuminate accompanied by an intermittent tone. In addition, the display will show the message, "WARNING! RIGHT SWING!" OR WARNING! LEFT SWING!". The alarm condition will clear upon swinging back into the working arc.

Note: The user set swing alarm will not result in a function kick-out, (FKO) when triggered.

OPERATOR PROGRAMMABLE ALARMS

Setting the Work Area Alarm

This alarm when set, permits the operator to define an Operating Zone by only two set points. The use of this method results in an enhanced working area and also clearly defines the Exclusion Zone area. The following diagram illustrates the Operating Zone and the Exclusion Zone.



The operator defined work area alarm when set, will define an imaginary vertical plane between two set points to optimize the working area. When the plane is passed the red warning indicator will be displayed, the alarm will sound, and the message "Exclusion Zone" will flash as shown below.

WARNING!

THE OPERATOR DEFINED WORK AREA ALARM IS A WARNING DEVICE. ALL FUNCTIONS REMAIN OPERATIONAL WHEN ENTERING THE OPERATOR DEFINED EXCLUSION ZONE. "SAFE WORKING DISTANCE" IS THE TIME IT WOULD TAKE AN OPERATOR TO REACT TO AN ALARM AND FOR THE MACHINE MOTION TO BE HALTED BEFORE ENTERING THE EXCLUSION ZONE. IT IS THE RESPONSIBILITY OF THE OPERATOR TO SET POINTS THAT ENSURE THE CRANE'S BOOM MAINTAINS A SAFE WORKING DISTANCE FROM THE OBSTACLE. AVOID POSITIONING THE BOOM IN THE EXCLUSION ZONE WHEN MOVING TO SET POINTS 1 AND 2. WHEN SELECTING SET POINTS 1 AND 2 ENSURE THAT THE LOAD WILL MAINTAIN A SAFE DISTANCE FROM THE OBSTACLE. IF THE CRANE OR OBSTACLE IS MOVED OR IF A DIFFERENT SIZE LOAD IS LIFTED, THE WORK AREA ALARM MUST BE RESET.

OPERATOR PROGRAMMABLE ALARMS

Setting the Work Area Alarm

1. To access the swing and work area alarms from the main working screen the operator must first press the configuration button.
2. Next press the alarm button.
3. Now press the alarm button shown.
4. Press the button adjacent to "SET SWING AND/OR WORK AREA ALARMS?".

OPERATOR PROGRAMMABLE ALARMS

Setting the Work Area Alarm

To set a new working area, the left and right points must be reset.

1. Press the buttons adjacent to "LEFT POINT" and "RIGHT POINT."
2. By doing this, the display will show "LEFT POINT OFF", "RIGHT POINT OFF."
3. Rotate the boom to the left point. This will be the point to the left facing the exclusion zone to be defined.
4. Press the button adjacent to "LEFT POINT."

5. Rotate the boom to the right by raising or retracting the boom, or raising the load above the obstacle until the right point is reached. Or, rotate the boom to the left until the right point is reached (this will avoid having to pass through the exclusion zone). This will be the point to the right facing the exclusion zone to be defined.
6. Press the button adjacent to "RIGHT POINT."
7. To deactivate the swing alarms, press the operator alarm button twice.
8. Press the button adjacent to "LEFT POINT" and "RIGHT POINT."
9. By doing this, the display will show "LEFT POINT OFF" and "RIGHT POINT OFF."

Note: In order for the work alarm to function properly, both alarms must be set. If the procedure is aborted prior to setting both points it will default to "OFF."

OPERATOR PROGRAMMABLE ALARMS

Working Area Alarm

If the swing travels past either set point by one degree, an alarm condition will occur. The red indicator will illuminate followed by an intermittent tone. In addition, the display will show "!!EXCLUSION ZONE!!". The alarm condition will clear upon swinging back into the operating zone. During a swing alarm condition, there is no function kick-out.

Zeroing the Swing Sensor

To access the swing and work area alarms from the main working screen, press the operator alarm button twice.

1. Press the "NEXT" button adjacent to "RESET SWING SENSOR ZERO?".

2. Ensure the boom is in its rest , (stowed position) and press the button adjacent to "CONFIRM." The swing sensor is now zeroed.

GLOSSARY OF TERMS

Actual Load	The load suspended below the lifting point.
Alarm	A signal that warns or alerts, such as a flashing light or loud noise.
Angle Sensor	A device that measures the inclination of a boom.
Anti Two-Block	A device that, when activated, prevents movement which may cause two-blocking.
Audible Alarm	A signal that alerts by means of noise.
Auxiliary Hoist, (AUXHOIST)	A separate hoist rope system other than the main hoist.
Bar Graph	A pictorial device used to illustrate quantitative relationships.
Boom	A member hinged to the upper structure that supports the hoisting tackle.
Boom Angle	The angle of the longitudinal axis of the boom relative to horizontal.
Boom Hoist	A device for controlling the boom angle.
Boom Length	The length of the boom along its longitudinal axis from the foot pin to the axis of the head machinery.
Boom Moment	The turning moment around the boom pivot caused by the moment of the luffing boom.
Capacity Chart	A table showing the rating of the crane.
Center Line of Rotation	The vertical axis around which the crane upper structure rotates.
Center of Gravity	The point at which the entire weight of a body may be concentrated so that if this point of the body would remain in equilibrium in any position.
Commissioning	Preparing to be put into service.
Configuration	An arrangement of the lifting components of a crane.
Counterweight (CTWT)	A weight used to supplement the weight of the crane to provide stability for lifting.
Cursor	A pointer on a display that indicates the position where data is to be entered.
Derate	A reduction in rated capacity for an unusual allowed or erected attachment.
Direction	The direction of rotation of the superstructure.
Duty	A working configuration of a crane usually contained in a single column of a capacity chart.
Erected Attachment	An attachment on the main boom fitted in its working position.
Extension Sensor	A device that measures the extension of the telescoping sections of a boom.
Function Kick-Out	A device that disengages certain crane functions whose movement could cause overload or two-blocking.
Height	The vertical distance from the ground to the tip of the boom or attachment.
Horizontal	Parallel to the horizon.
Information Screen	A display that gives information supplemental to the information on the load graph.
Integrated Circuits	A tiny complex of electronic components and

GLOSSARY OF TERMS

Integrated Circuits (Continued),	connections on a small slice of material.
Jib	Something attached such as a lattice or fly jib on a crane boom.
Manual Section	The tip of the main boom that can be telescoped independently of other sections.
Moment	A product of force and distance on a particular axis.
Operator Alarms	Alarms that may be set by the operator which provide working limits, in addition to the chart limits.
Outer Duty	A point which is either longer than the longest permitted radius or lower than the lowest permitted angle on a capacity chart.
Outrigger	A projecting support running out of a structure to provide additional stability or support.
Overload	The point at which the actual load exceeds the rated capacity of the crane.
Parts of Line	The number of parts of hoist rope between the upper and lower blocks.
Pantograph	A pictorial representation of the crane.
Point of Lift	The location of the hoist rope for the current lift, example: main boom, auxiliary head or jib.
Pre-Alarm	The point at which the actual load is 90% of the rated capacity of the crane.
Pressure	Hydraulic pressure in the boom hoist cylinder.
Radius	The horizontal distance from the centerline of rotation to the center of the hook.
Rated Capacity	The lifting capacity of a crane as determined by the published chart.
Rating	A factor determined by legislation that limits the proportions of cranes capabilities that may be utilized in a lifting operation. Usually expressed as a percentage of strength or stability.
Reeving	A rope system in which the rope travels around drums and reeves.
Rope Limit	The maximum permitted single line pull determined by the construction and diameter of a wire rope.
Sensor	A device that responds to physical stimulus and transmits a resulting impulse.
Sheave	A grooved wheel or pulley.
Sew Offset	The horizontal distance from the boom pivot to the center of rotation.
Stowed Attachment	An attachment usually stowed on the main boom when not in use.
Upper Structure	The structural part of a crane above the carrier, usually rotating.
Swing	The rotation of a crane upper arc and its centerline.
Swing Alarms	Audible alarms occurring when the upper structure swings into areas defined by the operator by use of the operator alarms.

GLOSSARY OF TERMS

SWL (% SWL)	Percentage of safe working load. The proportion of the crane capacity which is being utilized at any one time expressed as a percentage of rated capacity
Transducer	A device which is actuated by energy from one system and converts this to another form for use by a different system, (as a loudspeaker that is actuated by electrical signals and supplies acoustic power)
Two-Blocking	The condition when the lower load block or hook assembly comes into contact with the upper load block or boom point
Unlader	A boom which has no additional stowed or erected attachments and which is not supporting a load
Winch	A hoist drum used in conjunction with a rope for raising and lowering loads.
Work Area Alarm	Permits the operator to define an operating zone by means of any two set points.

4.4 LMI Calibration and Troubleshooting Manual – Greer INSIGHT

Introduction

The GREER INSIGHT System is designed for use as an aid to crane operation. Do not use this system in place of a properly trained operator who is knowledgeable in safety guidelines, crane capacity information, and the crane manufacturer's specifications.

This manual describes the operation of the GREER INSIGHT, (hereinafter referred to as "the system"). Please read, understand, and follow the contents and instructions contained within this manual.

TABLE OF CONTENTS

OVERVIEW AND PREPARATION

The Troubleshooting Manual provides general information and methods for isolating problems that may arise during operation of the system. Most issues may be corrected in the field. However, other problems may require replacement of parts or the return of parts to the factory for servicing. Service personnel should have previous training and experience in the procedure for operation and setup of this system.

A tool kit consisting of wrenches and screwdrivers (flat and Phillips blades) will be required to remove covers and units for inspection. In addition, the following may be required:

- Digital level accurate to 0.1 °
- 150-200 ft. tape measure graduated in 1/10's
- Digital voltmeter (may be required).

Low-cost analog meters are not appropriate since the input impedance of these meters may give false readings. The graphic below provides an outline of the system:

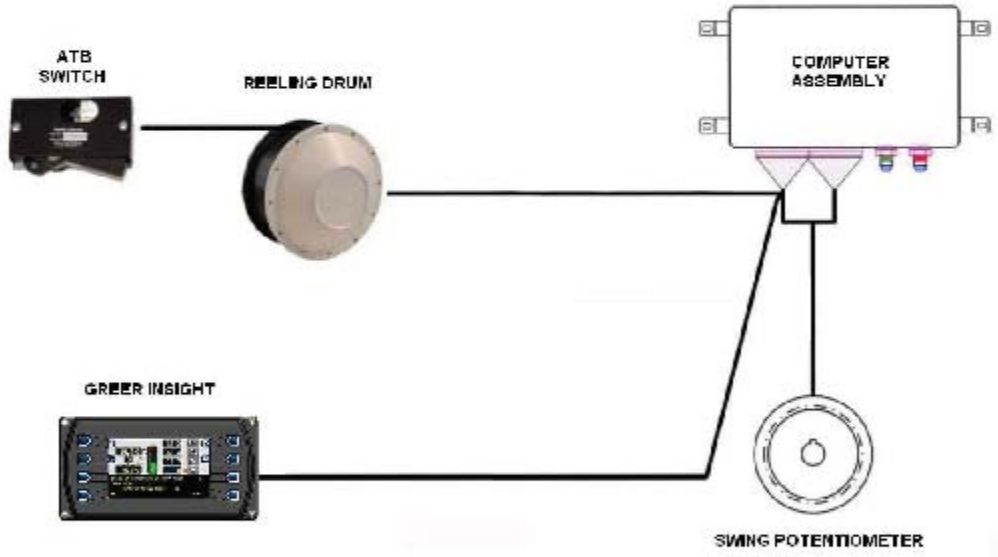


Image 1
System Overview

COMPUTER UNIT OVERVIEW

The COMPUTER UNIT, shown on the following page, is the center of the system. The computer unit provides all necessary functions to read the sensors, control computations, disconnect functions, and communicate with the display console/internal bar graph. The computer unit connects directly to the crane wiring harness via a 60-way bulkhead connector. There are no wiring connections or screw terminals within the unit.

Also contained within the unit, are two hydraulic pressure transducers whose function is to sense pressure within the boom hoist cylinder.

The sensors and the computer are factory pre-calibrated as a unit and, as such, may not be separately replaced in the field.

COMPUTER UNIT LAYOUT

Note: Due to differences in computer unit configurations, the locations of various board components may vary.

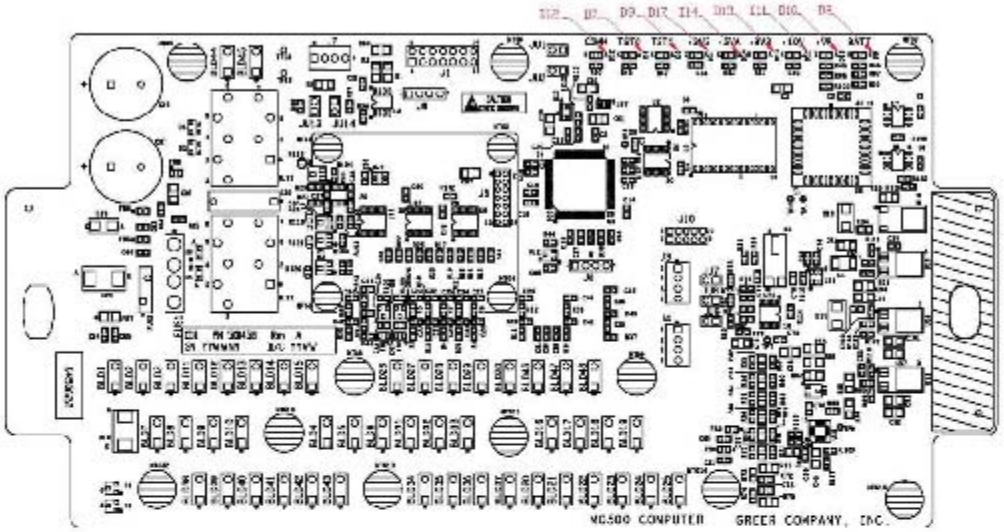


Image 2
Greer MG6500 Blade Style Computer

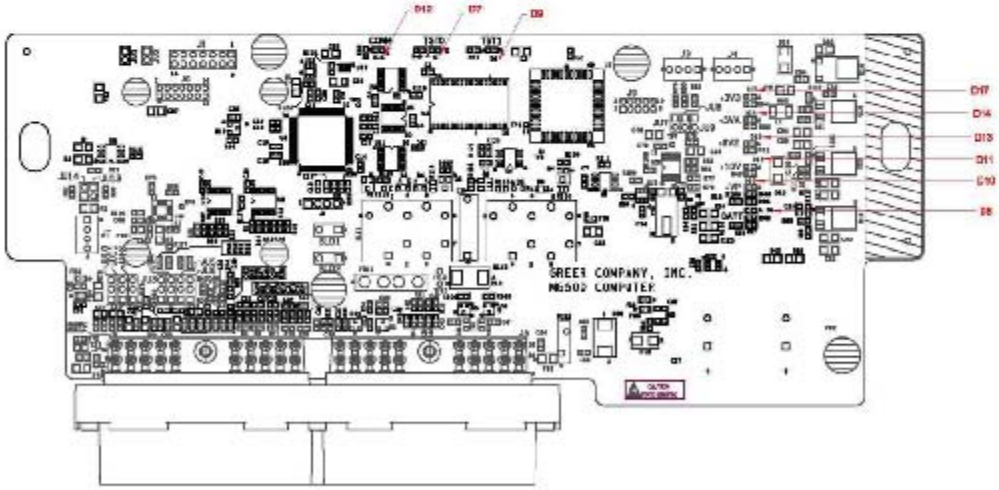


Image 3
Greer MG6500 Metri-Pack Style Computer

COMPUTER INTERNAL STATUS INDICATORS

The computer unit contains 9 indicators that provide an aid to checking presence of power supply voltages and communications between the computer and display console. There are 6 power indicators (D8, D10, D11, D13, D14, AND D17), and three communications indicators (D7, D9, and D12). All indicators are bright green light emitting diodes, (LED's). A missing or dimly lit indicator, with the exception of the communications indicator may indicate a power supply problem.

Note: Different modes and operations may affect the LED's. These instances are outlined below.

1. Normal Operation - All LED's will be lit, with the COMM indicator pulsing.

2. Power up Self Test Mode - All LED's will be lit, with the exception of the COMM indicator.

3. Program Mode - All LED's will be lit, with the exception of the TST0, with the COMM indicator pulsing.

4. If there are any other instances not listed above, it may be necessary to replace the computer unit.

Note: If more than one fault is present, the most serious fault will appear first, and therefore must be resolved first. When the first fault is corrected, other existing faults may be displayed, and must be resolved one at a time until no further fault codes are listed. Fault messages must be reported to the Service Representative including any noticeable damage encountered during system installation or routine checks. Please refer to Routine Checks and Maintenance in this manual.

LED Indicator	Function
D7	Communication Indicator TST0
D8	Battery Power_POS
D9	Communication Indicator TST1
D10	+VP
D11	+10V
D12	COMM (Communication Indicator)
D13	+8V2
D14	+5VA
D17	+3V3

THE COMM INDICATOR

The COMM indicator provides an indication of the success of communication with the display console, and of the running state of the computer program. Carefully observe the COMM indicator and the display console at power up and through self-test; then, use the following chart to help decide the course of action.

COMM INDICATOR Indications at Power ON	ACTION
From the moment the power is applied, the COMM indicators do not illuminate. During and after the self-test period of 6 seconds, the COMM indicators remain off.	The computer is not running. Check status indicators. Try to reset the system by powering off and on again. Listen to the computer for the relays to click. If not successful, replace the computer.
At the moment power is applied, the COMM indicators flash briefly, then switches off. After a few seconds, the COMM indicators start to flash at a fast rate and never stop.	This is the normal operation of the communication between the computer and display console.

COMPUTER UNIT REPLACEABLE PART

The computer unit contains a standard 10 AMP replaceable fuse, which protects the function kickout circuit and relay contacts. The fuse, identified as FUS1 on the computer board, may be replaced in the event system error codes indicate the function kickout power feed is missing or, if it has been established that the crane circuit breaker is closed, and power from the crane is present.

SYSTEM SELF-TEST

When the power is turned on, the computer and operator's display console perform a self-test, which verifies that the computer, display console, cables, and all remote sensors are working properly. During the self test the display will show the expected crane model/load chart number and units of measurement.

Image 4
System Self Test

The display will pause with the message shown below:

Image 5
OSHA Screen

Pressing the button adjacent to the prompt "PRESS TO CONTINUE" will advance the screen.

DISPLAY PROBLEMS

To solve problems using display indications, carefully observe the display at "power on" and through self-test. Use the chart below to help decide the course of action.

Problem	Action
There are no display indications in any of the windows when power is turned on. "No Communi-cations" or another message appears.	Please refer to the section titled "**Computer Internal Status Indicators.**"
The display unit does not cycle through the self test. The data in the display windows appear jumbled, with missing segments.	Replace the display unit.

"NO FAULT CODE" PROBLEMS

This section addresses problems which may not be reported by the computer fault code system.

ANTI TWO-BLOCK ALARM (A2B)

PROBLEM:

- The anti two-block alarm is continuously ON. Operating the switch at the boom head does not deactivate the alarm.

This problem suggests an open circuit between the computer A2B input and the A2B switch(es), or an open circuit between the computer A2B feed and the A2B switch(es).

1. Check extension reel-off cable for damage.
2. Make sure that the Two-Block switches are correctly connected.
3. Check the slip-ring and wiring inside the extension reel.
4. Check the signal cable from the extension reel to the computer.
5. Check connectors.

PROBLEM:

- The anti two-block alarm is continuously OFF (safe). Opening the switch at the boom head, by lifting the A2B weight does not activate the alarm.

This problem suggests a short circuit between the computer A2B input and the computer A2B feed somewhere between the computer and the A2B switch(es).

1. Check extension reel-off cable for damage.
2. Make sure that the two-block switches are correctly connected.
3. Check the slip-ring and wiring inside the extension reel.
4. Check the signal cable from the reel to the computer.
5. Check connectors.

DISPLAYED LOAD OR RADIUS ERRORS

This section gives direction to fault diagnosis of load and radius errors as displayed on the console. Load or radius errors may give rise to early or late tripping of overload alarms. Accuracy of load, radius, length, and angle is determined by the correct installation and maintenance of the system sensors. Accuracy of load measurements are governed by the radius accuracy, and the extension, angle, and pressure sensors. Accuracy of radius measurements (unloaded) are governed by the extension and angle sensors. Before continuing, make sure there are no system faults.

CHECK BOOM EXTENSION

First check that the boom is fully retracted.

1. Check that the extension reel-off cable is correctly layered as a single layer across the extension reel surface. Any stacking of the cable will cause extension errors causing the system to exceed the 0.5 ft. tolerance allowed by the computer for boom mode selection. If the reel-off cable is stacking on the reel, see CHECKING THE REEL-OFF CABLE LAYERING SECTION in this manual.

2. Check the zero of the extension sensor at the fully retracted boom position. Enter the Calibration Mode and use the "ZERO" command. Select sensor No. 2 to view the extension value in feet. The value of extension must be between -0.2 and +0.2, with the boom fully retracted. If the extension value is incorrect, follow the EXTENSION SENSOR SETUP procedure outlined in the Calibration Section of this manual.

3. Fully telescope the boom and check that the displayed boom length value matches the maximum length of the boom. If the length value is incorrect, follow the EXTENSION SPAN procedure located in the Calibration Section of this manual.

CHECK MAIN BOOM RADIUS

1. Fully retract the boom and make sure that the crane configuration is correctly set up.

Note: The required accuracy of taped radius measurements is within 0.1 feet. When taking radius measurements always use a good quality tape that does not stretch. The tape should be graduated in feet and tenths of a foot. Always measure between the swing center of the crane and hook line, using a single part of line with the crane centered over front, (rough terrain), or centered over rear, (truck crane).

2. Boom up to about 45° and measure the radius. The measured radius must match the displayed radius within +/- 0.2 ft. If it does not match, continue to the "CHECK BOOM ANGLE" procedure. If it does match, continue to "CHECK PRESSURE SENSORS."

3. Boom up to a high angle (at least 70°) and measure the angle with the inclinometer. Check that the displayed angle matches the inclinometer reading within 0.2°. If the displayed angle is incorrect, follow the angle span calibration procedure located in the Calibration Section of this manual.

CHECK PRESSURE SENSORS

The Pressure sensing system is pre-calibrated, and as such, pressure sensors may not be individually replaced. Any problems with these sensors will necessitate changing the entire computer unit.

1. Boom down until the boom hoist cylinder is fully retracted and on its stop.
2. Loosen the hydraulic connections to the pressure sensors to verify zero pressure is present.
3. Enter the CALIBRATION MODE and use the "PRESSURE MONITOR" command to view both sensor pressures and nett pressure.
4. Check that the PRESSURE values of both sensors are between -75 and + 75 PSI. If not, replace the computer unit.
5. Check that the NETT pressure is between -35 and +35 PSI. If not, replace the computer unit.

Image 6
Pressure Monitor

PRESSURE SENSORS

There are two pressure sensors installed as part of the Insight System. The sensors are mounted within the computer unit and electrically connected to the computer board. One is connected to the PISTON side of the boom hoist cylinder via a flexible hose; while the other is connected to the ROD side of the boom hoist cylinder via a flexible hose. Both hoses are protected by velocity fuses within the boom hoist cylinder valve block on the end of the cylinder(s).

The pressure sensor, located on the piston side, is subject to the hydraulic pressure needed to support the weight of the boom, any attachments, and the load. The rod side sensor monitors the pressure necessary to control the down motion of the boom. The computer unit uses this information (along with other sensors such as extension, length, and angle), to compute the weight of the suspended load. The maximum continuous working pressure for these devices is 250 bar (3625 PSI).

WARNING!

THE PRESSURE SENSORS ARE FACTORY PRE-CALIBRATED, AND ARE PROVIDED AS A COMPONENT OF THE COMPUTER UNIT. REMOVAL OR REPLACEMENT OF THESE DEVICES FROM THE COMPUTER UNIT INVALIDATES THE WARRANTY AND WILL ADVERSELY AFFECT THE PRESSURE CALIBRATION.

REPLACING THE COMPUTER UNIT

COMPUTER REMOVAL

1. Boom down all of the way so that the boom hoist cylinder is fully retracted, or the boom is firmly in the boom rest.
2. Disconnect hydraulic connections at the computer unit.
3. Note which hose is connected to the piston and rod pressure ports.
4. Disconnect both electrical connectors at the computer unit.
5. Remove the hardware mounting the computer to the cab wall.

WARNING!

THE HYDRAULIC HOSES CONNECT DIRECTLY TO THE BOOM HOIST CYLINDER. DO NOT OPERATE THE CRANE UNLESS THE COMPUTER HAS BEEN PROPERLY REPLACED, OR THE HYDRAULIC CONNECTIONS ARE PROPERLY CAPPED.

COMPUTER INSTALLATION

1. Secure the computer unit to the cab wall with the mounting hardware.
2. Ensure that the electrical connections are facing downward.
3. Remove two protective covers from the electrical bulkhead connector.
4. Connect the electrical connectors.
5. Remove the protective caps from the hydraulic ports.
6. Connect the base-side pressure hose to the piston pressure port.
7. Connect the rod-side pressure hose to the rod pressure port.

DISPLAY CONSOLE OVERVIEW

The operator's display console (Image 7) allows the user to see the crane values and crane configuration selection. The display also provides calibration functions used for testing and fault diagnosis.

Image 7
Operator's Display Console

CHECKING THE DISPLAY CONSOLE

It is important to note that the operator's display console may become damaged. The damage is not always apparent. To help identify subtle faults that are sometimes difficult to find, please review the possible causes listed throughout this section.

VIEWING THE DISPLAY

The display may be repositioned to reduce reflections on gimbal bracket mounted models only.

UNRESPONSIVE BUTTONS

Please replace any display with worn buttons. Note that all button options are not available for use at all times. Refer to OPERATOR's DISPLAY CONSOLE - REMOVAL AND INSTALLATION.

CONNECTORS

There are four 6-pin Deutsch connector plugs located on the rear of the Greer Insight. The connector plugs are plugged into ports C and B illustrated below.

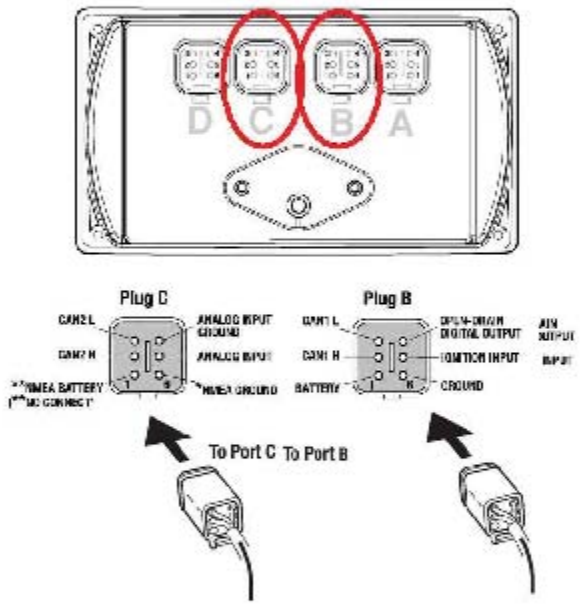


Image 8
Deutsch Connector Plug

HORN

Ensure the horn is connected to the wiring harness via the two pin Deutsch connector shown below.

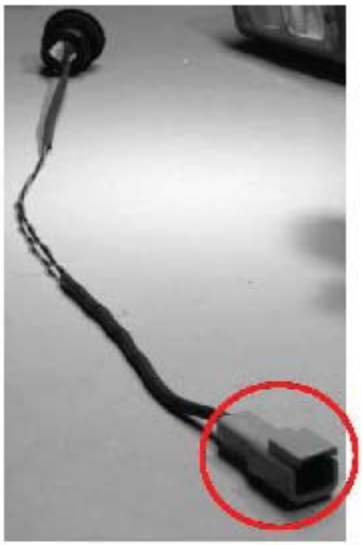


Image 9
Two-Pin Deutsch Connector

MOISTURE

The DISPLAY CONSOLE conforms to IP67 in protection against dust and water.

REPLACING THE DISPLAY CONSOLE

REMOVAL

1. Disconnect the electrical cable from the electrical connector on the rear of the operator's display console.
2. Remove the knob on each side of the console, and retain for future use.
3. Now, remove the display console from the bracket in the cab.

INSTALLATION

1. Put the operator's display console on the bracket located in the cab by positioning it between the bracket legs.
2. Next, insert and tighten the knob on each side of the console.
3. Connect the electrical cable to the electrical connector on the rear of the console.

ENTERING THE CALIBRATION MODE

Note: The Greer Insight display is designed for use as an aid to crane operation. Use this system with an operator who is properly trained in Safety Guidelines, crane capacity information, and the crane manufacturer's specifications.

REASONS TO CALIBRATE

When the computer is new, it is necessary to set "Zero" and "Span" points. In order to do this, the system must be put into a "Calibration" mode and the "Zero" and "Span" settings must be entered.

TOOLS NEEDED:

- Digital level accurate to 0.1 °
- 150 - 200 ft. tape measure graduated in tenths.
- Digital voltmeter

PRE-REQUISITES FOR CALIBRATION

Note: The steps listed below, must be followed to ensure proper Calibration of the Insight unit. The actual crane setup must be reflected on the display. Please check the Greer Insight Operator's manual for proper setup of the display unit.

- The unit must be properly set up on level ground as per the crane manufacturer's specifications.
- Maximum boom height will be needed. Therefore, it is necessary that the area be clear of overhead obstructions.
- All options such as jibs, flies, and auxiliary heads must be configured in the computer.

CALIBRATION STEPS

1. To enter Calibration mode, the display must be in "Normal Operating" mode as shown below.

Image 10
Entering Calibration Mode

2. Press and hold the Information key as well as the Alarm key simultaneously until the display prompts for the correct key sequence.

3. Enter Calibration key sequence, sometimes referred to as the Security Code within 5 seconds. (1) Upper Left , (2) Lower Right, (3) Lower Left, then (4) Upper Right. This sequence must be completed within 5 seconds or the system will revert back to the "Normal Operating" mode.

Image 11
Calibration Key Sequence

USING CALIBRATION MENUS

When the key sequence has been entered, the display will present a menu screen as shown in Image 12. The primary menu items used to calibrate the system are:

- 02 Zero Sensors
- 03 Span Sensors
- 04 Swing Potentiometer

Image 12
Calibration Menus

Menu items can be found by pressing the menu up or menu down buttons. To select an item, press the key adjacent to the menu listing as shown in the example.

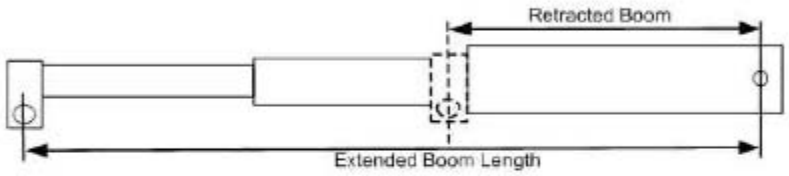
Note: The boom must be completely collapsed in order for the zero point to be accurate on the display.

USING CALIBRATION MENUS (CONTINUED),

The only calibration required is to communicate to the computer where the point zero point is for the Boom Extension Function (Sensor #2), and Boom Angle Function (Sensor #3).

The system is also equipped with a Swing Potentiometer which is designed to track the movement of the turret in relation to the chassis. Setup of this function is performed using Menu #4, Swing Potentiometer.

A value must be given to the boom extension, and boom angle functions in order for the Span of the function (or the futhermost point) to calculate to. These numbers are determined by using a digital level on the Boom Angle, and a tape measurement of the Boom Length for Span, (See Below).



Extended Length – Retracted Length = Span

Image 13
Extended Length - Retracted Length = Span

CALIBRATING EXTENSION ZERO ("0")

1. Position crane boom into the fully retracted position, and set boom angle to "0.0" while using a digital level.
2. Remove the cover from the reeling drum exposing the sensor plate, and locate the extension sensor.
3. Rotate the extension sensor gear clockwise until the clutch drags/ clicks, then rotate the gear counterclockwise 1/2 turn.
4. The voltage reading between the blue wire (Dr-) and the white wire (Ext. Signal) on the terminal block should measure about .25 to .35 volts. Rotate the gear to attain proper voltage reading.

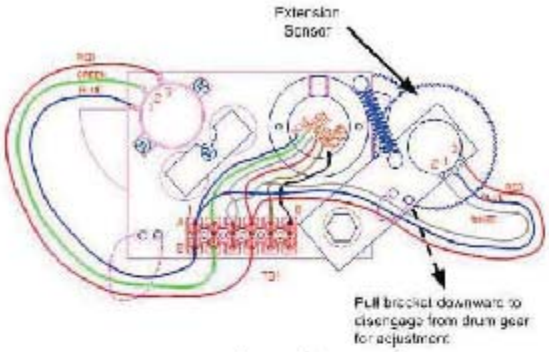
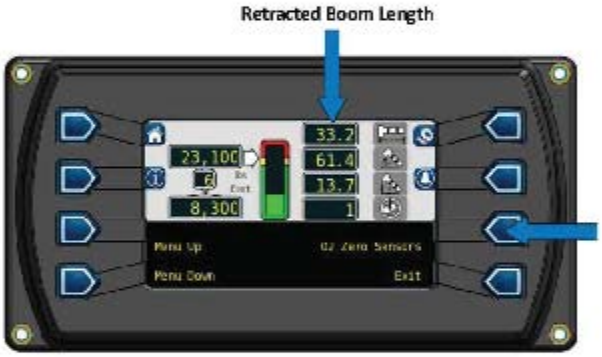


Image 14
Reeling Drum Components

Note: This voltage signal is used to indicate a problem. For example, if the ATB cable should break and the sensor suddenly hits the zero voltage position, then the clutch would prevent damage to the sensor potentiometer.



With the boom fully retracted and the unit in calibration, please do the following:

5. Press the Menu Up button until 02 Zero Sensors is reached.
6. Press the upper right button one time and the screen should appear as the screen above.
7. Pressing the button adjacent to the "Zero No. 2 =" will cause the system to verify the intentions of the user with a question, "Calibrate Yes?" pressing the button a second time will calibrate the zero.
8. The display will then read Zero No. 2 = "0". The retracted boom length will be displayed in the boom length window.
9. Calibration of Extension is complete.

ZEROING ANGLE SENSOR ("0")

Prior to leaving the factory, angle sensors are preset to "0.0" on the Potentiometer. The Potentiometer has limited travel, and as such, if the potentiometer has been disturbed the "0.0" setting could be affected and will not span properly.

If it is determined that the factory setting has been disturbed, it can be re-established by loosening the attaching screws and rotating the pot until the desired voltage reading is attained.

Alternatively, this situation may be avoided by elevating the boom to "0.0" degrees (verified by using a digital level) then check the voltage between the blue wire (DR-) and the green wire (Angle Output). The digital voltmeter should indicate between .475 and .500 volts in the correct position.

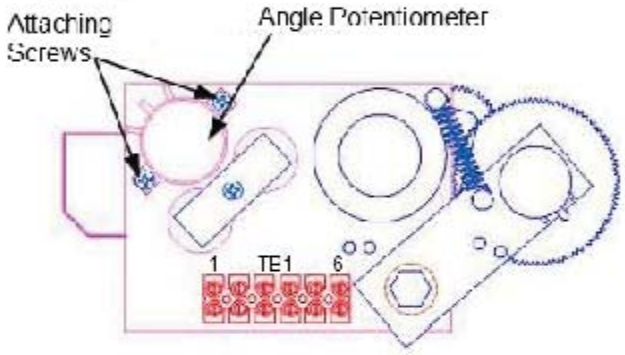


Image 15
Zeroing the Angle Sensor

CALIBRATING EXTENSION ZERO CONCLUSION

1. Verify that the digital level is reading "0.0".

Note: Pressing the upper right button twice will cause "ZERO NO. 3 =" to read "0".

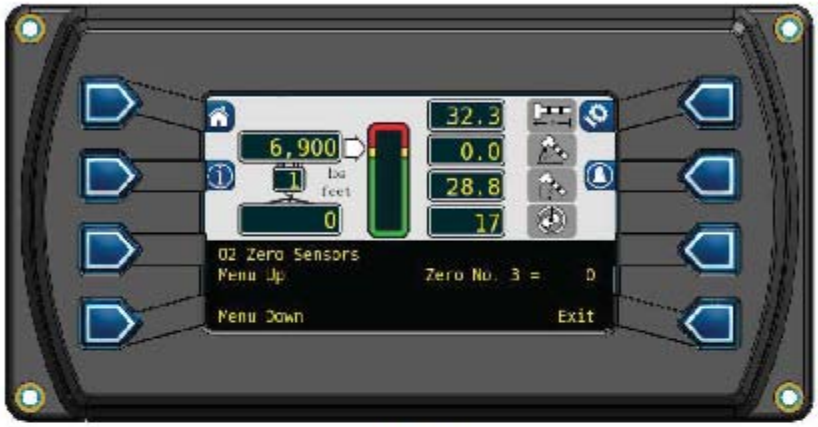


Image 16
02 Zero Sensors Zero No. 3

2. This completes the Zero No. 3 routine. Both the calibration screen and the boom angle window should read "0".

3. Press the button adjacent to the "Exit" prompt to move back to the "02 Zero Sensors" menu in preparation for the Spanning routine.

CALIBRATING SPAN OF EXTENSION AND ANGLE

CAUTION!

THE AREA MUST BE CLEAR OF OVERHEAD OBSTRUCTIONS OR POWER LINES PRIOR TO BEGINNING THE FOLLOWING OPERATION.

In order for the system to properly calculate the boom length and the boom angle, the "Span Number" must be entered into the system's memory. The Span Number is easily obtained by following these steps:

1. Elevate the boom to 60+ degrees of elevation and read the Angle Span number from the digital level.

2. Now, note the angle number from the digital level, and enter it into the computer.

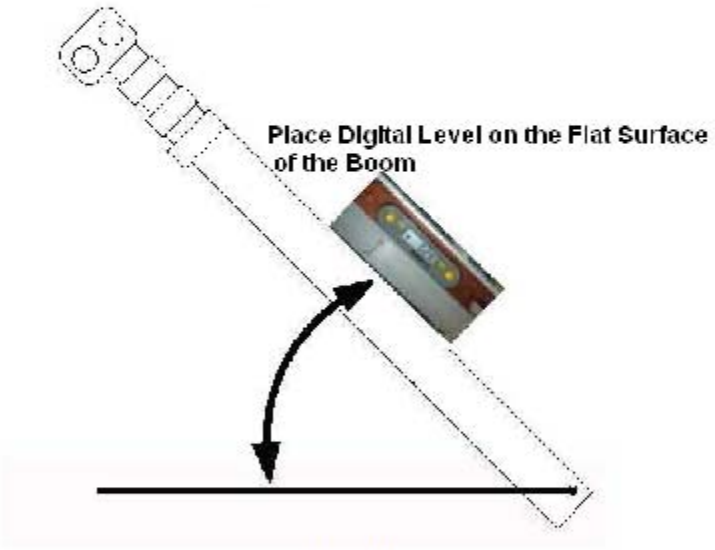
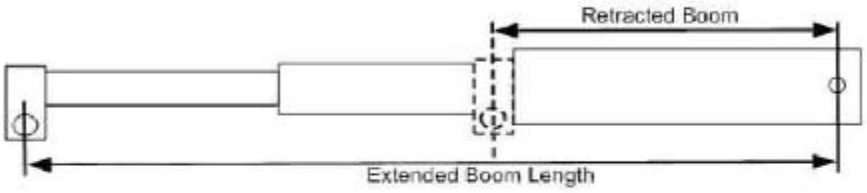


Image 17
Calibrating Span of Extension and Angle

CALIBRATING SPAN OF EXTENSION

In order for the system to properly calculate the boom length and the boom angle, the "Span Number" must be entered into the system's memory. The Span Number is easily obtained by following these steps:

1. Get the extension number by measuring the boom from base foot pin to the center of the head sheave pin, or by taking measurements from the load the chart. The formula to obtain this value is shown below:



Extended Length – Retracted Length = Span

Image 18
Extended Length - Retracted Length = Span

CALIBRATING SPAN OF EXTENSION (CONTINUED),

In order to calculate the Extension Span, the boom must be elevated and extended to maximum extension. By having the digital level in place, extension and angle span numbers may be entered by advancing the display screen.

From the main menu screen, press the menu up button until 03 "Span Sensors" is reached. Pressing the upper right button will cause the system to default to "Span No. 2 = X.X".

Image 19
03 Span Sensors Menu

With the boom fully extended, press the upper right key. The system will verify the intentions of the user with a question, Yes! Calibrate or No, Exit/ Abort. Selecting Yes! Calibrate will allow the user to enter the 03 Span Sensors screen, and enter the angle span number.

CALIBRATING SPAN OF EXTENSION WHILE USING THE NUMBER ENTRY SCREEN

The 03 Span Sensors Enter Sensor Span number entry screen is where all the numbers previously collected for angle and extension span are entered.
(Note: These numbers should always be entered with a decimal point).

The lower left keys are used to select the number needed. The upper left button is used to enter the number into the brackets allowing the user to enter each number one at a time.

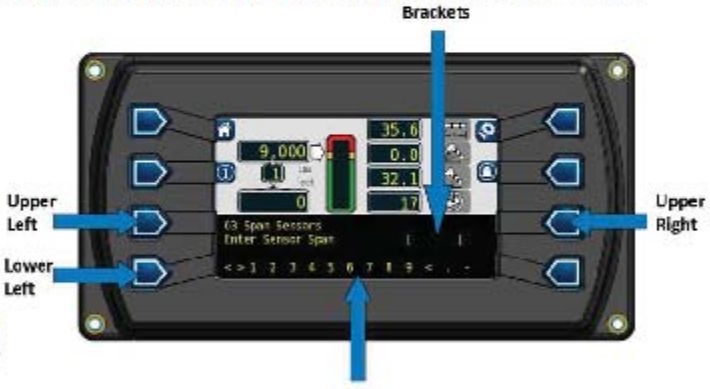


Image 20
03 Span Sensors Enter Sensor Span Number

Pressing the upper right key will enter the bracketed number into the system's memory, and set the span. Once the extension span number is entered, the maximum length of the boom will be shown in the boom length window.

CALIBRATING SWING POTENTIOMETER

When the spanning of the extension and angle are completed, it will be necessary to exit back to the main calibration screen. This may be accomplished by pressing the menu down button until "00 Error Codes" is reached. From here, menu up to Menu 4 Swing Potentiometer menu. This menu will allow a "0" point to be set on the swing circle, and a direction for the system to track the rotation angle.

The swing must be in the stowed position, and the house lock must be engaged to prevent movement. Inaccuracy in the swing "0" setting may result in loss of load chart for pick and carry.

Pressing the upper right hand button as shown will allow the user to enter the "Swing Zero" command.

With the swing locked down as described, pressing the upper right button will allow the "0" to be installed into the computer memory.

Image 21
Swing Zero Command

SWING SENSOR SETUP AND CHECKS

The following procedures may be used to check or setup the SWING SENSOR. Only two setup operations are required (ZERO and DIRECTION). Unlike other system sensors, the swing sensor requires no span calibration to operate. Span is automatically calculated by the computer.

CHECKING AND SETTING ZERO

1. The 0° (zero) angle of the upper structure should be set with the house-lock engaged over front for all types of cranes.
2. Before continuing, ensure that the upper structure is positioned over FRONT and the house-lock is engaged.
3. Enter the CALIBRATION MODE at the display console. (Refer to Calibration Mode Entry).
4. Select Command 07, SWING SENSOR. Check that the angle value displayed is between -0.5° and + 0.5°. If not, reset the zero by pressing the zero key.

CHECKING AND SETTING DIRECTION

1. Enter the CALIBRATION MODE at the display console.(Refer to Calibration Mode Entry).
2. Select Command 04, SWING SENSOR.
3. Remove the house-lock and swing to the right.
4. Check that the angle value displayed increases from zero. If not, the displayed value will immediately jump to over 350° and continue counting down as the crane upper is swung to the right.
5. If this is the case, press the direction key to reverse the calibrated direction of the sensor.

AFTER THE CALIBRATION ROUTINE

When the calibration routine is complete, it is a good practice to thoroughly test the unit to ensure the radius on the unit is accurate to within ± .5 of a foot. In order to perform load testing, a known weight is necessary, and testing should be performed at two or three different boom angles, as well as extensions. The load must be within ± 10% when testing. If there is a discrepancy, the calibration should be re-checked for accuracy.

EXTENSION REEL OVERVIEW

The primary operation of the EXTENSION REEL is to measure the extension of the telescoping sections of the main boom. The extension reel also includes an angle sensor to measure the main boom angle, and an electrical slip-ring which transfers the two-block signal from the extension reel cable to the system computer.

The extension reel is designed to provide a very accurate measurement of extension and angle. It is important that the setup and maintenance of these devices be properly carried out as per the procedures contained within this manual. Incorrect maintenance will result in system calculation errors.

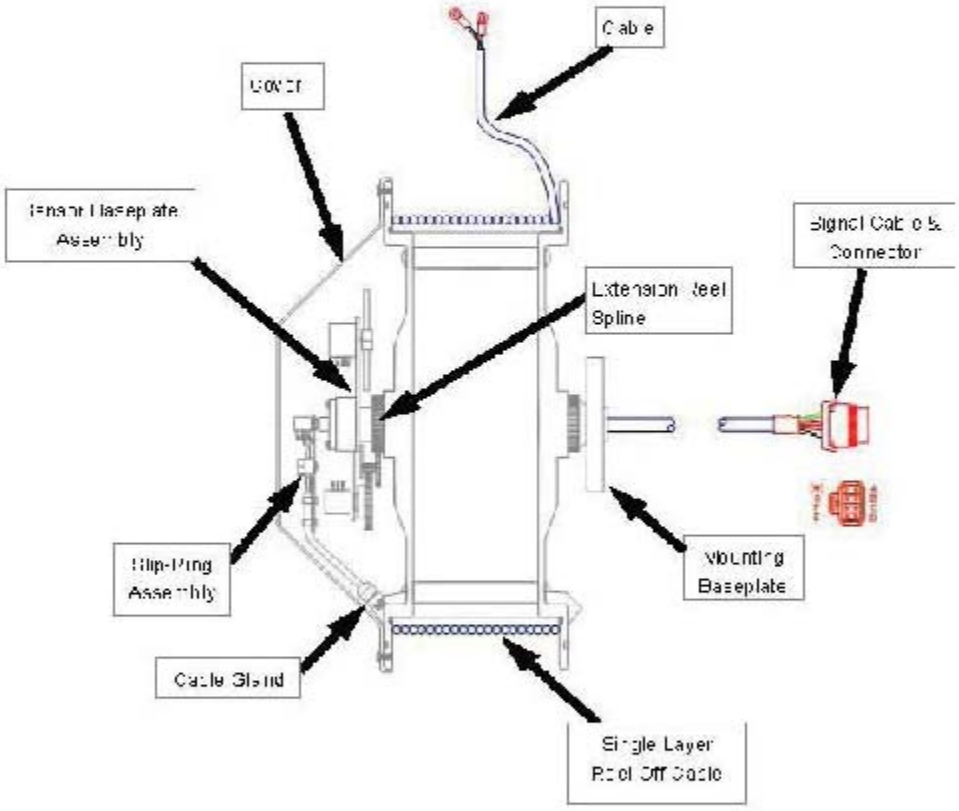


Image 22
Extension Reel Cut-Away

CHECKING THE REEL-OFF CABLE LAYERING

The extension reel is designed to provide accurate measurement of boom extension when the REEL-OFF CABLE forms a single flat layer across the surface of the extension reel as the boom is telescoped in and out. Any stacking of the cable will cause extension errors as the boom retracts.

1. Telescope the boom fully out and then fully in.

2. Check that the reel-off cable forms a flat single layer across the surface of the extension reel, with each successive turn of cable laying next to the last.

Note: If any noticeable stacking or build up of the cable occurs, verify that the first cable guide at the top of the boom root section is correctly aligned with the outside edge of the extension reel. Clean the reel-off cable and lubricate it with a silicone oil, as shown in Image 23 below.

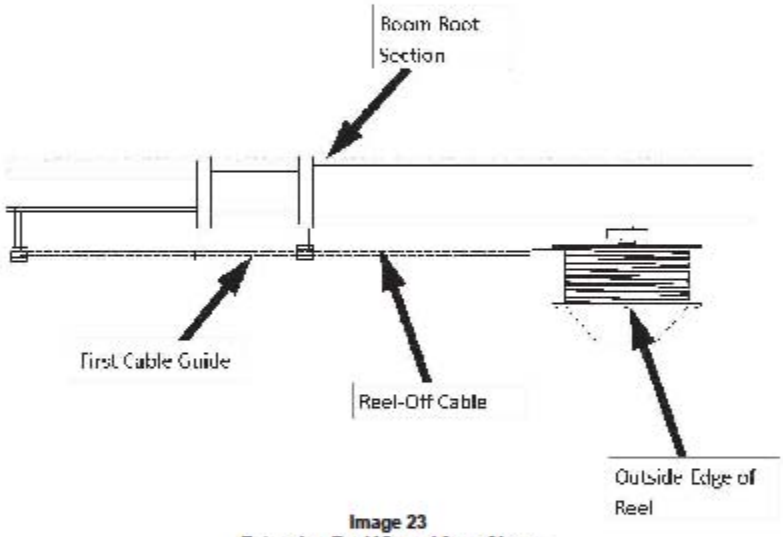


Image 23
Extension Reel Viewed from Above

SENSOR BASEPLATE ASSEMBLY

The SENSOR BASEPLATE ASSEMBLY supports both the extension and angle sensors and provides interconnection between the sensors, the two-block switch signal to the slip-ring, and the signal cable to the system computer.

Electrical or mechanical failure of either the angle sensor or the extension sensor potentiometers may not be field-repaired, since the angle sensor pendulum is factory set on the potentiometer shaft, and the extension potentiometer gear contains a protection clutch which is difficult to replace in the field. In the event of failure of either of these items the entire sensor baseplate assembly must be replaced.

The terminal block (TB1), mounted on the assembly, provides wiring connection for all internal parts of the extension reel and the signal cable connecting the reel to the system computer. Most electrical diagnoses of the boom sensors may be made at this terminal block.

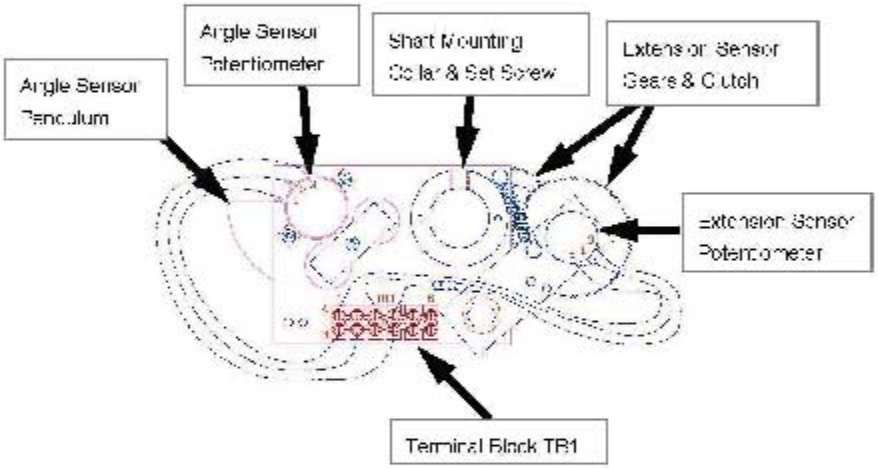


Image 24
Sensor Baseplate Assembly

ANTI TWO-BLOCK FUNCTION OVERVIEW

This section describes fault diagnoses of the anti two-block, (A2B) detection circuit. The computer supplies a protected positive feed to the A2B switches at the boom/jib head via the extension reel signal cable, slip-ring, and extension reel-off cable. With the A2B weight hanging freely on the switch(es), the switch contact is closed and the signal return to the computer is high (6.25 volts). When the weight is lifted by the hook block, the switch contact is opened, and the computer will sense a low signal input (0 volts) from the A2B signal return.

Since the computer checks the protected feed voltage internally, the system is capable of detecting a short circuit of the feed (or the A2B signal return when the switch is closed) to the crane chassis.

The A2B detection circuit is probably the most susceptible part of the system, since it is carried through so many of the system components. Often, most problems with this circuit may be identified through inspection of cables, switches, and the extension reel. Damage to these parts may result in continuous or intermittent A2B alarms.

CHECKING THE EXTENSION REEL-OFF CABLE

The outer braid of the cable carries the anti two-block feed to the switches. If the cable sheath is damaged, this may cause a short circuit to the boom/chassis. If this is the case, a fault code of "B 8" will be indicated. The same fault code will be indicated if the A2B switch is closed and the inner core of the cable is shorted to chassis at some point in the wiring.

1. Carefully inspect the reel-off cable for wear.
2. Check for signs of damage to the outer sheath of the cable.
3. Check for any signs of severe "kinking" or crushing of the cable.

CHECKING THE ANTI TWO-BLOCK CIRCUIT

Before continuing, ensure that connectors are correctly connected to the A2B switches at the boom head/jib.

1. Remove the extension reel cover.
2. Disconnect the slip-ring arm from the plug by pulling it away from the center of the reel.
3. Close the A2B switch at the boom head by suspending the weight from it or pulling on the chain.
4. Measure the resistance between TB2-1 & TB2-2 terminal connections on the sensor arm.
5. With the A2B switch closed, the resistance should be less than 300 ohms. If not, this suggests that the reel-off cable, A2B switch, or one of the boom head connectors has an open circuit.
6. Open the A2B switch at the boom head by lifting the weight.
7. Measure the resistance between TB2-1 & TB2-2 terminal connections on the sensor arm.
8. With the A2B switch open, the resistance should be greater than 10,000 ohms. If not, this suggests that the reel-off cable, A2B switch, or one of the boom head connectors has a short circuit.

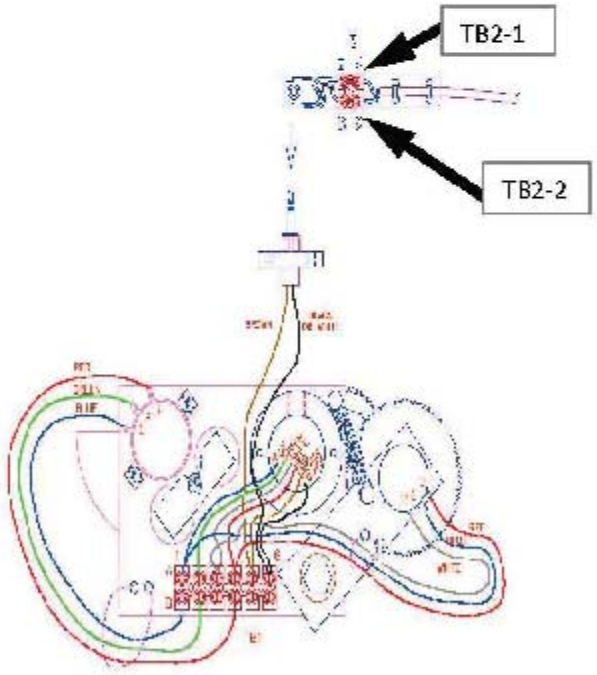


Image 25
Sensor Assembly Wiring and Slip-Ring

SWING SENSOR OVERVIEW

The SWING SENSOR measures the angle of the upper structure of the crane relative to its carrier. This angle is then used to select capacity charts and operator swing alarms and working area alarms. In the event that the swing sensor fails, the computer will be unable to select a valid capacity chart. For fault diagnosis, the swing sensor may be accessed by removing the cover of the collector at the cranes swing center. See Image 26 below. For swing sensor replacement procedures, consult factory service.

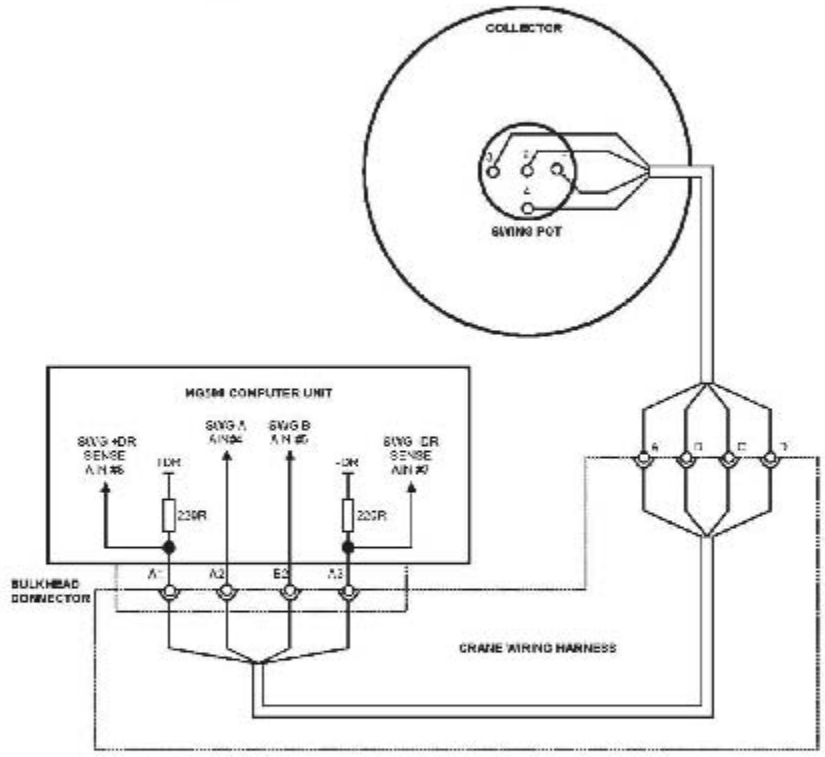


Image 26
Swing Sensor Schematic

CHECKING THE SWING SENSOR DRIVE VOLTAGE

1. Remove the collector ring cover to expose the swing sensor.
2. With the system power turned on, measure the voltage between terminal one of the swing sensor and crane ground. The voltage should be between 4.4 and 4.8 volts.
3. Measure the voltage between terminal 3 of the swing sensor and crane ground. The voltage should be between 0.2 and 0.5 volts.

Voltages outside of those shown in steps 2 and 3 indicate a problem with the swing sensor or cabling connections. If voltages are incorrect, proceed to the following section.

CHECKING THE SWING SENSOR OUTPUT VOLTAGE

1. Remove the collector ring cover to expose the swing sensor.
2. With the system power turned on, measure the voltage between terminal two of the swing sensor and crane ground. The voltage should be between 0.2 and 4.8 volts.
3. Measure the voltage between terminal four of the swing sensor and crane ground. The voltage should be between 0.2 and 4.8 volts.

Voltages outside of those shown in Steps 2 and 3 indicate a problem with the swing sensor or cabling connections. If voltages are incorrect, proceed to the following section.

CHECKING THE SWING SENSOR RESISTANCE

1. Disconnect the connector (behind the collector ring).
2. Measure the resistance between pins C and D of the connector on the swing sensor side. The resistance should be between 2200 and 2800 ohms.
3. Measure the resistance between pins A and B of the connector on the swing sensor side. The resistance should be between 1800 and 2300 ohms.

Note: Resistances outside of those shown in Steps 2 and 3 indicate a problem with the swing sensor or associated cable connections. If resistances are incorrect, replace the swing sensor and its cable.

ERROR REPORTING AND ERROR CODES

System error codes provide ways to locate and assess problems within the Insight system. Each time the system is turned on, it goes through a self-testing process lasting approximately 6 seconds. This process automatically detects most errors in the system. Many fault conditions are detected without a system self-test.

Errors detected in the system during the self-test, are indicated on the display console in the following ways:

- "WARNING SYSTEM FAULT!" will be displayed at the bottom of the text window.

Error codes may be displayed on the console. To view the codes, press and hold the (i) button as shown below.

Image 27
00 Error Codes

There are four groups of ERROR CODES: A,B,C & D. The function of these groups and a complete listing of each code is provided on the following pages.

Note: It is important to always investigate Errors in the "B" and "C" groups before continuing with "A" and "D" group errors.

GROUP "A" FAULT CODES

Note: Group "A" fault codes represent faults detected for analog sensors. Check and repair "B" and "C" group faults before proceeding with group "A" fault finding sensors.

The following chart details the available codes in the left column and the actions to take in the right column.

FAULT CODE	Swing Sensor	Boom Angle Sensor	Extension Sensor	Tdx 1 Rod Pressure	Tdx 0 Piston Pressure	ACTION
000	No	Fault	Found			None
001					X	Replace Computer
002				X		
003				X	X	
004			X			Refer to the Extension Calibration Instructions in this manual
008		X				Please refer to the Angle Sensor Section in the Calibration Section of this manual
012		X	X			Please refer to the Extension, Angle, and Extension Reel in the Calibration Section of this manual
016	X					Please refer to the "Calibrating Swing Potentiometer" Section of this manual

Table 1
Group A Fault Codes

GROUP "B" FAULT CODES

Note: Group "B" fault codes represent faults detected for internal analog functions and power feeds which go to the function kickout and anti-two block switches.

The following chart details the available codes in the left column and the actions to take in the right column.

FAULT CODE	FKO Power Feed	A2B Power Feed	Display Console	ADC 2 Internal Fault	ADC 1 Internal Fault	ACTION
016	X					Check Crane Circuit Breakers.

Table 2
Group B Fault Codes

GROUP "C" FAULT CODES

Note: Group "C" fault codes represent faults detected for internal computer memories.

The following chart details the available codes in the left column and the actions to take in the right column.

FAULT CODE	Serial EEPROM	Crane Data	RAN	Duty Data	Program	ACTION
000	No Fault Found					None
008		X				Erase Crane Data
016	X					Replace Computer

Table 3
Group C Fault Codes

GROUP "D" FAULT CODES

Note: Group "D" fault codes represent faults detected for capacity and chart selection.

The following chart details the available codes in the left column and the actions to take in the right column.

FAULT CODE	WRONG SWING AREA	WRONG BOOM LENGTH	CHART NOT FOUND	ACTION
000	No Fault Found			NONE
001			X	Re-select CRANE SETUP. Check other sensor faults first.
002		X		Boom length is out of range for selected chart. Check crane setup, boom length and extension
003		X	X	Re-select CRANE SETUP. Check other sensor faults first.
004	X			Swing to correct working area to select chart. Check swing sensor zero position.
005	X		X	Swing to correct working area to select chart. Check swing sensor zero position.
006	X	X		Re-select CRANE SETUP. Check other sensor faults first.
007	X	X	X	Re-select CRANE SETUP. Check other sensor faults first.

Table 4
Group D Fault Codes

4.5 Radio Remote Controls – Omnex Operator's Manual

OMNEX
TRUSTED WIRELESS

Elliott LMI Interface

Installation / Configuration Manual

T2300 Transmitter

R2170 Receiver

D160 Expansion Module

D180 Expansion Module

October 7, 2008

Revision 2

DM-R2170-0002A

#74-1833 Coast Meridian Road, Port Coquitlam, BC, Canada • V3C 6G5
Ph# (604) 944-9247 • Fax# (604) 944-9267
Toll Free 1-800-663-8806

Table of Contents

***NOTE:** These instructions are intended only for installing and operating the remote control equipment described here. This is not a complete Operator's Manual. For complete operating instructions, please read the Operator's Manual appropriate for your particular machine.*

Safety Precautions

READ ALL INSTRUCTIONS

CAUTION: Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Failure to follow the SAFETY PRECAUTIONS may result in radio equipment failure and serious personal injury

Installation

PROVIDE A SAFETY CUTOFF SWITCH. If maintenance is required, the radio must be disconnected from power

USE PROPER WIRING. Loose or frayed wires can cause system failure, intermittent operation, machine damage, etc.

DO NOT INSTALL IN HOT AREAS. This apparatus can be damaged by heat in excess of 158°F (70°C)

Personal Safety

MAKE SURE MACHINERY AND SURROUNDING AREA IS CLEAR BEFORE OPERATING. Do not activate the remote system unless it is safe to do so.

TURN OFF THE RECEIVER POWER BEFORE WORKING ON MACHINERY. Always disconnect the remote system before doing any maintenance to prevent accidental operation of the machine

Care

KEEP DRY. Do not clean the transmitter / receiver under high pressure. If water or other liquids get inside the transmitter battery or receiver compartment, immediately dry the unit. Remove the case and let the unit air dry

CLEAN THE UNIT AFTER OPERATION. Remove any mud, dirt, concrete, etc. from the unit to prevent clogging of buttons, switches, etc. by using a damp cloth.

Maintenance / Welding

DISCONNECT THE RADIO RECEIVER BEFORE WELDING on the machine the receiver is connected to. Failure to disconnect will result in the destruction of the radio receiver.

System Overview

The **ORIGA** T2300 / R2170 / D180 / D160 is a portable, long range, programmable radio remote control system. Designed as a compact and easy-to-use product, this member of the **ORIGA** family puts complete control of your crane where it's needed most, with the operator. It's robust, easy to install and has complete self-diagnostics. This system can be a simple cable replacement or add intelligence to make it a total control package. It's a radio, a PLC and a valve driver all in one.

The **ORIGA** T2300 / R2170 / D180 / D160 system uses Frequency Hopping Spread Spectrum (FHSS) technology. FHSS devices concentrate their full power into a very narrow signal that randomly hops from frequency to frequency within a designated band. This transmission pattern, along with CRC-16 error-checking techniques, enables signals to overcome interference that commonly affects licensed radios.

The R2170 receiver is designed to be powered from a 12VDC or 24VDC system. The R2170 is a radio receiver that takes commands from an OMNEX wireless transmitter and translates the commands into CANbus or 485 protocol messages. The R2170 receiver may also be configured as a CANbus bridge.

The D180 Expansion Unit has up to fourteen current-control, PWM, or voltage outputs, or a combination of these types.

The D160 Expansion Unit has up to nineteen digital I/O channels, four of which may be configured as proportional PWM or voltage output signals.

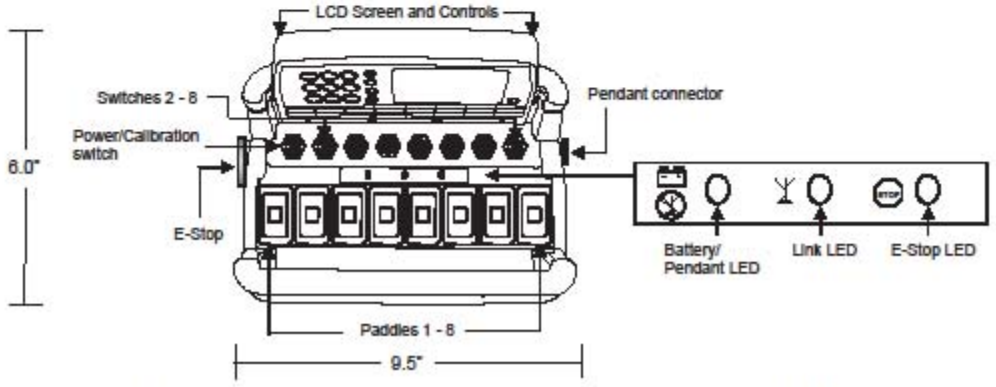
The T2300 transmitter comes with up to sixteen proportional and sixteen digital controls. The T2300 can accommodate up to eight single axis paddles, eight three-position switches and a re-settable E-Stop. A unique ID code is used by each T2300 to ensure that no two systems will conflict on a job site.

Features

- FCC, ISC, CE approved
- License free
- 900 foot range @ 2.4 GHz
- Compact / weatherproof / ergonomic
- Simple "wire-and-use" installation
- Resilient to impact and shock
- Available with paddles and/or joysticks for proportional control
- Available with an optional pendant cable
- Factory configurable for all custom applications.

T2300 Transmitter

T2300 Dimensions and Controls

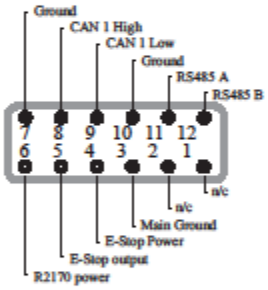


R2170 Pin Assignments

There are two connectors on the R2170. Connector A is Grey, while Connector B is Black. Normally, OMNEX will provide you with the appropriate pre-terminated cables for connection to the R2170. For reference, the pin functions for both connectors are provided below:

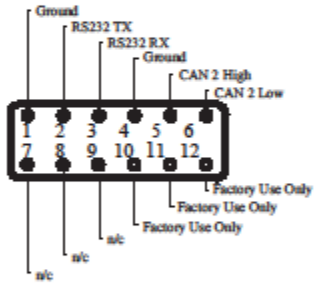
Connector A (Grey)

Pin	Function
1	n/c
2	n/c
3	Main Ground Connection
4	Power in to E-Stop Relay (internally fused to 7.5A)
5	Output of E-Stop Relay
6	Positive Battery supply for R2170 Electronics
7	Ground
8	CAN 1 High
9	CAN 1 Low
10	Ground
11	RS485 A (for Wired Remotes)
12	RS485 B (for Wired Remotes)

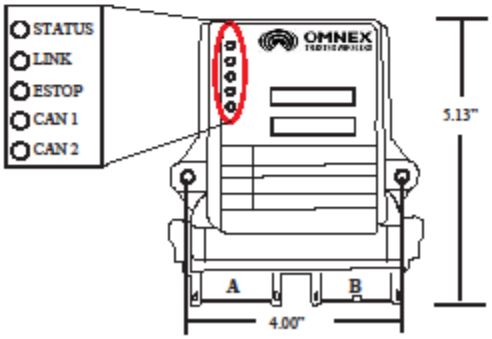


Connector B (Black)

Pin	Function
1	Ground
2	RS232 TX (for serial configuration menus)
3	RS232 RX (for serial configuration menus)
4	Ground
5	CAN 2 High
6	CAN 2 Low
7	n/c
8	n/c
9	n/c
10	Factory Use Only
11	Factory Use Only
12	Factory Use Only



R2170 Dimensions and Status Indicators



The (Status) light is GREEN when in normal operating mode.

The (Link) light flashes GREEN to indicate a signal is being received from an OMNEX transmitter.

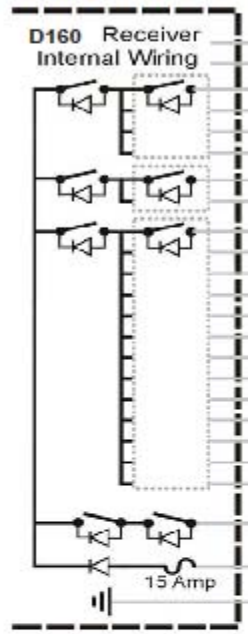
The (E-Stop) light is RED when the Emergency-Stop relay is open and GREEN when the relay is closed (a valid radio link is received by the R2170).

The (CAN 1) and (CAN 2) lights indicate when the respective CAN ports are active.

Installing the D160 Expansion Module for T2300-000201

Use the **Wiring Diagram** and the **Connector Diagram** below to connect the receiver pins directly to the appropriate contacts of the machine electronics. D160 Output Cables can be provided with every system to simplify the wiring process. The Wire Color column below only applies to the OMNEX Output Cable configuration. Tips on mounting, power connections and filtering are also provided under **Installation Considerations**.

Wiring Diagram



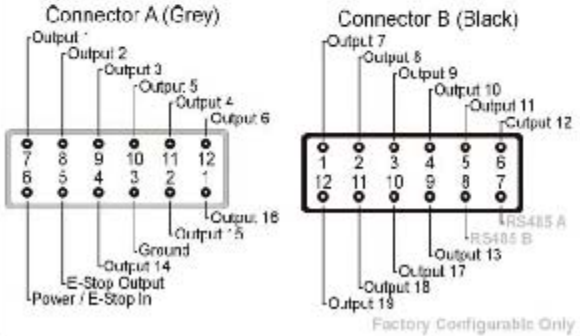
Pin-Output	Wire Colors	Functions
B7		Factory Configurable Only
B8		Factory Configurable Only
B12 - 19	Black/Red	TOOL CIRCUIT ON (Momentary Digital Output)
B11 - 18	White/Black	POLE GRAB CLOSE (Momentary Digital Output)
B10 - 17	Blue/White	POLE GRAB OPEN (Momentary Digital Output)
A1 - 16	Blue/Black	AUGER LATCH CLOSE (Momentary Digital Output)
A2 - 15	Black/White	AUGER LATCH OPEN (Momentary Digital Output)
A4 - 14	Green/Black	ENGINE SPEED LOW (Momentary Digital Output)
B9 - 13	Red/White	HYD. ENABLE (On while any paddle is activated)
B6 - 12	Orange	ENGINE SPEED HIGH (Momentary Digital Output)
B5 - 11	White	Unused
B4 - 10	Green/Black/White	OVERRIDE (Momentary Digital Output)
B3 - 9	Green	Unused
B2 - 8	Red/Black/White	Unused
B1 - 7	White/Red/Black	Unused
A12 - 6	Orange/Red	Unused
A10 - 5	Orange/Black	CONTROL RANGE HIGH (Momentary Digital Output)
A11 - 4	Blue/Red	TRUCK KILL (Momentary Digital Output)
A9 - 3	White/Red	TRUCK START (Momentary Digital Output)
A8 - 2	Red/Green	Unused
A7 - 1	Orange/Green	HORN (Momentary Digital Output)
A5	Black/White/Red	Switches to Power with Link
A6	Red	Power Input (+9V to 30VDC)
A3	Black	Ground

Outputs: 19 solid state, high-side driver outputs, 5A max. per pin and 7A max per bank, total combined current 15A

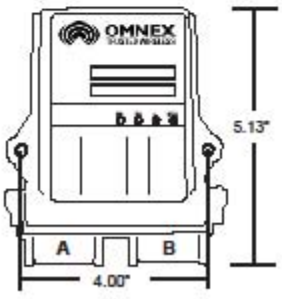
Inputs: All output pins can be factory configured as inputs. Input pins should be connected to a current limiting (fused) source

Connector Pin Assignments

Connectors as seen from under the receiver



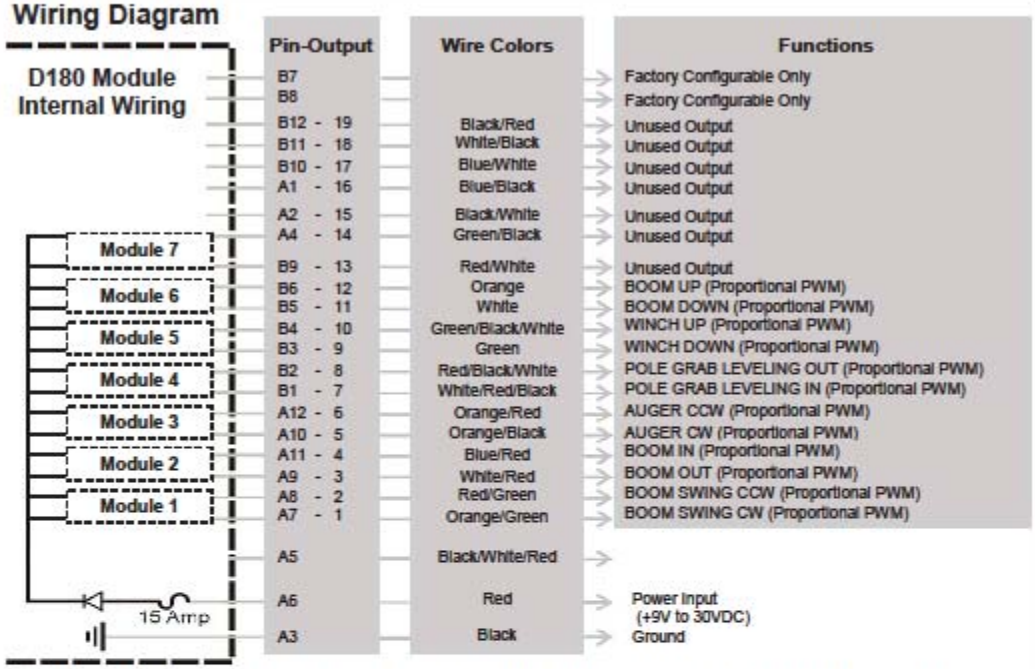
D1XX Dimensions



Installing the D180 Expansion Module for T2300-000201

Use the **Wiring Diagram** and the **Connector Diagram** below to connect the Expansion module pins directly to the appropriate contacts of the machine electronics. D180 Output Cables are provided with every system to simplify the wiring process. The Wire Color column below only applies to the OMNEX Output Cable configuration. Tips on mounting, power connections and filtering are also provided under **Installation Considerations**.

Wiring Diagram



Pin-Output	Wire Colors	Functions
B7		Factory Configurable Only
B8		Factory Configurable Only
B12 - 19	Black/Red	Unused Output
B11 - 18	White/Black	Unused Output
B10 - 17	Blue/White	Unused Output
A1 - 16	Blue/Black	Unused Output
A2 - 15	Black/White	Unused Output
A4 - 14	Green/Black	Unused Output
B9 - 13	Red/White	Unused Output
B6 - 12	Orange	BOOM UP (Proportional PWM)
B5 - 11	White	BOOM DOWN (Proportional PWM)
B4 - 10	Green/Black/White	WINCH UP (Proportional PWM)
B3 - 9	Green	WINCH DOWN (Proportional PWM)
B2 - 8	Red/Black/White	POLE GRAB LEVELING OUT (Proportional PWM)
B1 - 7	White/Red/Black	POLE GRAB LEVELING IN (Proportional PWM)
A12 - 6	Orange/Red	AUGER CCW (Proportional PWM)
A10 - 5	Orange/Black	AUGER CW (Proportional PWM)
A11 - 4	Blue/Red	BOOM IN (Proportional PWM)
A9 - 3	White/Red	BOOM OUT (Proportional PWM)
A8 - 2	Red/Green	BOOM SWING CCW (Proportional PWM)
A7 - 1	Orange/Green	BOOM SWING CW (Proportional PWM)
A5	Black/White/Red	
A6	Red	Power Input (+9V to 30VDC)
A3	Black	Ground

Outputs: 14 solid state, high-side driver Current Control outputs 5A max. each, total combined current 15A

Special Functions

Paddle controlled outputs are set to 50% of the full stroke while the CONTROL RANGE [LOW] switch is latched.

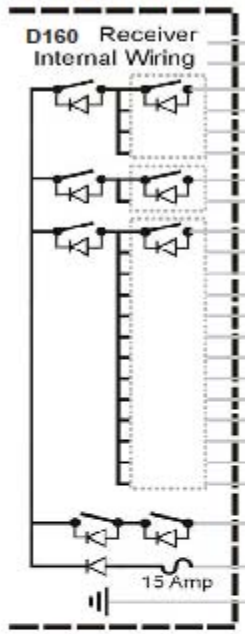
The WINCH [UP, DOWN] functions are enabled while the WINCH [DISABLE] switch is not latched.

All remote functions except TRUCK [START/KILL] must be enabled by pressing the HORN switch. These functions must be re-enabled after 15 seconds of inactivity.

Installing the D160 Expansion Module for T2300-000205

Use the **Wiring Diagram** and the **Connector Diagram** below to connect the receiver pins directly to the appropriate contacts of the machine electronics. D160 Output Cables can be provided with every system to simplify the wiring process. The Wire Color column below only applies to the OMNEX Output Cable configuration. Tips on mounting, power connections and filtering are also provided under **Installation Considerations**.

Wiring Diagram



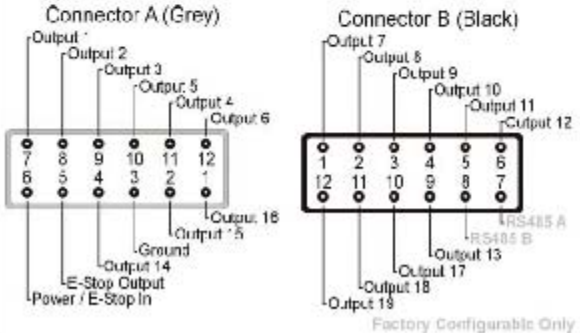
Pin-Output	Wire Colors	Functions
B7		Factory Configurable Only
B8		Factory Configurable Only
B12 - 19	Black/Red	WINCH HIGH (Momentary Digital Output)
B11 - 18	White/Black	AUX WINCH DISABLE (Momentary Digital Output)
B10 - 17	Blue/White	AUX WINCH HIGH (Momentary Digital Output)
A1 - 16	Blue/Black	Spare Down (Momentary Digital Output)
A2 - 15	Black/White	Spare Up (Momentary Digital Output)
A4 - 14	Green/Black	ENGINE SPEED LOW (Momentary Digital Output)
B9 - 13	Red/White	HYD. ENABLE (On while any paddle is activated)
B6 - 12	Orange	ENGINE SPEED HIGH (Momentary Digital Output)
B5 - 11	White	Unused
B4 - 10	Green/Black/White	OVERRIDE (Momentary Digital Output)
B3 - 9	Green	Unused
B2 - 8	Red/Black/White	Unused
B1 - 7	White/Red/Black	Unused
A12 - 6	Orange/Red	Unused
A10 - 5	Orange/Black	CONTROL RANGE HIGH (Momentary Digital Output)
A11 - 4	Blue/Red	TRUCK KILL (Momentary Digital Output)
A9 - 3	White/Red	TRUCK START (Momentary Digital Output)
A8 - 2	Red/Green	Unused
A7 - 1	Orange/Green	HORN (Momentary Digital Output)
A5	Black/White/Red	Switches to Power with Ignition
A6	Red	Power Input (+9V to 30VDC)
A3	Black	Ground

Outputs: 19 solid state, high-side driver outputs, 5A max. per pin and 7A max per bank, total combined current 15A

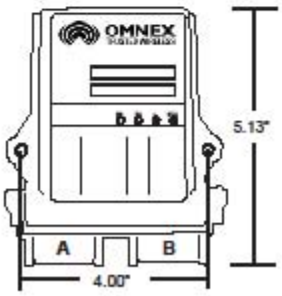
Inputs: All output pins can be factory configured as inputs. Input pins should be connected to a current limiting (fused) source

Connector Pin Assignments

Connectors as seen from under the receiver



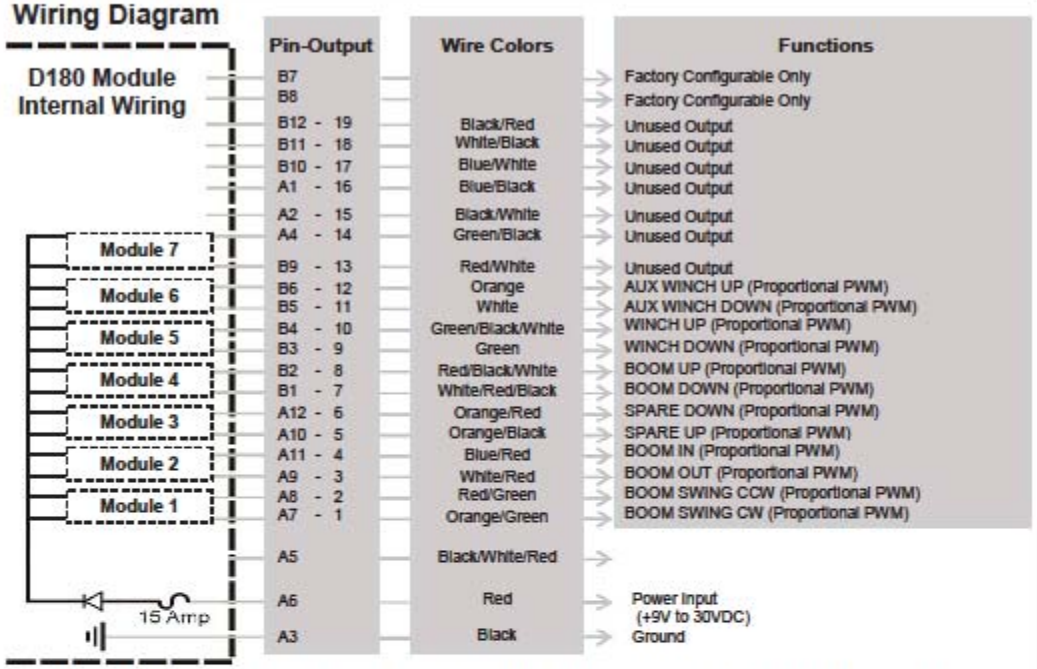
D1XX Dimensions



Installing the D180 Expansion Module for T2300-000205

Use the **Wiring Diagram** and the **Connector Diagram** below to connect the Expansion module pins directly to the appropriate contacts of the machine electronics. D180 Output Cables are provided with every system to simplify the wiring process. The Wire Color column below only applies to the OMNEX Output Cable configuration. Tips on mounting, power connections and filtering are also provided under **Installation Considerations**.

Wiring Diagram



Outputs: 14 solid state, high-side driver Current Control outputs 5A max. each, total combined current 15A

Special Functions

Paddle controlled outputs are set to 50% of the full stroke while the CONTROL RANGE [LOW] switch is latched.

The WINCH [UP, DOWN] functions are enabled while the WINCH [DISABLE] switch is not latched.

All remote functions except TRUCK [START/KILL] must be enabled by pressing the HORN switch. These functions must be re-enabled after 15 seconds of inactivity.

Installation Considerations

NOTE: The FCC and ISC require that the antenna be restricted to that supplied by the manufacturer and approved for use with this product. An optional 0dB coax wire antenna may be supplied. For other antenna options, please contact OMNEX Control Systems ULC

Mounting and Installation

The receiver can be mounted by fastening two ¼" bolts through the two mounting holes in the unit's enclosure. When mounting, ensure that the receiver is oriented so that the text is reading right and the connectors pointing "down".

When selecting a mounting point for the receiver, it is recommended that the location require only a minimal length of wiring to connect it to the control panel, that it will be in a visible area where it has good exposure to the operator and that it is mounted on a surface that sustains minimal vibration. It is also recommended that the receiver have the best possible line of sight with the transmitter

Power Connections and Wiring

Whenever a power connection is made to an electronic device, it is a good practice to make both the Power (+) and Ground (-) connections directly to the Battery and avoid connecting the power from the charging side of existing wiring or making use of existing "ACC" or other peripheral connection points.

Make sure that wire of sufficient gauge and insulator type is used when connecting the outputs of the receiver to the control panel. Observe any component manufacturer's instructions and recommendations for proper integration of their product. This includes the power ratings and requirements of such components as relays, valves, solenoids, etc.

Be sure to test each of the outputs with a multi-meter prior to connecting the outputs to your end devices. This will ensure that each output has been programmed to operate in the manner required by each end device.

Filtering and Noise Suppression

Whenever a solenoid or electromagnetic switch is controlled by the receiver, it is a good practice to install a Diode across its terminals to ensure that surges and spikes do not continue back into the circuit. Appropriate 36V Bi-directional Diodes kits can be ordered under the OMNEX part number "AKIT-2492-01".

Power the Transmitter

1. **Install the batteries in the transmitter**

   Batteries are installed in the transmitter by removing the battery cover using a slotted screwdriver and inserting 4 "C" alkaline batteries. Orientation of the batteries is embossed inside the battery housing. No batteries are required when the transmitter is connected to the receiver by a Pendant cable.

   NOTE: For operation at temperatures below –10°C lithium batteries are recommended. Low temperatures reduce battery performance for both alkaline and lithium types. Refer to the battery manufacturer's specifications for detailed information on low temperature performance.

Transmitter Battery Housing

2. **Turn on the transmitter**

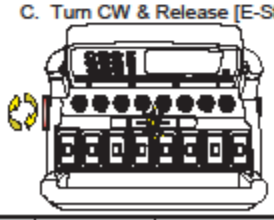
   Ensure all transmitter switches and paddles are in the neutral position. Turn on the transmitter by, pressing and releasing the [Power] switch The RED (E-Stop) light will flash quickly. Release the [E-Stop], the yellow (Active) light on the transmitter will begin to flash.

WARNING: do not install batteries backwards, charge, put in fire, or mix with other battery types. May explode or leak causing injury. **Replace all batteries at the same time as a complete set and do not mix and match battery types.**

A. Press the [E Stop]

B. Press and release [Power] switch

C. Turn CW & Release [E-Stop]



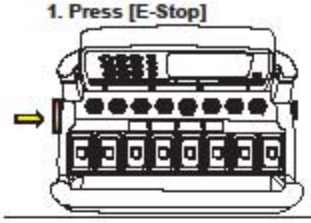
Light Legend	Solid	Slow Flash	Fast Flash	Red Light	Green Light	Yellow Light	Alternating Red & Green Light

Test the Transmitter / Receiver Link

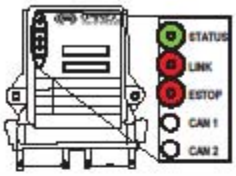
Follow these steps to ensure that there is a Radio Link between the transmitter and receiver

Refer to the Light Legend below for diagram details

1. Press [E-Stop]

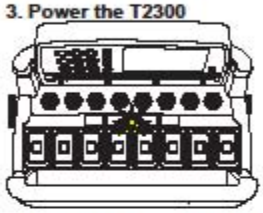


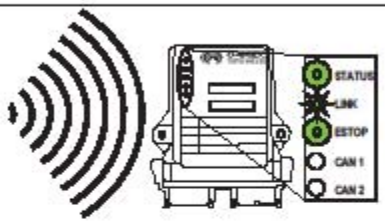
2. Power the R170



The (E-Stop) light and the (Link) light will display RED (provided the transmitter is off), and the (Status) light will show GREEN.

3. Power the T2300





If the (Active) light on the transmitter is flashing and the (Link) light on the receiver is flashing GREEN, a link between the two exists.

NOTE: *The transmitter will shut itself off (and the receiver will then shut off all outputs) after 2 hours of inactivity as a battery saving feature. To restart the timer before the transmitter shuts off automatically, momentarily operate any toggle switch or paddle.*

The ORIGA System is now ready for use.

If the receiver's (Link) light does not become GREEN follow the steps under **Download ID Code**.

Light Legend	Solid	Slow Flash	Fast Flash	Red Light	Green Light	Yellow Light	Alternating Red & Green Light

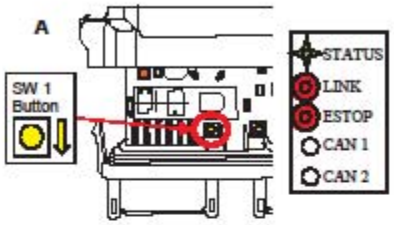
Downloading the Transmitter ID

The R2170 requires a transmitter ID from an OMNEX wireless transmitter before it can be operated. The R2170 can only hold a single transmitter ID; if another ID is downloaded then the new ID will overwrite the previous ID. OMNEX transmitter IDs are unique, ensuring that the R2170 will only respond to the correct transmitter.

1. Setting R2170 into Configuration Mode

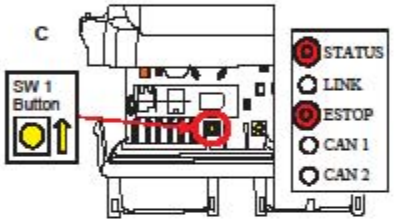
A. Press and hold [SW 1] on the front of the R2170

B. Hold [SW 1] until the (Status) light begins to flash GREEN quickly



C. When this occurs, release the button to enter Setup mode.

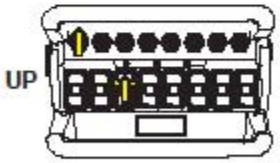
D. If the [SW1] button is held for more than 10 seconds, the (Status) and (Link) LEDs will rapidly flash RED showing the "stuck switch" indicator.

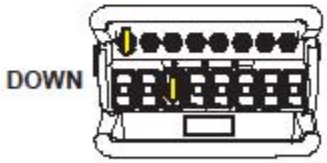


NOTE: The R2170 will only remain in Setup Mode for 30 seconds. If a transmitter ID is not successfully received during this time, the R2170 will exit Setup Mode. The (Status) and (Link) lights will also flash RED to indicate that there was an error downloading the transmitter ID. If this happens try downloading the transmitter ID again as described above. Pressing [SW 1] again will stop the (Status) and (Link) lights from flashing RED.

Unsuccessful ID download

NOTE: For this document, orientation of the paddle and switch operation will be defined as follows:
Paddle UP—is towards the switches
Paddle DOWN—is away from switches
Switch UP—is away from paddles
Switch DOWN—is towards the paddles.



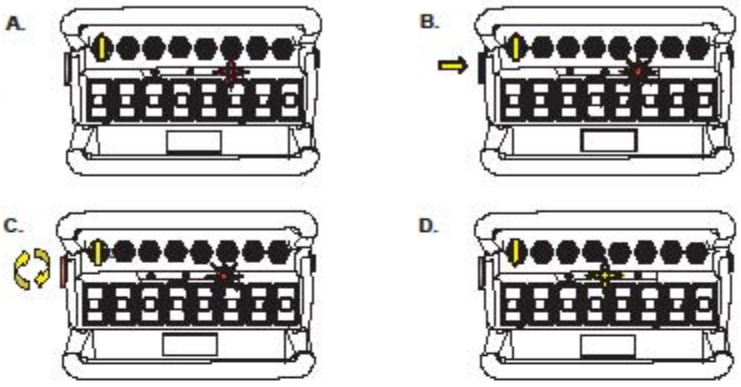


Light Legend	Solid	Slow Flash	Fast Flash	Red Light	Green Light	Yellow Light	Alternating Red & Green Light

Downloading the Transmitter ID (continued)

4. Power T2300 into Configuration

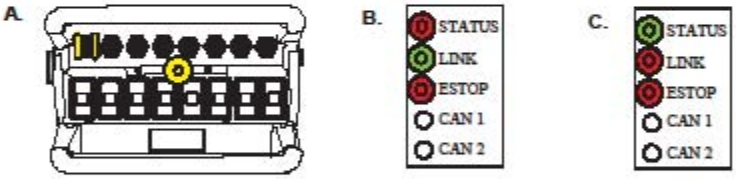
A. Hold [Power] switch UP
B. Press [E-Stop]
C. Twist CW & release [E-Stop]
D. Release [Power] Switch



5. Download ID Code

NOTE: When downloading a new ID to a receiver, a safety feature requires that the transmitter be in close proximity to the receiver. This will prevent a transmitter from accidentally reprogramming a different receiver in the area.

A. Press [Power] switch UP and release
B. (Link) light goes to GREEN during download.
C. Once complete, (Link) light goes to RED as the transmitter turns off



***NOTE:** When replacing the receiver cover, ensure the cover snaps completely into place to create a weather proof seal around the base of the receiver.*

***NOTE:** A transmitter ID may be downloaded at anytime even if the R2170 already has a valid transmitter ID—the new ID will simply overwrite the previous ID. When the R2170 enters Setup Mode, it shuts down the CAN ports and opens the Emergency-Stop Relay, thus disabling normal operations.*

If, for some reason, [SW 1] or [SW 2] is stuck "on", the R2170 will indicate this fault by flashing its (Status) and (Link) lights RED, and also flash its (CAN 1) light GREEN. (Refer to the R2170 Diagnostic page for more details

Stuck Buttons

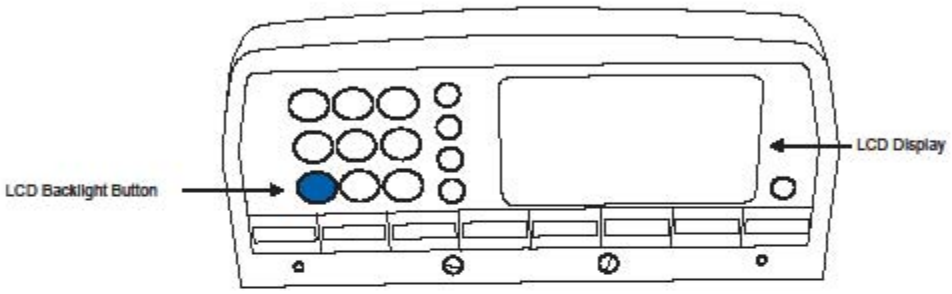
LCD Display Operations

The LCD display contains a 9 button keypad.

For this version, the bottom left button is operational.

Pressing this button toggles the LCD backlight feature to either ON or OFF.

***Note:** Leaving the LCD backlight on will reduce battery life*



Calibrating Proportional Controls

The transmitter's Paddles control the receiver's proportional output. The Paddles/Joysticks are used in conjunction with any of the transmitter's switches. The proportional output can be activated when a switch is held UP or DOWN; it will become active at an increasingly high level as the Paddle/Joystick is pushed/pulled. The minimum and maximum levels of the proportional output can be calibrated by following these steps.

Refer to the **Light Legend** below for diagram details.

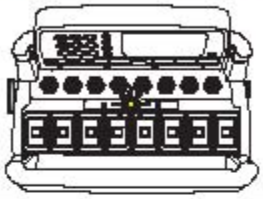
NOTE: Calibration settings can be reset to factory default in steps 3 & 4 by holding the [Power] switch UP or DOWN for 5 seconds.

1. Power T2300, Power R2170

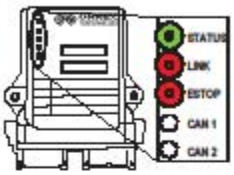
A. Refer to steps in "Power the Transmitter"

B. Supply power to the R2170

A.



B.

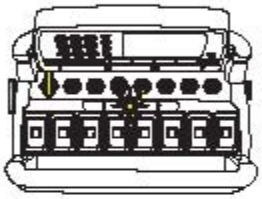


2. Setup T2300 for Output Calibration

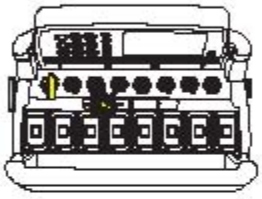
A. Hold [Power] switch DOWN for 5 seconds until the (Battery) LED goes to alternating RED and YELLOW.

B. Release [Power] switch

A.



B.

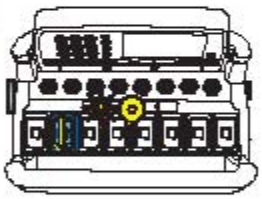


3. Set Minimum Level

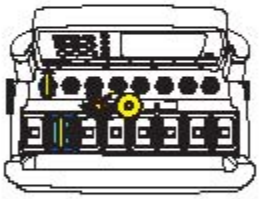
A. Push the paddle (function) in the direction you wish to calibrate until the (Active) LED comes on

B. Hold paddle and Press [Power] switch UP to decrease minimum level or DOWN to increase it

A.



B.

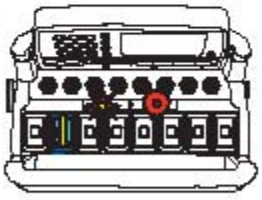


4. Set Maximum Level

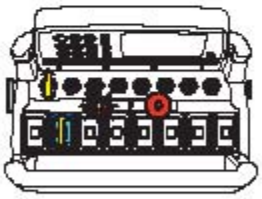
A. Fully push the paddle (function) in the direction you wish to calibrate until the (E-Stop) LED comes on.

B. Hold paddle and Press [Power] switch UP to decrease maximum level or DOWN to increase it

A.



B.

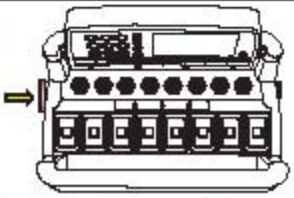


***Note:** Repeat steps 3 and 4 for each paddle (function) that needs to be calibrated.*

5. Power Off

A. Press [E-Stop]

A.



Light Legend	Solid	Slow Flash	Fast Flash	Red Light	Green Light	Yellow Light	Alternating Red & Yellow Light

Diagnostics - R2170 Receiver

Normal Operation

Indicator Lights	Description
	**Transmitter is OFF** If the transmitter is off, the receiver is operating properly. This will be the status of the receiver after the Download ID procedure as the transmitter automatically shuts off after ID download.
	**Transmitter is ON** When the transmitter is turned on, the Link light (fast flashing) and E-Stop (GREEN) indicates the receiver is operating properly

Trouble Indicators

Note: In some cases, the indicator lights will be different depending on whether the transmitter is on or off. For all cases listed below, the transmitter's status is OFF unless otherwise indicated. Please note the transmitter status in the "Description" column for each case.

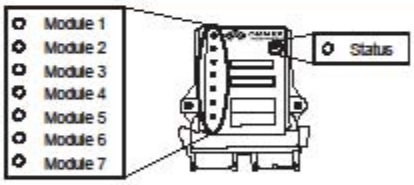
Indicator Lights	Description	Solution	Indicator Lights	Description	Solution
	**Transmitter is OFF** The SW 1 button is stuck for more than 10 seconds *(If the transmitter is on, the LINK light will be OFF)*	Wiggle the button to try and get unstuck. If condition persists, contact customer service.		During normal operation, this may indicate irrecoverable CAN software error or upon power-up, out of the box, the unit has no setup information or setup information is corrupt	Proceed through the Download ID procedure. If this doesn't work contact Customer Service
	**Transmitter is OFF** The SW 2 button is stuck for more than 10 seconds *(If the transmitter is on, the LINK light will be OFF)*	Wiggle the button to try and get unstuck. If condition persists, contact customer service.		Setup download failed.	Try again, no more than a couple of times, or contact customer service.
	**Transmitter is OFF** A low battery condition has been detected.	To detect intermittent conditions caused by poor or corroded ground or power circuits, the GREEN light will continue to flash for		**Transmitter is OFF** E-Stop relay failure *(If the transmitter is ON, the LINK light will be fast flashing GREEN)*	Contact Customer Service

Diagnostics—T2300 Transmitter

	Tether connection detected
	Low battery. Unit will run approximately 20 hours after Battery light starts flashing.
	The transmitter is in Calibration mode
	Power switch is stuck in the **"UP"** position.
	The Active light remain on momentarily when a function is activated (i.e. a switch or paddle is triggered). This is normal operation.
	Normal Operation The transmitter is in Download Mode.
	Normal Operation The Active light will flash 2 times per second, indicating that the transmitter is sending signals to the receiver.
	Stuck switch detected. Ensure that all switches are in a centered position. The transmitter will not power up when a function is ON.
	On Power Up Release the E-Stop button within 10 seconds to power up the transmitter, or the unit will power down.
	On Power Up Press and release the E-Stop button within 10 seconds to power up the transmitter, or the unit will power down.

Diagnostics - D180 Expansion Module

Indicator lights for the D180 Expansion Module



Status Indicator

STATUS	Module is operating properly	STATUS	Low battery condition detected
STATUS	There is a fault with the module	STATUS	Fuse blown
STATUS	Communication to the module is active		

Module 1-7 Indicators

MODULE	Module is installed and operating properly	MODULE	There is a short to supply
MODULE	There is a short to ground / over current	MODULE	No Module installed

Light Legend	Solid	Slow Flash	Fast Flash	Red Light	Green Light	Yellow Light	Alternating Red & Yellow Light

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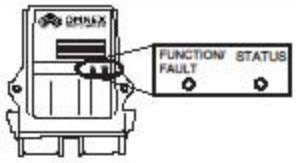
Diagnostics - D160 Expansion Module

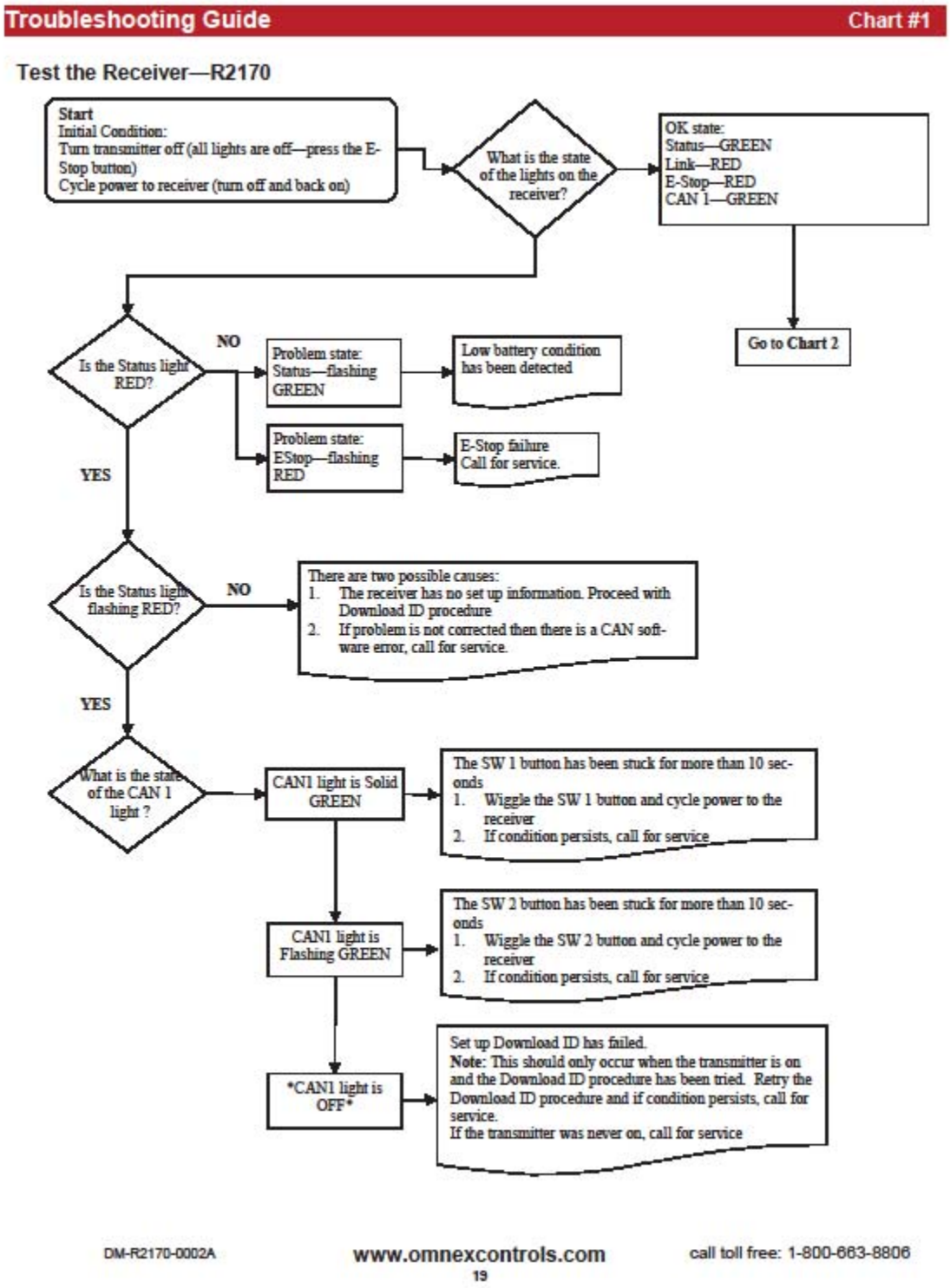
Indicator lights for the D160 Expansion Module



Status Indicator

Module is operating properly with a function on		Low battery condition detected (refer to R160 diagnostic page for possible solution)
Module is operating properly with a function off		Fuse blown (refer to R160 diagnostic page for possible solution)
Module has an unrecoverable fault, return for service		There is a short to ground/over current (refer to R160 diagnostic page for possible solution)
The module is powered incorrectly (refer to R160 diagnostic page for possible solution)		There is a short to supply (refer to R160 diagnostic page for possible solution)

Light Legend	Solid	Slow Flash	Fast Flash	Red Light	Green Light	Yellow Light	Alternating Red & Green Light


Troubleshooting Guide
Chart #1
Test the Receiver—R2170
Start
Initial Condition:
Turn transmitter off (all lights are off—press the E-Stop button)
Cycle power to receiver (turn off and back on)
What is the state of the lights on the receiver?
OK state:
Status—GREEN
Link—RED
E-Stop—RED
CAN 1—GREEN
Go to Chart 2
Is the Status light RED?
NO
Problem state:
Status—flashing GREEN
Low battery condition has been detected
Problem state:
EStop—flashing RED
E-Stop failure
Call for service.
YES
Is the Status light flashing RED?
NO
There are two possible causes:
1. The receiver has no set up information. Proceed with Download ID procedure
2. If problem is not corrected then there is a CAN software error, call for service.
YES
What is the state of the CAN 1 light ?
CAN1 light is Solid GREEN
The SW 1 button has been stuck for more than 10 seconds
1. Wiggle the SW 1 button and cycle power to the receiver
2. If condition persists, call for service
CAN1 light is Flashing GREEN
The SW 2 button has been stuck for more than 10 seconds
1. Wiggle the SW 2 button and cycle power to the receiver
2. If condition persists, call for service
CAN1 light is OFF
Set up Download ID has failed.
Note: This should only occur when the transmitter is on and the Download ID procedure has been tried. Retry the Download ID procedure and if condition persists, call for service.
If the transmitter was never on, call for service
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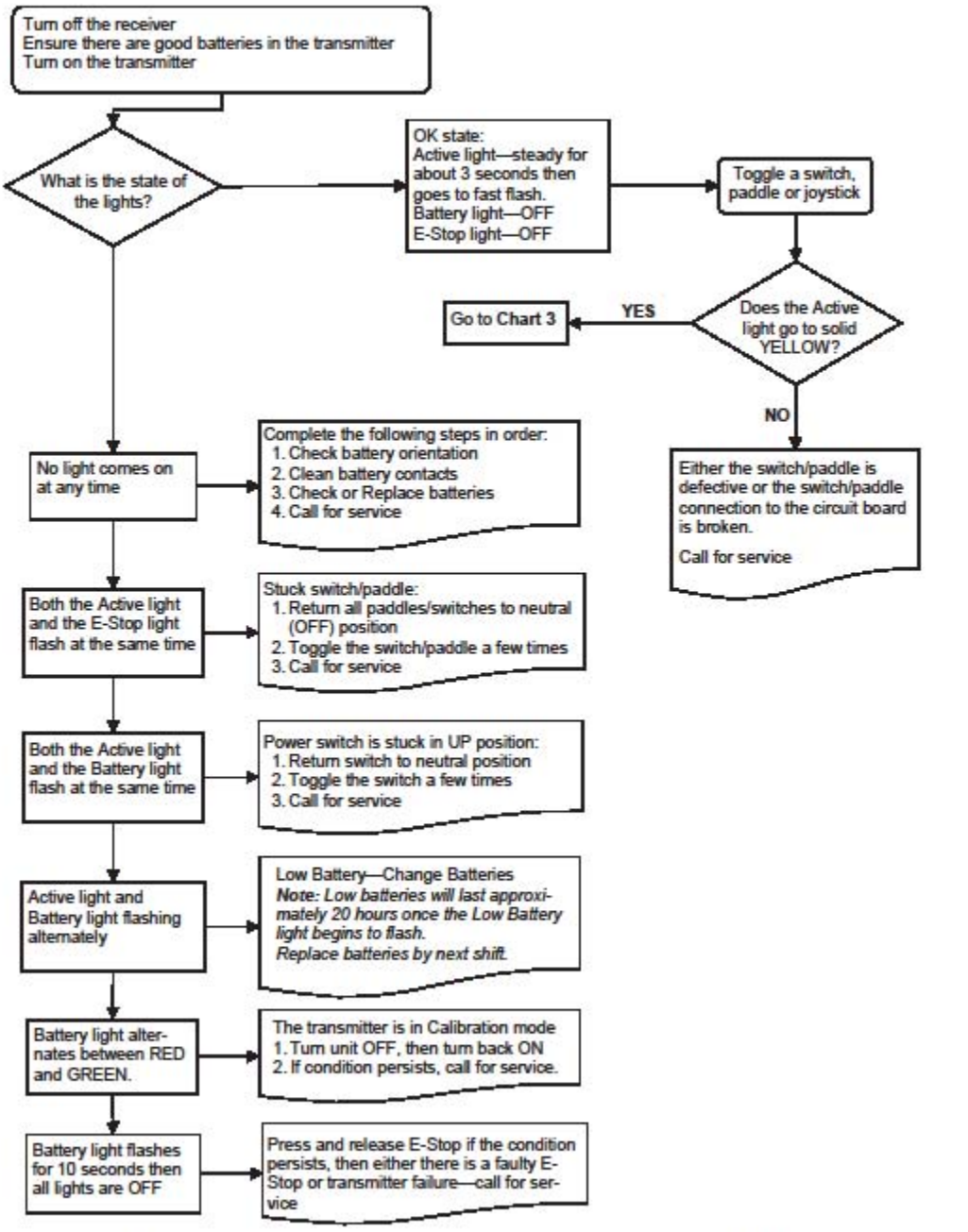
call toll free: 1-800-663-8806

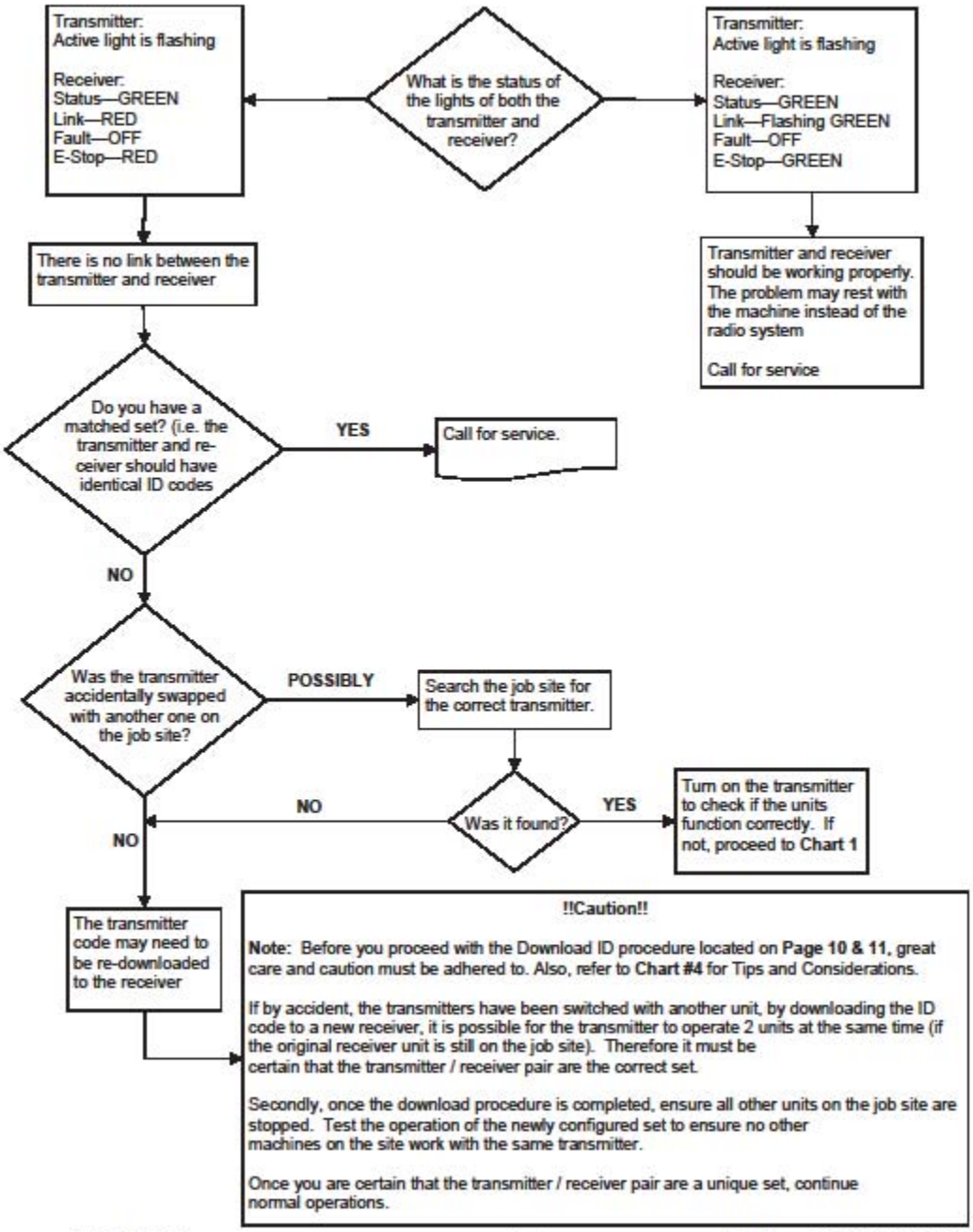
Troubleshooting Guide (con't) Chart #2

Test the Transmitter—T2300



Troubleshooting Guide (con't) Chart #3

Testing the Transmitter / Receiver Communication



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Troubleshooting Guide (con't) Chart #4

Considerations when Downloading the ID

Potential downloading issues

If testing of the receiver and transmitter both show the system as working (Chart 1 & 2), then the transmitter and receiver will both go into Download/Configuration mode.

Possible issues could arise during Step 4, the download phase of reprogramming. In this case there are 2 symptoms to look for:

1. The Link light on the receiver will not turn GREEN when the power switch is toggled on the transmitter to download
2. The receiver will "time out" indicating that it didn't receive a signal from the transmitter within the 30 seconds from the time the receiver was put into Setup Mode.

If all indications appear normal during the download phase, test the link by turning on the transmitter (note: the transmitter shuts off after transmitting the ID code in Step 4)

1. If the Link light on the receiver doesn't turn GREEN, the receiver didn't receive all of the information that was sent from the transmitter.

Possible Solutions

1. Try the Downloading steps again
2. If this doesn't correct the problem, send both the transmitter and receiver in for service.

***Note:** you could try to determine whether the fault lies with the transmitter or receiver by completing the downloading procedure with a different transmitter. If this step works, then the fault lies with the original transmitter. If not, the fault may lie with the receiver.*

!!Caution!!

Note: Before attempting downloading with another transmitter, understand that reprogramming the receiver with another transmitter, could result in two receivers on the job site responding to the one transmitter. If the original transmitter was sent in for repair, Disconnect the receiver (disconnect connector A) to continue using the machine without remote capability and without fear of inadvertently operating the machine with the other transmitter.

Reprogramming Tips:

1. Use a pointy instrument to depress the Setup button on the receiver (i.e. a pen) as the button is relatively small
2. Follow each step as laid out in the procedure
3. Never lay the receiver circuit board down on anything metallic (there are contact points on the back which could contact the metal and damage the receiver)

Parts & Accessories

Part	OMNEX Part Number	Description
Batteries	B0012	4 x "C" alkaline
Fuse	F0055	36V Bi-directional, Bussman ATM-7.5
Shoulder Strap	FMEC-2709-01	T300 Tear-away shoulder strap
Output Cable	ACAB– 2727-01	R170 Output Cable, Generic
Pendant Cable	ACAB-2455-01	Cable, 10m
	ACAB-2455-02	Cable, 8m
	ACAB-2710-01	Cable, 4-12ft
Connector Kit	AKIT-2337-01	Includes Deutsch socket connectors, wedges, pins and sealing plugs
Bipolar Diode Kit	AKIT-2492-01	Motorola P6KE36CA


Shoulder Strap


Pendant Cable


Pendant Coil


R170 Output Cable

Specifications

	D160/D180 Module	R2170 Receiver	T2300 Transmitter
Size	5.1" x 4.7" x 1.4" (130mm x 119mm x 36mm)	5.1" x 4.7" x 1.4" (130mm x 119mm x 36mm)	9.5" x 6.0" x 5.0" (240mm x 152mm x 127mm)
Weight	0.65lbs (0.295kg)	0.65lbs (0.295kg)	3.5 lbs (incl. batteries) (1.2kg)
Construction	High impact plastic, weather-proof	High impact plastic, weather-proof	High impact, low temperature plastic, weatherproof
Input Power	+9V to 30VDC	+9V to 30VDC	4C alkaline batteries
Battery Life	N/A	N/A	500 hours (continuous use)
Operating Temperature Range	-40F to 158F (-40C to 70C)	-40F to 158F (-40C to 70C)	-40F to 140F (-40C to 60C)
Outputs	3A (max) each (sourcing), 10A (max) each (combined)	N/A	N/A
Antenna	N/A	External	Internal
Approvals	USA- FCC part 15.247 Canada- ISC RSS 210 Issue 6, Sept. Europe- EN 440 Australia- C-Tick		

FCC Rules and Compliance

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

FCC	Part 15.247
ISC	RSS 210 Issue 6, Sept. 2005

Warranty

OMNEX Control Systems ULC warrants to the original purchaser that the OMNEX products are free from defects in materials and workmanship under normal use and service for a period of ONE YEAR, parts (EXCLUDING: SWITCHES, CRYSTALS, OR PARTS SUBJECT TO UNAUTHORIZED REPAIR OR MODIFICATION) and labor from the date of delivery as evidenced by a copy of the receipt. OMNEX's entire liability and your exclusive remedy shall be, at OMNEX's option, either the (a) repair or (b) replacement of the OMNEX product which is returned within the warranty period to OMNEX freight collect by the OMNEX APPROVED carrier with a copy of the purchase receipt and with the return authorization of OMNEX. If failure has resulted from accident, abuse or misapplication, OMNEX shall have no responsibility to repair or replace the product under warranty. In no event shall OMNEX be responsible for incidental or consequential damage caused by defects in its products, whether such damage occurs or is discovered before or after replacement or repair and whether or not such damage is caused by the negligence of OMNEX Control Systems ULC.

OMNEX Control Systems ULC

74-1833 Coast Meridian Road
Port Coquitlam, BC, Canada
V3C 6G5

Tel: 604-944-9247
Fax: 604-944-9267

Toll Free: 1-800-663-8806

www.omnexcontrols.com