

## OPERATOR'S MANUAL

This manual has been prepared for and is considered part of -

### RT540E

Crane Model Number

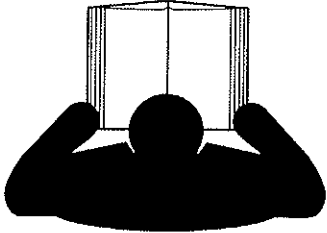
This Manual is divided into the following sections:

SECTION 1	INTRODUCTION
SECTION 2	SAFETY INFORMATION
SECTION 3	OPERATING CONTROLS AND PROCEDURES
SECTION 4	SET-UP AND INSTALLATION
SECTION 5	LUBRICATION
SECTION 6	MAINTENANCE CHECKLIST

#### NOTICE

The crane serial number is the only method your distributor or the factory has of providing you with correct parts and service information.

The crane serial number is identified on the builder's decal attached to the operator's cab. **Always furnish crane serial number** when ordering parts or communicating service problems with your distributor or the factory.



## ⚠ WARNING

**To prevent death or serious injury:**

- Avoid unsafe operation and maintenance.
- This crane must be operated and maintained by trained and experienced personnel. Manitowoc is not responsible for qualifying these personnel.
- Do not operate or work on this crane without first reading and understanding Operator's Manual and Rating Plate supplied with crane.
- Store Operator's Manual in holder provided on crane.
- Attach laminated Capacity Charts supplied with crane to chain in operator's cab.
- If Operator's Manual or Capacity Charts are missing from cab, contact your distributor for new ones.





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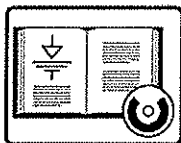
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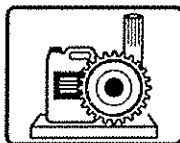
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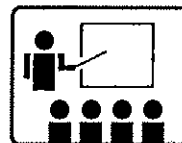
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# SECTION 1 INTRODUCTION

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## SECTION 1

### INTRODUCTION

#### GENERAL

**NOTE:** Throughout this handbook, reference is made to left, front, and rear when describing locations. These reference locations are to be considered as those viewed from the operator's seat with the superstructure facing forward over the front of the carrier frame.

This Handbook provides important information for the operator of the Model RT540E Series Grove Crane.

The rough terrain crane incorporates an all welded steel frame, using planetary drive axles to provide four-wheel drive. Axle steering is accomplished utilizing hydraulic steer cylinders. The engine is mounted at the rear of the crane and provides motive power through a six speed forward and reverse transmission. Hydraulic, double box, sliding beam outriggers are integral with the frame.

The carrier frame incorporates an integral fifth wheel, to which the rear axle is mounted, to provide axle oscillation. Axle oscillation lockout is automatic when the superstructure rotates from the travel position.

The superstructure is capable of 360° rotation in either direction. All crane functions are controlled from the fully-enclosed cab mounted on the superstructure. The crane is

equipped with a four-section cable synchronized full power boom. Additional reach is obtained by utilizing a swingaway boom extension. Lifting is provided by a main hoist and an optional auxiliary hoist.

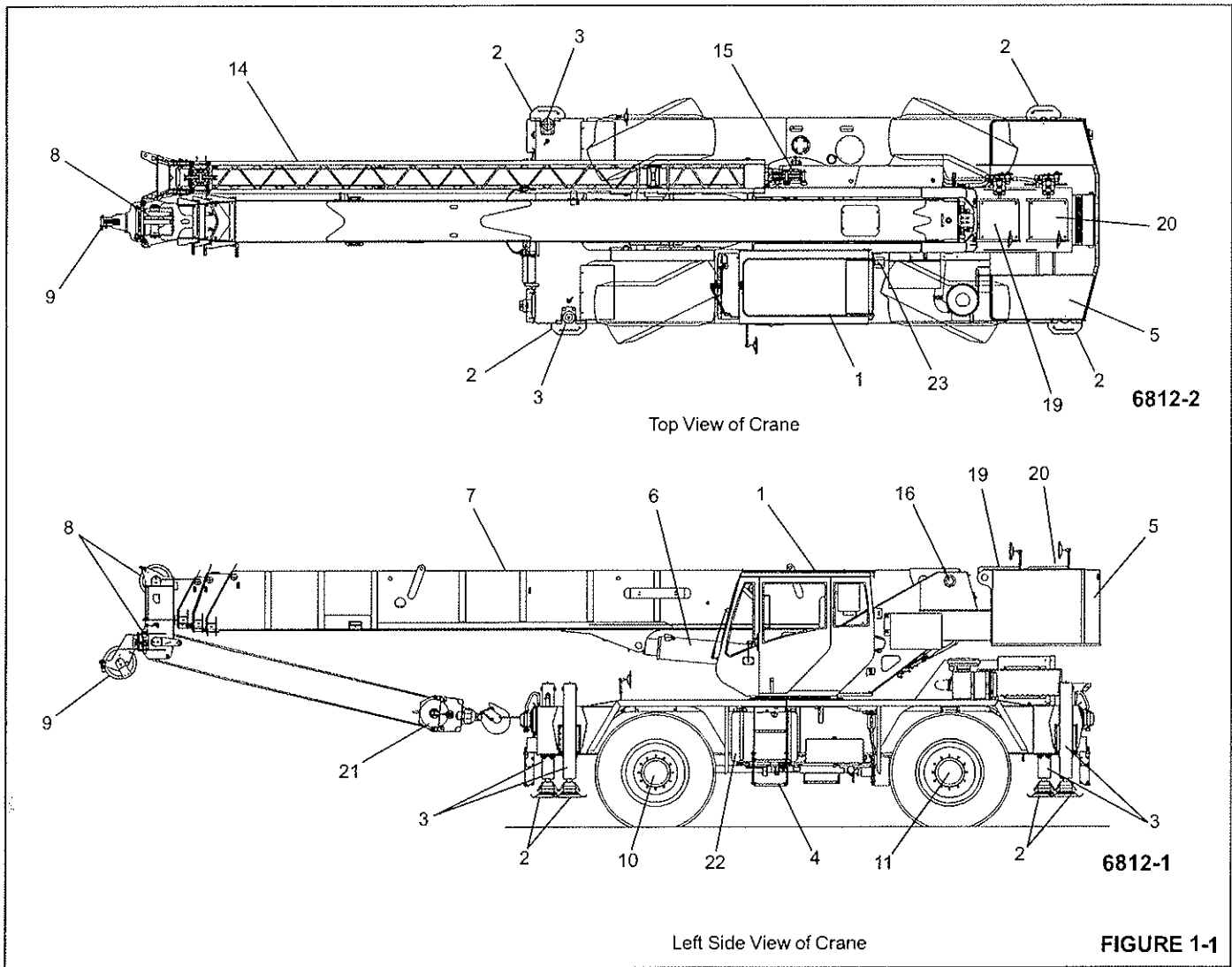
#### NOISE/VIBRATION TEST RESULTS

##### Noise Level Test Results Are As Follows:

- At the operator's station with closed cab operation, the value is 78.5 dba maximum when measured according to the directives 98/37/EC and Keboatief 27.

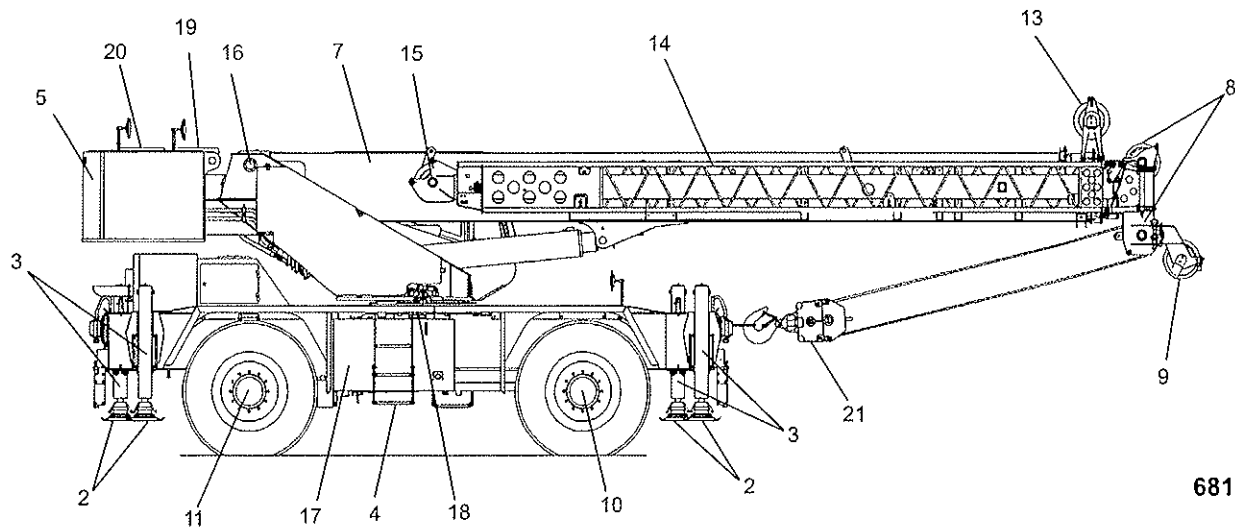
##### Vibration Level Test Results Are As Follows:

- At the operator's station with closed cab operation, vibration levels are less than 0.5 m/s/s for Whole Body Vibration exposure and are less than 2.5 m/s/s for Hand Arm Vibration exposure when measured according to 89/392/EEC Community Legislation on Machinery per standard ISO 2631/1 - Evaluation of Human Exposure to Work Body Vibration, ISO 5349 - Guidelines for the Measurement and Assessment of Human Exposure to Hand Transmitted Vibrations, and ISO/DIS 8041 - Human Response Vibration Measuring Instrumentation.



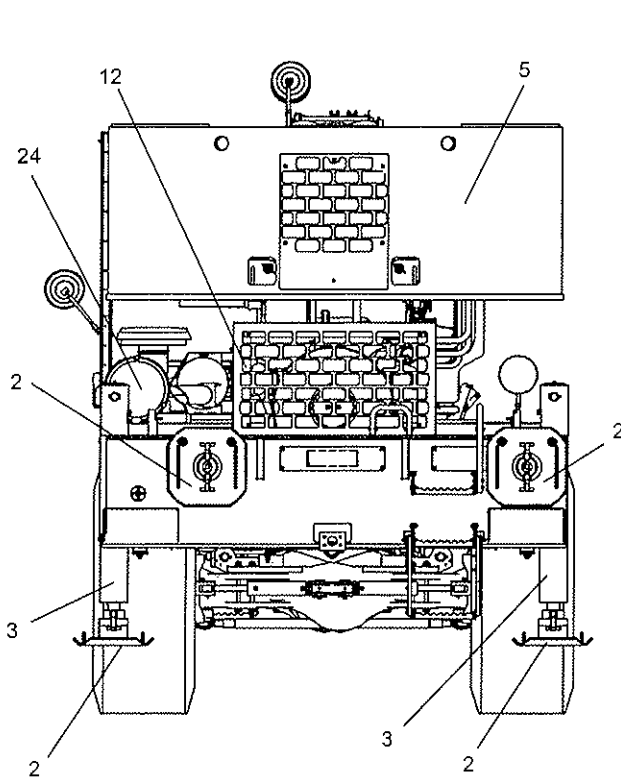
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1	Cab
2	Outrigger Float
3	Outrigger Stabilizer Cylinder
4	Steps
5	Counterweight
6	Lift Cylinder
7	Boom
8	Boom Nose Sheaves
9	Auxiliary Boom Nose
10	Front Axle
11	Rear Axle
12	Engine

Item	Description
13	Boom Extension Mast Sheave
14	Boom Extension
15	Boom Extension Nose
16	Boom Pivot
17	Hydraulic Tank
18	Hydraulic Filter
19	Main Hoist
20	Auxiliary Hoist
21	Hookblock
22	Fuel Tank
23	Windshield Washer Fluid Container
24	Air Cleaner



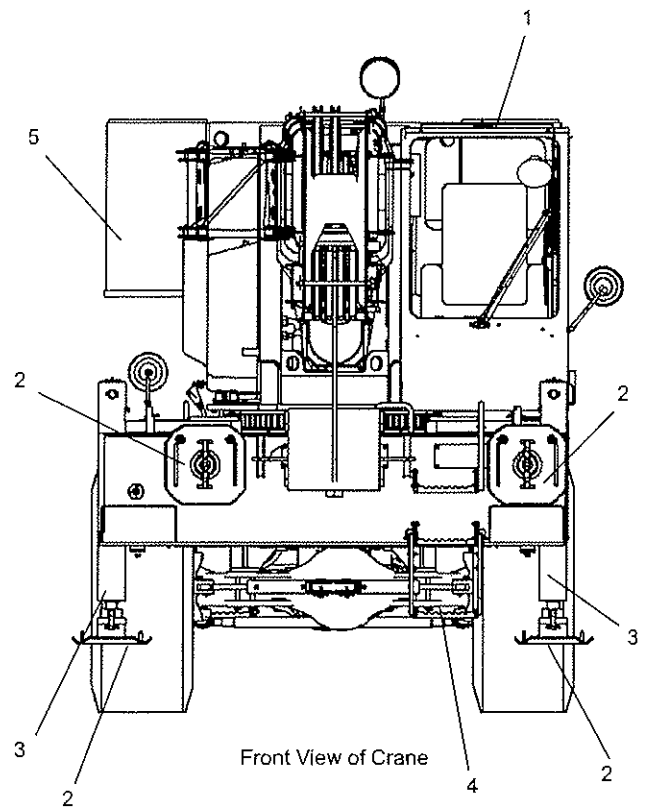
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Right Side View of Crane



Rear View of Crane

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Front View of Crane

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FIGURE 1-1 continued

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## SECTION 2

### SAFETY INFORMATION

#### DIESEL ENGINE EXHAUST

 **CALIFORNIA  
PROPOSITION 65 WARNING**

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

#### BATTERY POSTS, TERMINALS, AND RELATED ACCESSORIES

 **CALIFORNIA  
PROPOSITION 65 WARNING**

The battery posts, terminals, and related accessories contains chemical lead and lead compounds, chemicals known to the State of California to cause cancer, birth defects or other reproductive harm. Wash hands after handling.

#### SAFETY MESSAGES

##### General

The importance of safe operation and maintenance cannot be over emphasized. Carelessness or neglect on the part of operators, job supervisors and planners, rigging personnel, and job site workers can result in their death or injury and costly damage to the crane and property.

To alert personnel to hazardous operating practices and maintenance procedures, safety messages are used throughout the manual. Each safety message contains a safety alert symbol and a signal word to identify the hazard's degree of seriousness.

##### Safety Alert Symbol



This safety alert symbol means **ATTENTION!** Become alert — **your safety is involved!** Obey all safety messages that follow this symbol to avoid possible death or injury.

#### Signal Words

 **DANGER**

Identifies **immediate hazards** that will result in death or serious injury if the message is ignored.

 **WARNING**

Identifies **potential hazards** that could result in death or serious injury if the message is ignored.

 **CAUTION**

Identifies **potential hazards** that could result in minor or moderate injury if the message is ignored.

**CAUTION**

Without the safety alert symbol, identifies **potential hazards** that could result in property damage if the message is ignored.

**NOTE:** Highlights operation or maintenance procedures.

##### GENERAL

**NOTE:** Illustrations have been included in this section to emphasize certain proper and improper points; **READ AND FOLLOW PRINTED INSTRUCTIONS.**

It is impossible to compile a list of safety precautions covering all situations. However, there are basic principles that **MUST** be followed during your daily routine. Safety is **YOUR PRIMARY RESPONSIBILITY**, since any piece of equipment is only as safe **AS THE PERSON AT THE CONTROLS.**

With this thought in mind, this information has been provided to assist you, the operator, in promoting a safe working atmosphere for yourself and those around you. It is not meant to cover every conceivable circumstance which could arise. It is intended to present basic safety precautions that should be followed in daily operation.

Because you, the operator, are the only part of the crane that can think and reason, your responsibility is not lessened by the addition of operational aids or warning devices. Indeed, you must guard against acquiring a false sense of security when using them. They are there to assist, not direct the

operation. Operational aids or warning devices can be mechanical, electrical, electronic, or a combination thereof. They are subject to failure or misuse and should not be relied upon in place of good operating practices.

You, the operator, are the only one who can be relied upon to assure the safety of yourself and those around you. Be a PROFESSIONAL and follow the RULES of SAFETY.

REMEMBER, failure to follow just one safety precaution could cause an accident that results in death or serious injury to personnel or damage to equipment. You are responsible for the safety of yourself and those around you.

IMMEDIATELY report all accidents, malfunctions, and equipment damages to your local Grove distributor. Following any accident or damage to equipment, the local Grove distributor must be immediately advised of the incident and consulted on necessary inspections and repairs. Should the distributor not be immediately available, contact should be made directly with Manitowoc CraneCARE. The crane must not be returned to service until it is thoroughly inspected for any evidence of damage. All damaged parts must be repaired or replaced as authorized by your local Grove distributor and/or Manitowoc CraneCARE.

## OPERATOR'S INFORMATION

You must READ and UNDERSTAND the Operator's and Safety Handbook and the Load Chart before operating the crane. You must also VIEW and UNDERSTAND the safety video titled "The Real Key to Crane Safety" supplied with your new Grove product. The handbook and Load Chart must be readily available to the operator at all times and must remain in the cab while the crane is in use.

Ensure that all personnel working around the crane are thoroughly familiar with safe operating practices. You must be thoroughly familiar with the location and content of all placards and decals on the crane. Decals provide important instructions and warnings and must be read prior to any operational or maintenance function.

You must be familiar with the regulations and standards governing cranes and their operation. Work practice requirements may vary slightly between government regulations, industry standards, and employer policies so a thorough knowledge of all such relevant work rules is necessary.

DO NOT REMOVE the Load Chart, this Operator's and Safety Handbook, or any decal from this crane.

Inspect the crane every day (before the start of each shift). Ensure that routine maintenance and lubrication are being dutifully performed. Don't operate a damaged or poorly maintained crane. You risk lives when operating faulty machinery - including your own.

Allow **No One** other than the operator to be on the crane while the crane is functioning or moving, unless they are seated in a two-man cab.

## OPERATIONAL AIDS

Grove remains committed to providing reliable products that enable users and operators to safely lift and position loads. Grove has been an industry leader in the incorporation of operational aids into the design of its cranes. Federal law requires that cranes be properly maintained and kept in good working condition. The manuals that Grove provides that are specific for each crane and the manufacturer's manuals for the operational aids shall be followed. If an operational aid should fail to work properly, the crane user or owner must assure that repair or recalibration is accomplished as soon as is reasonably possible. If immediate repair or recalibration of an operational aid is not possible and there are exceptional circumstances which justify continued short-term use of the crane when operational aids are inoperative or malfunctioning, the following requirements shall apply for continued use or shutdown of the crane:

1. Steps shall be taken to schedule repairs and recalibration immediately. The operational aids shall be put back into service as soon as replacement parts, if required, are available and the repairs and recalibration can be carried out. Every reasonable effort must be made to expedite repairs and recalibration.
2. When a **load indicator, rated capacity indicator, or rated capacity limiter** is inoperative or malfunctioning, the designated person responsible for supervising the lifting operations shall establish procedures for determining load weights and shall ascertain that the weight of the load does not exceed the crane ratings at the radius where the load is to be handled.
3. When a **boom angle or radius indicator** is inoperative or malfunctioning, the radius or boom angle shall be determined by measurement.
4. When an **anti-block device, two-blocking damage prevention or two-block warning device** is inoperative or malfunctioning, the designated person responsible for supervising the lifting operations shall establish procedures, such as assigning an additional signal person to furnish equivalent protection. This does not apply when lifting personnel in load-line supported personnel platforms. Personnel shall not be lifted when anti-two block devices are not functioning properly.
5. When a **boom length indicator** is inoperative or malfunctioning, the designated person responsible for supervising the lifting operations shall establish the boom lengths at which the lift will be made by actual measurements or marking on the boom.

- 6. When a level indicator is inoperative or malfunctioning, other means shall be used to level the crane.

- You read, understand, and follow the safety and operating recommendations contained in the manufacturer's 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 manufacturer's manuals.
- You are sure that all safety signs, guards, and other safety features are in place and in proper condition.

**OPERATOR'S QUALIFICATIONS**

**! 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 READ, UNDERSTAND AND FOLLOW THE SAFETY AND OPERATING RECOMMENDATIONS CONTAINED IN THE MANUFACTURER'S 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 MANUFACTURER'S MANUAL;
- YOU ARE SURE THAT ALL SAFETY SIGNS, GUARDS AND OTHER SAFETY FEATURES ARE IN PLACE AND IN PROPER CONDITION.

**AVOID ELECTROCUTION, TIPPING, TWO-BLOCKING AND OTHER OPERATIONAL HAZARDS**

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An untrained operator subjects himself and others to death or serious injury.

**YOU MUST NOT OPERATE THIS MACHINE UNLESS:**

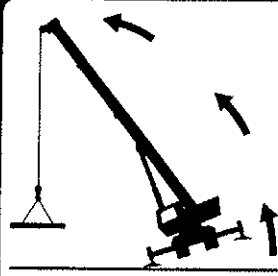
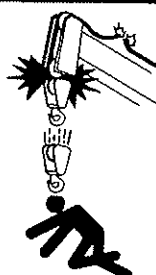
- You have been trained in the safe operation of this machine.

Do not attempt to operate the crane unless you are trained and thoroughly familiar with all operational functions. Controls and design may vary from crane to crane, therefore, it is important that you have specific training on the particular crane you will be operating.

Training is **ESSENTIAL** for proper crane operation. Never jeopardize your own well-being or that of others by attempting to operate a crane on which you have not been trained.

You must be mentally and physically fit to operate a crane. Never attempt to operate a crane while under the influence of medication, narcotics, or alcohol. Any type of drug could impair physical, visual and mental reactions, and capabilities.

**! DANGER**

	<p style="text-align: center;"><b>TIPPING HAZARD</b></p> <p>To avoid death or serious injury, ensure load and crane's configuration are within capacity as shown on crane's load rating chart and notes.</p> <p>This crane should have a functional load moment indicator and control lock-out system. Test daily for proper operation.</p> <p style="text-align: center; font-weight: bold;">POSITION CRANE ON FIRM SURFACE. EXTEND OUTRIGGERS AND LEVEL CRANE.</p>	<p style="text-align: center;"><b>TO AVOID DEATH OR SERIOUS INJURY:</b></p> <p><b>NEVER</b> handle personnel with this machine unless the requirements of the applicable national, state and local regulations and safety codes are met.</p> <p><b>NEVER</b> use this crane for bungee jumping or any form of amusement or sport.</p> <p><b>NEVER</b> permit anyone to ride loads, hooks, slings or other rigging for any reason.</p> <p><b>NEVER</b> get on or off a moving crane.</p> <p><b>NEVER</b> allow anyone other than the operator to be on this crane while it is operating or traveling.</p>
	<p style="text-align: center;"><b>TWO-BLOCKING HAZARD</b></p> <p>To avoid death or serious injury, keep load handling devices away from boom/jib tip when extending or lowering the boom and when hoisting up.</p> <p>This crane should have a functional anti-two-block and control lock-out system. Test daily for proper operation.</p> <p style="text-align: center; font-weight: bold;">DO NOT PASS LOADS OR BOOM OVER GROUND PERSONNEL.</p>	<p style="text-align: center;"><b>ELECTRONIC EQUIPMENT</b> on this crane is intended as an aid to the operator.</p> <p>Under no condition should it be relied upon to replace the use of capacity charts and operating instructions. Sole reliance upon these electronic aids in place of good operating practices can cause an accident.</p> <p>Do not remove any decal, the load chart, or the Operator's and Safety Handbook from this crane.</p>

FOLLOW INSTRUCTIONS IN OPERATOR'S AND SAFETY HANDBOOK.

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## CRANE STABILITY/STRUCTURAL STRENGTH

To avoid death or serious injury, ensure that the crane is on a firm surface with load and crane's configuration within capacity as shown on the crane's Load Chart and notes.

Do not lift loads unless the outriggers are properly extended and the crane leveled. On models equipped with outriggers that can be pinned at the mid-extend position, the outriggers must also be pinned when operating from the mid-extend position.

This crane should have a functional load moment indicator and control lock-out system. Test daily for proper operation. Never interfere with the proper functioning of operational aids or warning devices.

Before swinging the superstructure over the side when the outriggers are retracted, check the load chart for backwards stability.

Long cantilever booms can create a tipping condition when in an extended and lowered position. Retract the boom proportionally with reference to the capacity of the applicable Load Chart.

Check crane stability before lifting loads. Ensure the outriggers (or tires if lifting on rubber) are firmly positioned on solid surfaces. Ensure the crane is level, brakes are set, and the load is properly rigged and attached to the hook. Check the Load Chart against the weight of the load. Lift the load slightly off the ground and recheck the stability before proceeding with the lift. Determine the weight of the load before you attempt the lift.

The RT535E on rubber load charts have a minimum radius of 10 feet with a load. Without a load, a radius of 9 feet is safe for 360 degrees on rubber. A radius of less than 9 feet must be avoided on rubber because of backward stability considerations.

Ensure all pins and floats are properly installed and outrigger beams are properly extended before lifting on outriggers.

Unless lifting within On Rubber capacities, outrigger beams must be properly extended and jack cylinders extended and set to provide maximum leveling of the crane. On models equipped with outriggers that can be pinned at the mid-extend position, the outriggers must also be pinned when operating from the mid-extend position. Tires must be clear of the ground before lifting on outriggers. Remove all weight from tires before lifting on outriggers.

Use adequate cribbing under outrigger floats to distribute weight over a greater area. Check frequently for settling.

Carefully follow the procedures in this handbook when extending or retracting the outriggers. Death or serious injury could result from improper crane setup on outriggers.

Be sure the outriggers are properly extended and set, and the crane is level for operation on outriggers.

All four outrigger beams must be equally extended to the mid position vertical stripe or fully extended position before beginning operation.

Be sure the outriggers are properly extended and set, and the crane is level for operation on outriggers.

All four outrigger beams must be equally extended to the mid position vertical stripe or fully extended position before beginning operation.

All four outrigger beam lock pins must be engaged before operating from the mid-extend position.

The operator must select the proper Load Chart and Load Moment Indicating (LMI) System program for the outrigger position selected.

**! DANGER**

**DEATH OR SERIOUS INJURY  
COULD RESULT FROM IMPROPER  
CRANE SET-UP ON OUTRIGGERS**

**FAILURE TO FOLLOW THESE INSTRUCTIONS  
CAN RESULT IN THE CRANE OVERTURNING**

- BE SURE OUTRIGGERS ARE PROPERLY EXTENDED AND SET AND CRANE IS LEVEL FOR OPERATION ON OUTRIGGERS.
- ALL FOUR OUTRIGGER BEAMS MUST BE EQUALLY EXTENDED TO THE APPROPRIATE VERTICAL STRIPE BEFORE BEGINNING OPERATION.
- ALL FOUR OUTRIGGER BEAM LOCK PINS MUST BE ENGAGED BEFORE OPERATING FROM THE MID-EXTEND POSITION.
- OPERATOR MUST SELECT PROPER LOAD CHART AND LMI PROGRAM FOR THE OUTRIGGER POSITION SELECTED.

**KEEP THE BOOM SHORT.** Swinging loads with a long line can create an unstable condition and possible structural failure of the boom.

### Load Charts

Load Charts represent the absolute maximum allowable loads, which are based on either tipping or structural limitations of the crane under specific conditions. Knowing the precise load radius, boom length, and boom angle should be a part of your routine planning and operation. Actual loads, including necessary allowances, should be kept below the capacity shown on the applicable Load Chart.

You must use the appropriate Load Chart when determining the capability of the crane in the configuration required to perform the lift.

Table 2-1  
Wind Velocity Chart

Wind Force		Wind Velocity km/h (mph)	Visible Indicator Effects of wind as observed on land
Beauford Scale	Designation		
Zero (0)	Calm	<2 (<1)	No wind: smoke rises vertically
1	Light Air	2-5 (1-3)	Wind direction seen by smoke but not by wind vanes
2	Light Breeze	6-11 (4-7)	Wind felt on face: leaves rustle: wind vane moves slightly
3	Gentle Breeze	13-19 (8-12)	Leaves/small twigs in constant motion: wind extends flag
4	Moderate Breeze	21-29 (13-18)	Raises dust & loose paper: moves small branches
Reduce crane load ratings and operating parameters at 32 km/h (20 mph)			
5	Fresh Breeze	31-39 (19-24)	Small trees in leaf begin to sway: on ponds, crested wavelets form
6	Strong Breeze	40-50 (25-31)	Large branches in motion: telegraph wires whistle: umbrellas used with difficulty
Cease all craning operations at 48 km/h (30 mph); lower & retract boom			
7	Moderate Gale	52-61 (32-38)	Whole trees in motion: walking against wind is inconvenient

Maximum lifting capacity is available at the shortest radius, minimum boom length, and highest boom angle.

Do not remove the Load Charts from the crane.

## Work Site

Prior to any operation, you must inspect the ENTIRE work site, (including ground conditions) where the crane will travel and operate. Be sure that the surfaces will support a load greater than the crane's weight and maximum capacity.

Barricade the area where the crane is working and keep all unnecessary personnel out of that area.

Use caution when operating in the vicinity of overhanging banks and edges.

Be aware of all conditions that could adversely affect the stability of the crane.

Wind can have a significant affect on loads that may be lifted by a crane. Wind forces act differently on a crane depending upon the direction from which the wind is blowing (e.g., wind on the rear of the boom can result in decreased forward stability, wind on the underside of the boom can result in decreased backward stability, wind on the side of the boom can result in structural damages, etc.). To assist you in determining prevailing wind conditions, refer to the Wind Velocity Chart (Table 2-1).

## Lifting Operations

If the boom extension, jib, or auxiliary boom nose is to be used, ensure the electrical cable and the weight for the anti-two-block switch are properly installed and the LMI is

programmed for the crane configuration. Refer to the LMI handbook supplied with the crane.

Before lifting, position the crane on a firm surface, properly extend and set the outriggers, and level the crane.

If the boom extension or auxiliary boom nose is to be used, you must ensure that the cable for the LMI system is properly connected at the junction box located on the boom nose.

Depending on the nature of the supporting surface, adequate cribbing may be required to obtain a larger bearing surface.

**DO NOT OVERLOAD THE CRANE** by exceeding the capacities shown on the appropriate Load Chart. Death or serious injury could result from the crane tipping over or failing structurally from overload.

Do not rely on the crane's tipping to determine your lifting capacity.

If you should encounter a tipping condition, immediately lower the load with the hoist line and retract or elevate the boom to decrease the load radius. Never lower or extend the boom, this will aggravate the condition.

Be sure the load is properly rigged and attached. Always determine the weight of the load before you attempt to lift it and remember that all rigging (slings, etc.) and lifting devices (hook block, jib, etc.) must be considered part of the load.

Measure the load radius before making a lift and stay within approved lifting areas based on the range diagrams and working area diagrams on the crane's load chart.

Verify the crane's capacity by checking the Load Chart against the weight of the load. Then, lift the load slightly at first to ensure stability before proceeding with the lift.

Always keep the load as near to the crane and as close to the ground as possible.

The crane can tip over or fail structurally if:

- The load and crane's configuration is not within the capacity as shown on the applicable load rating chart and notes.
- The ground is soft and/or the surface conditions are poor.
- Outriggers are not properly extended and set. On models equipped with outriggers that can be pinned at the mid-extend position, the outriggers must also be pinned when operating from the mid-extend position.
- Cribbing under the outrigger pads is inadequate.
- The crane is improperly operated.

Wind forces can exert extreme dynamic loads. **Grove recommends that a lift not be made if the wind can cause a loss of control in handling the load.** Grove recommends if the wind speed (velocity) is between 32 km/h (20 mph) to 48 km/h (30 mph), that the load capacities shall be reduced to account for the size and shape of the load and the wind direction in relation to the machine for all boom, boom extension, and jib lengths. Further, operation of the crane in wind velocities over 48 km/h (30 mph) is not recommended. To assist you in determining prevailing wind conditions, refer to the Wind Velocity Chart (Table 2-1).

The crane cab is equipped with a sight level bubble that should be used to determine whether the crane is level. The load line can also be used to estimate the levelness of the crane by checking to be sure it is in-line with the center of the boom at all points on the swing circle.

Use tag lines whenever possible to help control the movement of the load.

When lifting loads, the crane will lean toward the boom and the load will swing out, increasing the load radius. Ensure the load capacity chart is not exceeded when this occurs.

Be sure the hoist line is vertical before lifting. Do not subject the crane to side loading. A side load can tip the crane or cause it to fail structurally.

Do not strike any obstruction with the boom. If the boom should accidentally contact an object, stop immediately. Inspect the boom. Remove the crane from service if the boom is damaged.

Never push or pull with the crane boom.

Avoid sudden starts and stops when moving the load. The inertia and an increased load radius could tip the crane over or cause it to fail structurally.

Load Chart capacities are based on freely suspended loads. Do not pull posts, pilings, or submerged articles. Be sure the load is not frozen or otherwise attached to the ground before lifting.

Use only one hoist at a time when lifting loads.

Always use enough parts-of-line to accommodate the load to be lifted. Lifting with too few parts-of-line can result in failure of the wire rope.

Never operate the crane with less than two wraps of wire rope on the hoist drum.

## Counterweight

On cranes equipped with removable counterweights, ensure the appropriate counterweight sections are properly installed for the lift being considered.

To reduce the crushing hazard and to prevent death or serious injury, always clear all personnel from the counterweight and superstructure area before moving the counterweight or rotating the superstructure.

Do not add material to the counterweight to increase capacity.

Federal law prohibits modification or additions which affect the capacity or safe operation of the equipment without the manufacturer's written approval. [29CFR 1926.550]

## MULTIPLE CRANE LIFTS

Multiple crane lifts are not recommended.

Any lift that requires more than one crane must be precisely planned and coordinated by a qualified engineer.

If it is necessary to perform a multi-crane lift, the operator shall be responsible for assuring that the following minimum safety precautions are taken.

1. Secure the services of a qualified engineer to direct the operation.
2. Use one qualified signal person.
3. Coordinate lifting plans with the operator, engineer, and signal person prior to beginning the lift.
4. Communication between all parties must be maintained throughout the entire operation. If possible, provide approved radio equipment for voice communication between all parties engaged in the lift.
5. Use cranes and rigging of equal capabilities and use the same boom length.
6. Use outriggers on cranes so equipped.
7. Be certain cranes are of adequate lifting capacity.

8. Calculate the amount of weight to be lifted by each crane and attach slings at the correct points for proper weight distribution.
9. Ensure the load lines are directly over the attach points to avoid side loading and transfer of loading from one crane to the other.
10. DO NOT TRAVEL. Lift only from a stationary position.

## LOAD MOMENT INDICATING (LMI) SYSTEMS

Electronic equipment on this crane is intended as an aid to the operator.

Under NO CONDITION should it be relied upon to replace the use of capacity charts and operating instructions. Sole reliance upon these electronic aids in place of good operating practices can cause an accident.

Know the weight of all loads and always check the capacity of the crane as shown on the Load Chart before making any lifts.

NEVER exceed the rated capacity shown on the Load Chart. Always check the Load Chart to ensure the load to be lifted at the desired radius is within the rated capacity of the crane.

Never interfere with the proper functioning of operational aids or warning devices.

For detailed information concerning the operation and maintenance of the load moment indicating system installed on the crane see the manufacturer's manual supplied with the crane.

### Two-Blocking

Two-blocking occurs when the load block (hook block, headache ball, rigging, etc.) comes into physical contact with the boom (boom nose, sheaves, jib, etc.). Two-blocking can cause hoist lines (wire rope) rigging, reeving, and other components to become highly stressed and overloaded in which case the wire rope may fail allowing the load, block, etc. to free fall.

Two-blocking is more likely to occur when both the main and auxiliary hoist lines are reeved over the main boom nose and boom extension/jib nose respectively. An operator, concentrating on the specific line being used, may telescope or lower the boom allowing the other hoist line attachment to contact the boom or boom extension/jib nose, thus causing damage to the sheaves, or causing the wire rope to fail, dropping the lifting device to the ground and possibly injuring personnel working below.

Caution must be used when lowering or extending the boom. Let out load line(s) simultaneously to prevent two-blocking the boom tip(s) and the hook block, etc. The closer the load is carried to the boom nose the more important it becomes to simultaneously let out wire rope as the boom is lowered. Keep load handling devices a minimum of 107 cm (42 in) below the boom nose at all times.

Two-blocking can be prevented. Operator awareness of the hazards of two-blocking is the most important factor in preventing this condition. An anti two-block system is intended to assist the operator in preventing dangerous two-block conditions. It is not a replacement for operator awareness and competence.

To avoid death or serious injury, keep load handling devices away from boom/jib tip when extending or lowering the boom and when hoisting up.

This crane should have a functional ANTI-TWO-BLOCK and CONTROL LOCK-OUT system. Test daily for proper operation.

Do not pass loads or boom over ground personnel.

Barricade the area where the crane is working and keep all unnecessary personnel out of that area. DO NOT allow personnel to be under the load or boom.

Never pass loads, load handling devices, or the crane boom over people on the ground.

Never operate the crane with less than two wraps of wire rope on the hoist drum.

Never interfere with the proper functioning of operational aids or warning devices.

### ELECTROCUTION HAZARD

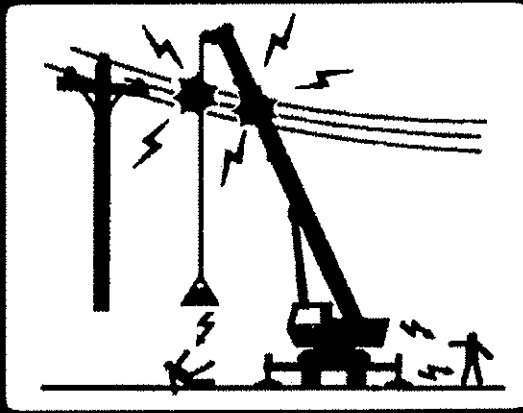
To avoid death or serious injury, keep all parts of this machine, the rigging, and materials being lifted at least 6 m (20 ft) away from all electrical power lines and equipment.

Keep all personnel away from this machine if it is being operated near electrical power lines or equipment.

Before operating this crane in the vicinity of electrical power lines or equipment, notify the power utility company. Obtain positive and absolute assurance that the power has been turned off.

This machine is NOT INSULATED. Always consider all parts of the load and the crane, including the wire rope, hoist cable, pendant cables, and tag lines, as conductors.

Most overhead power lines ARE NOT insulated. Treat all overhead power lines as being energized unless you have reliable information to the contrary from the utility company or owner.



**THIS CRANE IS NOT INSULATED.**

**⚠ DANGER**

**ELECTROCUTION HAZARD**

- TO AVOID DEATH OR SERIOUS INJURY, KEEP ALL PARTS OF THIS CRANE, THE RIGGING, AND MATERIALS BEING LIFTED AT LEAST 20 FEET AWAY FROM ALL ELECTRICAL POWER LINES AND EQUIPMENT.
- KEEP AWAY FROM THIS CRANE IF IT IS BEING OPERATED NEAR ELECTRICAL POWER LINES OR EQUIPMENT.
- BEFORE OPERATING THIS CRANE IN THE VICINITY OF POWER LINES OR EQUIPMENT, NOTIFY THE POWER UTILITY COMPANY. HAVE POWER TURNED OFF.
- FOLLOW INSTRUCTIONS IN OPERATOR'S AND SAFETY HANDBOOK.

The rules in this Operator's Manual must be followed at all times, even if the electrical power lines or equipment have been de-energized.

Crane operation is dangerous when close to an energized electrical power source. Exercise extreme caution and prudent judgement. Operate slowly and cautiously when in the vicinity of power lines.

If the load, wire rope, crane boom, or any portion of the crane contacts or comes too close to an electrical power source, everyone in, on, and around the crane can be seriously injured or killed.

The safest way to avoid electrocution is to stay away from electrical power lines and electrical power sources.

You, the operator, are responsible for alerting all personnel of dangers associated with electrical power lines and equipment. The crane is not insulated. Do not allow unnecessary personnel in the vicinity of the crane while operating. Permit no one to lean against or touch the crane. Permit no one, including riggers and load handlers, to hold the load, load lines, tag lines, or rigging gear.

Even if the crane operator is not affected by an electrical contact, others in the area may become seriously injured or killed.

It is not always necessary to contact a power line or power source to become electrocuted. Electricity, depending on magnitude, can arc or jump to any part of the load, load line, or crane boom if it comes too close to an electrical power source. Low voltages can also be dangerous.

Thoroughly read, understand, and abide by all applicable federal, state, and local regulations.

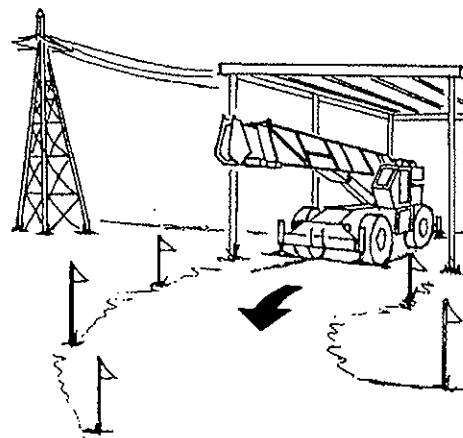
Federal law prohibits the use of cranes closer than 3 m (10 ft) to power sources up to 50,000 volts and greater distances for higher voltages [29CFR1910.180 and 29CFR1926.550].

Manitowoc/Grove recommends keeping cranes twice the minimum distance [e.g., 6 m (20 ft)] as specified by US Department of Labor - Occupational Safety and Health Administration (OSHA) standards.

### Set-Up and Operation

During crane use, assume that every line is energized ("hot" or "live") and take the necessary precautions.

Set up the crane in a position such that the load, boom, or any part of the crane and its attachments cannot be moved to within 6 m (20 ft) of electrical power lines or equipment. This includes the crane boom (fully extended to maximum height, radius, and length) and all attachments (jibs, boom extensions, rigging, loads, etc.). Overhead lines tend to blow in the wind so allow for lines' movement when determining safe operating distance.



A suitable barricade should be erected to physically restrain the crane and all attachments (including the load) from



entering into an unsafe distance from electrical power lines or equipment.

Plan ahead and always plan a safe route before traveling under power lines. Rider poles should be erected on each side of a crossing to assure sufficient clearance is maintained.

Appoint a reliable and qualified signal person, equipped with a loud signal whistle or horn and voice communication equipment, to warn the operator when any part of the crane or load moves near a power source. This person should have no other duties while the crane is working.

Tag lines should always be made of non-conductive materials. Any tag line that is wet or dirty can conduct electricity.

DO NOT store materials under power lines or close to electrical power sources.

### Electrocution Hazard Devices

The use of insulated links, insulated boom cages/guards, proximity warning devices, or mechanical limit stops does not assure that electrical contact will not occur. Even if codes or regulations require the use of such devices, failure to follow the rules listed here may result in serious injury or death. You should be aware that such devices have limitations and you should follow the rules and precautions outlined in this handbook at all times even if the crane is equipped with these devices.

Insulating links installed into the load line afford limited protection from electrocution hazards. Links are limited in their lifting abilities, insulating properties, and other properties that affect their performance. Moisture, dust, dirt, oils, and other contaminants can cause a link to conduct electricity. Due to their capacity ratings, some links are not effective for large cranes and/or high voltages/currents.

The only protection that may be afforded by an insulated link is below the link (electrically downstream), provided the link has been kept clean, free of contamination, has not been scratched or damaged, and is periodically tested (just before use) for its dielectric integrity.

Boom cages and boom guards afford limited protection from electrocution hazards. They are designed to cover only the boom nose and a small portion of the boom. Performance of boom cages and boom guards is limited by their physical size, insulating characteristics, and operating environment (e.g. dust, dirt, moisture, etc.). The insulating characteristics of these devices can be compromised if not kept clean, free of contamination, and undamaged.

Proximity sensing and warning devices are available in different types. Some use boom nose (localized) sensors and others use full boom length sensors. No warning may be given for components, cables, loads, and other attachments located outside of the sensing area. Much reliance is placed

upon you, the operator, in selecting and properly setting the sensitivity of these devices.

Never rely solely on a device to protect you and your fellow workers from danger.

Some variables you must know and understand are:

- Proximity devices are supposed to detect the existence of electricity and not its quantity or magnitude.
- Some proximity devices will detect only alternating current (AC) and not direct current (DC).
- Some proximity devices detect radio frequency (RF) energy and others do not.
- Most proximity devices simply provide a signal (audible, visual, or both) for the operator and this signal must not be ignored.
- Sometimes the sensing portion of the proximity devices becomes confused by complex or differing arrays of power lines and power sources.

DO NOT depend on grounding. Grounding of a crane affords little or no protection from electrical hazards. The effectiveness of grounding is limited by the size of the (wire) conductor used, the condition of the ground, the magnitude of the voltage and current present, and numerous other factors.

### Electrical Contact

If the crane should come in contact with an energized power source, you must:

1. Stay in the crane cab. DON'T PANIC.
2. Immediately warn personnel in the vicinity to stay away.
3. Attempt to move the crane away from the contacted power source using the crane's controls which are likely to remain functional.
4. Stay in the crane until the power company has been contacted and the power source has been de-energized. NO ONE must attempt to come close to the crane or load until the power has been turned off.

Only as a last resort should an operator attempt to leave the crane upon contacting a power source. If it is absolutely necessary to leave the operator station, JUMP COMPLETELY CLEAR OF THE CRANE. DO NOT STEP OFF. Hop away with both feet together. DO NOT walk or run.

Following any contact with an energized electrical source, the local, authorized, Grove distributor must be immediately advised of the incident and consulted on necessary inspections and repairs. Thoroughly inspect the wire rope and all points of contact on the crane. Should the distributor not be immediately available, contact Manitowoc CraneCARE. The crane must not be returned to service until it is thoroughly inspected for any evidence of damage and all

damaged parts are repaired or replaced as authorized by Manitowoc CraneCARE or your local Manitowoc/Grove distributor.

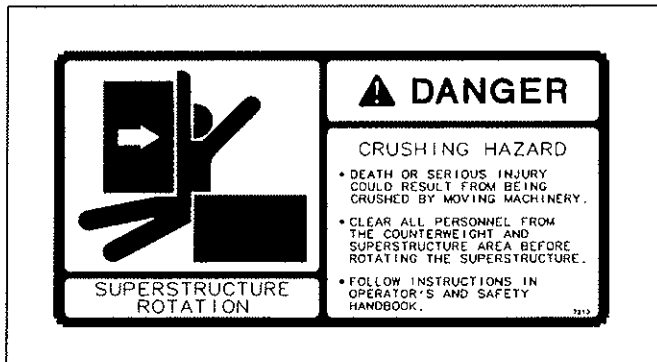
## Special Operating Conditions and Equipment

Never operate the crane during an electrical thunderstorm.

Working in the vicinity of radio frequency transmission towers and other transmission sources may cause a crane to become "electrically charged."

When operating cranes equipped with electromagnets you must take additional precautions. Permit no one to touch the magnet or load. Alert personnel by sounding a warning signal when moving a load. Do not allow the cover of the electromagnet power supply to be open during operation or at any time the electrical system is activated. Shut down the crane completely and open the magnet controls switch prior to connecting or disconnecting magnet leads. Use only a non-conductive device when positioning a load. Lower the magnet to the stowing area and shut off power before leaving the operator's cab.

## CRUSHING HAZARDS



Death or serious injury could result from being crushed by moving machinery.

Clear all personnel from the counterweight and superstructure area before removing the counterweight or rotating the superstructure.

Barricade the entire area where the crane is working and keep all unnecessary personnel out of the work area.

Never allow anyone to stand or work on or near the superstructure while the crane is in operation.

Always barricade the tail-swing of the rotating superstructure.

Before actuating swing or any other crane function, sound the horn and verify that all personnel are clear of rotating and moving parts.

Watch the path of the boom and load when swinging. Avoid lowering or swinging the boom and load into ground personnel, equipment, or other objects.

Always be aware of your working environment during operation of the crane. Avoid contacting any part of the crane with external objects.

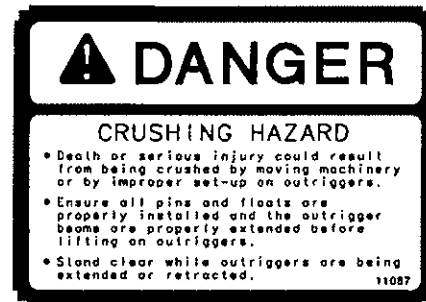
You must always be aware of everything around the crane while lifting or traveling. If you are unable to clearly see in the direction of motion, you must post a look out or signal person before moving the crane or making a lift. Sound the horn to warn personnel.

Clear all personnel from the outrigger area before extending or retracting the outriggers.

Carefully follow the procedures in this handbook when extending or retracting the outriggers. Death or serious injury could result from improper crane set up on outriggers.

Be sure the outriggers are properly extended, set and the crane is level for operation on outriggers.

All four outrigger beams must be equally extended to the mid position vertical stripe or fully extended position before beginning operation.



All four outrigger beam lock pins must be engaged before operating from the mid-extend position.

The operator must select the proper Load Chart and LMI program for the outrigger position selected.

Only the crane operator shall occupy the crane when traveling or in operation.

## PERSONNEL HANDLING

The American Society of Mechanical Engineers issued a new American National Standard entitled, Personnel Lifting Systems, ASME B30.23-1998. This standard provides, "lifting and lowering of personnel using ASME B30 Standard hoisting equipment shall be undertaken only in circumstances when it is not possible to accomplish the task by less hazardous means. Unless all of the applicable requirements of this volume are met, the lifting or lowering of personnel using ASME B30 Standard equipment is

prohibited." This new standard is consistent with the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) regulations for Construction that state, in 29CFR1926.550(g)(2): "General requirements. The use of a crane or derrick to hoist employees on a personnel platform is prohibited, except when the erection, use, and dismantling of conventional means of reaching the worksite, such as a personnel hoist, ladder, stairway, aerial lift, elevating work platform or scaffold, would be more hazardous or is not possible because of structural design or worksite conditions." Additional requirements for crane operations are stated in ASME B30.5, Mobile And Locomotive Cranes, and in OSHA regulations 29CFR1910.180 for General Industry and 29CFR1926.550 for Construction.

Use of a Grove crane to handle personnel is acceptable provided:

- The requirements of the applicable national, state and local regulations and safety codes are met.
- A determination has been made that use of a crane to handle personnel is the least hazardous means to perform the work.
- The crane operator shall be qualified to operate the specific type of hoisting equipment used in the personnel lift.
- The crane operator and occupants have been instructed in the recognized hazards of personnel platform lifts.
- The crane is in proper working order.
- The crane is equipped with a functional anti-two block device.
- The crane's load capacity chart is affixed inside the crane's cab, readily accessible to the operator. The total weight of the loaded personnel platform and related rigging shall not exceed 50 percent of the rated capacity for the radius and configuration of the crane.
- The crane is uniformly level within one percent of level grade and located on a firm footing. Cranes with outriggers shall have them all fully deployed following manufacturer's specifications.
- The crane's Operator's And Safety Handbook and other operating manuals are inside the crane's cab, readily accessible to the operator.
- The platform meets the requirements as prescribed by applicable standards and regulations.
- For wire rope suspended platforms, the crane is equipped with a hook that can be closed and locked, eliminating the throat opening.
- The platform is properly attached and secure.

To avoid death or serious injury:

NEVER use this crane for bungee jumping or any form of amusement or sport.

NEVER permit anyone to ride loads, hooks, slings or other rigging for any reason.

NEVER get on or off a moving crane.

NEVER allow anyone other than the operator to be on this crane while the machine is operating or traveling.

Manitowoc CraneCARE continues to recommend that cranes be properly maintained, regularly inspected and repaired as necessary. Manitowoc CraneCARE reminds crane owners to ensure that all safety decals are in place and legible. Manitowoc CraneCARE continues to urge Grove crane owners to upgrade their cranes with load moment indicator (LMI) and control lever lockout systems for all lifting operations.

The following standards and regulations are available by mail at the following addresses:

- ASME (formerly ANSI) B30 Series American National Safety Standards For Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, And Slings; ASME B30.5, Mobile And Locomotive Cranes, and ASME B30.23, Personnel Lifting Systems, are available by mail from the ASME, 22 Law Drive, Fairfield, New Jersey, 0700-2900
- US DOL/OSHA Rules and Regulations are available by mail from the Superintendent of Documents, PO Box 371954, Pittsburgh, PA, 15250-7954.

## TRAVEL OPERATION

- Strictly adhere to the guidelines and restrictions in the Load Chart for pick and carry operations.
- Before travel, fully retract and lower the boom into the boom rest and engage the turntable pin swing lock. See SECTION 3 for Traveling with Boom Extension Erected.
- Secure the hook block and other items before moving the crane.
- Follow the instructions in this handbook when preparing the crane highway travel.
- If using for a boom dolly/trailer, thoroughly read and understand all the steps and safety precautions in the handbook for setup and travel.
- Watch clearances when traveling. Do not take a chance of running into overhead or side obstructions.
- When moving in tight quarters, post a signal person to help guard against collisions or bumping structures.
- Never back up without the aid of a signal person to verify the area behind the crane is clear of obstructions and/or personnel.

- Check load limit of bridges. Before traveling across bridges, ensure they will carry a load greater than the crane's weight.
- Always drive the crane carefully, obeying speed limits and highway regulations.
- Keep lights on, use traffic warning flags and signs, and use front and rear flag vehicles when necessary. Check state and local restrictions and regulations.
- When parking on a grade, apply the parking brake and chock the wheels.

## ACCIDENTS

If this crane becomes involved in a property damage and/or personal injury accident, immediately contact your local Manitowoc/Grove distributor. If the distributor is unknown and/or cannot be reached, contact Product Safety and Reliability at:

**Manitowoc Crane Group**  
1565 East Buchanan Trail  
Shady Grove, PA 17256-0021

Phone: 888-777-3378 (888-PSR-DEPT)  
Fax: 717-593-5102  
E-mail: psafety@groveworldwide.com

Provide a complete description of the accident, including the crane model and serial number.

## MAINTENANCE

The crane must be inspected prior to use on each work shift. The owner, user, and operator must ensure that routine maintenance and lubrication are being dutifully performed. NEVER operate a damaged or poorly maintained crane.

Keep the crane properly maintained and adjusted at all times. Shut down the crane while making repairs or adjustments.

Always perform a function check after repairs have been made to ensure proper operation. Load tests should be performed when structural or lifting members are involved.

Follow all applicable safety precautions in this handbook when performing crane maintenance as well as crane operations.

Before crane use:

- Conduct a visual inspection for cracked welds, damaged components, loose pin/bolt, and wire connections. Any item or component that is found to be loose or damaged (broken, chipped, cracked, worn-through, etc.) must be repaired or replaced.
- Check for proper functioning of all controls and operator aids (e.g. LMI).

- Check all braking (e.g. wheel, hoist, and swing brakes) and holding devices before operation.

Keep the crane clean at all times, free of mud, dirt, and grease. Dirty equipment introduces hazards, wears-out faster, and makes proper maintenance difficult. Cleaning solutions used should be non-flammable, non-toxic and appropriate for the job.

**ROUTINE MAINTENANCE and INSPECTION of this crane must be performed by a qualified person(s)** according to the recommendations in the Grove Maintenance and Inspection Manual. Any questions regarding procedures and specifications should be directed to the your local, authorized Grove Distributor.

## Service and Repair

Service and repairs to the crane must only be performed by a qualified person. All service and repairs must be performed in accordance with manufacturer's recommendations, this handbook, and the service manual for this machine. All replacement parts must be approved by Manitowoc CraneCARE.

Any modification, alteration, or change to a crane which affects its original design and is not authorized and approved by Manitowoc CraneCare is STRICTLY PROHIBITED. Such action invalidates all warranties and makes the owner/user liable for any resultant accidents.

Before performing any maintenance, service or repairs on the crane:

- The boom should be fully retracted and lowered and the load placed on the ground.
- Stop the engine and disconnect the battery.
- Controls should be properly tagged. Never operate the crane if it is TAGGED-OUT nor attempt to do so until it is restored to proper operating condition and all tags have been removed by the person(s) who installed them.

Recognize and avoid pinch-points while performing maintenance. Stay clear of sheave wheels and holes in crane booms.

After maintenance or repairs:

- Replace all guards and covers that have been removed.
- Remove all tags, connect the battery, and perform a function check of all operating controls.
- Perform load tests when a structural or lifting member is involved in a repair.

## Lubrication

The crane must be lubricated according to the factory recommendations for lubrication points, time intervals, and

types. Lubricate at more frequent intervals when working under severe conditions.

Exercise care when servicing the hydraulic system of the crane, as pressurized hydraulic oil can cause serious injury. The following precautions must be taken when servicing the hydraulic system:

1. Follow the manufacturer's recommendations when adding oil to the system. Mixing the wrong fluids could destroy seals, causing machine failure.
2. Be certain all lines, components, and fittings are tight before resuming operation.
3. When checking for suspected leaks, use a piece of wood or cardboard and wear appropriate personal protective equipment.
4. Never exceed the manufacturer's recommended relief valve settings.

## Tires

Inspect the tires for nicks, cuts, embedded material, and abnormal wear.

Ensure all lug nuts are properly torqued.

Ensure pneumatic tires are inflated to the proper pressure (refer to the Load Chart Book in the crane cab). When inflating tires, use a tire gauge, clip-on inflator, and extension hose which will permit standing clear of the tire while inflating.

## Wire Rope

Use ONLY the wire rope specified by Manitowoc CraneCARE as indicated on the crane's load capacity chart. Substitution of an alternate wire rope may require the use of a different permissible line pull and, therefore, require different reeving.

**NOTE:** Wire rope may be purchased by contacting the Manitowoc CraneCARE Parts Department.

Always make daily inspections of the wire rope, keeping in mind that all wire rope will eventually deteriorate to a point where it is no longer usable. Wire rope shall be taken out of service when any of the following conditions exist:

1. For rotation-resistant running ropes—more than two (2) broken wires in a length of rope equal to six (6) times the rope diameter, or more than four (4) broken wires in a length of rope equal to thirty (30) times the rope diameter.
2. For running ropes other than rotation resistant—six (6) broken wires in one rope lay or three (3) broken wires in one strand.

3. One valley break where the wire fractures between strands in a running rope is cause for removal.
4. Abrasion of the rope resulting in wear of the individual outside wires of 1/3 of the original wire diameter.
5. Any kinking, bird caging, crushing, corrosion, or other damage resulting in distortion of the rope structure.
6. Rope that has been in contact with a live power line or has been used as a ground in an electric circuit (e. g. welding) may have wires that are fused or annealed and must be removed from service.
7. In standing ropes, more than three (3) breaks in one rope lay in sections beyond the end connection or more than two (2) broken wires at an end connection.
8. Core deterioration is usually observed as a rapid reduction in rope diameter and is cause for immediate removal of the rope.

Refuse to work with worn or damaged wire rope.

When installing and inspecting wire ropes and attachments, keep all parts of your body and clothing away from rotating hoist drums and all rotating sheaves.

Never handle the wire rope with bare hands.

Periodic rope inspection records are required by law. Make sure these records have been reviewed and are up to date.

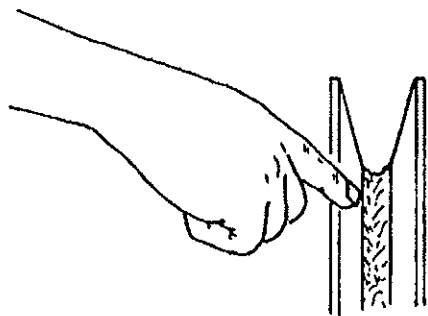
When installing a new rope:

- Follow proper instructions for removing rope from a reel.
- Apply back tension to the storage/payoff reel of the new rope to insure tight, even spooling onto the hoist drum.
- Operate the new rope - first through several cycles at light load and then through several cycles at intermediate load to allow the rope to adjust to operating conditions.

When using a wedge socket:

- Always inspect socket, wedge, and pin for correct size and condition.
- Do not use parts that are damaged, cracked, or modified.
- Assemble the wedge socket with live end of rope aligned with the centerline of pin and assure proper length of tail (dead end) protrudes beyond the socket.

Never overload or shock load a wire rope. Lubricate the wire rope periodically as the lubricant becomes depleted.



Inspect the boom nose and hook block sheaves for wear. Damaged sheaves cause rapid deterioration of wire rope.

To attain maximum wire rope life and minimize hook block rotation, it is recommended that even numbers of parts-of-line be used in multiple-part reeving whenever possible.

If applicable to your crane, the use of nylon (nylatron) sheaves, as compared with metallic sheaves, may change the replacement criteria of rotation-resistant wire rope.

**NOTE:** If applicable to your crane, the use of cast nylon (nylatron) sheaves, as compared with steel sheaves, will substantially increase the service life of wire rope. However, conventional rope retirement criteria based only upon visible wire breaks may prove inadequate in predicting rope failure. The user of cast nylon sheaves is therefore cautioned that a retirement criteria should be established based upon the user's experience and the demands of his application.

## BATTERIES

Battery electrolyte must not be allowed to contact the skin or eyes. If this occurs, flush the contacted area with water and consult a doctor immediately.

When checking and maintaining batteries exercise the following procedures and precautions:

- Disconnect the batteries.
- Wear safety glasses when servicing batteries.
- Do not short across the battery posts to check charge. Short circuit, spark, or flame could cause battery explosion.
- Maintain battery electrolyte at the proper level. Check the electrolyte with a flashlight.
- If applicable to your crane, check battery test indicator on maintenance-free batteries.
- Do not break a live circuit at the battery terminal. Disconnect the ground battery cable first when removing a battery and connect it last when installing a battery.

- Check battery condition only with proper test equipment. Batteries shall not be charged except in an open, well-ventilated area that is free of flame, smoking, sparks, and fire.

## ENGINE

Be careful when checking the engine coolant level. The fluid may be hot and under pressure. Shut down the engine and allow the radiator time to cool before removing the radiator cap.

Shut down the engine and disconnect the battery before performing maintenance. If unable to do so for the task required, keep hands clear of the engine fan and other moving parts while performing maintenance.

Be careful of hot surfaces and hot fluids when performing maintenance on or around the engine.

## WORK PRACTICES

### Crane Access

You must take every precaution to ensure you do not slip and/or fall off the crane. Falling from any elevation could result in serious injury or death.

Never exit or enter the crane cab or deck by any other means than the access system(s) provided (i.e., steps and grab handles).

If necessary, use a ladder or aerial work platform to access the boom nose.

Do not step on surfaces on the crane that are not approved or suitable for walking and working. All walking and working surfaces on the crane should be clean, dry, slip-resistant, and have adequate supporting capacity. Do not walk on a surface if slip-resistant material is missing or excessively worn.

Do not use the top of the boom as a walkway.

Do not step on the outrigger beams or outrigger pads (floats) to enter or exit the crane.

Wear shoes with a highly slip-resistant sole material. Clean any mud or debris from shoes before entering the crane cab or climbing onto the crane superstructure. Excessive dirt and debris on the hand-holds, access steps, or walking/working surfaces could cause a slipping accident. A shoe that is not clean might slip off a control pedal during operation.

Do not make modifications or additions to the crane's access system that have not been evaluated and approved by Manitowoc CraneCARE.

### Job Preparation

You must inspect the crane prior to your work shift - checking for cracked welds, damaged components, and evidence of

improper maintenance (consult Maintenance-Inspection and Service Manual).

You must ensure that the crane is properly equipped including access steps, covers, doors, guards, and controls.

You must ensure that the outriggers are properly extended and set before performing any lifting operations. On models equipped with outriggers that can be pinned at the mid-extend position, the outriggers must also be pinned when operating from the mid-extend position.

Wear appropriate clothing and personal protective equipment whether or not required by local or job regulations. Be prepared for the work day.

Before entering the cab, you must be THOROUGHLY familiar with the planned route of travel and area of operation, including surface conditions and the presence of overhead obstructions and power lines.

Always keep the crane clean, free of dirt, debris, and grease.

Fuel the crane ONLY with the engine turned off. Do not smoke while fueling the crane. Do not store flammable materials on the crane or in the operator's cab.

Follow standard safety precautions when refueling. **FUEL IT SAFELY.**

Be familiar with the location and use of the nearest fire extinguisher.

Cold weather requires special starting procedures, use of built-in starting aids, if provided, and ample time for hydraulic oil to warm-up. Keep the crane free of ice and snow.

## Working

Never operate the crane when darkness, fog, or other visibility restrictions make operation unsafe. Never operate a crane in thunderstorms or high winds.

Keep unauthorized personnel clear of the working area during operation.

Operate the crane only from the operator's seat. Do not reach in a window or door to operate any controls.

Operate the crane slowly and cautiously, looking carefully in the direction of movement.

"Stunt" driving and "horse-play" are strictly prohibited. Never allow anyone to hitch a ride or get on or off a moving crane.

A good practice is to make a "dry run" without a load before making the first lift. Become familiar with all factors peculiar to the job site.

Ensure the wire rope is properly routed on the hook block and boom nose and that all rope guards are in place.

**USE ENOUGH PARTS OF LINE FOR ALL LIFTS AND CHECK ALL LINES, SLINGS, AND CHAINS FOR CORRECT ATTACHMENT.** To obtain maximum lifting

capacities, the hook block must be set up with enough parts of line. **NO LESS THAN TWO WRAPS** of wire rope should remain on the hoist drum. When slings, ties, hooks, etc., are used, make certain they are correctly positioned and secured before raising or lowering the loads.

Be sure the rigging is adequate before lifting. Use tag lines when possible to position and restrain loads. Personnel using tag lines should be on the ground.

Be sure good rigging practices are being used. Refuse to use any poorly maintained or damaged equipment. Never wrap the hoist cable around a load.

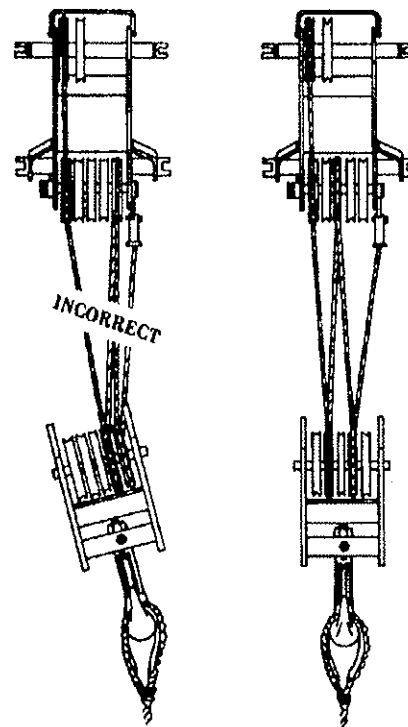
## Lifting

Operate the crane at or near governed RPM during all lifting operations.

Check the hoist brake by raising the load a few inches, stopping the hoist and holding the load. Be sure the hoist brake is working correctly before continuing the lift.

When lowering a load always slow down the load's descent before stopping the hoist. Do not attempt to change speeds on multiple-speed hoists while the hoist is in motion.

**LIFT ONE LOAD AT A TIME.** Do not lift two or more separately rigged loads at one time, even if the loads are within the crane's rated capacity.



Never leave the crane with a load suspended. Should it become necessary to leave the crane, lower the load to the ground and stop the engine before leaving the cab.

Remember - all rigging equipment must be considered as part of the load. Lifting capacities vary with working areas. Permissible working areas are posted in the crane cab. When swinging from one working area to another, ensure load chart capacities are not exceeded. Know your crane!

Never swing or lower the boom into the carrier cab.

Stop the hook block from swinging when unhooking a load.

Swinging rapidly can cause the load to swing out and increase the load radius. Swing the load slowly. Swing with caution and keep the load lines vertical.

Look before swinging your crane. Even though the original setup may have been checked, situations do change.

Keep everyone away from suspended loads. Allow no one to walk under a load. Ensure that all slings, ties, and hooks are correctly placed and secured before raising or lowering the load.

Use tag lines (as appropriate) for positioning and restraining loads. Check the load slings before lifting.

Be sure everyone is clear of the crane and work area before making any lifts.

Never swing over personnel, regardless of whether load is suspended from or attached to the boom.

Be sure the load is well secured and attached to the hook with rigging of proper size and in good condition.

Use only slings or other rigging devices rated for the job and use them properly. Never wrap the hoist cable around a load.

Check all tackle, hardware, and slings before use. Refuse to use faulty equipment.

Never work the crane when darkness, fog, or other visibility restrictions make such operations unsafe.

## Hand Signals

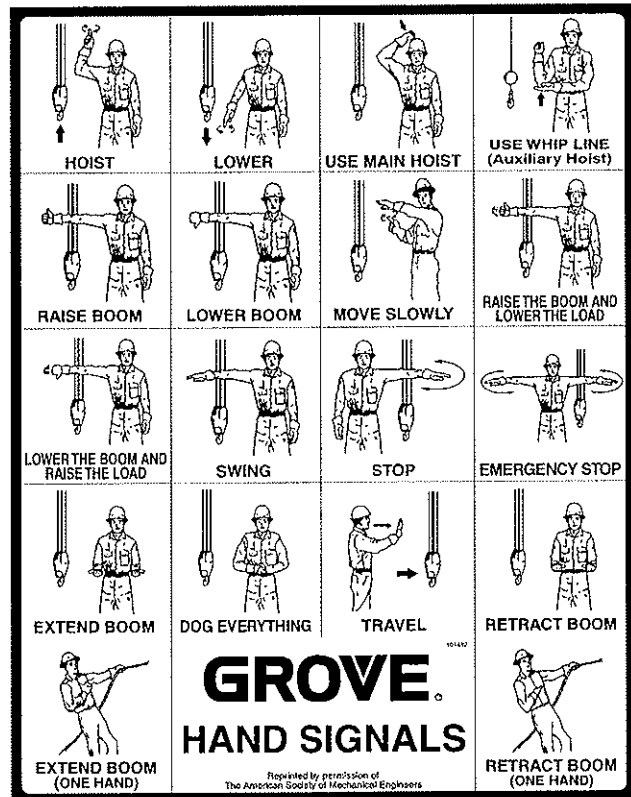
A qualified signal person shall be used at all times when:

- Working in the vicinity of power lines.
- The crane operator cannot clearly see the load at all times.
- Moving the crane in an area or direction in which the operator cannot clearly see the path of travel.

At all times use standardized hand signals - previously agreed upon and completely understood by the operator and signal person.

If communication with the signal person is lost, crane movement must be stopped until communications are restored.

Keep your attention focused on the crane's operation. If for some reason you must look in another direction, stop all crane movement first.



When vision is obscured, use and follow the directions of a single qualified signal person.

Obey a signal to stop from anyone.

## TRANSPORTING THE CRANE

When loading or unloading the crane on a trailer or railroad car, use a ramp capable of supporting the weight of the crane.

Ensure the crane is adequately secured to the transporting vehicle.

If it is necessary to take the crane on a road or highway, first check state and local restrictions and regulations.

Check load limits of bridges on the travel route and ensure they are greater than the combined weight of the crane and transporting vehicle.

Always drive the crane carefully, obeying speed limits and highway regulations. Keep lights on and use traffic warning flags and signs and front and rear flag vehicles as applicable.

## SHUT-DOWN

Never leave the crane with a load suspended. Lower the load to the ground before shutting down the crane.

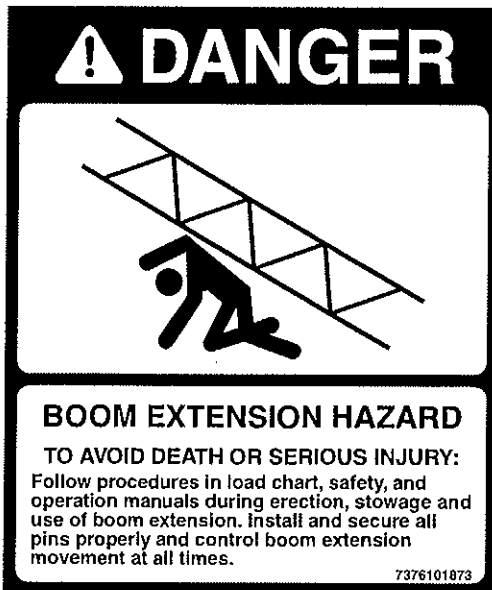
Use the following steps when shutting down the crane:



- Engage the parking brake.
- Fully retract and lower the boom.
- Engage the pin swing lock or 360 degree swing lock.
- Place controls in neutral position.
- Shut down the engine and remove the ignition key.
- Chock the wheels.
- Lock the operator's cab and install vandal guards, if used.

In cold weather, never park the crane where the tires can become frozen to the ground.

## BOOM EXTENSION/JIB



To avoid death or serious injury, follow proper procedures during erection, stowage, and use of the boom extension/jib.

Install and secure all pins properly.

Control movement of boom extension/jib at all times.

Do not remove right side boom nose pins unless boom extension is properly pinned and secured on front and/or rear stowage brackets.

Do not remove all the pins from both front and rear stowage brackets unless the boom extension is pinned to the right side of the boom nose.

See the appropriate section of this handbook for the proper boom extension/jib erection and stowage procedure.

Properly inspect, maintain, and adjust boom extension/jib and mounting.

Slings jib sections from the main chords or the end fittings.

When assembling and disassembling jib sections, use blocking to adequately support each section and to provide proper alignment.

Stay outside of jib sections and lattice work.

Watch for falling or flying pins when they are being removed.

## COLD WEATHER OPERATION

Cold weather operation requires additional caution on the part of the operator.

Check operating procedures for cold weather starting. During cold weather operation, it is recommended that a cold engine be started from the carrier cab with the pump disconnected.

Don't touch metal surfaces that could freeze you to them.

Clean the crane of all ice and snow.

Allow ample time for hydraulic oil to warm up.

In freezing weather, park the crane in an area where it cannot become frozen to the ground. The drive line can be damaged when attempting to free a frozen crane.

If applicable to your crane, frequently check all air tanks for water in freezing weather.

If applicable to your crane, always handle propane tanks according to the supplier's instructions.

Never store flammable materials on the crane.

If cold weather starting aids are provided on your crane, use them. The use of aerosol spray or other types of starting fluids containing ether/volatiles can cause explosions or fire.

## TEMPERATURE EFFECTS ON HYDRAULIC CYLINDERS

Hydraulic oil expands when heated and contracts when cooled. This is a natural phenomena that happens to all liquids. The coefficient of expansion for API Group 1 hydraulic oil is approximately 0.00043 cubic inches per cubic inch of volume for 1°F of temperature change. **Thermal contraction will allow a cylinder to retract as the hydraulic fluid which is trapped in the cylinder cools.** The change in the length of a cylinder is proportional to the extended length of the cylinder and to the change in temperature of the oil in the cylinder. For example, a cylinder extended 25 feet in which the oil cools 60°F would retract approximately 7 3/4 inches (see chart below). A cylinder extended 5 feet in which the oil cools 60°F would only retract approximately 1 1/2 inches. The rate at which the oil cools depends on many factors and will be more noticeable with a larger difference in oil temperature verses the ambient temperature.

Thermal contraction coupled with improper lubrication or improper wear pad adjustments may, under certain

conditions, cause a "stick-slip" condition in the boom. This "stick-slip" condition could result in the load not moving smoothly. Proper boom lubrication and wear pad adjustment is important to permit the boom sections to slide freely. Slow movement, of the boom may be undetected by the operator unless a load is suspended for a long period of time.

If a load and the boom is allowed to remain stationary for a period of time and the ambient temperature is cooler than the trapped oil temperature, the trapped oil in the cylinders will cool. The load will lower as the telescope cylinder(s) retracts allowing the boom to come in. Also, the boom angle will decrease as the lift cylinder(s) retracts causing an increase in radius and a decrease in load height.

This situation will also occur in reverse. If a crane is set up in the morning with cool oil and the daytime ambient

temperature heats the oil, the cylinders will extend in similar proportions.

Figure 2-2 has been prepared to assist you in determining the approximate amount of retraction/extension that may be expected from a hydraulic cylinder as a result of change in the temperature of the hydraulic oil inside the cylinder. The chart is for dry rod cylinders. If the cylinder rod is filled with hydraulic oil, the contraction rate is somewhat greater.

**NOTE:** Operators and service personnel must be aware that load movement, as a result of this phenomena, can be easily mistaken as leaking cylinder seals or faulty holding valves. If leaking seals or faulty holding valves are suspected to be the problem, refer to Service Bulletin 98-036 dealing with testing telescope cylinders

**Table 2-2: BOOM DRIFT CHART (Cylinder length change in inches)**

Coeff. = 0.00043 (in <sup>3</sup> /in <sup>3</sup> / °F)											
STROKE (FT.)	Temperature Change (°F)										
	10	20	30	40	50	60	70	80	90	100	
5	0.26	0.52	0.77	1.03	1.29	1.55	1.81	2.06	2.32	2.58	
10	0.52	1.03	1.55	2.06	2.58	3.10	3.61	4.13	4.64	5.16	
15	0.77	1.55	2.32	3.10	3.87	4.64	5.42	6.19	6.97	7.74	
20	1.03	2.06	3.10	4.13	5.16	6.19	7.22	8.26	9.29	10.32	
25	1.29	2.58	3.87	5.16	6.45	7.74	9.03	10.32	11.61	12.90	
30	1.55	3.10	4.64	6.19	7.74	9.29	10.84	12.38	13.93	15.48	
35	1.81	3.61	5.42	7.22	9.03	10.84	12.64	14.45	16.25	18.06	
40	2.06	4.13	6.19	8.26	10.32	12.38	14.45	16.51	18.58	20.64	
45	2.32	4.64	6.97	9.29	11.61	13.93	16.25	18.58	20.90	23.22	
50	2.58	5.16	7.74	10.32	12.90	15.48	18.06	20.64	23.22	25.80	
55	2.84	5.68	8.51	11.35	14.19	17.03	19.87	22.70	25.54	28.38	
60	3.10	6.19	9.29	12.38	15.48	18.58	21.67	24.77	27.86	30.96	

Length change in inches = Stroke (Ft.) X Temperature Change ( °F) X Coeff. (in<sup>3</sup>/in<sup>3</sup>/ °F) X 12 in/ft

## SECTION 3

### OPERATING CONTROLS AND PROCEDURES

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## SECTION 3

### OPERATING CONTROLS AND PROCEDURES

The following paragraphs describe all the available (standard and optional) controls and indicators located in the cab. Some machines may not be equipped with the optional controls shown. The cab utilizes international symbols to label the various controls.

The numbers in ( ) represent the index number from (Figure 3-1), (Figure 3-2) and (Figure 3-3).

**NOTE:** All rocker switches contain one or two LED's in the switch for illumination.

**NOTE:** All indicators on the top row of the console will illuminate solid, all at the same time for approximately two seconds as a diagnostic test when the ignition switch is positioned to on. If any indicator fails to illuminate, replace it immediately.

#### CONTROLS AND INDICATORS

##### Tachometer with Hourmeter

The tachometer/hourmeter (1) is located in the center of the front console and registers engine RPM and speed of rotation. The tachometer is calibrated in rpm x 100 with a range of zero (0) to 35. It receives a signal from the crane's electronic operating system which receives the signal from the engine ECM via J1939.

The hourmeter at the bottom of the tachometer is used to register hours of engine operation.

##### Gauge Cluster

The gauge cluster (2) is located in the center of the front console assembly and contains a voltmeter, oil pressure gauge, water temperature gauge and a fuel quantity gauge.

##### Voltmeter

The voltmeter (VOLTS) is located on the lower right of the gauge cluster. With the ignition switch in the run (between vertical and far right) position and before starting the engine, the voltmeter indicates the condition of the batteries. With the engine running, the voltmeter indicates output voltage of the alternator. The voltmeter scale is from 10 to 16 volts.

##### Engine Oil Pressure Gauge

The engine oil pressure (OIL) gauge is located on the upper right of the gauge cluster. The gauge indicates the engine oil pressure on a scale calibrated from zero (0) to 80 psi. It receives a signal from the crane's electronic operating system which receives the signal from the engine ECM via J1939.

##### Water Temperature Gauge

The engine coolant temperature (TEMP) gauge is located on the lower left of the gauge cluster. The gauge indicates the engine coolant temperature on a scale calibrated from 100° to 240° F. The gauge receives a signal from the crane's electronic operating system which receives the signal from the engine ECM via J1939.

##### Fuel Quantity Gauge

The fuel quantity (FUEL) gauge is located on the upper left of the gauge cluster. The gauge indicates the quantity of fuel in the tank and has a scale calibrated from empty (E) to full (F). The fuel quantity gauge receives a signal from the crane's electronic operating system which monitors a sending unit in the fuel tank.

##### Right Turn Signal Indicator

The right turn signal indicator (3) is located on the top right side of the front console. It is a green indicator light that flashes when the turn signal lever or hazard switch is pushed up.

##### Left Turn Signal Indicator

The left turn signal indicator (4) is located on the top left side of the front console. It is a green indicator light that flashes when the turn signal lever or hazard switch is pulled down.

##### Four Wheel Engaged/Rear Wheels Not Centered Indicator

The rear wheels not centered indicator (5) is located on the left side of the front console. The bottom of the indicator will illuminate amber any time the rear wheels are not centered, after the Rear Steer Control Switch (63) is activated. The indicator in the top of the switch will illuminate amber to indicate that four-wheel drive has been activated by the Drive Select Switch (28).

##### High Beam/Lamp Malfunction Indicator

The headlight high beam/lamp malfunction indicator (6) is located on the top left of the front console. The indicator is a blue light that illuminates when the headlights are on high beam or amber when there is a lamp malfunction.

##### Low Brake Pressure/Low Fuel Level Indicator

The low brake pressure indicator (7) is located on the top left side of the front console. The top of the switch illuminates red and a warning buzzer is activated when the pressure in the

dual accumulator charge valve falls below normal operating requirements.

The bottom of the switch illuminates amber if the fuel level is low.

### Engine Wait To Start Indicator/Transmission Service Indicator (XMSN)

The engine wait to start indicator (8) is located on the top left side of the front console. The top of the switch illuminates amber for a period of time when the ignition switch is turned to the on position. The engine should not be cranked until the wait to start indicator turns off.

The bottom of the switch illuminates red and a warning buzzer sounds for high transmission oil temperature condition.

### Engine Warning/Electrical System Diagnostic Indicator

The engine warning/electrical system diagnostic indicator (9) is located at the top left side of the front console. The top portion is the warning indicator. It illuminates amber when energized by a signal from the engine ECM that signals the operator of an engine problem which must be corrected.

In addition to alerting the operator of system faults, the warning light, in conjunction with the stop light, is used in the diagnostic operation of the engine control system. The diagnostic mode begins when the ignition and engine diagnostic switch is on and the engine is not running. The amber light flashes at the beginning of a fault code sequence, the red light flashes the three-digit or four-digit code for the active fault and the amber light flashes again to separate the previous red light sequence from the next one. Each code will be flashed twice before moving to the next code. When all codes have been flashed, the sequence will begin again. If no codes are present, both the warning and stop lights will remain on.

The bottom portion of the switch is the electrical system diagnostic indicator. There are three conditions for this indicator as follows:

- a. On solid with buzzer sounding - There is an interruption of communication over the main canbus control line between the crane's electronic control modules. Proper crane operating condition shall be restored as quickly as possible.
- b. Flashing with buzzer sounding - An undesirable condition with the crane's joysticks has been detected. Proper crane operating condition shall be restored before performing any hydraulic function.

- c. Flashing without buzzer - An undesirable component or electrical system condition has occurred.

### Engine Stop/Module Off Line Indicator

The engine stop/module off line indicator (10) is located on the top left side of the front console. The top portion of the switch is the stop indicator. It illuminates red when energized by a signal from the engine ECM that signifies a serious engine problem that requires the vehicle and the engine to be stopped as soon as safely possible. In addition, a warning buzzer will also sound.

In addition to alerting the operator of system faults, the stop light, in conjunction with the warning light, is used in the diagnostic operation of the engine control system. The diagnostic mode begins when the ignition and engine diagnostic switch is on and the engine is not running. The amber light flashes at the beginning of a fault code sequence, the red light flashes the three-digit or four-digit code for the active and the amber light flashes again to separate the previous red light sequence from the next one. Each code will be flashed twice before moving to the next code. When all codes have been flashed, the sequence will begin again. If no codes are present, both the warning and stop lights will remain on.

The bottom portion is the module off line indicator. This indicator will illuminate solid red and a buzzer will sound whenever communication with one of the crane's electronics modules is lost. The vehicle should be stopped as soon as safely possible. The crane must be restored to proper condition before operating again.

### Park Brake/Swing Brake Engaged Indicator

The park brake engaged indicator (11) is located on the left side of the front console. The top of the indicator illuminates red when the crane parking brakes are applied. It is illuminated by a pressure switch on the parking brake valve.

The bottom of the indicator illuminates red to warn the operator that the swing brake is engaged.

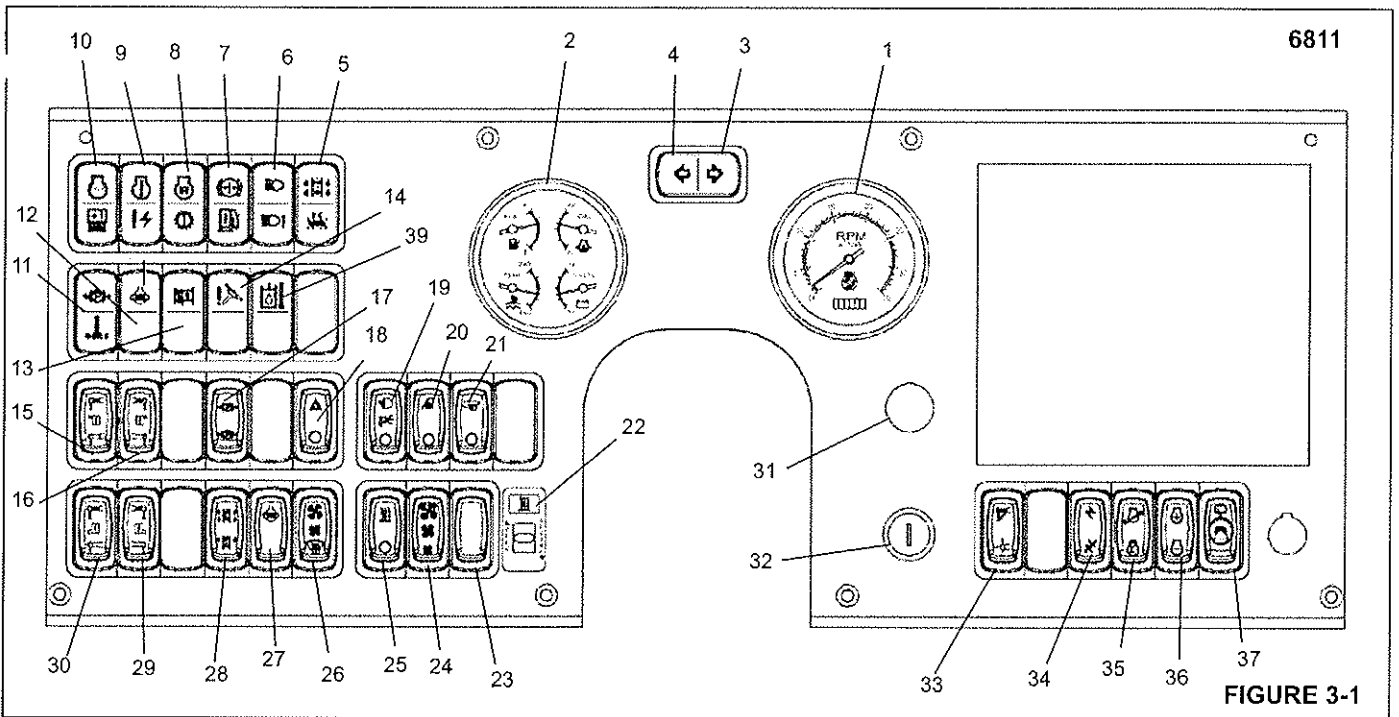
### Inter-Axle Differential Lock Indicator

The inter-axle differential lock indicator (12) is located on the left side of the front console. The amber indicator illuminates when the inter-axle differential lock is engaged.

### Hoist 3rd Wrap Indicator (Optional w/CE)

The hoist 3rd wrap indicator (13) (optional w/CE) is located on the left side of the front console. The indicator is a red light that will illuminate when three wraps or less of cable remains on either hoist. This light is controlled by the LMI System.





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FIGURE 3-1

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Item	Description
1	Tachometer with Hourmeter
2	Gauge Cluster
3	Right Turn Signal Indicator
4	Left Turn Signal Indicator
5	Four Wheels Engaged/Rear Wheels Not Centered Indicator
6	High Beam/Lamp Malfunction Indicator
7	Low Brake Pressure/Low Fuel Level Indicator
8	Engine Wait to Start Indicator/Transmission Service Indicator (XMSN)
9	Engine Warning/Electrical System Diagnostic Indicator
10	Engine Stop/Module Off Line Indicator
11	Park Brake/Swing Brake Indicator
12	Inter-Axle Differential Lock Indicator
13	Hoist 3rd Wrap Indicator (Optional w/CE)
14	Low Steer Pressure Indicator (CE Option)
15	Left Front Outrigger Beam/Stabilizer Switch
16	Right Front Outrigger Beam/Stabilizer Switch
17	Park Brake On/Off Switch
18	Hazard Light Switch

Item	Description
19	Headlights Switch
20	Work Lights Switch
21	Boom Lights Switch (Optional)
22	Heater Control Switch
23	Air Condition Switch (Optional)
24	Hi/Med/Lo Fan Switch
25	Heater On/Off Switch
26	Fan Defroster Switch
27	Cross Differential Axle Lock Switch (Optional)
28	Drive Axle Selector Switch
29	Right Rear Outrigger Beam/Stabilizer Switch
30	Left Rear Outrigger Beam/Stabilizer Switch
31	Emergency Stop Switch
32	Ignition Switch
33	Outrigger Extend/Retract Switch
34	Crane Function Power Switch
35	Engine Idle/Diagnostic Switch
36	Engine Increment/Decrement Switch
37	Skylight Wiper Switch
38	Throttle Pedal
39	Hydraulic Oil Cooler High Temp Indicator

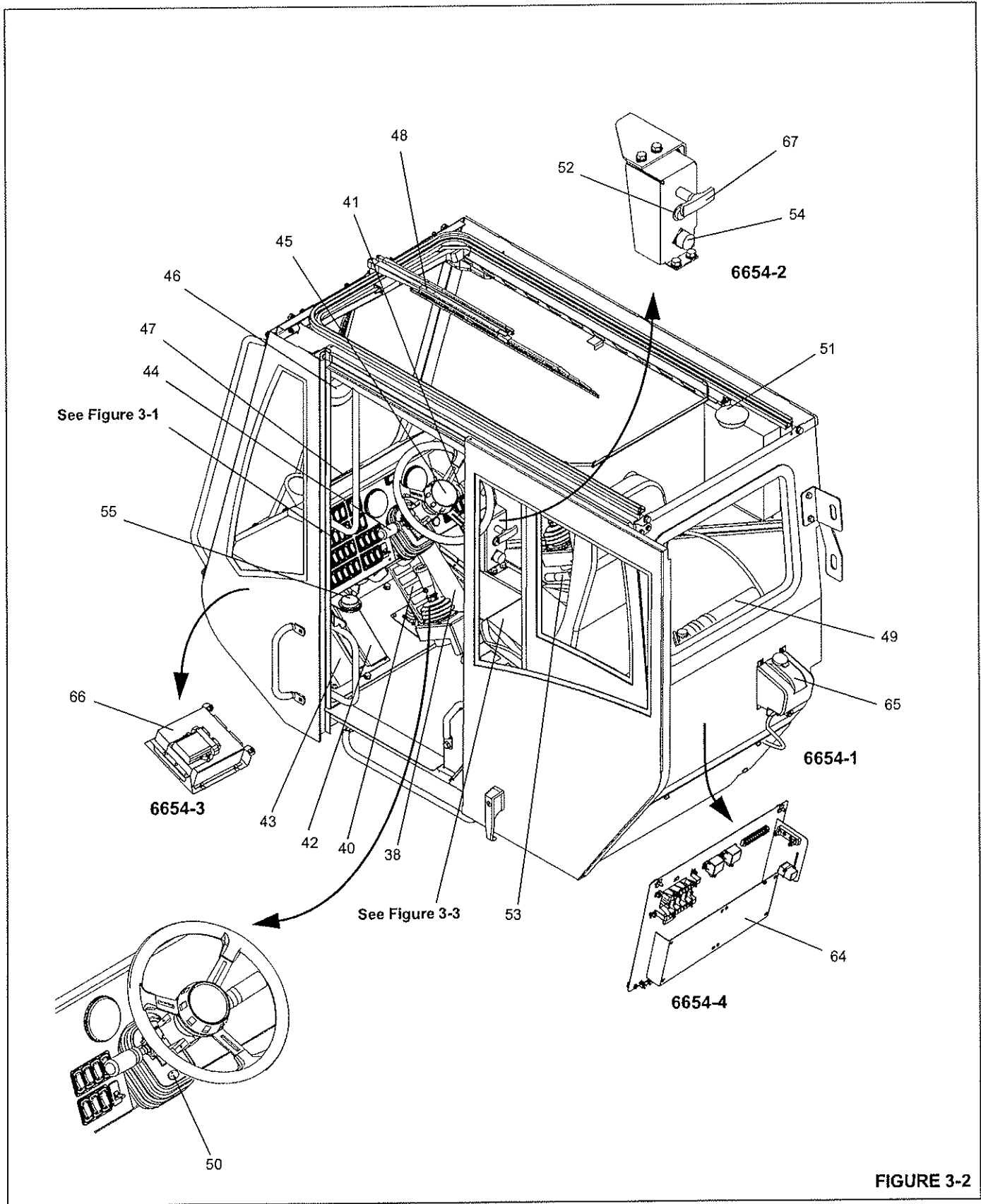


FIGURE 3-2

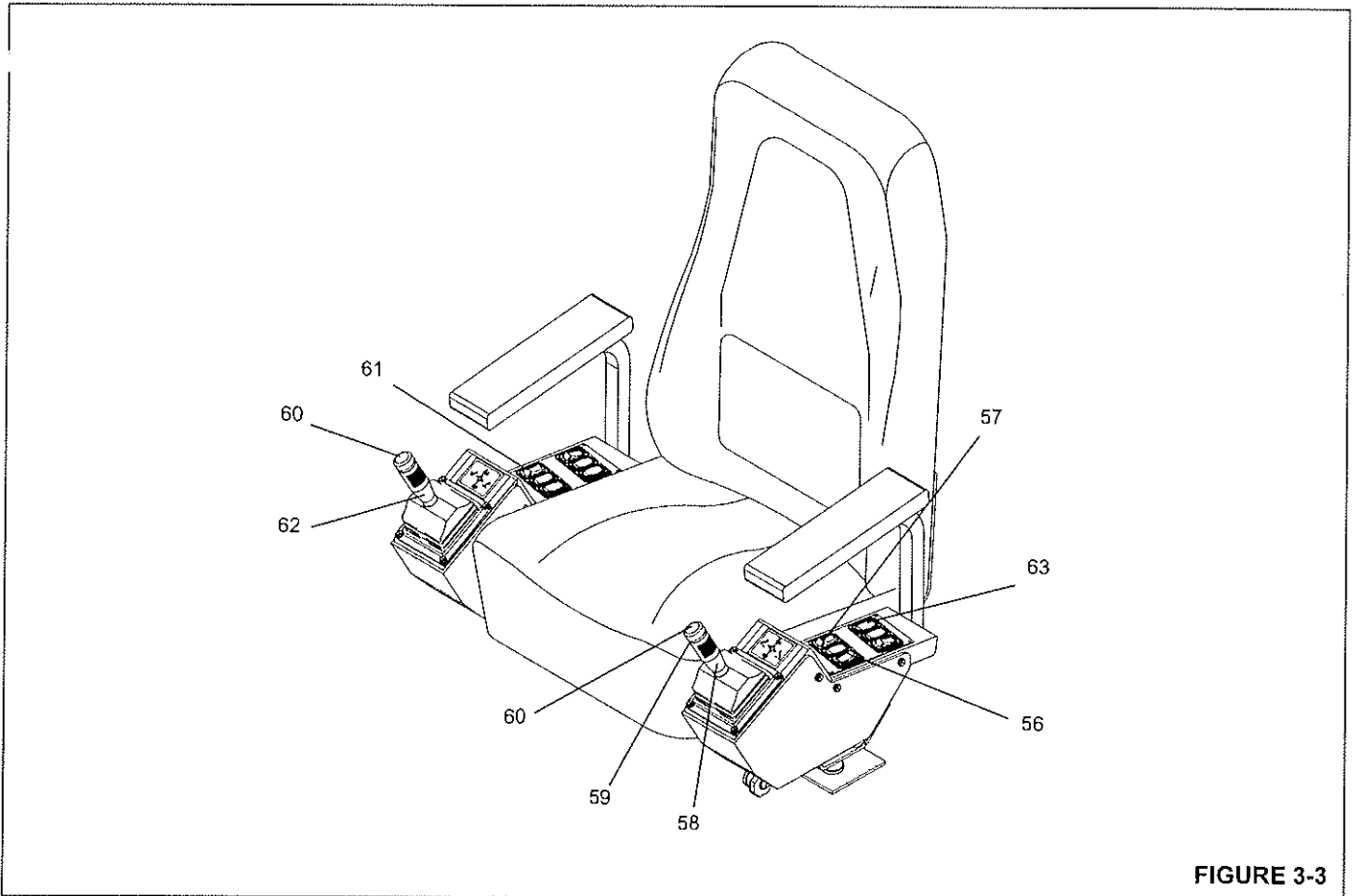


FIGURE 3-3

3

Item	Description
40	Service Brake Pedal
41	Transmission Shift Gear
42	Telescope Control Foot Pedal (Optional w/ Auxiliary Hoist)
43	Swing Brake Pedal
44	Turn Signal Lever
45	Horn Button
46	Cab Circulating Fan
47	Defroster Fan
48	Skylight Wiper
49	Fire Extinguisher
50	Steering Column Tilt Switch
51	Cab Dome Light
52	12 VDC Accessory Outlet
53	360° Swing Lock Control (Positive Lock Type) (Optional)

Item	Description
54	Electrical Diagnostic Connector
55	Bubble Level Indicator
56	Swing Brake Selector Switch
57	Auxiliary Hoist Speed Selector Switch
58	Telescope/Auxiliary Hoist/Swing Controller
59	Swing Horn Button
60	Hoist Rotation Indicators (Main and Auxiliary Hoist)
61	Main Hoist Speed Selector Switch
62	Boom Lift/Main Hoist Controller
63	Rear Steer Control Switch
64	Fuse Panel
65	Canister Pump Assembly
66	Cab Control Module
67	Turntable Lock Control (Pin Type)

### **Low Steer Pressure Indicator (CE Option)**

The low steer pressure indicator (14) is located on the left side of the front console. The indicator illuminates red and a buzzer is activated when the steer pressure hydraulic pressure is low.

### **Left Front Outrigger Beam/Stabilizer Switch**

#### ***Left Front Outrigger Switch***

The left front outrigger switch (15) is located on the left side of the front console. It is a three-position switch used to extend or retract the left front stabilizer and extension cylinders. It must be used in conjunction with the outrigger extend/retract switch (33) located on the right side of the front console.

To extend the left front outrigger beam, push the top of the outrigger extend/retract switch (33) and the top of the left front outrigger switch.

To retract the left front outrigger beam, push the bottom of the outrigger extend/retract switch (33) and the top of the left front outrigger switch.

To extend the left front stabilizer, push the top of the outrigger extend/retract switch (33) and the bottom of the right front outrigger switch.

To retract the left front stabilizer, push the bottom of the outrigger extend/retract switch (33) and the bottom of the right front outrigger switch.

### **Right Front Outrigger Beam/Stabilizer Switch**

#### ***Right Front Outrigger Switch***

The right front outrigger switch (16) is located on the left side of the front console. It is a three-position switch used to extend or retract the right front stabilizer and extension cylinders. It must be used in conjunction with the outrigger extend/retract switch (33).

To extend the right front outrigger beam, push the top of the outrigger extend/retract switch (33) and the top of the right front outrigger switch.

To retract the right front outrigger beam, push the bottom of the outrigger extend/retract switch (33) and the top of the right front outrigger switch.

To extend the right front stabilizer, push the top of the outrigger extend/retract switch (33) and the bottom of the right front outrigger switch.

To retract the right front stabilizer, push the bottom of the outrigger extend/retract switch (33) and the bottom of the right front outrigger switch.

### **Park Brake On/Off Switch**

The park brake on/off switch (17) is located on the left side of the front console. The two position switch energizes the park brake. When the top of the switch is pushed, the switch is in the on position.

### **Hazard Light Switch**

The hazard light switch (18) is located on the left side of the front console. Pushing the top of the switch causes all the turn signals and the red indicator light on the console to flash.

### **Headlights Switch**

The headlights switch (19) is a three position switch located on the left side of the front console. The bottom position is off. The center position will illuminate marker, clearance and gauge lights. The top position will turn on the headlights in addition to the marker, clearance and gauge lights.

### **Work Lights Switch**

The work lights switch (20) is a two position on/off switch located on the left side of the console that controls the crane's work lights mounted on the bottom front of the cab. Press the top of the switch to the on position to illuminate the work lights. Press the bottom of the switch to turn the work lights off.

### **Boom Lights Switch (Optional)**

The boom lights switch (21) is a two position on/off switch located on the left side of the front console. The switch controls the flood lights located on the boom base section. Press the top of the switch to the on position to illuminate the flood lights. The amber indicator in the switch will illuminate. Press the bottom of the switch to turn the flood lights off.

### **Heater Control Switch**

The heater control switch (22) is located on the bottom left side of the front console. Push the switch up to (OPEN) the valve for heat. Push the switch down to (CLOSE) the valve.

### **Air Conditioner Switch (Optional)**

The air conditioning switch (23) is located on the bottom left side of the front console. The switch controls the operation of the optional air conditioning system in conjunction with the fan switch. Press the top of the switch to turn the air conditioner on. Press the bottom of the switch to turn the air conditioner off. The indicator will illuminate amber.

### Hi/Med/Low Fan Switch

The Hi/Med/Low fan switch (24) is located at the bottom left side of the front console. It is a three-position switch that controls the speed which in turn regulates the volume of heated air output of the heater fan.

**NOTE:** The heater switch must be positioned to on (press top of switch) before fan will become operational.

- High speed - press top of switch
- Medium speed - switch centered
- Low Speed - press bottom of switch

### Heater On/Off Switch

The heater on/off switch (25) is located on the bottom left side of the front console. Press the top of the switch to turn heater on. Press the bottom of the switch to turn the heater off.

### Fan Defroster Switch

The fan defroster switch (26) is located at the bottom left side of the front console. It is a three position switch that controls operation of the defroster fan (47), located on top of the front console. When the switch is in the high (press top of switch) or low (switch centered) position, the amber indicator on the switch is illuminated at all times.

### Cross-Axle Differential Lock Switch (Optional)

The cross-axle differential lock switch (27) is located on the left bottom side of the front console and is used to lock the right and left wheels in a tandem set. The cross-axle differential lock increases traction on slippery roads. It is a two position momentary on switch. Press and hold top of switch for the lock position release switch for the unlock position.

---

#### CAUTION

Do not operate cross-axle differential lock while crane wheels are spinning or at speeds over approximately 16 km/h (10 mph). Release the throttle when locking or unlocking.

---

### Drive Axle Selector Switch

The drive axle selector switch (28) is located on the lower left side of the front console. The two-position switch selects 2WD HI (high range) or 4WD LO (low range). The switch controls a solenoid valve (energized for 2WD HI) that operates the speed range and axle disconnect cylinders on the transmission. When the switch is in the 4WD LO position, the indicator on the switch is illuminated amber, and the four-wheel engaged indicator (5) will illuminate amber.

### Right Rear Outrigger/Stabilizer Switch

The right rear outrigger switch (29) is located on the left side of the console. It is a three-position switch used to extend or retract the right rear stabilizer and extension cylinders. It must be used in conjunction with the outrigger extend/retract switch (33).

To extend the right rear outrigger beam, push the top of the outrigger extend/retract switch (33) and the top of the right rear outrigger switch.

To retract the right rear outrigger beam, push the bottom of the outrigger extend/retract switch (33) and the top of the right rear outrigger switch.

To extend the right rear stabilizer, push the top of the outrigger extend/retract switch (33) and the bottom of the right rear outrigger switch.

To retract the right rear stabilizer, push the bottom of the outrigger extend/retract switch (33) and the bottom of the right rear outrigger switch.

### Left Rear Outrigger/Stabilizer Switch

The left rear outrigger switch (30) is located on the left side of the console. It is a three-position switch used to extend or retract the left rear stabilizer and extension cylinders. It must be used in conjunction with the outrigger extend/retract switch (33).

To extend the left rear outrigger beam, push the top of the outrigger extend/retract switch (33) and the top of the left rear outrigger switch.

To retract the left rear outrigger beam, push the bottom of the outrigger extend/retract switch (33) and the top of the left rear outrigger switch.

To extend the left rear stabilizer, push the top of the outrigger extend/retract switch (33) and the bottom of the left rear outrigger switch.

To retract the left rear stabilizer, push the bottom of the outrigger extend/retract switch (33) and the bottom of the left rear outrigger switch.

### Emergency Stop Switch

The emergency stop switch (31) is located on the right side of the front console. Push in on the switch to remove power and stop the engine.

### Ignition Switch

The ignition switch (32) is located on the right side of the front console. The switch is key operated with four positions: accessory (left position), off (vertical position), run (position between vertical and right), and start (right position).

With the ignition switch in the off position, all electrical power is off except for the headlights, marker lights, gauge lights,

turn and stop light, cab dome light, cab 12V accessory outlet, cab work lights, and horn.

The accessory position energizes all electrical components except the engine ECM. The run position is the same as accessory except the engine ECM is energized. The start position energizes the starter relay which in turn energizes the cranking motor solenoid and cranks the engine for starting. The switch will return to run when the switch is released after the engine is started. Turn the switch to off to shut down the engine.

### Outrigger Extend/Retract Switch

**NOTE:** The park brake in the cab must be set before the outrigger controls will operate.

**NOTE:** Be sure the outriggers are properly extended and set, and the crane is level for operation on outriggers.

All four outrigger beams must be equally extended to the mid position vertical stripe or fully extended position before beginning operation.

The outrigger extend/retract momentary switch (33) is located on the right side of the front console. It must be used in conjunction with the outrigger selector switches to control the operation of the stabilizer and extension cylinders.

Push the top of the switch to select the extend function or push the bottom of the switch to select the retract function, then select desired outrigger selector switch.

In addition, when the switch is positioned to either extend or retract position, a signal is sent to the engine ECM to increase engine speed above idle for operation of the outriggers.

### Crane Function Power Switch

The crane function power switch (34) is located on the right bottom side of the front console. This two-position on/off switch permits the operator to disconnect power from the crane functions controlled by the hydraulic remote controllers on the armrests.

Push the bottom of the switch to disconnect power from the crane functions controlled by the controllers on the armrests.

Push the top of the switch to energize the pilot supply solenoid to allow functions controlled by the controllers on the armrests to be performed.

Positioning the switch to OFF prevents inadvertent operation of functions due to bumping the controllers while roading or any other operation.

**NOTE:** The seat switch must be activated and the left hand armrest must be in the down position before the crane function solenoid may be energized.

**NOTE:** When crane function power switch is in the on position, the engine is limited to 2200 RPM's.

### Engine Diagnostic Switches

Two engine diagnostic switches are located on the bottom right side of the front console.

#### Engine Idle/Diagnostic Switch

The engine idle/diagnostic switch (35) located on the bottom right side of the front console is used when servicing the engines electronic control system.

It is a two position on/off switch used to activate the testing mode (fault codes). When the switch is in the diagnostic position and is used in conjunction with the engine increment/decrement (+/-) switch (36), access will be gained to toggle up and down through the fault codes.

#### Engine Increment/Decrement Switch

The engine increment/decrement switch (36) located on the right side of the front console is used when increasing and decreasing engine rpm's.

It is a two-position (+/-) momentary switch that is a secondary throttle control which provides idle-control inputs that increase and decrease the engine idle when the idle/diagnostic switch is in the idle position.

Pushing and holding the top of the switch will increase (+) engine RPM. Release the switch and the engine RPM will stay at that level with transmission in neutral. Push the switch once, the engine will go to max engine RPM. Push the bottom of the switch and the engine RPM will go to idle mode.

### Skylight Wiper Switch

The skylight wiper switch (37) is installed on the bottom right side of the front console. The wiper is used to remove moisture from the skylight. The switch has an off and high position with six intermittent positions between high and off. Pushing the switch up from the off position energizes the wiper motor. Continue to push switch up for each intermittent position and the high position. Push the switch down to off to stop the motor and return the wiper blade to the parked position.

### Throttle Pedal

The foot throttle pedal (38) is located on the right side of the cab floor. The pedal is used to control engine RPM. The foot pedal modulates engine speed proportionately to the foot pressure applied. The foot pedal is monitored by the crane's electronic operating system which sends the information to the engine ECM via J1939.

## Hydraulic Oil Cooler Temperature Indicator

The hydraulic oil cooler temperature indicator (39) is located on the top left side of the front console. The indicator is controlled by a switch located at the hydraulic tank and illuminates red when the temperature reaches 190°.

## Service Brake Pedal

The brake pedal (40) is located on the cab floor, to the left of the foot throttle and is used to apply the service brakes.

## Transmission Shift Lever

The transmission shift lever (41) is located on the right side of the steering column. The control lever operates the transmission selector valve electrically.

Positioning the lever up actuates forward and positioning the lever down actuates reverse. When the lever is in neutral, it rests in a detent. To move the lever up or down, pull back on the lever first. To shift the transmission to first, second, or third gear, rotate the knob to 1, 2, or 3.

Refer to OPERATING PROCEDURES - Traveling Forward or Traveling Reverse in this section for complete transmission operating instructions.

## Telescope Control Foot Pedal (Optional w/ Aux. Hoist)

The telescope control foot pedal (42) is located on the left side of the cab floor. Pushing forward on the top of the pedal will extend the boom and pushing down on the bottom of the pedal will retract the boom.

## Swing Brake Pedal

The swing brake pedal (43) is located on the left side of the cab floor. The swing brake pedal is used to actuate the swing brake to slow or stop swing motion. Braking is proportional to pedal depression.

With the pedal not depressed and the swing brake control valve disengaged, hydraulic pressure is applied to the brake, overcoming spring pressure and releasing the brake.

Depressing the pedal actuates a swing power brake valve to apply pressure to the brake assembly. This pressure aids the spring pressure to overcome the hydraulic pressure being applied to the brake release circuit and applies the spring brake according to the pressure from the swing power brake valve.

## Turn Signal Lever

The turn signal lever (44) is located on the left side of the steering column.

Pushing the turn signal lever down causes the left turn signal indicator lamp and the left front and left rear turn signals to flash.

Pushing the turn signal lever up causes the right turn signal indicator lamp and the right front and right rear turn signals to flash.

The windshield wiper switch is incorporated in the turn signal lever. The knob of the lever has three positions: O, I, and II. Pushing the button in the end of the knob energizes the windshield washer pump to spray washer fluid on the windshield. Positioning the knob to I operates the wiper at low speed and positioning the knob to II operates the wiper at high speed. Positioning the knob to O turns the wiper motor off and automatically returns the wiper to the parked position.

## Horn Button

The horn button (45) is located in the center of the steering wheel (45). Depressing the horn button energizes the circuit sounding the horn.

## Cab Circulating Fan

The cab circulating fan (46) is mounted on the left front of the cab. A swivel allows the fan to be rotated and it is controlled by a two speed switch on the base of the fan.

## Defroster Fan

A defroster fan (47) is located on the front of the dashboard. The fan is controlled by the defroster switch (26) on the bottom left side of the front console.

The fan is used to circulate air to remove moisture and fog from the inside of the windshield.

## Skylight Wiper

The electrically-operated skylight wiper (48) removes moisture from the skylight. The skylight wiper is controlled by the skylight wiper switch (37) located on the front console.

## Fire Extinguisher

The fire extinguisher (49) is mounted behind the operator's seat in the cab.

## Steering Column Tilt Switch

The steering column tilt switch (50) is located on the steering column. Push the switch in the direction of the arrows (up or down) to allow the steering column to be tilted in the desired direction.

## Cab Dome Light

The cab dome light (51) is located on the right rear corner of the cab roof. It is controlled by a switch on the light to provide illumination in the cab.

## 12 VDC Accessory Outlet

The 12 vdc accessory outlet (52) is located on the front of the turntable lock control bracket. It provides an outlet for the operator to plug in a 12 vdc accessory. This outlet should be used only for components requiring 8 amps or less.

## 360° Swing Lock Control (Positive Lock Type) (Optional)

The 360 degree swing lock control lever (53) is located on the right side of the operator's seat next to the control armrest. The purpose of the swing lock is to secure the superstructure in position at any point in its 360 degree of rotation. The lock is engaged when the control lever is pushed down and disengaged when the control lever is pulled up.

## Electrical Diagnostic Connector

The electrical diagnostic connector (54) is located on the front of the turntable lock control mounting bracket. It is used for servicing the engine ECM, transmission ECM or the crane's electrical system.

**NOTE:** A laptop computer with appropriate cable and engine or electrical system software are required.

## Bubble Level Indicator

The bubble level indicator (55) is located on a bracket on the left side of the cab. The indicator provides the operator with a visual indication for determining the levelness of the machine.

## Swing Brake Selector Switch

The swing brake selector switch (56) is located on the left armrest. This two-position switch on/off is used to control a hydraulic valve that directs a regulated flow of pressure to and from the swing brake. Push the top of the switch to apply the swing brake or push the bottom of the switch to release the swing brake.

## Auxiliary Hoist Speed Selector Switch

The three-position auxiliary hoist speed selector switch (57) is located on the left armrest. Select the top of the switch for high speed and the bottom of the switch for low speed. Position the switch in the center to "off" to disable auxiliary hoist functions.

## Telescope/Auxiliary Hoist/Swing Controller

The telescope or auxiliary hoist/swing controller (58) is located on the left armrest. The controller controls the

telescope functions when the crane is not equipped with an auxiliary hoist. Pushing the controller forward actuates the control valve to telescope the boom out and pulling the controller back telescopes the boom in.

When equipped with an auxiliary hoist, the controller controls auxiliary hoist functions and telescope functions through a foot pedal (3). Pushing the controller forward actuates the control valve to let out the hoist cable and pulling the controller back reels the cable in.

When used for swing, the controller, when pushed to the right (rotates the turntable clockwise) or left (rotates the turntable counterclockwise), actuates a control valve to provide 360 degree continuous rotation in the desired direction.

## Swing Horn Button

The swing horn button (59) is located on the right side of the swing controller and is used by the operator to provide a warning that the superstructure is rotating. Press in on the button to sound the swing horn.

## Hoist Rotation Indicators (Main and Auxiliary Hoist)

The hoist rotation indicators (60) are located on the top of the main and auxiliary hoist controllers. The indicator is electronically driven by a sensor attached to the main hoist. A pulsating signal is sensed by the operator's thumb during hoist operation at slow rotation only.

## Main Hoist Speed Selector Switch

The three-position main hoist speed selector switch (61) is located on the right armrest. Select the top of the switch for high speed or the bottom of the switch for low speed. Position the switch in the center position to off to disable main hoist functions.

## Boom Lift/Main Hoist Controller

The boom lift/main hoist controller (62) is located on the right armrest. The controller, when pushed to the right (lowers the boom) or left (raises the boom), actuates the control valve to raise or lower the boom.

When used for main hoist, the controller, when pushed forward (lowers the cable) or back (raises the cable), actuates the control valve to raise or lower the main hoist cable.



### Rear Steer Control Switch

The rear steer control switch (63) is located on the left armrest. This two-position momentary switch controls the rear steer function. Push the top of the switch to steer left or push the bottom of the switch to steer right. An amber indicator will illuminate.

If the rear wheels are not centered after the switch is activated, the Rear Wheels Not Centered Indicator (5) on the front console will illuminate amber.

### Fuse Panel

The fuse panel (64) is located under a cover on the back wall of the cab behind the seat. It contains 16 fuses and 4 relays that protect and control various circuits of the superstructure.

### Canister Pump Assembly

The washer fluid canister (65) is installed on the rear of the cab.

### Cab Control Module

The cab control module (66) is installed beneath the dash on the left side of the cab.

### Turntable Lock Control (Pin Type)

The turntable lock control handle (67) is located beside the front console on the right side of the cab. The purpose is to lock or unlock the turntable. To lock the superstructure, the cable must be depressed and the knob must be turned to the right (clockwise). To unlock the superstructure, the cable must be pulled and the knob turned to the left (counterclockwise).

Turning the knob only locks and unlocks the cable.

## OPERATING PROCEDURES

### New Crane Conditioning

Your new Grove carrier has been thoroughly tested, adjusted, lubricated, and inspected prior to delivery. However, during the initial hours of operation, an occasional oil, air, or coolant leak may develop. Immediate corrective action should be taken concerning each of these leaks to avoid major repairs later. For detailed engine conditioning, refer to the applicable engine manual.

The guidelines below will aid in getting a long service life out of the crane.

1. Operate as much as possible in the half to three-quarters throttle or load range.
2. Avoid long periods of operation with the engine at idle or continuous maximum horsepower levels.
3. Observe instruments often and shut down at the first indication of an abnormal reading.
4. Operate to a power requirement that allows acceleration to governed speed when conditions require more power.
5. Check all components frequently for proper operation, unusual noises, and excessive heating.
6. Check the engine oil and coolant levels frequently.

These guidelines should not be considered limitations but rather as a guide for familiarization of the machine and development of good operating habits.

### Pre-Starting Checks

A complete walk-around visual inspection of the crane should always be made with special attention to structural damage, loose equipment, leaks, or other conditions that would require immediate correction for safe operation. Refer to Section 6 - Maintenance Checklist. The following checklist items are suggested to ensure the crane is prepared for starting the day's work.

### Fuel Supply

Fill the fuel tank and ensure the cap is on tight.

### Engine Oil

---

#### CAUTION

Do not overfill.

---

Check the oil level in the crankcase and fill to the FULL mark on the dipstick. Do not overfill.

### Engine Coolant

Check the coolant level in the radiator and fill to the proper level. Do not overfill and ensure the radiator cap is secure.



#### DANGER

Do not loosen radiator cap on a hot engine. Steam or hot coolant will cause severe burns.

---

### Batteries

Check the state-of-charge indicator if applicable with maintenance free batteries or check each cell for the correct fluid level if equipped with standard or low maintenance batteries. Use only clean distilled water and do not overfill. On all types of batteries, make sure the cables and clamps are tight and not corroded.

### Hydraulic Reservoir and Filter

Check the hydraulic level sight gauge and filter condition indicator on the hydraulic tank. Hydraulic fluid should be at normal operating temperature and the boom and outriggers in a retracted position.

Check breather for cleanliness and security.

### Wire Rope

Inspect the wire rope in accordance with applicable Federal Regulations. Sheaves, guards, guides, drums, flanges, and any other surfaces that come in contact with the rope should be inspected for any condition that could cause possible damage to the rope.

### Hook Block and Headache Ball

Inspect for nicks, gouges, cracks, and evidence of any other damage. Replace a hook that has cracks or shows evidence of excessive deformation of the hook opening (including twist). Be sure the safety latch is free and aligned.

### Seats and Mirrors

Adjust seat and mirrors for clear vision and safe driving.

### Seat Belts

#### Seat Belt Maintenance

Seat belt assemblies are maintenance-free; however, they should be periodically inspected to ensure that they are not damaged and are in proper operating condition, especially if they have been subjected to severe stress.

### Cleaning Seat Belt Webbing

Wash the seat belt webbing with any mild soap or detergent. Do not use commercial solvents. Also, bleaching or re-dyeing the webbing is not recommended because of possible loss of webbing strength.

### Signal and Running Lights

Check all signal and running lights for proper operation. Replace burned out lamps with those of the same number, or equivalent.

### Service and Parking Brakes

Check for proper operation.

### Tires

Check the pressure and condition of all tires before traveling.

**NOTE:** For tire inflation pressures, refer to the Tire Inflation Decal on the crane.

### Wheels

Maintain proper torque on wheel lugs and check for proper wheel mounting. If equipped with steel or aluminum wheels, the wheels should be retorqued 80 to 160 km (50 to 100 miles) after initial installation or after any time the tires and wheels are removed. Doing this will reseal the lug nuts. Recheck the lug nuts for proper torque every (800 km) 500 miles thereafter.

### Safety Equipment

Check all lights, windshield wipers, washers, washer liquid supply, horn, instruments, signaling devices, etc.

### Daily Lubrication

Ensure all components requiring daily lubrication have been serviced. Refer to Section 5 - LUBRICATION.

### Boom

Before extending the boom, ensure the large access cover on top of the boom base section is installed.

### Cold Weather Operation

The following recommendations are for operating Grove cranes in very low (i.e. freezing) temperatures.

Use particular care to ensure that cranes being operated in very cold temperatures are operated and maintained in accordance with the procedures as provided by Manitowoc Crane Group. Cranes should have appropriate hydraulic oil, lubricants, and other auxiliary items required for operation in sub-zero temperatures. Individual crane functions should be operated to ensure they are sufficiently warmed prior to performing a lift.

Operation of cranes at full rated capacities in temperatures between 0°C and -40°C (+32°F and -40°F) or lower shall be accomplished only by competent operators who possess the skill, experience, and dexterity to ensure smooth operation. Shock loading shall be avoided. See Section #5 of this manual for more detailed information on operation of cranes down to -40°F.

### Operation Below -40°C

For crane operation below -40°C, capacities shall be derated 3.67% of the capacities shown on the load chart for each degree (1°C) below -40°C.

### Engine Operation

Start-up and shutdown procedures for most diesel engines are generally the same. Therefore, the following procedures can be applied, except where specific differences are noted. (Refer to the applicable engine manufacturer's manual for detailed procedures).

### Start-Up Procedure

Make an under-the-hood inspection for fuel, oil, and coolant leaks, worn drive belts, and trash build-up.



### DANGER

Diesel engine exhaust can be harmful to your health. Only operate the engine in a well ventilated area or vent exhaust outside.

---

### CAUTION

Never crank engine for more than 30 seconds during an attempted start. If engine does not start after 30 seconds, allow starter motor to cool for about two minutes before attempting another start.

---

### CAUTION

If engine does not start after four attempts, correct malfunction before attempting another start.

---

Use the correct grade of oil for the prevailing temperature in the crankcase to prevent hard cranking. Diesel fuel should have a pour point of 5°C (10°F) less than the lowest expected temperature. In case of an emergency, white kerosene can be added to the fuel to bring the pour point down to the required temperature. This will prevent clogging of filters and small passages by wax crystals. The addition of kerosene is NOT recommended for general use.

## Warm Engine

The engine warning and engine stop indicators will illuminate and go off in sequence after about two seconds (as a check) when the key is first turned on. If an indicator comes on and continues to blink after initial start-up, there is a problem that needs to be corrected. Position the engine diagnostic idle switch to ON for code retrieval and check the engine manufacturer's service manual for code identification.

1. Ensure the parking brake is set and emergency stop is not off, and position the transmission in neutral.

**NOTE:** The engine will not crank unless the transmission shift is in neutral.

2. Turn the ignition switch to start (far right position) and release immediately when the engine starts. Do not push or hold the throttle down. The ECM will automatically provide the proper amount of fuel to start the engine.
3. Immediately check the engine instruments for proper indication after starting. Shut down the engine if the oil pressure gauge does not reach the proper reading within 15 seconds.
4. Function the boom retract control to warm up the hydraulic oil by running oil over the relief.

---

### CAUTION

If oil pressure and/or temperature indicator(s) do not display the proper readings, shut down engine and correct malfunction.

5. Allow the engine to warm up for about five minutes before applying a load. Do not race the engine for a faster warm up.

## Cold Engine

The engine warning and engine stop indicators will illuminate and go off in sequence after about two seconds (as a check) when the key is first turned on. If an indicator comes on and continues to blink after initial start-up, there is a problem that needs to be corrected. Position the engine diagnostic idle switch to on for code retrieval and check the engine manufacturer's service manual for code identification.

An engine block heater and grid heater are provided to aid in cold-starting.

**NOTE:** The engine will not crank unless the transmission shift is in neutral.

1. Ensure the parking brake is set and emergency stop is not off, and position the transmission in neutral.

**NOTE:** The top of the engine wait to start indicator located on the top left side of the front console illuminates

amber for a period of time when the ignition is turned to the on position. The engine should not be cranked until the indicator turns off.

2. Turn the ignition switch to start (far right position) and release immediately when the engine starts. Do not push or hold the throttle down. The ECM will automatically provide the proper amount of fuel to start the engine.
3. Immediately check the engine instruments for proper indication after starting. Shut down the engine if the oil pressure gauge does not reach the proper reading within 15 seconds.

---

### CAUTION

If oil pressure and/or temperature indicator(s) do not display the proper readings, shut down engine and correct malfunction.

4. Allow the engine to warm up for about five minutes before applying a load. Do not race the engine for a faster warm up.

## Idling The Engine

Idling the engine unnecessarily for long periods of time wastes fuel and fouls injector nozzles. Unburned fuel causes carbon formation; oil dilution; formation of lacquer or gummy deposits on the valves, pistons and rings; and rapid accumulation of sludge in the engine.

**NOTE:** When prolonged engine idling is necessary, maintain at least 800 rpm.

## Racing The Engine

DO NOT race the engine during the warm-up period or operate the engine beyond governed speed (as might occur in downhill operation or downshifting). Engine bearings, pistons, and valves may be damaged if these precautions are not taken.

## Shutdown Procedure

1. Allow the engine to run at fast idle speed for about five minutes to avoid high internal heat rise and allow for heat dissipation.
2. Position the ignition switch to off (vertical position).
3. Drain the fuel filter-water separator.

## Battery Disconnect

The battery disconnect switch is located in the battery box on the left side of the crane. To disconnect the batteries, turn the battery disconnect switch to OFF. Turn the switch to ON to connect the batteries.

## Crane Travel Operation

### Traveling - General

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#### CAUTION

Ensure the crane function switch is turned to off for extended traveling, cold weather starting, or engine checks.

RT machines are subject to the same road regulations as any truck, regarding gross weight, width, and length limitations.

Although RT machines are specifically designed for rough terrain, the operator should be extremely cautious and aware of the terrain in which he is operating.



#### WARNING

Do not travel with an empty hook in a position where it can swing freely.



#### DANGER

Do not drive the crane with the boom off center because automatic oscillation lockout will occur, making the crane subject to tipping on uneven surfaces.



#### DANGER

Avoid holes, rocks, extremely soft surfaces, and any other obstacles which might subject the crane to undue stresses or possible overturn.

---

#### CAUTION

Do not drive the crane with the lift cylinder bottomed. Position the boom slightly above horizontal.

Use four-wheel drive only when greater traction is necessary. Refer to FOUR-WHEEL DRIVE OPERATION, in this section, for operating instructions.



#### CAUTION

On open ground, tow or pull only on the tow/tie-down lugs or with the optional pintle hook.

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#### CAUTION

Should the crane become mired down, use a tow truck or tractor to free the vehicle. Severe damage to the transmission or axles may occur if the operator attempts to free the crane unassisted.

---

#### CAUTION

If the crane is mired down, use the tow/tie-down lugs to pull or tow.

There are tow/tie-down lugs on the front and rear of the crane. Use the lugs to tow or pull the crane.

### Traveling With 7.92 m (26 ft) Boom Extension Erected

Travel with 7.92 m (26 ft) boom extension erected is permissible under the following conditions.

1. Main boom shall be fully retracted.
2. The 7.92 m (26 ft) boom extension shall be erected at minimum (0 degrees) offset. The stinger section shall be pinned in the fully retracted position.
3. Jobsite travel shall only be on firm, level surface.
4. Maximum travel speed: 2.73 km/h (1.7 mph); machine to be in low range, first gear.
5. Main boom angle shall be between 0 degrees and 30 degrees.
6. Main counterweight shall be installed.
7. Boom shall be over the front and swing lock shall be engaged.
8. Hookblock must be removed from main boom nose.
9. Headache ball may be reeved over boom extension, hanging 0.9 m (3 feet) below sheave.

**NOTE:** Travel with 13.7 m (45 ft) boom extension erected is not permitted.

## Extended Travel

### CAUTION

For extended travel, check the cold tire pressure prior to start. Refer to tire inflation chart in load chart book. After every one hour of travel time, regardless of ambient temperature, stop and allow the tires to cool off for at least 30 minutes. At the destination, the tires must be allowed to cool to ambient temperature before crane lifting on rubber.

Depending upon the tire manufacturer, the higher inflation pressures normally specified for lifting on rubber are not recommended for site to site transfer over extended distances. The higher static/creep 8 km/h (5 mph) inflation pressures may remain in the tire while operating the crane on site within a distance of less than 6.4 km (4 miles).

## Moving The Crane

The following superstructure conditions should be strictly adhered to before moving the crane. Procedures for accomplishing the following can be found in the various sections of this manual.

1. Fully retract the boom.
2. Ensure the swingaway jib is properly stowed and secured.
3. Swing the boom to over-the-front and lower it to slightly above horizontal.
4. Press the top of the swing brake selector switch on the front console to apply the swing brake.
5. Remove the hook block and/or headache ball from the hoist cable(s) and stow securely before traveling or make sure the hook block or headache ball is properly secured to the tie down provided for that purpose.
6. Fully retract the outrigger stabilizers and remove the floats.
7. Properly store the floats.

## Steering

Steering is accomplished by the steering wheel and the rear steer control. These controls, used singly or together, provide front wheel steering, rear wheel steering, four-wheel steering, and crabbing capabilities (Figure 3-4).

## Front Wheel Steering

Conventional front wheel steering is accomplished with the steering wheel. This method of steering should always be used when traveling at higher speeds.



### DANGER

Operate the rear steer only for added job site maneuverability

## Rear Wheel Steering

Rear wheel steering is controlled by the rear steer control switch. Moving the control switch to the desired position activates the rear steer cylinders, thereby steering the crane in the selected direction.

## Four Wheel Steering

Four wheel steering is accomplished with the steering wheel and the rear steer control. Depending upon which direction the operator wishes to travel, the steering wheel is turned opposite direction of the rear steer control position. This allows the crane to turn or maneuver in close, restricted areas.

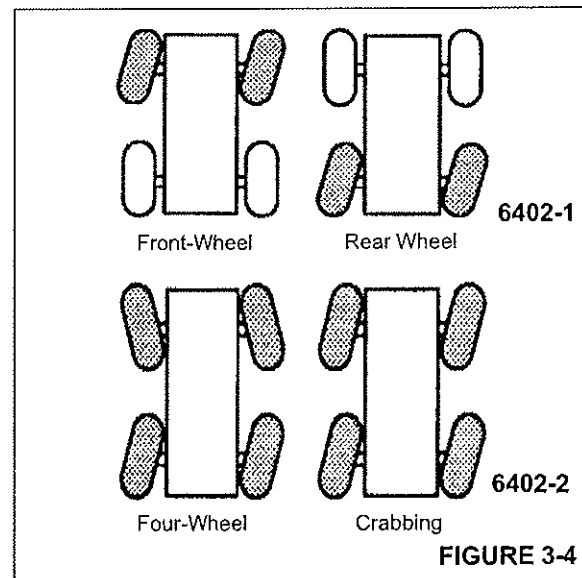


FIGURE 3-4

## Crabbing

Crabbing is accomplished with the steering wheel and the rear steer control switch. Depending upon which direction the operator wishes to travel (crab), the steering wheel is turned in the same direction as the rear steer control switch. This permits driving the crane forward or backward in a crabbing manner

## Traveling - Forward



### DANGER

Engage the swing lock pin for extended travel.

1. After the engine has warmed up, position the drive axle selector switch to either high range (2WD HI) or low range (4WD LO).

### CAUTION

Use four wheel drive only when more traction is required.

2. Put the transmission control lever in the first (F-1) gear position and release the parking brake. Depress the foot throttle until maximum first gear speed is attained and shift into the second (F-2) gear position.
3. When the maximum second gear speed is attained, shift from second to third (F-3) gear and accelerate to the desired speed.

### CAUTION

Do not downshift to a lower gear if the road speed is greater than the maximum speed of the lower gear.

## Traveling - Reverse

Traveling in reverse is accomplished the same way as traveling forward, except for shifting the transmission control lever to the applicable reverse (R-1, R-2, or R-3) position. (Refer to Traveling - Forward.)

### CAUTION

Apply service brakes and bring crane to a complete stop before shifting transmission into reverse.

## Four-Wheel Drive Operation

If more traction is required due to slipping or spinning wheels, engage the front axle drive as follows:

### CAUTION

Before shifting from two-wheel drive to four wheel drive (or from four back to two), crane travel must be stopped.

1. Position the drive axle selector switch to 4WD.
2. Select gear speed and direction of travel.
3. Return the drive axle selector switch to the 2WD position as soon as two-wheel traction will suffice.

## General Crane Operation

### Pump Drive

The main #1 hydraulic pump is driven by an engine PTO. The #2 hydraulic pump is direct engine driven.

### Control Lever Operation

The control lever operation for crane functions is proportional, i.e., the closer the lever is to neutral (center), the slower the system responds. Return the control lever to neutral to hold the load. Do not feather the hoist control to hold the load.

**NOTE:** Always operate the control levers with slow, even pressure.

### Preload Check

After the crane has been readied for service, an operational check of all crane functions (with no load applied) should be performed. Preload check is as follows:

- Extend and set the outriggers and level the crane.
- Raise, lower, and swing the boom right and left at least 45 degrees.
- Telescope the boom out and back in, ensuring all sections extend and retract properly.
- Raise and lower the cable a few times at various boom lengths. Make sure there are no kinks and that the cable is spooling on the hoist properly.

### CAUTION

Run the engine at or near the governed RPM during operation of all crane functions.

**NOTE:** Carefully read and become familiar with all crane operating instructions before and operating the crane.

## Using Your Load Chart

**NOTE:** One of the most important tools of every Grove crane is the load chart found in the crane operator's cab.

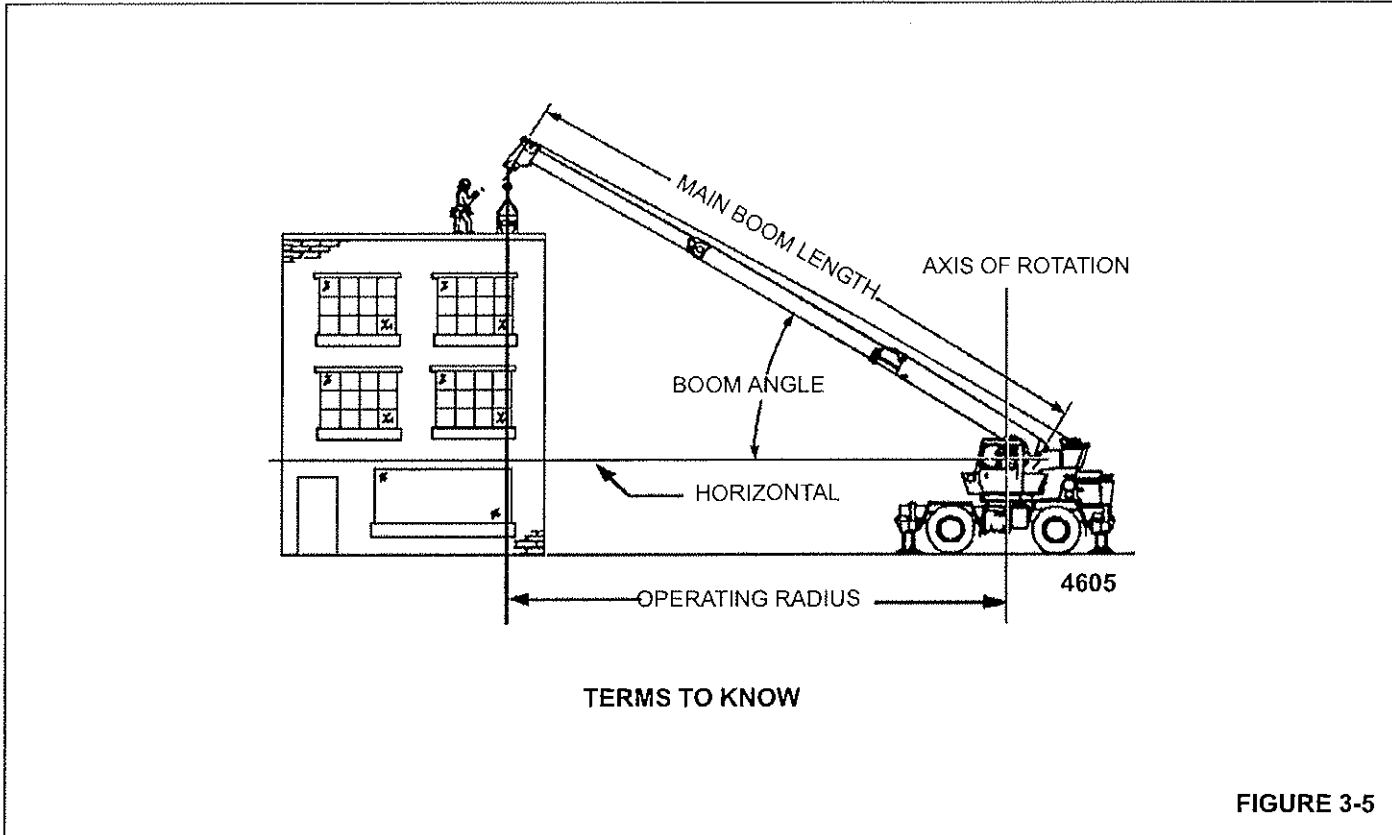
**NOTE:** Refer to (Figure 3-5) for terms to know in determining lifting capacities.

The load chart contains the lifting capacities of the crane in all allowable lifting configurations, and must be thoroughly understood by the operator.

The load chart is divided into capabilities limited by crane structural strength and stability which is shown by a bold line across the chart. Structural strength limits are above the line and stability limits are below the line.

The left column is the load radius, which is the distance from the axis of the crane rotation to the load center of gravity. The top row lists various boom lengths from fully retracted to fully extended (with swingaway extension). The number at the intersection of the left column and top row is the total load limit for that load radius and boom length. The number in parentheses below the total load limit is the required boom

angle (in degrees) for that load. Boom lengths between increments should always be treated as if it were the next longer length. For example, if the actual boom length is 15.2 m (50 ft) and the chart shows boom lengths of 14.6 to 16.4 m (48 to 54 ft), use the load capacity shown in the 16.4 m (54 ft) column.



**FIGURE 3-5**

Another important section is the range diagram. The range diagram shows the operating radius and tip height that can be achieved at a given boom length and angle. If the operator knows the radius and tip height required for a specific lift, the angle and boom length can quickly be determined from the range diagram. Or if he knows the boom length and angle, he can quickly determine the tip height and operating radius.

A lifting diagram is included for over-side, over-rear, and over-front lifting areas. The lifting area diagram shows that the locations of the outrigger stabilizer cylinders in the full extended position are used to mark the boundaries of the lifting areas.

Another section contains notes for lifting capacities. Be sure to read and understand all notes concerning lifting capacities.

The load chart also gives weight reductions for Manitowoc/Grove load handling devices such as hookblocks, overhaul balls, boom extension sections, etc., which must be

considered as part of the load. The weight of any other load handling devices such as chains, slings, or spreader bars must also be added to the weight of the load.

**NOTE:** The information in the following paragraph is an example of how to compute a lift. The numbers used in the example may not coincide with the load chart in the crane cab.

**Problem:** A concrete beam weighing 2268 kg (5000 pounds) needs to be lifted to a height of 9.1 m (30 ft) at a radius of 15.2 m (50 ft) (maximum). The range diagram indicates the boom must be extended to 18.9 m (62 ft) in order to reach a height of 9.1 m (30 ft) at a radius of 15.2 m (50 ft).

First we need to check the crane for load handling devices. In our example, the crane is equipped with an auxiliary boom nose (rooster sheave) and a five ton overhaul ball. The rooster sheave is 50 kg (110 pounds), and the overhaul ball is 78 kg (172 pounds) for a total of 128 kg (282 pounds). The lift requires slings and spreader bars weighing 159 kg (350



pounds) which makes the total weight for the load handling devices 286 kg (632 pounds).

A check of the load chart for a 15.2 m (50 ft) radius and 19.5 m (64 ft) of boom length shows a capacity of 3601 kg (7940 pounds) on outriggers over-front and 4970 pounds on outriggers 360 degrees. We subtract the load handling weight of 632 pounds from the load capacity of 3601 kg (7940 pounds) and 2254 kg (4970 pounds). The result is a weight capacity of 3315 kg (7308 pounds) over-the-front and 1968 kg (4338 pounds) for 360 degrees. We are constricted in making the lift over-front only and the boom angle will be about 29 degrees.

## Crane Functions

### Using the Outriggers

The outriggers are operated from the front console in the cab.



#### DANGER

To prevent serious injury or death, keep clear of moving outrigger beams/jacks.



#### DANGER

Death or serious injury could result from improper crane setup on outriggers.



#### WARNING

Be sure the outriggers are properly extended and set, and the crane is level for operation on outriggers.

All four outrigger beams must be equally extended to the mid position vertical stripe or fully extended position before beginning operation.



#### WARNING

When operating the crane on outriggers, the outriggers should always be fully extended or locked in the mid-extend position.

### Setting The Outriggers

**NOTE:** The park brake must be set before the outriggers will operate.

**NOTE:** The engine speed is increased to 1000 RPM when the extend/retract switch is placed in either position.

1. Position the outrigger floats directly out from each outrigger to where the outriggers will be properly extended.

#### CAUTION

Always press an outrigger selector switch on the front console before pressing the outrigger extend/retract switch to extend or retract.

2. Push the top of the desired outrigger selector switch then press the top of the outrigger extend/retract switch to extend the outrigger beam. The appropriate outrigger should begin to extend. Refer to Engaging the Mid-Extend Lock Pin if the crane is to be operated at the mid-extend position.



#### DANGER

All four outrigger beams must be equally extended to the mid position vertical stripe or fully extended position before beginning operation.

**NOTE:** More than one outrigger may be extended at one time. However, to ensure that each outrigger is fully extended, each outrigger selector switch should be depressed individually and the outrigger/retraction switch momentarily positioned to extend (press top of switch) after multi-outrigger extension.

3. To extend the stabilizers, press the bottom of the desired outrigger switch and the top of the outrigger extend/retract switch.
4. Extend each stabilizer, positioning the float as necessary, until the locking levers of the float engage the stabilizer cylinder rod.

**NOTE:** More than one stabilizer may be extended at one time.

5. With each stabilizer float firmly touching the ground, press the bottom of the left or right front outrigger selector switch and press the top of the extend/retract switch. Extend the front stabilizers approximately 76 to 102 mm (3 to 4 in).
6. Press the bottom of the left or right rear outrigger selector switch and press the top of the extend/retract switch. Extend the rear stabilizers approximately 76 to 102 mm (3 to 4 in).
7. After all floats are on the ground, extend the front stabilizers about 8 to 10 cm (3 to 4 inches) and then

extend the rear stabilizers the same distance. Repeat until all tires are off the ground.

**DANGER**

All four outrigger beam lock pins must be engaged before operating from the mid-extend position.

---

**DANGER**

Operator must select proper load chart and LMI program for the outrigger position selected.

---

8. Repeat step 3 until all wheels are clear of the ground and the crane is level as indicated by the sight level bubble located on the right side of the cab. If it is suspected that the bubble level indicator is out of adjustment, verify and adjust the bubble level as follows:
  - a. Locate the crane on a firm level surface.
  - b. Extend and set the outriggers. Level the crane, as indicated by the bubble level indicator, with the outriggers.
  - c. Place a miracle pointer, carpenter level, or similar type device on a machined surface such as the turntable bearing or bearing mounting surfaces.
  - d. Level the crane with the outriggers as indicated on the device used in step (c).
  - e. Adjust the bubble level indicator with the mounting screws to show level.

### ***Engaging the Mid Extend Lock Pin***

**NOTE:** It may be necessary to jog the outrigger extension/retraction switch slightly to ensure proper pin engagement.

1. With the outriggers fully retracted, turn the locking pin 90° from its stowed position and allow the pin to slip into the lug on the jack beam. If the pin will not slip into the lug, slowly extend or retract the outrigger beam, allowing the locking pin to drop into the lug.
2. Slowly extend or retract the outrigger beam, allowing the locking pin to drop into the hole in the top of the outrigger beam, engaging the outrigger beam at the desired length.

### ***Stowing The Outriggers***

1. Press the bottom of the left or right rear outrigger selector switch and press the bottom of the extend/retract switch. Retract until the rear stabilizers have retracted several inches .
2. Press the bottom of the left or right front outrigger selector switch and press the bottom of the extend/retract switch. Retract until the front stabilizers have retracted several inches.

**DANGER**

Keep feet and hands clear of floats when unlocking the floats from the stabilizers.

---

3. Repeat steps 1 and 2 until the crane is resting on all wheels and the stabilizer floats are several inches off the ground.
4. Release the locking levers and allow the floats to drop to the ground.

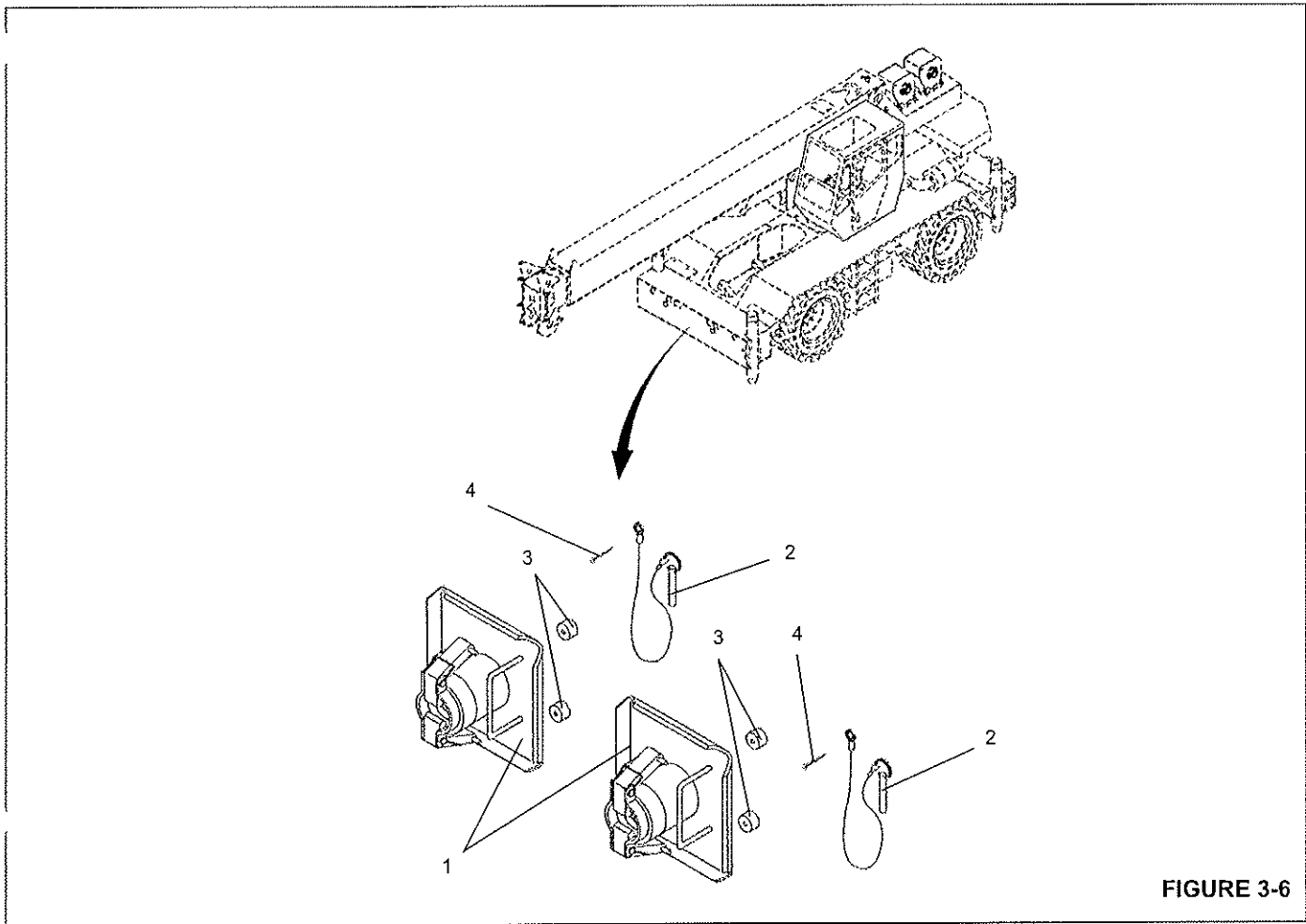


FIGURE 3-6

Item	Description
1	Outrigger Float Assembly
2	Quick Pin With Lanyard
3	Rubber Bumper
4	Cotter Pin

- Continue to retract the stabilizers until they are fully retracted.
- Push the top of the desired outrigger selector switch then press the bottom of the outrigger extend/retract switch to retract each outrigger beam. Refer to *Stowing the Mid-Extend Lock Pin* if the crane was operated at the mid-extend position.

**NOTE:** More than one outrigger beam may be retracted at one time.

- After all outriggers have been fully retracted, stow the outrigger floats(Figure 3-6) .

**Stowing the Mid-Extend Lock Pin**

**NOTE:** If the lock pin is wedged in the hole in the outrigger beam, it may be necessary to jog the outrigger extend/retract switch slightly while pulling upward on the pin.

**Swinging the Boom**

**! DANGER**

Death or serious injury could result from being crushed by moving machinery. Before activating swing, sound the steering wheel horn and verify that all personnel are clear of rotating and moving parts.

**WARNING**

Keep the area beneath the boom clear of all obstructions and personnel when lowering the boom.

**CAUTION**

The operator must select the proper load chart and LMI program for the outrigger position selected.

**CAUTION**

Never push or pull the swing control lever through neutral to the opposite direction to stop swing motion. Use the swing brake foot pedal to stop swing rotation.

1. To swing the boom, push the controller on the left hand armrest to the right for right swing (rotates turntable clockwise), or to the left for left swing (rotates turntable counterclockwise). Always operate the control lever with a slow, even pressure.

Use the swing brake foot pedal to stop rotation, then position the swing brake switch to ON to prevent further rotation.

**Elevating and Lowering the Boom****Elevating the Boom****WARNING**

Keep the area above and below the boom clear of all obstructions and personnel when elevating the boom.

1. To elevate the boom, push the controller on the right hand armrest to the left (raises the boom), and hold until the boom reaches the desired elevation.

**Lowering the Boom****WARNING**

Keep the area beneath the boom clear of all obstructions and personnel when lowering the boom.

**WARNING**

Long cantilever booms can create a tipping condition, even when unloaded and in an extended, lowered position.

**WARNING**

When lowering the boom, simultaneously let out the hoist cable to prevent two-blocking the boom nose and hook block.

**CAUTION**

The closer the load is carried to the boom nose, the more important it becomes to simultaneously let out the hoist cable as the boom is lowered.

1. To lower the boom, push the controller on the right hand armrest to the right (lowers the boom) and hold until the boom is lowered to the desired position.

**Telescoping the Boom**

**NOTE:** The telescope function is controlled by a foot pedal if the crane is equipped with an auxiliary hoist.

**Extending the Boom****WARNING**

When extending the boom, simultaneously let out the hoist cable to prevent two-blocking the boom nose and hookblock.

**DANGER**

Check the load chart for the maximum load at a given radius, boom angle, and length before extending the boom with a load.

**CAUTION**

Before extending the boom, ensure the large access cover on top of the boom base section is installed.

1. To extend the boom push the controller on the left hand armrest forward and hold until the boom reaches the desired length.

**Retracting the Boom****WARNING**

When retracting the boom, the load will lower unless the hoist cable is taken in at the same time

1. To retract the boom, pull the controller on the left armrest back and hold until the boom retracts to the desired position.

### Telescope Control Pedal

The telescope control pedal is used on cranes equipped with an auxiliary hoist. Push on the top of the pedal to extend the boom or push on the bottom of the pedal to retract the boom.

### Lowering And Raising The Hoist Cable



#### WARNING

Keep the area beneath the load clear of all obstructions and personnel when lowering or raising the cable (load).



#### CAUTION

Do not jerk controller when starting or stopping hoist. Jerking causes load to bounce, which could result in possible damage to the crane.

**NOTE:** When the load is stopped at the desired height, the automatic brake will engage and hold the load as long as the controller remains in neutral.

### Lowering The Cable

Push the main hoist (right hand armrest) or auxiliary hoist (left hand armrest) controller forward, away from the operator, and hold until the hook or load is lowered to the desired height.

### Raising the Cable

Pull the main hoist (right hand armrest) or auxiliary hoist (left hand armrest) controller, toward the operator, and hold until the hook or load is raised to the desired height.

### Hoist Speed Range Selection

#### CAUTION

Do not change the hoist speed range with the hoist rotating.

To change the speed range of the hoist(s), press the top (high speed) or bottom (low speed) of the main hoist speed switch located on the right hand armrest or auxiliary hoist speed switch located on the left hand armrest.

## Operational Aids



#### DANGER

Electronic equipment on this crane is intended as an aid to the operator. Under no condition should it be relied upon to replace the use of capacity charts and operating instructions. Sole reliance upon these electronic aids in place of good operating practices can cause an accident.

### Load Moment Indicator (LMI) System

The Load Moment Indicator (LMI) is an electro-mechanical sensing system designed to alert the crane operator of impending capacity when the system has been properly preset by the operator. The control panel is mounted in the front console of the operator's cab. When an overload condition is sensed, the system provides the operator with a visual and audible warning, and locks out the control levers to prevent lowering the boom, extending the boom, or raising the main or auxiliary hoist cables.

Three additional features are included within the LMI system:

- Swing Angle Set Limitation
- Work Area Definition
- Anti-two Block Device

**Swing Angle Set Limitation** allows left and right swing angle to be preset. When the preset angle is reached, the system will provide an audible warning.

**Work Area Definition** allows the crane operator to describe the crane's working area by setting up "virtual walls". They are referred to as virtual walls because they exist in the system and are not real walls. The virtual walls represent obstacles (i.e. buildings, towers, poles, etc.) in the crane's working range. They are set by defining points along the outer limits of the working area with the tip of the boom. Once the working area has been defined, the system will provide a visual and an audible warning if the boom approaches a virtual wall.

#### CAUTION

When defining virtual walls (s), always allow a safe working distance to any obstacles. Never work outside a safe working area as defined by common practice, standards, and manuals.

**WARNING**

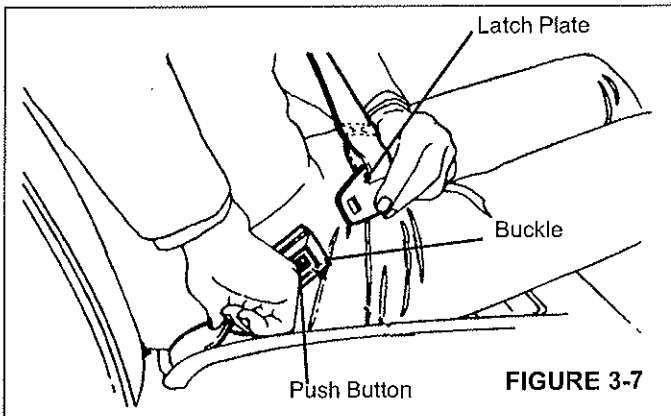
There are no cut-outs associated with the swing angle set limitation or the work area definition features.

An **Anti-two Block Device** is also incorporated into the system to prevent the hook block or headache ball from coming into contact with the boom nose or boom extension. This condition will also cause a lockout of hoist up, boom down, and telescope out, and also provide a visual and an audible alarm.

Refer to the LMI Operator's Handbook for more detailed information on the function of the LMI system.

**Control Lever Lockout System**

The control lever lockout system consists of hydraulic solenoid valves located in the directional control valves. The valves are activated in such a manner as to prevent worsening the condition, i.e. boom down, telescope out, or hoist up. The control lever lockout system is used with the anti-two-block system or the load moment indicator (LMI) system. The LMI sends a signal to the canbus system which turns off the solenoids on the directional valves.

**Crane Travel Operation****Active Restraints****Seat Belts**

1. Before fastening a seat belt, always adjust the driver's seat to the position in which you will drive.
2. Pull the belt across your lap and push the latch plate into the buckle until it clicks (Figure 3-7).
3. To reduce the risk of sliding under the belt during a collision, position the belt across your lap as low on your hips as possible and pull it toward the door to a snug fit so the retractor can take up the slack.

**NOTE:** The belt is designed to lock only during a sudden stop or impact. At other times it should move freely.

**Stowing and Parking****DANGER**

Never park crane near holes, on rocky surfaces, or on soft spots. This may cause crane to overturn, resulting in injury or death to personnel.

When parking the crane, do the following.

1. Remove the load from the hook.
2. Remove or stow boom extensions if so equipped.
3. Fully retract all boom sections.
4. Lower the boom to normal travel position.
5. Engage the swing brake, swing lock pin, and 360 degree house lock.
6. Retract all stabilizer cylinders and outrigger beams.
7. Turn the crane function power switch to the off position (press bottom of switch).
8. Park the crane on a stable surface.
9. Apply the parking brakes and if necessary, chock wheels.
10. Ensure all operating controls are in neutral position.
11. Shut down engine following proper procedures specified in this Operator's Manual and the applicable engine manual.
12. Remove the keys.
13. Close and lock, if applicable, all windows, covers, and doors.
14. Turn battery disconnect to OFF position if machine will be inactive for over 24 hours (Figure 3-8).

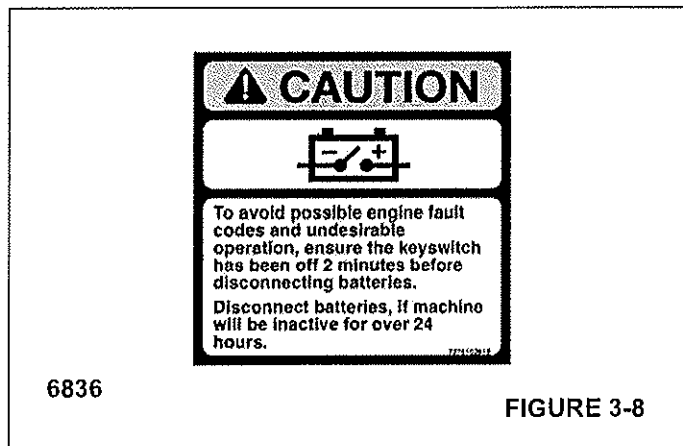


FIGURE 3-8

## SECTION 4 SET-UP AND INSTALLATION

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## SECTION 4

### SET-UP AND INSTALLATION PROCEDURES

#### GENERAL

This section provides procedures for installing the hoist cable on the hoist drum, cable reeving, and erecting and stowing the boom extension.

#### INSTALLING CABLE ON THE HOIST

##### CAUTION

If cable is wound from the storage drum, the reel should be rotated in the same direction as the hoist.

**NOTE:** The cable should preferably be straightened before installation on the hoist drum.

Install cable on the hoist drum in accordance with the following procedure.

1. Position the cable over the boom nose sheave and route to the hoist drum.
2. Position the hoist drum with the cable anchor slot on top.
3. Insert the cable through the slot and position around the anchor wedge (Figure 4-1).

**NOTE:** The end of the cable should be even with the bottom of the anchor wedge.

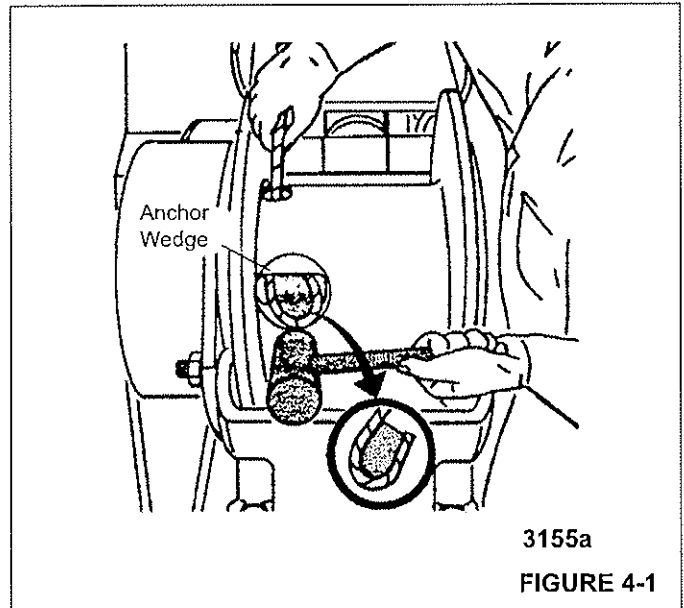
4. Position the anchor wedge in the drum slot; pull firmly on the free end of the cable to secure the wedge.

**NOTE:** If the wedge does not seat securely in the slot, carefully tap the top of the wedge with a mallet.

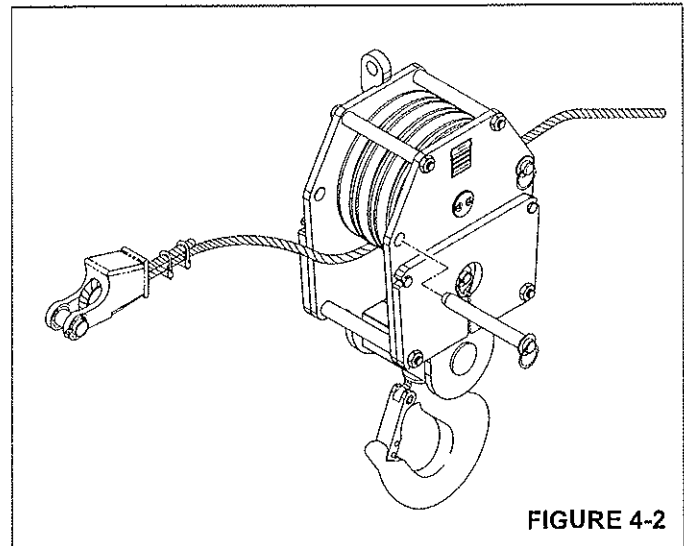
5. Slowly rotate the drum, ensuring the first layer of cable is evenly wound onto the drum.
6. Install the remainder of the cable, as applicable.

#### CABLE REEVING

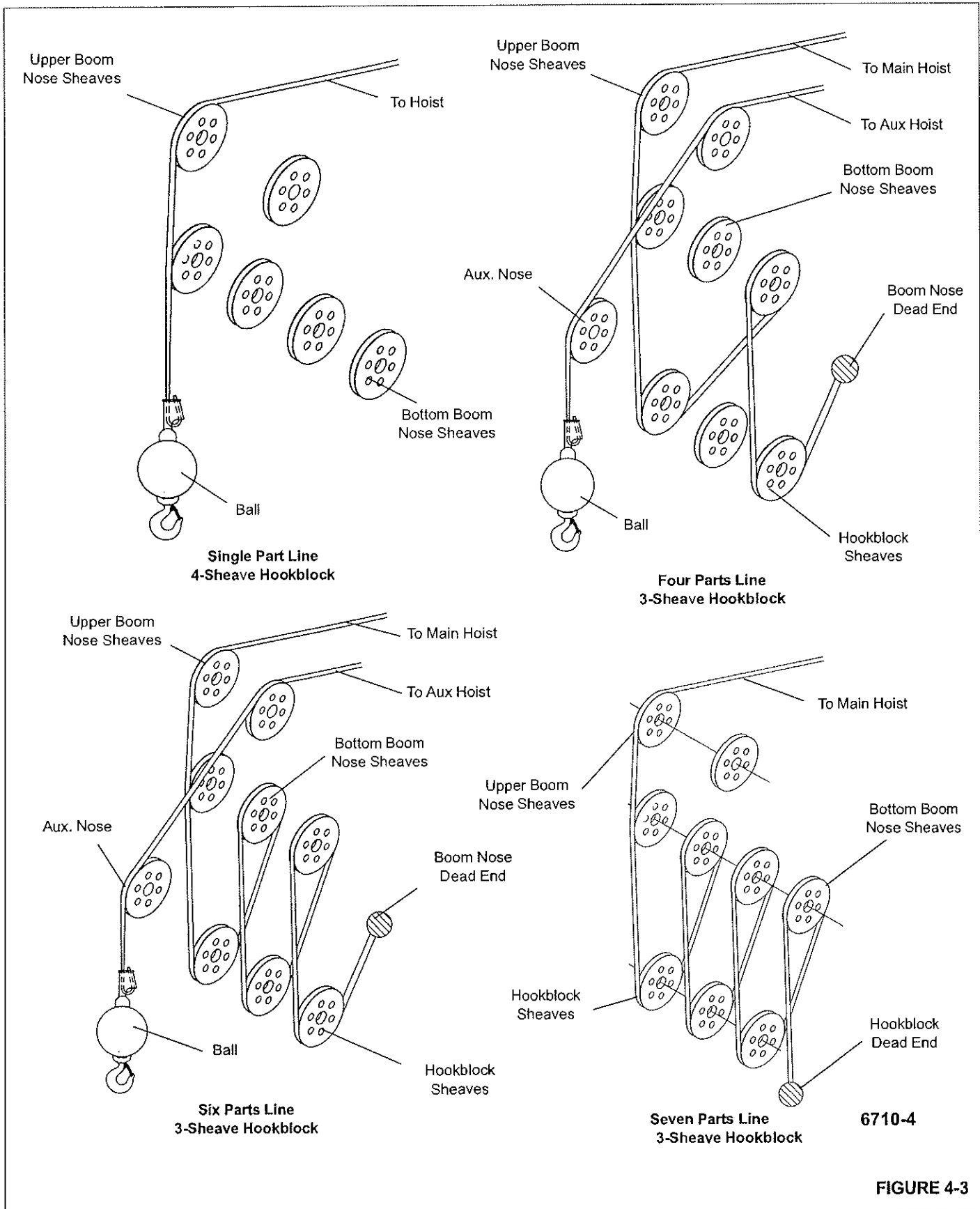
**NOTE:** There are two types of cable (wire rope) available on this crane; 6 x 37 WS and 35 x 7 (non-rotating).



Within the limits of the load and range charts and permissible line pull, multi-part lines allow the operator to raise a greater load than can be raised with a single part line. Various cable reeving (part line) is possible with the boom nose and hook block. This reeving should be accomplished by a qualified rigger using standard rigging procedures (Figure 4-3).

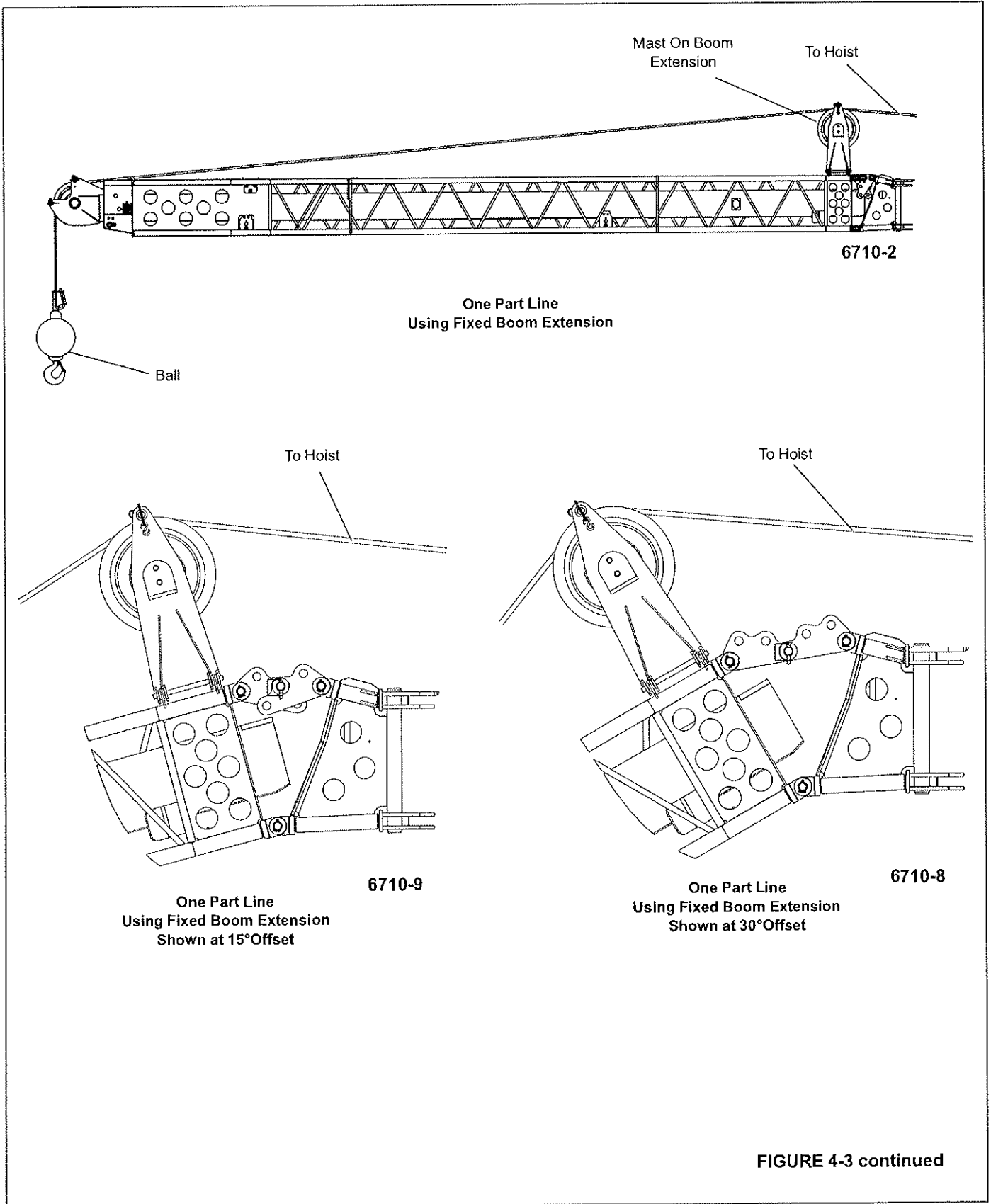


In order to quick reeve the hook block without removing the wedge socket on the end of the cable refer to (Figure 4-2)



6710-4

FIGURE 4-3



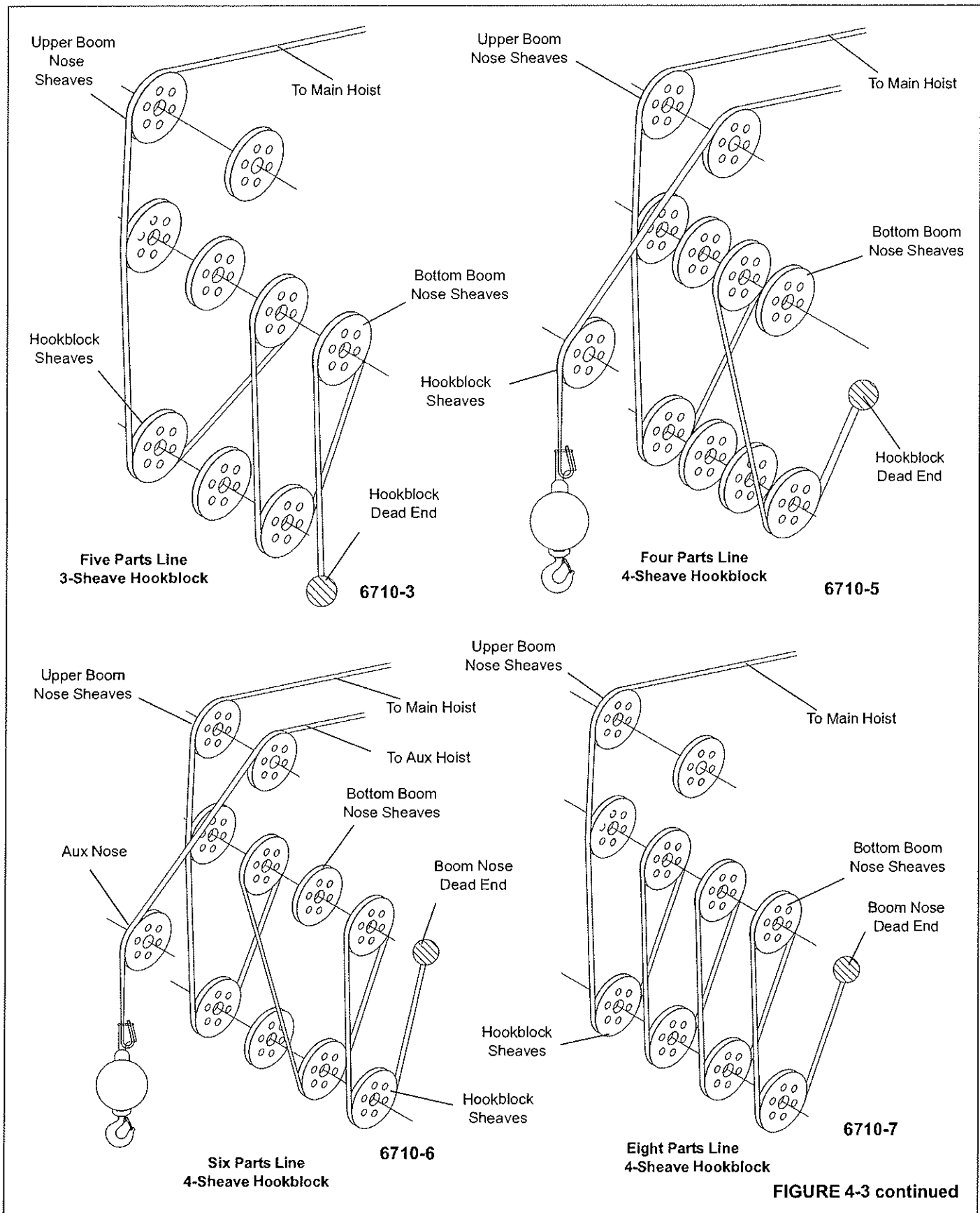


FIGURE 4-3 continued

**DEAD-END RIGGING/WEDGE SOCKETS**

Wedge socket assemblies are popular rigging accessories and have been successfully used for decades to terminate wire ropes on mobile cranes. A wedge socket assembly is easily installed and dismantled but it must be installed and used correctly. It is essential to use only a wedge and socket of the correct size for the rope fitted. Failure to do so may result in the rope pulling through the fitting.

Since state and local laws may vary, alternate attachment methods may be necessary depending upon work conditions. If alternate methods are selected, the user is responsible and should proceed in compliance with the regulations in force. If there are any questions, contact your local Grove Distributor or Manitowoc CraneCARE.

Do not mix components from different manufacturers. The selection, installation and use of a wedge socket assembly must be in accordance with the requirements of the wedge socket manufacturer and the wire rope manufacturer upon whose wire rope the wedge socket assembly will be used.

Grove Crane specifies the size, type, class and line pulls for wire rope, predominately rotation resistant wire rope, and rigging accessories such as overhaul balls and hook blocks for use with each new crane that it manufactures. Other wire ropes and rigging accessories are available from various vendors. Different wire rope manufacturers have differing requirements for the construction, handling, cutting, seizing, installation, termination, inspection and replacement of the wire ropes they produce. Their advice should be sought for each specific type of wire rope a crane user intends to install on a mobile crane.

When assembly is complete, raise the boom to a working position with a load suspended to firmly seat the wedge and rope into the socket before the crane is used operationally.

**CAUTION**

If the socket is not positioned with the flat face toward the boom sections, structural damage will occur.

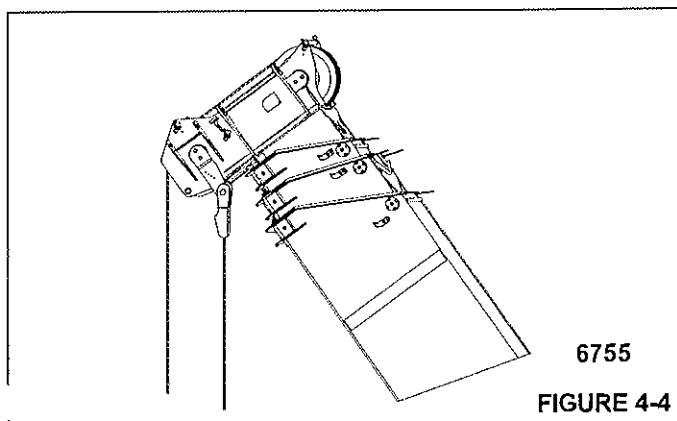
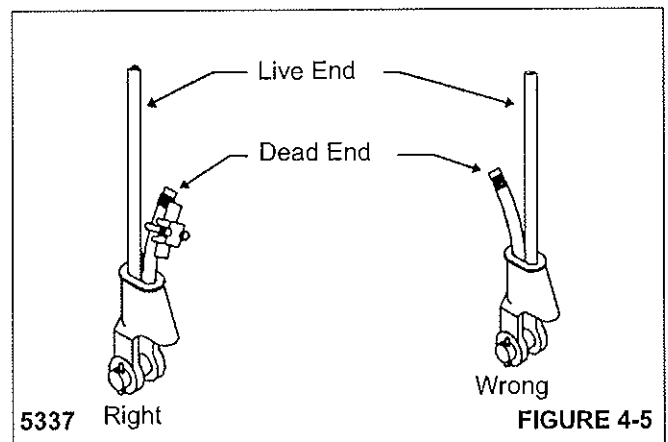


FIGURE 4-4

When anchoring the socket to the boom, ensure the flat face of the socket is in position, as shown, toward the boom sections (Figure 4-4).

**Installing Wedge And Socket**

1. Inspect the wedge and socket. Remove any rough edges and burrs.
2. The end of the wire rope should be seized using soft, or annealed wire or strand. If the end of the rope is welded, the welded end should be cut off. This will allow the distortion of the rope strands, caused by the bend around the wedge, to adjust themselves at the end of the line.



3. Make sure the live-loaded side (Figure 4-5) of the rope is directly in line with the ears of the socket and the direction of pull to which the rope will be subjected. If the rope is loaded into the socket incorrectly, under a load the rope will bend as it leaves the socket, and the edge of the socket will wear into the rope causing damage to the rope and eventual failure.
4. Insert the end of a wire rope into the socket, form a loop in the rope, and route the rope back through the socket allowing the "dead" end to protrude from the socket. Ensure the dead end of the rope is of sufficient length to apply end treatment to the dead end after the wedge has been seated.
5. Insert the wedge into the loop and pull the live end of the rope until the wedge and rope are snug inside the socket. It is recommended that the wedge be seated inside the socket to properly secure the wire rope by using the crane's hoist to first apply a light load to the live line.
6. After final pin connections are made, increase the loads gradually until the wedge is properly seated.
7. The wire rope and wedge must be properly secured inside the socket before placing the crane into lifting service. It is the wedge that secures the wire rope inside the socket whereas the dead-end treatment is used to

restrain the wedge from becoming dislodged from the socket should the rope suddenly become unloaded from the headache ball or hook block striking the ground, etc.

Sketches A through F (Figure 4-6) illustrate various methods for treating the dead-ends of wire ropes which exit a wedge socket assembly. While use of the loop-back method is acceptable, care must be exercised to avoid the loop becoming entangled with tree branches and other components during crane transport and with the anti-two block system and other components during use of the crane.

Of the methods shown below, Grove prefers that method A or B or F be used on Grove cranes, i.e., clipping a short piece of wire rope to the dead-end or using a commercially available specialty clip or wedge. Typically, it is recommended that the tail length of the dead-end should be a minimum of 6 rope diameters but not less than 15.2 cm (6 in) for standard 6 to 8 strand ropes and 20 rope diameters but not less than 15.2 cm (6 in) for rotation resistant wire ropes.

When using method A, place a wire rope clip around the dead end by clamping a short extra piece of rope to the rope dead end. DO NOT CLAMP THE LIVE END. The U-bolt should bear against the dead end. The saddle of the clip should bear against the short extra piece. Torque the U-bolts according to the figures listed in (Table 4-1).

Other sources for information with which crane users should be familiar and follow is provided by the American Society of Mechanical Engineers, American National Standard, ASME B30.5, latest revised. ASME (formerly ANSI) B30.5 applies to cableways, cranes, derricks, hoists, hooks, jacks, and slings. It states, in section 5-1.7.3, "(c) Swagged,

compressed, or wedge socket fittings shall be applied as recommended by the rope, crane or fitting manufacture." Wire ropes are addressed in ASME B30.5, section 5-1.7.2, ROPES, It states, in pertinent part, "(a) The ropes shall be of a construction recommended by the rope or crane manufacturer, or person qualified for that service." Additional information is published by the Wire Rope Technical Board in the Wire Rope Users Manual, latest revised.

Table 4-1

WIRE ROPE CLIP TORQUE VALUES			
Clip Sizes		*Torque	
mm	Inches	Nm	Ft-Lbs
3.18	1/8	6	4.5
4.76	3/16	10	7.5
6.35	1/4	20	15
7.94	5/16	40	30
13.28	3/8	60	45
11.11	7/16	90	65
12.70	1/2	90	65
14.29	9/16	130	95
15.88	5/8	130	95
19.05	3/4	175	130
22.23	7/8	300	225
25.40	1	300	225
28.58	1-1/8	300	225
31.75	1-1/4	490	360
38.68	1-3/8	490	360
38.10	1-1/2	490	360

\*The tightening torque values shown are based upon the threads being clean, dry, and free of lubrication.

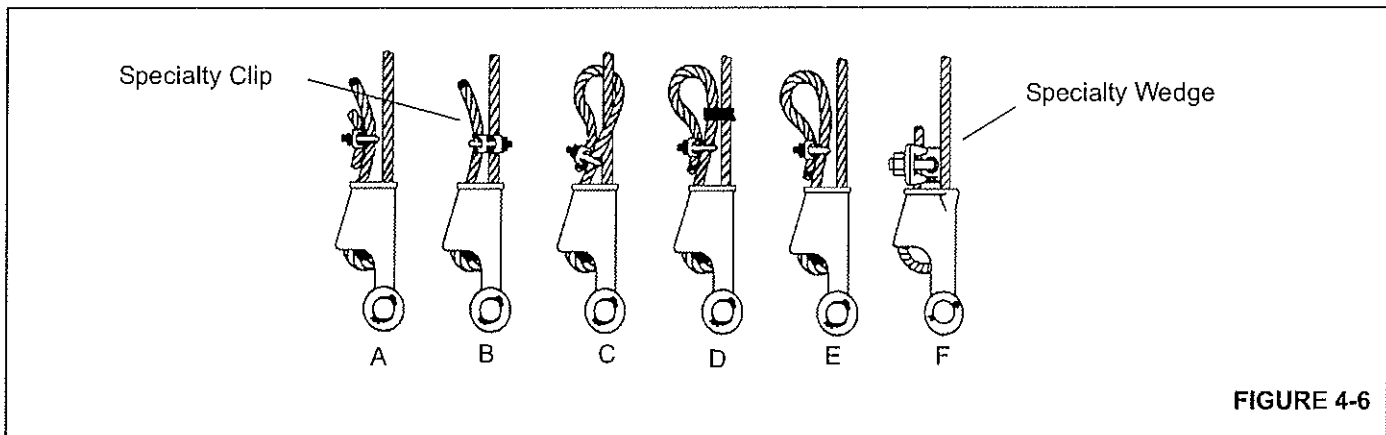


FIGURE 4-6

## ERECTING AND STOWING THE BOOM EXTENSION

### General Warnings



#### DANGER

To prevent serious injury or death, always wear personal protective equipment; i.e., a hard hat, eye protection, gloves and metatarsal boots.



#### DANGER

Boom angles are used to control speed at which extensions swing during erecting and stowage. Improper boom angles will cause uncontrollable swing speeds of extension.

**NOTE:** Tag line used in these procedures is to control the movement of the boom extension.



#### DANGER

Before attempting to erect or stow the boom extension; read and strictly adhere to all danger decals installed on the boom/boom nose, boom extension, and stowage brackets.

### Erecting



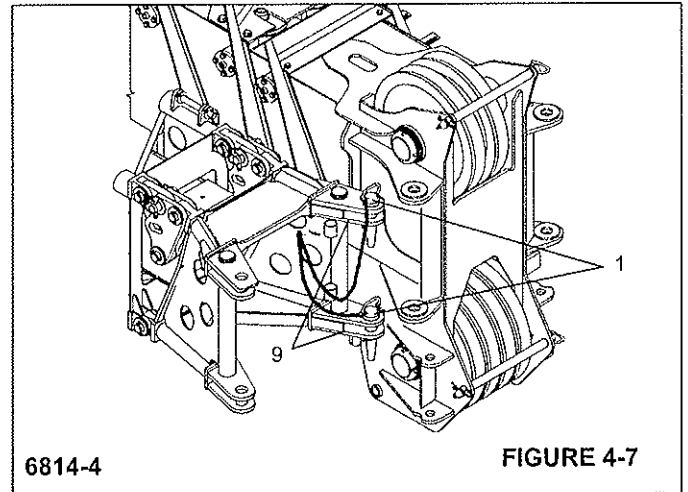
#### DANGER

To prevent serious injury or death, do not stand on decking until extensions are secure.

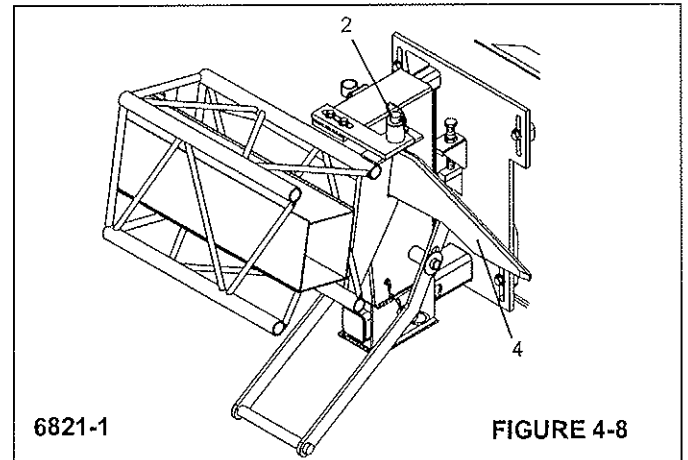
1. Visually check to ensure all pins are installed.
2. Crane should be set up on outriggers using normal setup procedures. Refer to Section 3 - OPERATING CONTROLS and PROCEDURES.
  - a. Fully retract boom.
  - b. Lower boom to horizontal for erecting over the front of the crane.

**NOTE:** The auxiliary boom nose (rooster sheave) does not have to be removed. However, if reeved, the hoist cable must be removed from the sheave.

3. Rig either the main hoist or optional auxiliary hoist cable for single part line with nothing but the wedge socket on the end of the cable. Refer to Cable Reeving and Dead End Rigging in this section.
4. Remove the retainer clips from the right side attachment pins stowed in the base of the boom extension and remove the attachment pins from the boom extension. Insert the right side attachment pins (1) through the boom attachment and boom extension anchor fittings. Install the retainer clips in the attachment pins. (Figure 4-7)

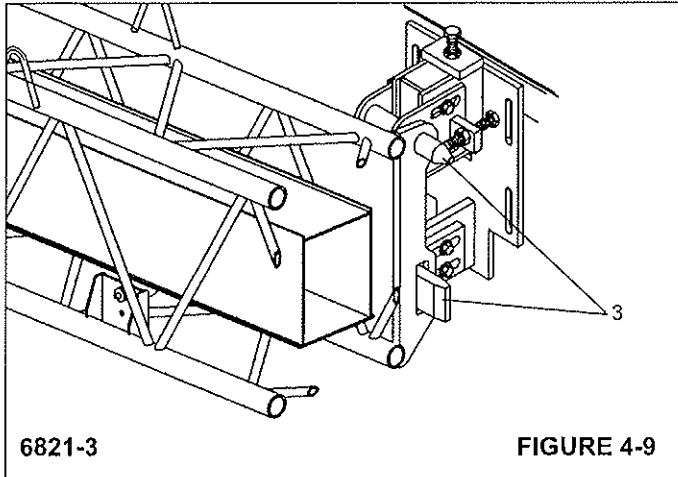


5. Remove the retaining pin from the hitch pin (4) that secures the boom extension to the rear stowage bracket. Remove the hitch pin, unlocking the boom extension from the boom. (Figure 4-8)



6. Attach a length of rope to the boom extension tip to aid in swinging the boom extension into place ahead of the boom nose.
7. Raise the boom to horizontal and extend the boom approximately 51 to 64 cm (20 to 25"). Make certain that the boom extension stowage lugs clear the guide pins

(Figure 4-9) (3) and ramp (Figure 4-8) (4) on the front and rear stowage brackets.

**DANGER**

When erecting the boom extension, ensure that all personnel and equipment are kept clear of the swing path.

8. Slightly raise and/or lower the boom to help control the boom extension. Using the rope attached to the top of the boom extension, manually swing the extension into place ahead of the boom nose, engaging the attachment fittings (5) with the anchor fittings on the left side of the boom nose. (Figure 4-10)

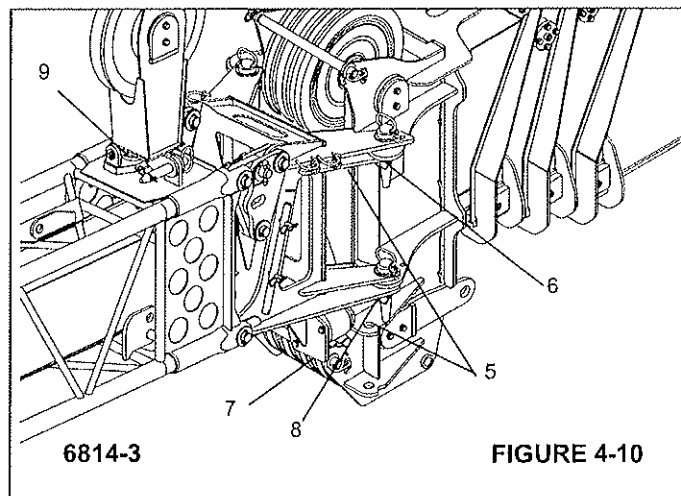
**DANGER**

Do not modify the attachment points to permit the installation of the attachment pins.

**CAUTION**

Do not place blocking under the boom extension sheave wheel. Damage to the sheave wheel may occur.

9. Install the top left side attachment pin (6) and retainer clip into the upper anchor and attachment fittings of the boom nose. (Figure 4-10)



10. Extend the boom extension alignment jack (7) until the lower left side boom nose and boom extension adapter lugs are aligned.
11. Install the bottom left side attachment pin (8) and retainer clip into the lower anchor and attachment fittings of the boom nose.
12. Connect LMI cables:
  - a. Remove cable from boom extension.
  - b. Remove dummy plug from junction box on the boom nose.
  - c. Install cable end connector from the boom extension where dummy plug was removed
13. Release pressure on the boom extension alignment jack (7). (Figure 4-10)
14. Install the Mast Assembly (9) in the upright position using the locking pin.
15. Reeve the hoist cable. Refer to Cable Reeving in this section.

**Stowing**

1. With crane set up on outriggers, fully retract the boom and swing to over-the-front.
2. Lower the boom to minimum elevation.
3. Remove the cable retainer pin from the boom extension tip and the mast assembly. Remove the hoist cable from the sheaves. Install the cable retainer pins.
4. Remove the mast assembly retainer pin and the pin securing the mast assembly in the upright position (9). (Figure 4-10) Lay the mast assembly over to the stowed position. Insert the pins securing the mast to the base section.
5. Attach a length of rope to the boom extension tip.



6. Disconnect LMI cable:
  - a. Remove connector from junction box on boom nose.
  - b. Install dummy plug in junction box.
  - c. Route cable to and attach to boom extension
7. Raise the boom to horizontal.
8. Extend the boom approximately 51 to 64 cm (20 to 25"). Make certain that the boom extension stowage lugs will line up in front of the guide pins (3) (Figure 4-9) and ramp (4) (Figure 4-8) on the stowage brackets when the boom extension is positioned to the side of the boom.
9. Ensure the hitch pin (2) (Figure 4-8) and clip pin are removed from the rear stowage bracket.
10. Extend the boom extension alignment jack (7) (Figure 4-10) until the bottom left side attachment pin (8) is free. Remove the bottom left side boom extension clip pin and attachment pin.
11. Release pressure on the boom extension alignment jack. Completely retract the jack.
12. Remove the top left side attachment pin (6) and clip pin from the upper anchor and attachment fittings of the boom nose.

**DANGER**

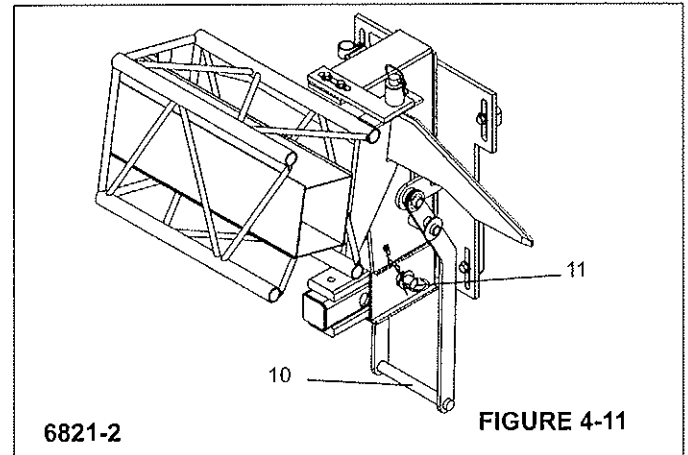
When stowing the boom extension, ensure that all personnel and equipment are kept clear of the swing path.

**CAUTION**

Do not allow the boom extension to slam into the stowage bracket when swinging into the stowed position.

13. Using the rope attached to the tip of the boom extension, manually swing the extension to the side of the boom.
14. Align the stowage lugs on the boom extension with the guide pins and ramp on the stowage brackets (Figure 4-8) and (Figure 4-9) and fully retract the boom.
15. Install the hitch pin (2) (Figure 4-8) and clip pin securing the boom extension to the rear stowage bracket.
16. Remove the attachment pins (1) and clip pins from the anchor and attachment fittings on the right side of the boom nose (Figure 4-7) and stow them in the base of the boom extension. Stow left side attachment pins and clips in outside attachment fitting on swingaway.

17. On the rear stowage bracket, remove the pin securing the sliding support in the "OUT" position. Push in on the handle (10) (Figure 4-11) to push the swingaway against the rear of the boom and disengage the swingaway anchor fittings from the boom nose attachment lugs (9) (Figure 4-7). Install the retainer pin (11) (Figure 4-11) securing the sliding support in the "IN" position.



18. Rig the boom nose and hoist cable as desired and operate the crane using normal operating procedures.

**Setting The Offset****CAUTION**

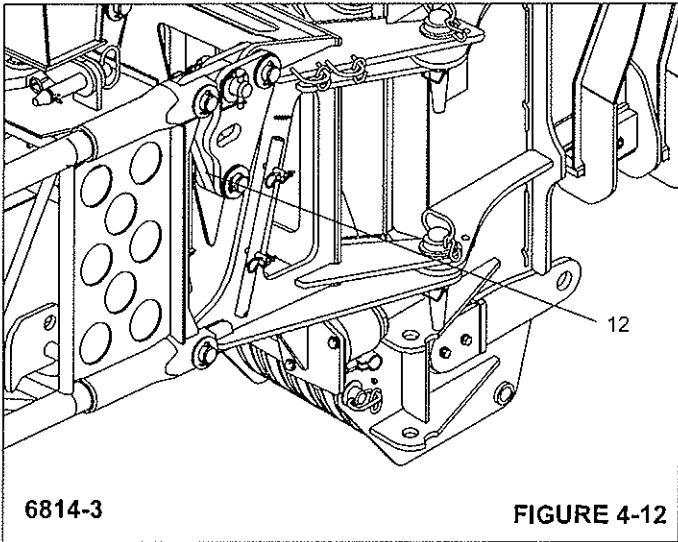
The mast assembly must be positioned on top of the base section before attempting to offset the swingaway to 30 degrees. Failure to do so can cause damage to the mast and/or swingaway adapter.

1. Extend and set the outriggers. Swing the boom over to the front of the crane.
2. To set the offset from zero degrees (0°) to thirty degrees (30°), perform the following:

**CAUTION**

Do not overload the swingaway or the attachment points when lowering the boom.

- a. Slowly lower the boom until the tip of the swingaway is on the ground and the pressure on the offset pin is relieved.
- b. Remove the lock pin, two washers, and offset pin (12). (Figure 4-12)



- c. Slowly elevate and telescope the boom at the same time until the offset shaft takes the full load of the swingaway.
3. To set the offset from thirty degrees (30°) to zero degrees (0°), perform the following:
    - a. Slowly lower the boom until the tip of the swingaway is on the ground and the offset pin can be installed.
    - b. Install the offset pin, two washers, and lock pin (12). (Figure 4-12)
    - c. Raise the boom and operate as desired.

### Changing Boom Extension From Telescoping Type To Fixed Type

1. Erect the boom extension.
2. Position the boom to horizontal.
3. Disconnect the anti-two block cable connector from the junction box.
4. Remove the telescoping section hitch pin and retaining pin.

**NOTE:** The telescoping section weighs approximately 250 kg (551 pounds).

5. Extend the telescoping section and attach an adequate lifting device to support the telescoping section. Remove the stop bolts from the base section and remove the telescoping section from the base.

**NOTE:** The pin-on boom extension nose weighs approximately 60 kg (132 lb).

6. Using an adequate lifting device, position the pin-on boom extension nose in the base section and secure with the two pins and hitch pins.

7. Connect the anti-two block cable connector to the junction box.

### Setting The Telescoping Extension Length

#### Extending

1. Position the boom to over the front.
2. Lower the boom to horizontal.
3. Remove the loop of anti-two block cable from the spool on the side of the base section and let the cable hang free.
4. Remove the hitch pin and retainer pin securing the telescoping section in the base.
5. Carefully pull the telescoping section from the base until the holes in the base and telescoping section lineup. Install the retainer pin and hitch pin.
6. If not already reeved, reeve the hoist cable over the mast and boom extension nose sheave. Install all cable retainer pins.

#### Stowing

1. Unreeve the boom extension nose.
2. Position the boom to horizontal.
3. Remove the hitch pin and retainer pin securing the telescoping section in the base.
4. Push the telescoping section into the base and secure with the retainer pin and hitch pin.
5. Loop the anti-two block cable over the spool on the side of the base section.

## COUNTERWEIGHTS

### Fixed Counterweight Description

The counterweight is pinned to the rear of the turntable and weighs 4300 kg (9490 pounds). For cranes without an auxiliary hoist, an additional 350.6 kg (773 pounds) counterweight is bolted to the hoist mounting area in lieu of the auxiliary hoist.

### Fixed Counterweight Removal



Death or serious injury could result from being crushed by a falling counterweight.

**! DANGER**

Ensure the retainer pin is properly installed to secure the counterweight mounting pin.

**NOTE:** Use of a forklift to remove/install the fixed counterweight is not recommended.

**NOTE:** Refer to (Figure 4-13) for counterweight removal.

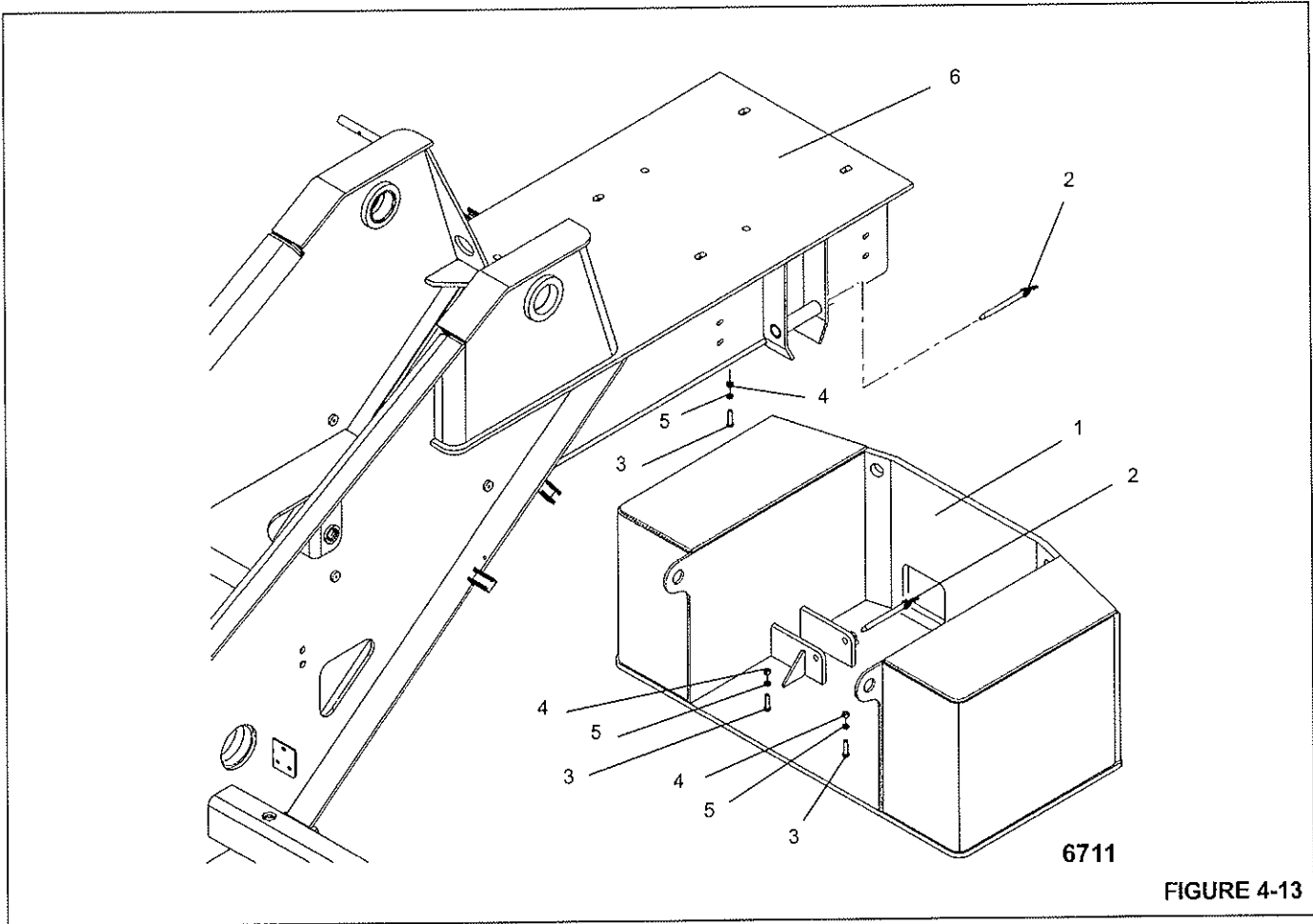


FIGURE 4-13

**4**

Item	Description
1	Counterweight
2	Pin Assembly
3	Capscrew
4	Jam Nut
5	Hex Nut
6	Turntable

1. Fully extend and set the outriggers.
2. Rotate the superstructure so the counterweight is over the front of the carrier to gain additional clearance. Engaging the pin type turntable lock will aid alignment.

**NOTE:** The counterweight weighs approximately 4300 kg (9490 pounds).

3. Lower and fully retract the boom
4. Shut down crane.
5. Remove and cap hydraulic lines from auxiliary hoist (if installed)
6. Attach an adequate lifting device to the counterweight.
7. Ensure the four counterweight leveling capscrews are set for maximum clearance with the turntable.
8. Slowly raise counterweight until pin assembly can be removed by pushing and turning the pin.
9. Remove pin assembly from opposite side.

10. Lower counterweight until attaching lugs are clear of the turntable.
11. Back counterweight away from turntable until it is clear of crane.
12. Replace pin assembly in turntable counterweight mounting lugs.
13. Move counterweight far enough from crane to allow the turntable/superstructure to clear during repositioning.
14. Rotate superstructure to the normal travel position.

### ***Fixed Counterweight Installation***

1. Fully extend and set the outriggers.
2. Rotate the superstructure so the counterweight will be over the front of the carrier to gain additional clearance.
3. Shut down crane.
4. Remove and cap hydraulic lines from auxiliary hoist (if installed).

---

### **CAUTION**

When lifting/handling the counterweight, keep the chains/straps vertical to minimize side pull on the lifting lugs.

---

**NOTE:** The counterweight weighs approximately 4300 kg (9490 pounds).

**NOTE:** Use of a forklift to remove/install the fixed counterweight is not recommended.

5. Attach an adequate lifting device to the counterweight and lift the counterweight into place on the superstructure, aligning the mounting holes on the counterweight to the holes in the superstructure.
6. Install the counterweight mounting pins and secure them in place with hitch pin retainers.
7. Remove the lifting device from the counterweight.
8. Using the four counterweight leveling bolts, level the counterweight and eliminate any relative movement between the counterweight and turntable. Maximum width of counterweight shall not exceed 6.0 mm (0.25 in) out of level with the turntable bearing when measured from either counterweight outer edge.

## SECTION 5 LUBRICATION

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## SECTION 5

### LUBRICATION

#### GENERAL

Following the designated lubrication procedures is important in ensuring maximum crane lifetime and utilization. The procedures and lubrication charts in this section include information on the types of lubricants used, the location of the lubrication points, the frequency of lubrication, and other information.

The service intervals specified are for normal operation where moderate temperature, humidity, and atmospheric conditions prevail. In areas of extreme conditions, the service periods and lubrication specifications should be altered to meet existing conditions. For information on extreme condition lubrication, contact your local Grove Distributor or Manitowoc CraneCARE.

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#### CAUTION

Chassis grease lubricants must not be applied with air pressure devices as this lubricant is used on sealed fittings.

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#### CAUTION

The multipurpose grease installed during manufacture is of a lithium base. Use of a noncompatible grease could result in damage to equipment.

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#### Arctic Conditions Below -18°C (0°F).

In general, petroleum based fluids developed especially for low temperature service may be used with satisfactory results. However, certain fluids, such as halogenated hydrocarbons, nitro hydrocarbons, and phosphate ester hydraulic fluids, might not be compatible with hydraulic system seals and wear bands. If you are in doubt about the suitability of a specific fluid, check with your authorized Grove distributor or Manitowoc CraneCARE.

**NOTE:** All fluids and lubricants may be purchased by contacting the Manitowoc CraneCARE Parts Department.

Regardless of temperature and oil viscosity, always use suitable start-up procedures to ensure adequate lubrication during system warm-up.

#### Arctic Conditions Down To -40°F.

#### *ALL Weather Package & Lubricants*

Engineering recommends the following lubricants for components for ambient temperatures to -40F. Special lubricants alone are not sufficient to operate at extreme low temperatures. We also recommend the use of appropriately sized heaters for the hydraulic tank, engine oil pan, engine jacket water and batteries. The operator needs to follow the guide lines as stated in the operator's manual. We assume that the customer has take steps for use of an appropriate engine antifreeze coolant, have taken care of the fuel, fuel system and starting system. And has done whatever they feel necessary to add insulation for under hood temperatures and meet the engine manufacture's intake air temperature. Other lubricants may be used if they meet the specification of the lubricant that is requested. Please consult factory.

**Axles and Swing Box** -- Petro- Canada Traxon E Synthetic 75W-90; CITGO, Syntetic Gear Lube 75W-90; Eaton, Roadranger EP75W-90; Mobil, Mobilube SCH 75W-90; Shell, Spirax S 75W-90; Sunoco Duragear EP75W-90; -- **Spec 6829014058**

**Engine** -- Petro-Canada Duron Synthetic CI-4- 5W-40; Mobil Delvac 1, 5W-40; -- **Spec 6829101560**

**Hydraulic tank and Transmission** -- Petro-Canada Duratran Synthetic THF; Chevron All Weather THF; Texaco TDH Oil SS; -- **Spec 6829101559**

**Hoist** -- Petro-Canada ENDURATEX Synthetic EP 150; Mobil SHC629; -- **Spec 6829103636**

**Grease** -- Petro-Canada Precision Synthetic EP1; Mobil: Mobilith SHC 220; -- **Spec 6829104275**

**Open Gear Lube** -- (bearing/swingdrive teeth) ---Vultrex... OGL Synthetic All Season -- **No Spec**

**Antifreeze Coolant** -- Petro-Canada AFC 60/40; Old World Industries, Inc Fleet Charge SCA Pre-charged Antifreeze/Coolant-60/40; Fleetguard Compleat EG Antifreeze/Coolant Premix 60/40; -- **Spec 6829104212**

#### *Standard Lubricants Package*

**Axle and Swing Box** -- Century Unigear Semi-synthetic SAE 80W-90; Texaco Multigear SS 80W-90; Chevron DELO 80W-90; -- **Spec 6829012964**

**Engine** -- CI-4 Rated 15W-40 Engine Oil Exxon XD-3; Conoco Fleet Supreme; -- **Spec 6829003483**

**Hydraulic Tank and Transmission** -- To meet John Deere Standard JDM J20C – Hyden 052-10W-20; Exxon Torque

Fluid 56- 10W-20; Esso Torque Fluid 56- 10W-20; BP-Eldoran UTH & Trak-Tran 9 – 10W20; BP- Blend- 7367 - 10W20; Exxon Mobil 424- 10W-30 -- **Spec 6829006444**

**Hoist** -- AGMA No. 4 EP Extreme Pressure Gear Lube-Mobil: Mobilfluid 629 ; Texaco: Meropa 150; -- **Spec 6829100213**

**Grease** -- EP-MPG- Multipurpose Grease – Citgo Lithoplex MP # 2; Texaco Starplex Moly # 2; Phillips 66 Philube M Grease; Mobil Mobilgrese XHP 222 Special, # 53055-0; Chemtool Inc, Lube-A-Boom-Grease; -- **Spec 6829003477**

**Open Gear Lube** -- (bearing / swingdrive teeth -- FUCHS: CEPLATTYN 300 SPRAY -- **Spec 6829102971**

**Antifreeze Coolant** -- AFC – 50/50 Old World Industries, Inc. Fleet Charge SCA Pre-charged Antifreeze/Coolant; Caterpillar DEAC Antifreeze/Coolant; Fleetguard Complete EG Antifreeze/Coolant; -- **Spec 6829101130**

## LUBRICATION POINTS

A regular frequency of lubrication must be established for all lubrication points. Normally, this is based on component operating time. The most efficient method of keeping track of lube requirements is to maintain a job log indicating crane usage. The log must use the engine hourmeter to ensure coverage of lube points that will receive attention based on their readings. Other lubrication requirements must be made on a time basis, i.e. weekly, monthly, etc.

All oil levels are to be checked with the crane parked on a level surface in transport position, and while the oil is cold, unless otherwise specified.

On plug type check points, the oil levels are to be at the bottom edge of the check port.

On all hoists with a check plug in the drum, the fill plug shall be directly on top of the hoist, and the check plug level.

All grease fittings are SAE STANDARD unless otherwise indicated. Grease non-sealed fittings until grease is seen extruding from the fitting. One ounce(28 grams) of EP-MPG equals one pump on a standard one pound (0.45 kg) grease gun.

Over lubrication on non-sealed fittings will not harm the fittings or components, but under lubrication will definitely lead to a shorter lifetime.

On sealed U-joints, care must be exercised to prevent rupturing seals. Fill only until expansion of the seals first becomes visible.

Unless otherwise indicated, items not equipped with grease fittings, such as linkages, pins, levers, etc., should be

lubricated with oil once a week. Motor oil, applied sparingly, will provide the necessary lubrication and help prevent the formation of rust. An Anti-Seize compound may be used if rust has not formed, otherwise the component must be cleaned first.

Grease fittings that are worn and will not hold the grease gun, or those that have a stuck check ball, must be replaced.

Where wear pads are used, cycle the components and relubricate to ensure complete lubrication of the entire wear area.

## Surface Protection for Cylinder Rods

Steel cylinder rods include a thin layer of chrome plating on their surfaces to protect them from corroding. However, chrome plating inherently has cracks in its structure which can allow moisture to corrode the underlying steel. At typical ambient temperatures, hydraulic oil is too thick to penetrate these cracks. Normal machine operating temperatures will allow hydraulic oil to warm sufficiently to penetrate these cracks and if machines are operated daily, protect the rods. Machines that are stored, transported, or used in a corrosive environment (high moisture, rain, snow, or coastline conditions) need to have the exposed rods protected more frequently by applying a protectant. Unless the machine is operated daily, exposed rod surfaces will corrode. Some cylinders will have rods exposed even when completely retracted. Assume all cylinders have exposed rods, as corrosion on the end of the rod can ruin the cylinder.

It is recommended that all exposed cylinder rods be protected using Boeshield® T-9 Premium Metal Protectant. Manitowoc CraneCARE has Boeshield® T-9 Premium Metal Protectant available in 12 oz. cans that can be ordered through the Parts Department.

Cylinder operation and inclement weather will remove the Boeshield® protectant; therefore, inspect machines once a week and reapply Boeshield® to unprotected rod

The following describe the lubrication points and gives the lube type, lube interval, lube amount, and application of each. Each lubrication point is numbered, and this number corresponds to the index number shown on the Lubrication Figures 5-1 thru 5-4. Lube description and symbols are found in (Table 5-1) and (Table 5-2).

## SAFETY

To lubricate many of the locations the engine will need to be started. After positioning areas of the unit for lubrication the engine must be turned off and the moved areas stable before approaching.



**WARNING**

Movement of the superstructure and the boom may create a crushing and/or pinching hazard. Failure to observe this warning could result in death or serious injury if the message is ignored.

**Table 5-1**

Symbol	Description
EP-MPG	Extreme Pressure Multipurpose Grease - Lithium Soap Base, NLGI Grade 2.
SSGL-5	Semi-Synthetic Gear Lubricant
AFC - 50/50	50/50 Blended Fully Formulated Antifreeze/Coolant, SAE J1941, ASTM D6210
HYDO	Hydraulic Oil - Must meet John Deere Standard JDM-J20C (Anti-brake chatter) and ISO 4406 cleanliness level 17/14
EO-15W/40	Engine Oil - SAE 15W-40, API Service Classification CI-4 or better
EP-OGL	Open Gear Lubricant, CEPLATTYN 300 Spray, NLGI Class 1-2
AGMA EP-4	Extreme Pressure Gear Lubricant.

**Table 5-2**  
**Lube Description**

Lubrication Description	Lube Specification
Extreme Pressure Multipurpose Grease	A6-829-003477
Extended Service Interval Gear Lube	A6-829-012964
Fully Formulated Anti-Freeze Coolant	A6-829-101130
Hydraulic Oil	A6-829-006444
Engine Oil SAE 15W40	A6-829-003483
Open Gear Lube	A6-829-102971
Extreme Pressure Gear Lube	A6-829-100213
See Service Manual	***

**CAUTION**

The following lube intervals are to be used as a guideline only. Actual lube intervals should be formulated by the operator to correspond accordingly to conditions such as continuous duty cycles and/or hazardous environments.

**STEERING & SUSPENSION LUBRICATION**

## 1. Steering Cylinder Pivot Pins (1). (Figure 5-1)

Lube Type - EP-MPG

Lube Interval - 500 hours or 3 months

Lube Amount - Until grease extrudes

Application - 8 grease fittings

## 2. Upper and Lower King Pins (2). (Figure 5-1)

Lube Type - EP-MPG

Lube Interval - 500 hours or 3 months

Lube Amount - Until grease extrudes

Application - 8 grease fittings

## 3. Fifth Wheel Pivots (3). (Figure 5-1)

Lube Type - EP-MPG

Lube Interval - 500 hours or 3 months

Lube Amount - Until grease extrudes

Application - 2 grease fittings

## 4. Lockout Cylinder Pivot Pins (4). (Figure 5-1)

Lube Type - EP-MPG

Lube Interval - 500 hours or 3 months

Lube Amount - Until grease extrudes

Application - 4 fittings

**AXLE LUBRICATION**

## 5. Differentials (5). (Figure 5-1)

Lube Type - SSGL-5

Lube Interval -

- Check lubricant level every 500 hours or 3 months and refill as necessary.
- Drain and refill every 4000 hours or 2 years.

**CAUTION**

If the makeup amount is substantially more than 0.5 pint (0.23 liter), check for leaks.

**CAUTION**

Use of non-extended service interval lubricant may damage components and/or invalidate published lubricant intervals.

Lube Amount - Capacity - 9.5 liters (20 pints) -  
Normal makeup - less than 0.23 liter (0.5 pint)

Application - Fill to bottom of hole in the housing on the steer cylinder side.

**NOTE:** Lube level close enough to the hole to be seen or touched is not sufficient. It must be level with the hole.

When checking lube level, also check and clean housing breathers.

## 6. Planetary Hubs and Wheel Bearings (6). (Figure 5-1)

Lube Type - SSGL-5

Lube Interval -

- Check fluid level every 500 hours or 3 months and refill as necessary.
- Drain and refill every 4000 hours or 2 years

**CAUTION**

Use of non-extended service interval lubricant may damage components and/or invalidate published lubricant intervals.

Lube Amount - 1.6 liters (3.5 pints)

Application - Fill to the bottom of the level hole in the housing with the fill plug and the oil level mark horizontal

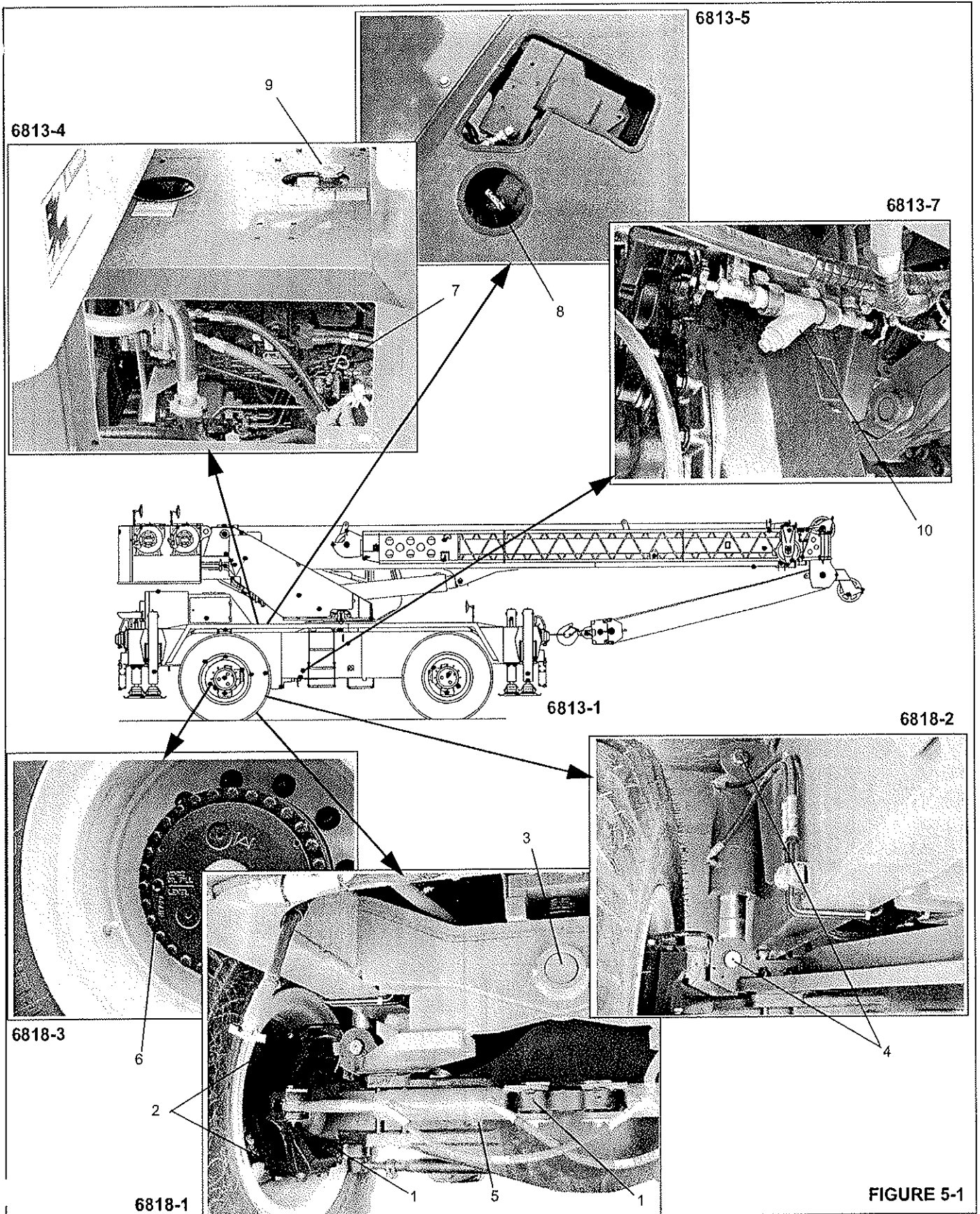


FIGURE 5-1

5

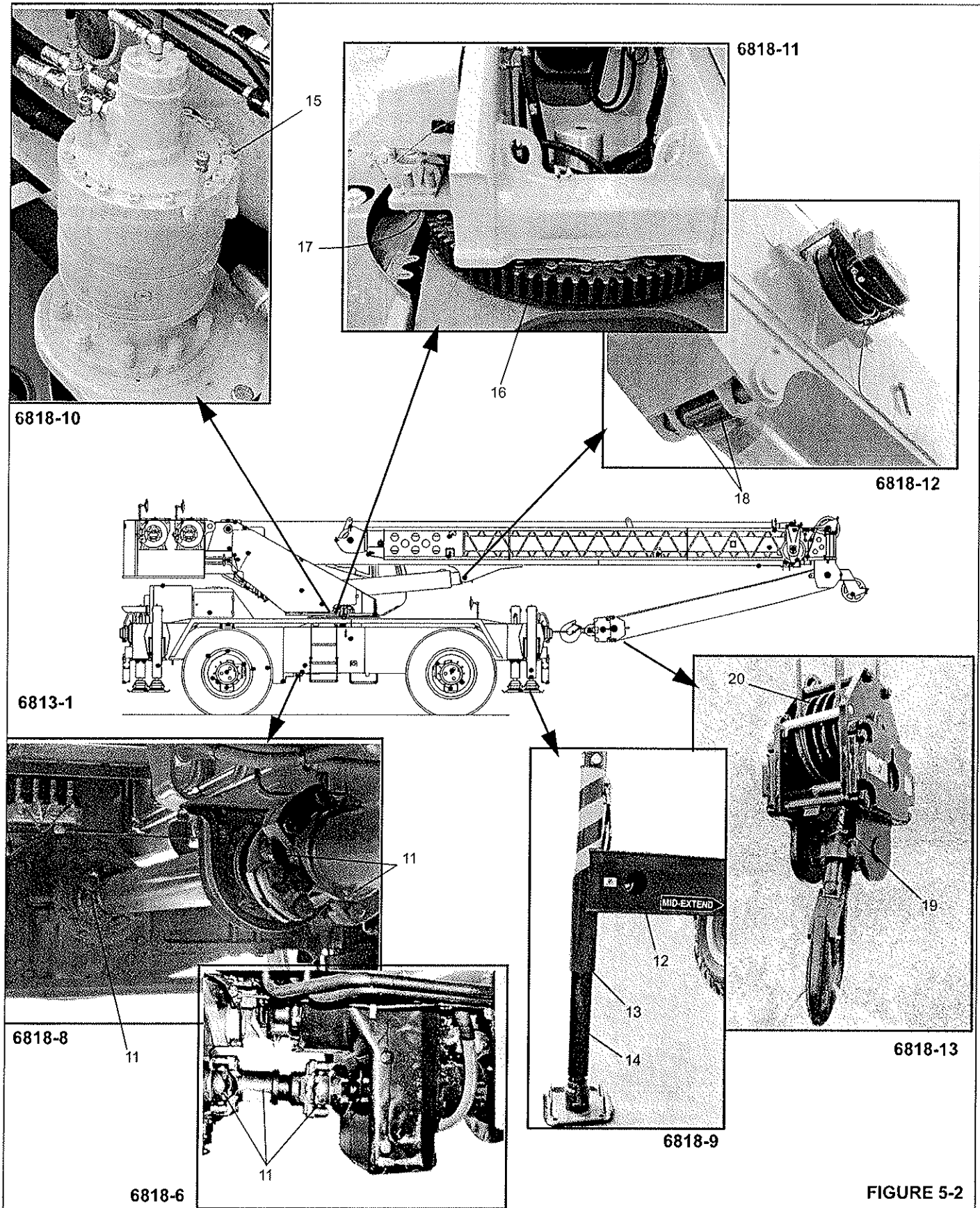


FIGURE 5-2

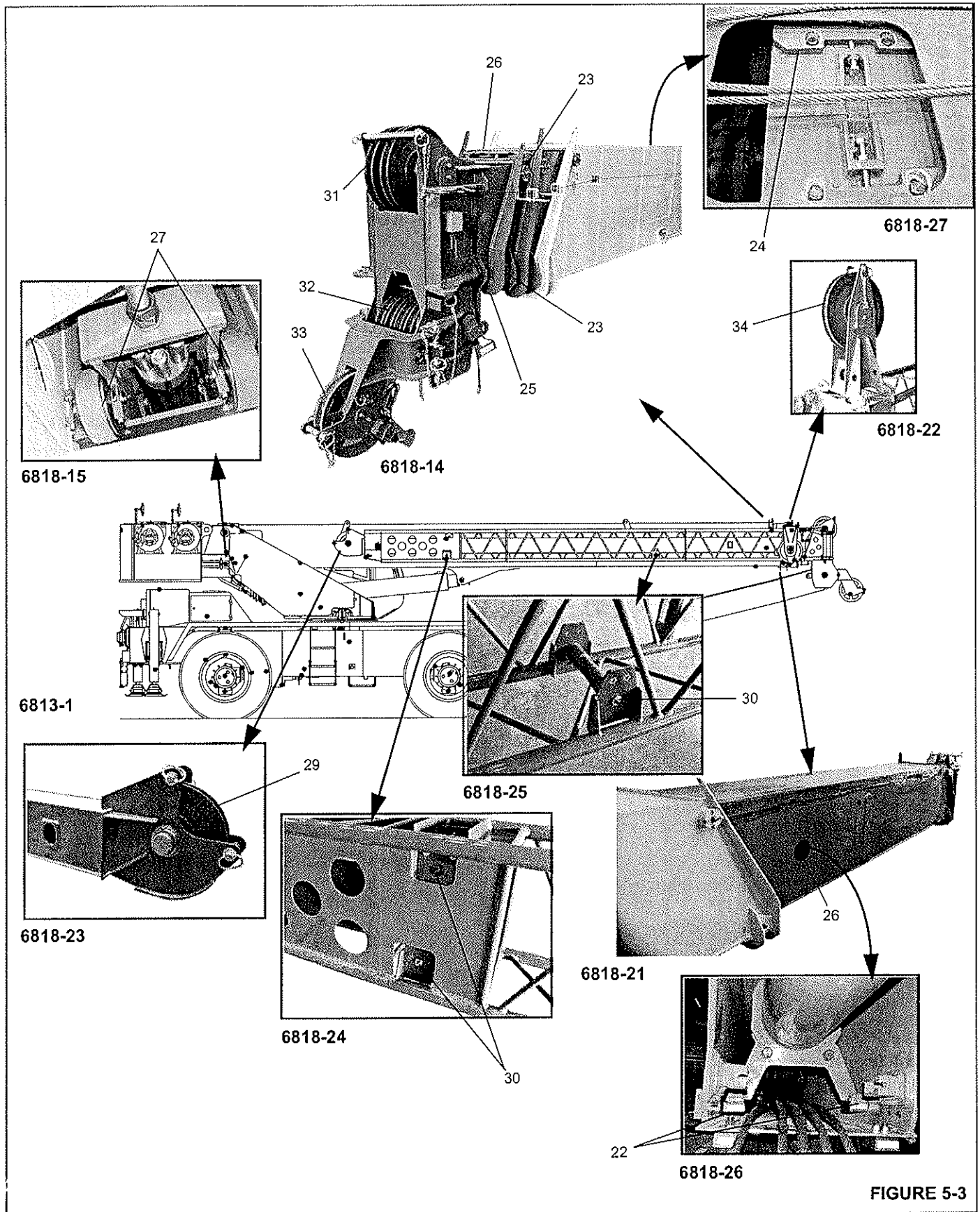


FIGURE 5-3

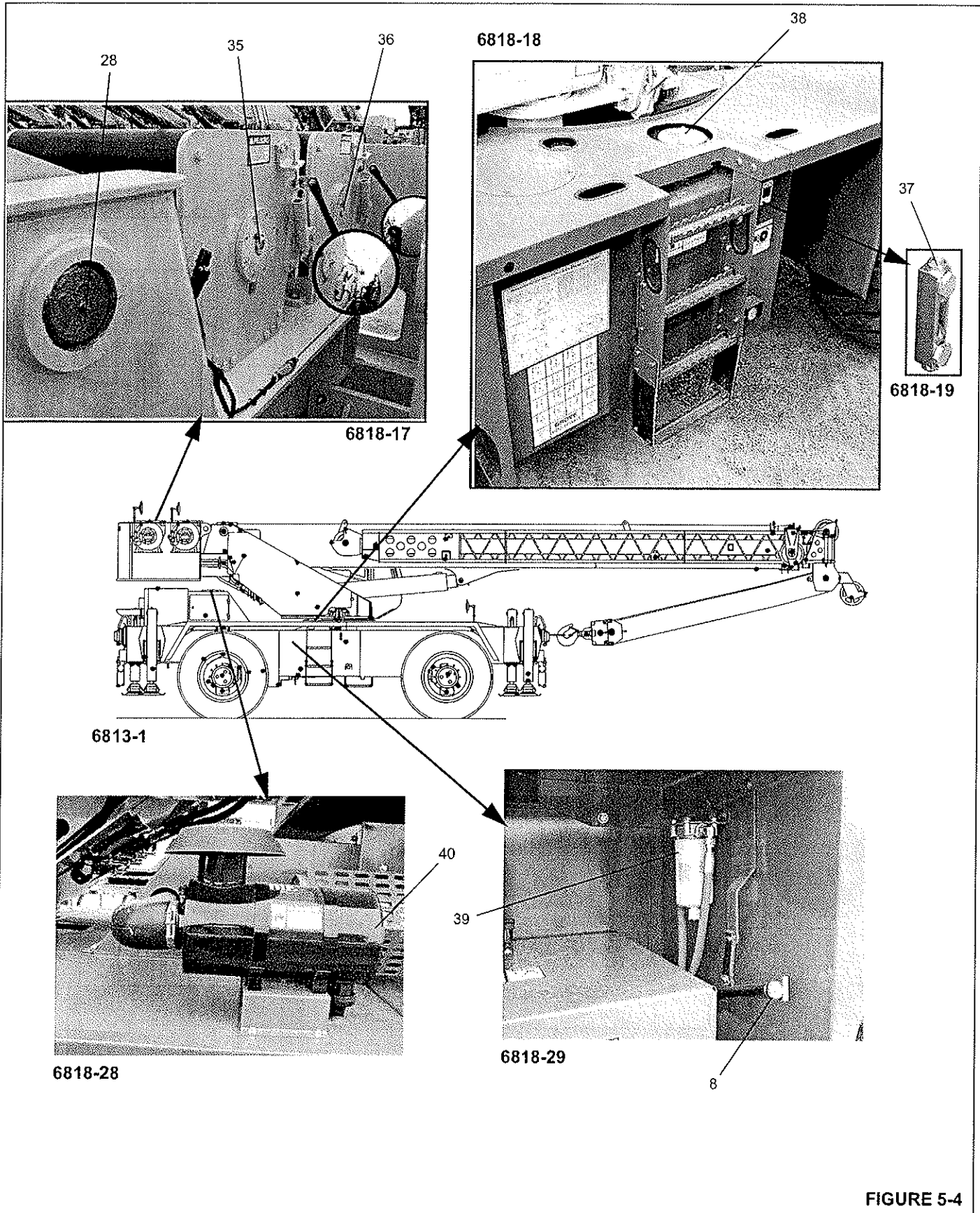


FIGURE 5-4

**DRIVE TRAIN LUBRICATION****7. Engine Crankcase (With Filter) (7). (Figure 5-1)**

Lube Type - EO-15W40

Lube Interval -

- Check fluid level every 10 hours or daily
- Drain and fill every 250 hours
- Replace filter every 250 hours

Lube Amount - Capacity - 16.4 liters (17.3 quarts)

Application - Fill to FULL mark on dipstick.

**8. Transmission, Torque Converter and Filter (8). (Figure 5-1) and (Figure 5-4)**

Lube Type - HYDO

Lube Interval -

- Check fluid level every 10 hours or daily with the engine running at 800 rpm and the oil at 82 to 93 °C (180 to 200 °F)
- Drain and refill every 1000 hours or 6 months with the oil at 65 to 93 °C (150 to 200 °F)
- Change transmission filter after the first 50 and 100 hours of service, then every 500 hours thereafter.

To add fluid:

- a. Fill to FULL mark on dipstick.
- b. Run engine at 800 rpm to prime torque converter and lines
- c. Check oil level with engine running at 800 rpm and oil at 82 to 93 °C (180 to 200 °F). Add oil to bring oil level to FULL mark on dipstick.

**NOTE:** When checking the oil level, the oil temperature must be stabilized at 82 to 93 °C (180 to 200 °F) to properly check the oil level. Do not attempt an oil level check with cold oil.

To bring the oil temperature to this range, it is necessary to either work the crane or stall the converter. Converter stall should be accomplished by engaging the shift lever in forward high range with the brakes applied and then accelerating the engine to half or three-quarter throttle. Hold the stall until the desired temperature is reached and stabilized.

Lube Amount - Capacity of torque converter, lines and transmission as a system - 23.7 liters (25 quarts)

Application - Through fill pipe to FULL mark on dipstick

**9. Engine Cooling System (9). (Figure 5-1)**

Lube Type - AFC-50/50

Lube Interval -

- Check and fill coolant level every 10 hours or daily
- Drain and refill cooling system per engine service manual

Lube Amount - Capacity - 19.9 liters (21 quarts)

Application - Fill surge tank to bottom of filler neck with mixture of 50% AFC and 50% water. Run engine through two (2) thermal cycles. Check coolant level and refill as required.

**10. Coolant Strainer (Cab Heater Supply) (10). (Figure 5-1)**

Lube Type - Not applicable

Lube Interval - Change strainer element at first 100 hours of cab heater use, and at 2000 hours or 1 year intervals of heater use thereafter.

Lube Amount - Not applicable

Application - Not applicable

**11. Driveline - Slip and U-Joints (11). (Figure 5-2)**

Lube Type - EP-MPG

Lube Interval - 500 hours or every 3 months

Lube Amount - Until grease extrudes

Application - 6 grease fittings

**OUTRIGGER LUBRICATION****12. Outrigger Beams (12). (Figure 5-2)**

Lube Type - EP-MPG

Lube Interval - 50 hours or one week, whichever comes first

Lube Amount - Brush on lubricant on both sides of the bottom of the outrigger beams.

Application - Brush on 8 points (4 beams)

**13. Jack Cylinder Support Tubes (13). (Figure 5-2)**

Lube Type - EP-MPG

Lube Interval - Inspect and grease weekly or every 50 hours of operation; whichever occurs first

Lube Amount - Thoroughly coat barrel

Application - Brush on 4 points

**14. Jack Cylinder Barrels (14). (Figure 5-2)**

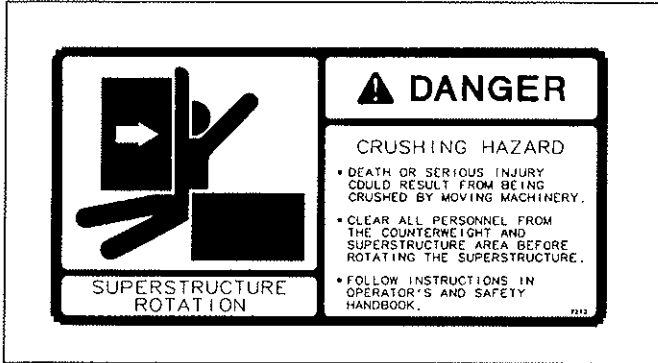
Lube Type - EP-MPG

Lube Interval - Inspect and grease weekly or every 50 hours of operation; whichever occurs first

Lube Amount - Thoroughly coat barrel

Application - Brush on 4 points

## TURNTABLE LUBRICATION



### 15. Turntable Gear Box (15). (Figure 5-2)

Lube Type - SSGI-5

Lube Interval -

- Check and fill every 50 hours.
  - a. Check level on dipstick. Do not screw dipstick cap into the tube to check.
  - b. If no lubricant is visible on dipstick, add until between minimum and maximum on dipstick
- Drain and fill after first 250 hours and every 500 hours or 12 months thereafter.
  - a. Unscrew drain plug; remove breather and dipstick to ensure all oil has been removed.
  - b. After oil is drained, replace the drain plug and any other plugs that were removed to drain the oil.
  - c. To refill with oil, make sure the breather is open. Fill until proper location on dipstick.
  - d. Tighten breather and dipstick.

Lube Amount - 4.0 liters (4.25 quarts)

Application - Fill to mark on dipstick

### 16. Turntable Gear and Drive Pinion (16). (Figure 5-2)

Lube Type -EP-OGL

Lube Interval - 500 hours or 6 months

Lube Amount - Coat all teeth

Application - Spray on

### 17. Turntable Bearing (17). (Figure 5-2)

Lube Type - EP-MPG

Lube Interval - 500 hours or 6 months

Lube Amount - Until grease extrudes the whole circumference of the bearing.

Application - 2 grease fittings at the front of the turntable. Rotate the turntable 90° and apply grease

to fittings. Continue rotating 90° and grease the fittings until the whole bearing is greased.

## LIFT CYLINDER LUBRICATION

### 18. Upper Lift Cylinder Pivot Pin (18). (Figure 5-2)

Lube Type - EP-MPG

Lube Interval - 500 hours or every 3 months

Lube Amount - Until grease extrudes

Application - 2 grease fitting

### 19. Lower Lift Cylinder Pivot Pin

Lube Type - NA

Lube Interval - NA

Lube Amount - NA

Application - NA

## BOOM LUBRICATION



### WARNING

Do not place hands into openings in the boom unless the engine is turned off and boom position is secured. Death or serious injury could result if this message is ignored.

### 20. Hook Block Swivel Bearing (19). (Figure 5-2)

Lube Type - EP-MPG

Lube Interval - 250 hours or 3 months

Lube Amount - Until grease extrudes

Application - 1 grease fitting

### 21. Hook Block Sheaves (20). (Figure 5-2)

Lube Type - EP-MPG

Lube Interval - 250 hours or 3 months

Lube Amount - Until grease extrudes

Application - 1 grease fitting per sheave

(4 fittings total - 35 ton)(3 fittings total - 35 ton)

### 22. Telescope Cylinder Wear Pads (22). (Figure 5-3)

Lube Type - EP-MPG

Lube Interval - 125 hours or 3 months

Lube Amount - Thoroughly coat the area the wear pad moves on

Application - Brush on 2 places; extend boom for access through access holes in fly section

**NOTE:** Lubricate more frequently than interval indicated if environmental condition and/or operating conditions necessitate.



- NOTE:** Should boom chatter or rubbing noises in the boom occur, it will be necessary to lubricate the telescope cylinder wear pads. By adding an extension adapter to a grease gun the wear pads and wear areas can be reached through the lubrication access holes in the side of the boom and through the access hole in the boom nose between the sheaves.
- 23. Side Wear Pads (23).** (Figure 5-3)  
Lube Type - EP-MPG  
Lube Interval - 250 hours or 3 months
- NOTE:** Lubricate more frequently than interval indicated if environmental condition and/or operating conditions necessitate.  
Lube Amount - Thoroughly coat all areas the wear pad moves on (bottom, top, and side plates)  
Application - By brush: 12 places; with boom in extended position.
- 24. Boom Section Upper Wear Pads (24).** (Figure 5-3)  
Lube Type - EP-MPG  
Lube Interval - 50 hours or 1 week
- NOTE:** Lubricate more frequently than interval indicated if environmental condition and/or operating conditions necessitate.  
Lube Amount - Thoroughly coat the area the wear pad moves on  
Application - Brush on - 6 places; with boom in extended position.
- 25. Boom Section Lower Wear Pads (25).** (Figure 5-3)  
Lube Type - EP-MPG  
Lube Interval - 50 hours or 1 week  
Lube Amount - Thoroughly coat all areas the wear pad moves on (bottom, top, and side plates)  
Application - By brush; 3 places; with boom in extended position.
- 26. Extend & Synchronization Cable Sheaves (26).** (Figure 5-3)  
Lube Type - EP-MPG  
Lube Interval - 250 hours or 3 months  
Lube Amount - Until grease extrudes  
Application - 3 grease fittings. Two on the top of the boom and one inside at the end of the tele cylinder.
- 27. Retract Cable Sheaves (27).** (Figure 5-3)  
Lube Type - EP-MPG  
Lube Interval - 250 hours or 3 months  
Lube Amount - Until grease extrudes  
Application - 4 grease fittings; extend boom for entry through access holes
- 28. Boom Pivot Shaft (28).** (Figure 5-4)  
Lube Type - EP-MPG  
Lube Interval - 250 hours or 3 months  
Lube Amount - Until grease extrudes  
Application - 2 grease fittings, one on each side
- 29. Boom Extension Sheave (29).** (Figure 5-3)  
Lube Type - EP-MPG  
Lube Interval - 250 hours or 3 months  
Lube Amount - Until grease extrudes  
Application - 1 grease fitting
- 30. Boom Extension Roller (30).** (Figure 5-3)  
Lube Type - EP-MPG  
Lube Interval - 250 hours or 3 months  
Lube Amount - Until grease extrudes  
Application - 4 grease fittings
- 31. Upper Boom Nose Sheave (31).** (Figure 5-3)  
Lube Type - EP-MPG  
Lube Interval - 250 hours or 3 months  
Lube Amount - Until grease extrudes  
Application - 1 grease fitting per sheave
- 32. Lower Boom Nose Sheave (32).** (Figure 5-3)  
Lube Type - EP-MPG  
Lube Interval - 250 hours or 3 months  
Lube Amount - Until grease extrudes  
Application - 1 grease fitting per sheave
- 33. Auxiliary Boom Nose Sheave (33).** (Figure 5-3)  
Lube Type - EP-MPG  
Lube Interval - 250 hours or 3 months  
Lube Amount - Until grease extrudes  
Application - 1 grease fitting
- 34. Mast Sheave (34).** (Figure 5-3)  
Lube Type - EP-MPG  
Lube Interval - 500 hours or 12 months  
Lube Amount - As Necessary  
Application - 1 grease fitting

**HOIST LUBRICATION****35. Main Hoist (35).** (Figure 5-4)

Lube Type - AGMA EP-4

Lube Interval - Every 1000 hours or 12 months

Lube Amount - Capacity - 5.2 liters (5.5 quarts)

Application - Fill until level with the check plug opening

**36. Auxiliary Hoist (Optional) (36).** (Figure 5-4)

Lube Type - AGMA EP-4

Lube Interval - Every 1000 hours or 12 months

Lube Amount - Capacity - 5.2 liters (5.5 quarts)

Application - Fill until level with the check plug opening

**HYDRAULIC LUBRICATION****37. Hydraulic Reservoir (Figure 5-4)**

Lube Type - HYDO

Lube Interval -

- Check fluid level every 10 hours or daily, using sight gauge (37) on side of tank, with boom down and all outrigger cylinders retracted
- Drain and refill as necessary

Lube Amount - 397.4 liters (105 gal.), to FULL mark on sight gauge.

Application - Fill through breather/fill cap on top of tank. When tank is drained, clean the magnetic pipe plug.

**38. Hydraulic Filter (38).** (Figure 5-4)

Change the filter when the restriction indicator is in the red.

**FUEL FILTER****39. Fuel Filter (39).** (Figure 5-4)

- Drain water trap every 10 hours or daily
- Change filter every 500 hours or 6 months

**AIR CLEANER FILTER****40. Air Cleaner Filter (40).** (Figure 5-4)

Replace air cleaner filter element when indicator shows red (25" H2O).

**WIRE ROPE LUBRICATION**

Wire rope is lubricated during manufacturing so that the strands, and individual wires in strands, may move as the rope moves and bends. A wire rope cannot be lubricated sufficiently during manufacture to last its entire life. Therefore, new lubricant must be added periodically throughout the life of a rope to replace factory lubricant which is used or lost.

**NOTE:** Wire rope may be purchased by contacting the Manitowoc CraneCARE Parts Department.

For more detailed information concerning the lubrication and inspection of wire rope, refer to WIRE ROPE in Section 1-INTRODUCTION in the Service Manual.

**SECTION 6**  
**MAINTENANCE CHECKLIST**

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## SECTION 6

### MAINTENANCE CHECKLIST

#### GENERAL

This section contains a list of daily inspection and maintenance checks. Performing the checks will help maintain the safety, dependability, and productivity designed into your crane.

#### INSTRUCTIONS

See Service Manual for specific maintenance and adjustment procedures.

Refer to your Maintenance Inspection Manual for all inspection intervals.

See Section 5 (in this handbook) for lubrication intervals, types of fluids, and lube point locations.

INSPECTION SERVICE LOG

Reference	Items to be Inspected Daily	Interval	DAY OF INSPECTION																																			
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31					
	<b>December</b>	D																																				
1	Verify Outrigger Foot Pads are properly installed & show no signs of structural damage	D																																				
2	Verify Tire Condition has no excessive wear and Pressure is at the proper level	D																																				
3	Visually check machine for any Hydraulic Components (including Hoses) with excessive wear, loose fittings, or leaks	D																																				
4	Visually check for any loose or damaged Wiring	D																																				
5	Verify Engine Coolant is at the proper level	D																																				
6	Verify Crankcase and Transmission have the proper fluid levels	D																																				
7	Verify Hoists are installed properly with no signs of damage, or leaks	D																																				
8	Operator's Manual installed properly on machine.	D																																				
9	Verify that the "Operator Aids" are working properly - Boom Angle Indicator, Load Moment Indicator (LMI), Antiwo-Block.	D																																				
10	Gauges and Instruments are functional	D																																				
11	Back-up Alarm operates properly when operating machine	D																																				
12	Swing Brake operates properly	D																																				
13	Verify Brakes and Air System (if equipped) are working properly	D																																				
14	Lights and Horn are in good working order and not damaged	D																																				
15	Verify Hydraulic Reservoir has the proper fluid level	D																																				
16	Hydraulic Oil Filter (check back pressure)	D																																				
17	Verify Boom and Attachments are properly installed with no signs of damage, or leaks	D																																				
18	Verify Wire Rope has no damaged, frayed, or broken strands	D																																				
19		D																																				
20		D																																				
<b>Inspector's Initials</b>																																						
22		D																																				
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