

# Grove GRT655 / GRT655L

## Operator Manual





## **WARNING**

### **California Proposition 65**

Breathing diesel engine exhaust exposes you to chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

- Always start and operate the engine in a well-ventilated area.
- If in an enclosed area, vent the exhaust to the outside.
- Do not modify or tamper with the exhaust system.
- Do not idle the engine except as necessary.

For more information, go to [www.P65warnings.ca.gov/diesel](http://www.P65warnings.ca.gov/diesel)

Batteries, battery posts, terminals, and related accessories can expose you to chemicals, including lead and lead compounds, which are known to the State of California to cause cancer and birth defects or other reproductive harm. Wash hands after handling. For more information, go to [www.P65warnings.ca.gov](http://www.P65warnings.ca.gov)

### **California Spark Arrestor**

Operation of this equipment may create sparks that can start fires around dry vegetation. A spark arrestor may be required. The owner/operator should contact local fire agencies for laws or regulations relating to fire prevention requirements.

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The original language of this publication is English.

# OPERATOR MANUAL

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

## GRT655/GRT655L

Crane Model Number

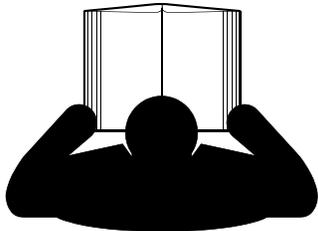
This Manual is divided into the following sections:

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

### 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 cab. **Always furnish crane serial number** when ordering parts or communicating service problems with your distributor or the factory.

	<h2><b>⚠ DANGER</b></h2> <p><b>An untrained operator subjects himself and others to death or serious injury. You must not operate this crane unless:</b></p> <ul style="list-style-type: none"><li>• You have been trained in the safe operation of this machine.</li><li>• 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.</li><li>• You are sure the machine is operating properly and has been inspected and maintained in accordance with the manufacturer's manuals</li><li>• You are sure all safety signs, guards, and other safety features are in place and in proper condition.</li></ul> <p>Avoid Electrocution, tipping, two-blocking, and other operational hazards</p>
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*For  
Reference  
Only*

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### GENERAL

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

This Operator Manual provides important information for the operator of the Model GRT655/655L 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 transmission range-shift with six forward and six reverse speeds. 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- or five-section, full power, fully synchronized boom. Additional reach is obtained by utilizing an optional swingaway boom extension. Lifting is provided by a main hoist and an optional auxiliary hoist.

### Customer Support

Grove and our distributor network want to ensure your satisfaction with our products and customer support. Your local distributor is the best equipped and most knowledgeable to assist you for parts, service and warranty issues. They have the facilities, parts, factory trained personnel, and the information to assist you in a timely manner. We request that you first contact them for assistance. If you feel you need factory assistance, please ask the distributor's service management to coordinate the contact on your behalf.

A compact disc or USB flash drive, which includes sections on Operation, Safety and Maintenance for crane operators and owners, is supplied when the crane is purchased new. Additional copies are available from your Grove distributor.

#### New Owners

If you are the new owner of a Grove crane, please register it with Manitowoc Crane Care so we have the ability to contact you if the need arises.

Go to: [https://www.manitowoccranes.com/en/Parts\\_Services/ServiceAndSupport/ChangeOfOwnershipForm](https://www.manitowoccranes.com/en/Parts_Services/ServiceAndSupport/ChangeOfOwnershipForm) and complete the form.

## NOISE/VIBRATION TEST RESULTS

### Noise Level Test Results

- When equipped with the CE certification package, the guaranteed sound power level is  $L_{wa}$  105 dB(A) as measured by Directive 2006/42/EC and 80 dB(A) at the crane operator position as measured by Annex G.1 of EN 13000:2010+A1:2014.

### Vibration Level Test Results

- At the operator 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.

### SERIAL NUMBER LOCATION

Refer to Figure 1-1.

Whenever contacting your local Grove distributor or Manitowoc Crane Care have the serial number of the crane available.

Serial Numbers are located at the following places on the crane:

1. Stamped on frame.
2. Data plate inside cab.
3. Operator Manual cover.



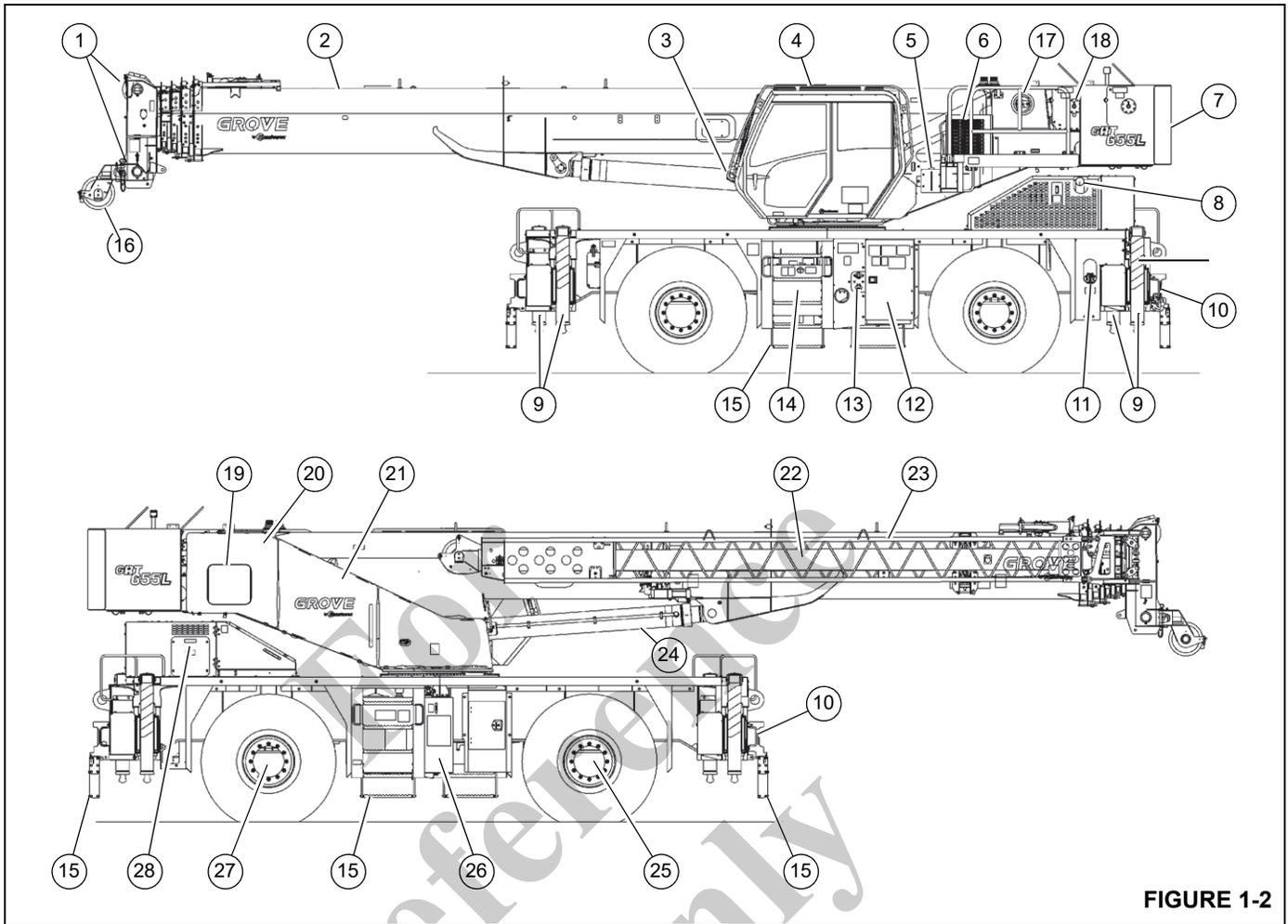


FIGURE 1-2

Item	Description	Item	Description
1	Boom Nose Sheaves	15	Crane Steps
2	Boom	16	Auxiliary Boom Nose
3	Work Lights	17	Auxiliary Hoist
4	Cab	18	Main Hoist
5	Windshield Washer Fluid Container	19	Hydraulic Oil Cooler
6	Air Conditioning Condenser	20	Boom Pivot Pin
7	Counterweight	21	Hydraulic Valves
8	Exhaust System	22	Boom Extension Fly Section
9	Outrigger Jack Cylinder	23	Boom Extension Base Section
10	Outrigger Pads	24	Lift Cylinder
11	Diesel Exhaust Fluid (DEF) Tank (Tier 4 only)	25	Front Axle
12	Battery and Control Module Compartment	26	Hydraulic Fluid Tank
13	Battery Disconnect Switch	27	Rear Axle
14	Fuel Tank*	28	Air Filter

\*Tier 4 engines use Ultra Low Sulfur Fuel (Max 15 ppm) and Diesel Exhaust Fluid (DEF).

## LIST OF SPECIFICATIONS

## General

Model	GRT655/655L
Rated Capacity	See Load Chart in cab
Drive	4 x 4 x 4
Gross Weight	See Axle Weight Distribution Table

## Dimensions

**NOTE:** Dimensions listed are for a crane with all components fully retracted in the travel mode.

Wheelbase	3810 mm (150 in)
Overall Crane Length	
GRT655	12,660 mm (498 in)
GRT655L	12,788 mm (503 in)
Overall Crane Width	
Standard Tire Width	3079 (121)
Narrow Tire Width	2938 (116)
Frame Width	2990 (118)
Overall Crane Height	
23.5x25 tire	3478 mm (136.9 in)
18.0x25 tire	3500 mm (137.8 in)
Outside Turning Radius (23.5x25 tire)	
2 Wheel Steer	10,161 mm (400 in)
4 Wheel Steer	6140 mm (242 in)
Outside Turning Radius (18.0x25 tire)	
2 Wheel Steer	10,138 mm (399 in)
4 Wheel Steer	6116 mm (241 in)
Outside Curb Clearance (23.5x25 tire)	
2 Wheel Steer	10,459 mm (412 in)
4 Wheel Steer	6435 mm (253 in)
Outside Curb Clearance (18.0x25 tire)	
2 Wheel Steer	10,386 mm (409 in)
4 Wheel Steer	6362 mm (250 in)
Outrigger Spread	
Retracted	2790 mm (110 in)
Mid Extend	4799 mm (189 in)
Fully Extended	6809 mm (268 in)

## Capacities

Fuel Tank	322 L (85 gal)
Coolant System	43 L (45.4 qt)
Engine Lubrication System	18 L (19 qt)
Hydraulic Tank (Reservoir Capacity)	
Total	524 L (138.5 gal)
Full Level	470 L (124.1 gal)
Hoist	8.5 L (18 pt)
Swing Gearbox	5.0 L (10.6 pt)
Axle Planetary Hub	2.4 L (2.5 qt)
Axle Differential	28.4 L (30 qt)
Transmission (includes Torque Converter)	
	29.3 L (61.9 qt)
Diesel Exhaust Fluid (DEF) Tank	37.9 L (10 gal)

## Torque Converter

Stall Ratio	2.024:1
Charge Pump Capacity	61 L/min (16 gpm)
	@ 2000 rpm

## Transmission

Gear Ratios	
Forward and Reverse	
Low Range	
1st	10.805
2nd	4.727
3rd	1.576
High Range	
4th	4.825
5th	2.111
6th	0.704

## Engine

**Cummins QSB 6.7 - Tier 4F**

Type	4-cycle, Diesel, Turbocharged
Number of Cylinders	6
Horse Power Rating	122 kW (164 hp) @ 2300 rpm
Fuel	Maximum 15 ppm "Ultra Low Sulfur Diesel Fuel" + diesel exhaust fluid (DEF)

**Cummins QSB 6.7 - Tier 3**

Type	4-cycle, Diesel, Turbocharged
Number of Cylinders	6
Horse Power Rating	119 kW (160 hp) @ 2500 rpm
Fuel	Maximum 5,000 ppm Sulfur Diesel

## Axles

Total Ratio	24.817:1
Carrier Ratio	5.86:1
Planetary Ratio	4.235:1

## Brakes

Type	Four-Wheel Hydraulic Disc
------	---------------------------

## Wheels and Tires

Lugs per Wheel	12
Torque	407 to 475 N-m (300 to 350 lb-ft)
Tire Size	
Standard	23.5 x 25, 24 ply rating
Optional	18.0 x 25, 28 ply rating

**NOTE:** For roading and lifting pressures, refer to the Load Chart Book in the cab.

## Swing Gearbox

Reduction Ratio	36.2:1
Output Torque	5630 N-m (49,830 in-lb)

## Boom

Length	10.7 to 43 m (35.3 to 141.2 ft)
Power	5 Section, Full Power
Length	10.6 to 34.8 m (34.9 to 114.3 ft)
Power	4 Section, Full Power
Elevation	-3 to +80 degrees
Extensions (Optional)	
Manual Telescopic	7.92 to 13.7 m (26 to 45 ft)
Offset	0°, 15°, or 30°

## Swivel Assembly

Electrical	20 Slip Rings
Hydraulic	10 ports
Water	2 ports
Air Conditioning	2 ports

**Hydraulic Pumps**

**NOTE:** Pump output figures are theoretical.

**Pump #1**

Type .....Piston  
 Sections .....1  
 Output - @ loaded engine speed  
 Section 1 ..... 246 L/min (65 gpm)

**Pump #2**

Type .....Gear  
 Sections .....1  
 Output - @ loaded engine speed  
 Section 1 ..... 46.6 L/min (12.3 gpm)

**Pump #3**

Type .....Gear  
 Sections .....1  
 Output - @ loaded engine speed  
 Section 1 ..... 87 L/min (22.9 gpm)

**Hoists**

**Drum Dimensions**

Diameter ..... 270 mm (10.63 in)  
 Length ..... 565 mm (22.25 in)

**Cable, 35x7 Steel**

Diameter ..... 16 mm (0.62 in)  
 Length ..... 180 m (590 ft)  
 Max Permissible  
 Line Pull ..... 5552 kg (12,240 lb)

**Cable, Synthetic**

Diameter ..... 18 mm (0.70 in)  
 Length ..... 185 m (607 ft)  
 Max. Permissible  
 Line Pull ..... 5771 kg (12,723 lb)

**Max. Single Line Speed at:**

Max. Motor Displacement .. 51 mpm (166 fpm)  
 Min. Motor Displacement .. 96 mpm (313 fpm)

**Motor Displacement**

Maximum ..... 77 cc (4.70 cu-in)  
 Minimum ..... 41 cc (2.68 cu-in)

For Reference Only

*For  
Reference  
Only*

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## SECTION 2

### SAFETY INFORMATION

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## SAFETY MESSAGES

### General

The importance of safe operation and maintenance cannot be overemphasized. 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 **hazards** that will result in death or serious injury if the message is ignored.



#### WARNING

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



#### CAUTION

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

#### CAUTION

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

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

## GENERAL

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**.

Read and follow the information located in *Model Specific Information* near the end of this section.

This information has been provided to assist 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 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 are the only one who can be relied upon to assure the safety of yourself and those around you. Be **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.

### Safety Decals

Refer to the *Parts Manual* for a drawing indicating the location of safety decals on the crane.

## ACCIDENTS

Following any accident or damage to equipment, the 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 Grove Product Safety at the address below. 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 Grove distributor and/or Manitowoc Crane Care.

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

**Grove U.S. L.L.C.**

1565 East Buchanan Trail  
Shady Grove, PA 17256-0021

Phone: 888-777-3378 (888-PSR.DEPT)  
717-597-8121

Fax: 717-593-5152

E-mail: [product.safety@manitowoc.com](mailto:product.safety@manitowoc.com)

## OPERATOR INFORMATION

You must **read** and **understand** this *Operator Manual* and the *Load Chart* before operating your new crane. You must also **view** and **understand** the supplied safety video. This manual and *Load Chart* must be readily available to the operator at all times and must remain in the cab (if equipped) or operator's station while the crane is in use.

The *Operator Manual* supplied with and considered part of your crane must be read and completely understood by each person responsible for assembly, disassembly, operation and maintenance of the crane.

No personnel shall be allowed to climb onto the crane or enter the crane cab or operator's station unless performance of their duties require them to do so, and then only with knowledge of the operator or other qualified person.

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



**Do not remove** the *Load Chart*, this *Operator Manual*, or any decal from this crane.

Inspect the crane every day (before the start of each shift). Make sure 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.

If adjustments or repairs are necessary, the operator shall notify the next operator and personnel responsible for the maintenance and repair of the crane.

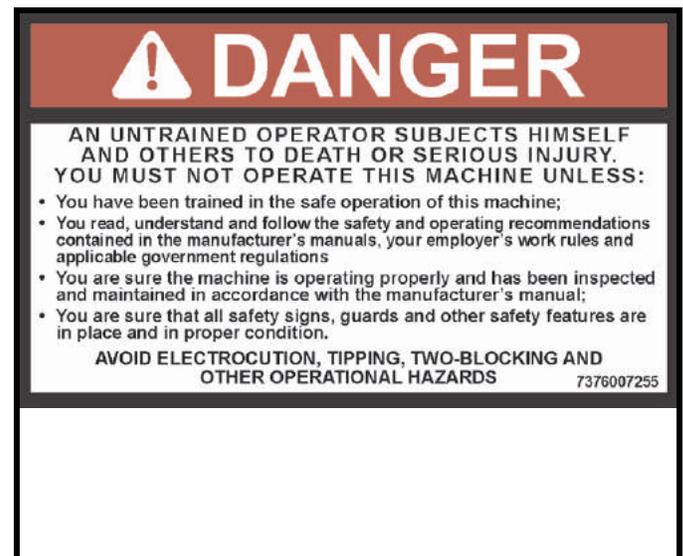
## OPERATOR QUALIFICATIONS

**Qualified person** is defined as one who by reason of knowledge, training and experience is thoroughly familiar with crane operations and the hazards involved. Such a person shall meet the operator qualifications specified in Occupational Safety and Health Administration (OSHA) Regulations (United States Federal Law), in ASME B30.5 American National Standard, or in any other applicable federal, state or local laws.

Make sure 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 decals on the crane. Decals provide important instructions and warnings and must be read prior to any operational or maintenance function.

Refer to the *Parts Manual* for this crane for the locations of all safety decals.

You must be familiar with the regulations and standards governing this crane and its 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.



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

**You must not operate this crane unless:**

- You have been trained in the safe operation of this 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 crane has been inspected and maintained in accordance with the manufacturer's manuals and is operating properly.
- You are sure that all safety decals, guards, and other safety features are in place and in proper condition.

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.

As operator of this crane, you are granted the authority to stop and refuse to lift loads until safety is assured.

## OPERATIONAL AIDS

Operational aids are accessories that provide information to facilitate operation of a crane or that take control of particular functions without action of the operator when a limiting condition is sensed, as stated in the latest revision of the ASME B30.5, and ASME B30.8 standards. Examples of such devices include, but are not limited to, the following: anti-two-block device, rated capacity indicator, rated capacity limiter, boom angle or radius indicator, boom length indicator, crane level indicator, hoist drum rotation indicator, load indicator, and wind speed indicator.

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:

- 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.
- 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.
- When a *Boom Angle or Radius Indicator* is inoperative or malfunctioning, the radius or boom angle shall be determined by measurement.
- When an *Anti-Two-Blocking Device, Two-Blocking Damage Prevention Device 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.
- 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.
- When a *Level Indicator* is inoperative or malfunctioning, other means shall be used to level the crane.

## Rated Capacity Limiter (RCL) Systems

Your crane is equipped with an RCL system which is intended to aid the operator. An RCL is a device that automatically monitors radius, load weight, and load rating and prevents movements of the crane, which would result in an overload condition

Test daily for proper operation. Never interfere with the proper functioning of operational aids or warning devices.

Under **no condition** should it be relied upon to replace the use of *Load 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 make sure that the load to be lifted at the desired radius is within the rated capacity of the crane.

For detailed information concerning the operation and maintenance of the RCL system installed on the crane, see the appropriate section later in this manual or the RCL manufacturer's manual supplied with the crane. Manufacturers of rated capacity limiters may refer to them in their manuals as a load moment indicator (LMI), a hydraulic capacity alert system (HCAS), a safe load indicator (SLI), or an EKS5; Grove refers to these systems as a rated capacity limiter (RCL) throughout its *Operator* and *Service manuals*.

### Anti-Two-Blocking Device

This crane should have a functional Anti-Two-Block and Control Lock-Out System. Test daily for proper operation.

Two-blocking occurs when the load block (hook block, overhaul ball, rigging, etc.) comes into physical contact with the boom (boom nose, sheaves, boom extension, etc.). Two-blocking can cause hoist rope (wire rope or synthetic rope), rigging, reeving, and other components to become highly stressed and overloaded in which case the hoist rope may fail allowing the load, block, etc. to 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 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 nose, thus causing damage to the sheaves, or causing the hoist rope to fail, dropping the lifting device to the ground and possibly injuring personnel working below.

Caution must be used when lowering the boom, extending the boom or hoisting up. 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 hoist 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.

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



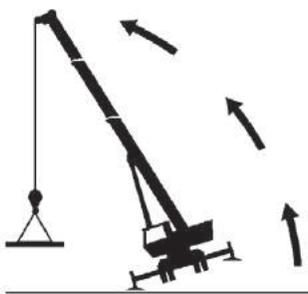
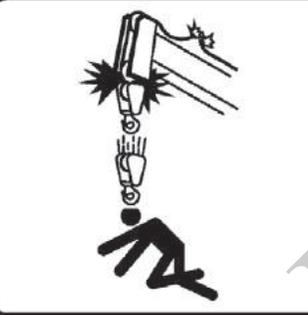
9250 Example decal. For reference only.

### Working Area Limiter (If Equipped)

This crane may be equipped with a working area limiter as part of the RCL system, designated as either Work Area Definition System (WADS) or Working Range Limiter (WRL). You must read and understand the operator manual before operating the working area limiter system. Become familiar with all proper operating procedures and with the identification of symbol usage.

The working area limiter is intended to be used as an aid to the operator. It is not a substitute for safe crane operating practices, experience and good operator judgments.

! 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;">POSITION CRANE ON FIRM SURFACE. EXTEND OUTRIGGERS AND LEVEL CRANE.</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;">DO NOT PASS LOADS OR BOOM OVER GROUND PERSONNEL.</p>

7340

FOLLOW INSTRUCTIONS IN OPERATOR'S AND SAFETY HANDBOOK.

7376 100 175

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## CRANE STABILITY/STRUCTURAL STRENGTH

To avoid death or serious injury, make sure 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.

Make sure that all pins and floats are properly installed and outrigger beams are properly extended before lifting on outriggers. On models equipped with outriggers that can be pinned at the mid-extend position (vertical stripe, if applicable), the outriggers must also be pinned when operating from the mid-extend position.

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

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

The operator must select the proper *Load Chart* and Rated Capacity Limiter (RCL) System program for the outrigger position selected.

Before swinging the superstructure over the side when the outriggers are retracted, check for backwards stability under the sub-section titled *Model Specific Information* later in this section.

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. Make sure that the outriggers (or tires if lifting on rubber) are firmly positioned on solid surfaces. Make sure that 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.

Unless lifting within On Rubber capacities, outrigger beams and jack cylinders (plus center front stabilizer, if equipped) must be properly extended and set to provide precise leveling of the crane. Tires must be clear of the ground before lifting on outriggers.



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*.

*Load Chart* capacities are based on freely suspended loads.

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

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. Make sure that the surfaces will support a load greater than the crane's weight and maximum capacity.

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

Be aware of the danger for people entering the working area. Do not allow unnecessary personnel in the vicinity of the crane while operating.

## WIND FORCES

There are basic principles that must be followed while operating in windy conditions. This information has been provided to assist in determining safe operation in windy conditions.

Always use extreme caution when windy conditions exist. NEVER exceed the rated capacity shown on the *Load Chart*.

**Always check the *Load Chart* to make sure that the load to be lifted is within the rated capacity of the crane.**

Wind can have a significant effect 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.)

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.

Wind forces can be determined by typical visible effects on the landscape. To assist you in determining prevailing wind conditions, refer to (Table 2-1).

**NOTE:** The wind speed corresponding to the Beaufort scale in the table is mean wind speed at 10 m (33 ft) elevation over a period of 10 minutes.

Table 2-1 Beaufort Wind Scale

Beaufort Number	Description	Maximum Wind Speed			Visible Indicator Effects of wind as observed on land
		m/s	km/h	mph	
Zero (0)	Calm	0.3	1.1	0.7	Calm; smoke rises vertically
1	Light Air	1.5	5.4	3.4	Smoke drift indicates wind direction. Leaves and wind vanes are stationary.
2	Light Breeze	3.3	11.9	7.4	Wind felt on exposed skin. Leaves rustle. Wind vanes begin to move.
3	Gentle Breeze	5.4	19.4	12.1	Leaves and small twigs constantly moving. Light flags extended.
4	Moderate Breeze	7.9	28.4	17.7	Dust and loose paper raised. Small branches begin to move.
5	Fresh Breeze	10.7	38.5	23.9	Branches of a moderate size move. Small trees in leaf begin to sway.
6	Strong Breeze	13.8	49.7	30.9	Large branches in motion. Whistling heard in overhead wires. Umbrella use becomes difficult. Empty plastic bins tip over.
7	High Wind	17.1	61.6	38.3	Whole trees in motion. Effort needed to walk against the wind.
8	Gale	20.7	74.5	46.3	Some twigs broken from trees. Cars veer on road. Progress on foot is seriously impeded.
9	Strong Gale	24.4	87.8	54.6	Some branches break off trees, and some small trees blow over. Construction/temporary signs and barricades blow over.
10	Storm	28.4	102.2	63.5	Trees are broken off or uprooted, structural damage likely.

## Wind Speeds

The maximum permissible wind speed referred to in the load charts is the 3-second wind gust speed measured at the boom tip height and is designated as  $V(z)$ . This value is either recorded at boom tip or calculated based on mean wind speed recorded at crane operation site. For lift planning purposes only, the 3-second wind gust speed,  $V(z)$ , may be calculated based on mean wind speed reported at <http://www.windfinder.com> "Super Forecast".

This 3-second wind gust is assumed to act on the entire crane and the load. The wind effect on the load can be conservatively estimated as:

- a) If  $V(z)$  is  $\leq 13.4$  m/s (30 mph), then the **allowable** load is the published rated capacity from the Load Chart.
- b) If  $V(z)$  is  $> 13.4$  m/s (30 mph) and is  $\leq 20.1$  m/s (45 mph), the **allowable** load is the published rated

capacity multiplied by the Capacity Reduction Factor from Table 2-4 (metric) or (non-metric).

**NOTE:** This condition is limited to operation with the main boom on fully extended outriggers only.

- c) If  $V(z)$  is  $> 20.1$  m/s (45 mph), then lifting is **NOT** permitted. Cease lifting operations and lower and retract the boom.

In both cases **a)** and **b)** above, the lift may also be limited by the projected wind area of the load  **$A_p$**  and by the wind drag coefficient  **$C_d$** : This limit can be determined by comparing the **Actual** wind resistance area with the **Allowable** wind resistance area.

Refer to Figure 2-1 for a simplified calculation method to determine permissible wind speed.

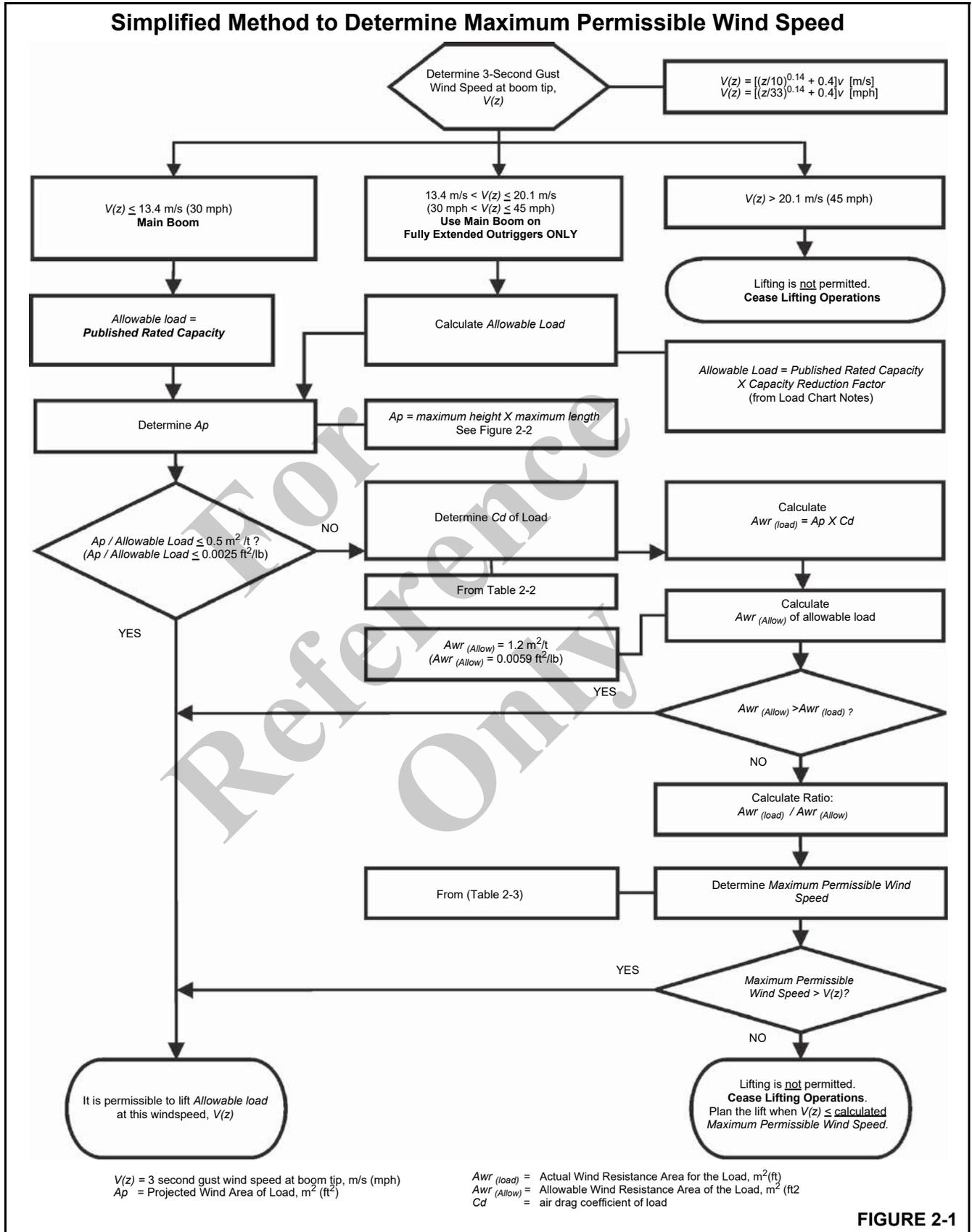


FIGURE 2-1

**Determination of 3-second wind gust speed at boom tip height:**

The following example illustrates how to calculate 3-second wind gust speed at boom tip height based on mean wind speed recorded by the device located at the crane operation site:

$V(z)$  is the 3-second wind gust speed at boom tip height  $Z$  then:

Metric, with  $Z$  [m] and  $V$  [m/s]

$$V(z) = [(Z/10)^{0.14} + 0.4] \times V \quad (2.1)$$

Non-metric, with  $Z$  [ft] and  $V$  [mph]

$$V(z) = [(Z/33)^{0.14} + 0.4] \times V \quad (2.2)$$

where:

$V$  [m/s] [mph] - Mean wind speed at 10 m (22 ft) elevation (upper limit of Beaufort scale)

**Example:** Suppose you want to lift the load with the maximum boom tip height of 30 m (100 ft) and the recorded mean wind speed by the device located at the crane operation site is 5.5 m/s (13 mph). This mean wind speed of 5.5 m/s (13 mph) corresponds to Beaufort number 4 (see Table 2-1). The maximum wind velocity according to the Beaufort scale of 4 is 7.9 m/s (17.7 mph).

The mean wind speed (upper limit of Beaufort number) at 10 m (33 ft) height, to be used for calculation is:

$$V = 7.9 \text{ m/s (17.7 mph)}$$

Boom tip height for this lift is  $Z = 30$  m (100 ft)

then:

Metric, with  $Z$  [m] and  $V$  [m/s]

$$V(z) = [(30/10)^{0.14} + 0.4] \times 7.9 = 12.4 \text{ m/s}$$

Non-metric, with  $Z$  [ft] and  $V$  [mph]

$$V(z) = [(100/33)^{0.14} + 0.4] \times 17.7 = 27.8 \text{ mph}$$

Since  $V(z)$  is  $\leq 13.4$  m/s (30 mph), the allowable loads are the published rated capacities from the Load Chart and can be lifted at this condition.

**Size and Shape of the load:**

These rated capacities are also based on the assumption that the Wind Resistance Area of load,  $Awr_{(load)}$  is not more than 0.0012 square meters per kilogram (0.0059 sq.ft per pound of load. (See below Formulas 2.4 and 2.5.)

The load capacities shall be reduced to account for the larger wind resistance area of load and 3-second wind gust speed at boom tip height. Use tag lines when the wind gust speed is above 13.4 m/s (30 mph) to help control the movement of the load. **Grove recommends that a lift not be made if the wind can cause a loss of control in handling the load.**

The lift may also be limited by the projected wind area of the load  $Ap$  and by the wind drag coefficient  $Cd$ . This limit can be determined by comparing the actual wind resistance area of the load with the allowable wind resistance area.

$$Awr_{(load)} = Ap \times Cd \quad (2.3)$$

where:

$Awr_{(load)}$  [m<sup>2</sup>] [ft<sup>2</sup>] - Wind resistant area of the load

$Ap$  [m<sup>2</sup>] [ft<sup>2</sup>] - projected wind area,

$Cd$  - wind drag coefficient.

$Ap$  is determined by using the calculation of maximum height x maximum length (see Figure 2-2).

For  $Cd$ , refer to Table 2-2. If the  $Cd$  cannot be calculated or estimated, use a value of 2.4.

The allowable wind resistant area of the load  $Awr_{(allow)}$  is equal to 0.0012 square meters per kilogram (0.0059 sq.ft per pound) of allowable load:

Metric, with  $m_{(load)}$  [kg] - Mass of the allowable load

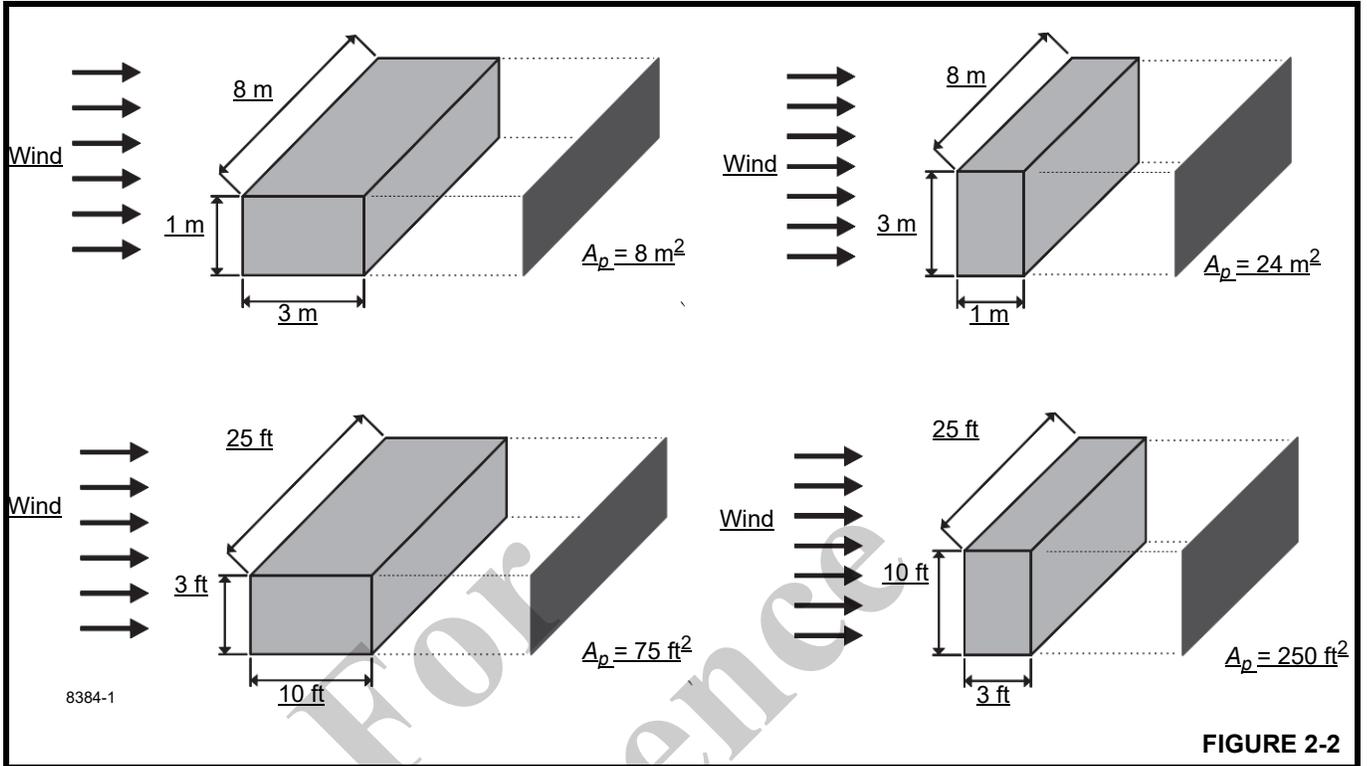
$$Awr_{(allow)} = 0.0012 \times m_{(load)} \quad (2.4)$$

Non-metric, with  $m_{(load)}$  [lb] - Mass of the allowable load

$$Awr_{(allow)} = 0.0059 \times m_{(load)} \quad (2.5)$$

If  $Awr_{(load)}$  is greater than  $Awr_{(allow)}$ , then lifting this load at this wind speed  $V(z)$  is NOT permitted.

Calculation of Projected Wind Area ( $A_p$ ):



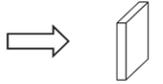
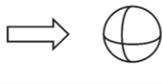
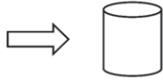
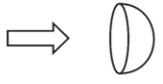
**Determining Wind Drag Coefficient ( $C_d$ )**

Table 2-2 shows the typical Shapes and corresponding Wind Drag Coefficient ( $C_d$ ) values.

If the exact Wind Drag Coefficient of a shape is not known, use the maximum value of the shape's range ((Table 2-2)).

If the wind drag coefficient of the load cannot be estimated or determined, it shall be assumed that ( $C_d$ ) = 2.4.

Table 2-2 Wind Drag Coefficient

Shape	$C_d$
	1.1 to 2.0
	0.3 to 0.4
	0.6 to 1.0
	0.8 to 1.2
	0.2 to 0.3
	0.05 to 0.1
	Approximately 1.6

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**Maximum Permissible Wind Speed**

If the wind resistant area of the load  $A_{wr(load)}$  is greater than the allowable wind resistant area  $A_{wr(allow)}$ , the ratio can be used to determine a permissible wind speed  $V(z)$  for the load using (Table 2-3).

Table 2-3  $A_{wr}$  Ratio and Permissible Wind Speed  $V(z)$  - Imperial units

Note: Permissible and rated wind speeds in this table are the 3-second gust wind speeds at boom tip height.					
Ratio:	1.2	1.4	1.6	1.8	2
	Maximum Permissible Wind Speed (mph)				
For Rated Capacity at 30 mph	27.4	25.4	23.7	22.4	21.2
For Allowable Capacity at 45 mph	41.1	38.0	35.6	33.5	31.8

Rated Load Chart Example - Metric

RATED LIFTING CAPACITIES IN KILOGRAMS  
10.9 m - 33.5 m BOOM  
ON OUTRIGGERS FULLY EXTENDED - 360°

Radius in Meters	#001									
	Main Boom Length in Meters									
	10.9	12.2	15.2	**18.4	21.3	24.4	27.4	30.5	33.5	
3	+60,000 (69.5)	40,950 (72)	40,950 (76)							
3.5	53,000 (66.5)	40,950 (69.5)	40,950 (74)	28,350 (78)						
4	47,450 (63.5)	40,950 (66.5)	40,950 (72)	28,350 (75.5)	*18,225 (78)					
4.5	42,875 (60.5)	40,950 (64)	40,950 (70)	28,350 (73.5)	18,225 (76)					
5	39,050 (57.5)	39,025 (61.5)	38,300 (67.5)	28,350 (72)	18,225 (75)	*18,225 (78)				
6	32,950 (50.5)	32,925 (55.5)	32,825 (63.5)	28,350 (68.5)	18,225 (72)	18,225 (75)	*18,225 (78)			
7	28,325 (42.5)	28,300 (49)	28,225 (59)	26,250 (65)	18,225 (69)	18,225 (72)	18,225 (74.5)	*16,725 (78)	*11,400 (78)	
8	24,150 (32.5)	24,150 (42)	23,975 (54.5)	23,275 (61)	18,225 (69.5)	18,225 (72)	16,575 (74.5)	15,250 (74.5)	11,400 (76)	
9	20,600 (16.5)	20,550 (33.5)	20,375 (49.5)	20,250 (55)	18,225 (63)	16,575 (67)	15,050 (70)	13,875 (72.5)	11,400 (74.5)	
10		17,200 (20.5)	17,125 (41)	17,025 (54)	17,325 (60)	15,125 (66)	13,725 (67.5)	12,700 (70.5)	11,400 (72.5)	
12			14,025 (35)	12,575 (45.5)	12,575 (53.5)	12,125 (63)	11,600 (63)	10,725 (66.5)	10,050 (69)	
14				9,000 (35)	9,360 (46)	9,730 (53.5)	9,955 (58.5)	9,205 (62)	8,620 (65)	
16				6,750 (19)	7,110 (37.5)	7,475 (47)	7,920 (53)	7,980 (57.5)	7,470 (61.5)	
18					5,960 (47)	5,960 (39.5)	6,340 (47.5)	6,525 (53)	6,530 (57.5)	
20						4,755 (30.5)	5,145 (41)	5,320 (48)	5,495 (53)	
22							3,790 (16.5)	4,210 (33.5)	4,380 (42.5)	4,545 (48.5)
24								3,435 (23.5)	3,620 (36)	3,780 (43.5)
26									2,975 (28)	3,150 (37.5)
28									2,400 (16)	2,620 (31)
30										2,135 (22)
Minimum boom angle (°) for indicated length (no load)										0
Maximum boom length (m) at 0° boom angle (no load)										33.5

NOTE: ( ) Boom angles are in degrees.  
#RCL operating code. Refer to RCL manual for operating instructions.  
\*This capacity is based on maximum boom angle.  
+ 9 parts line required to lift this capacity (using aux. boom nose) when using wire rope with a minimum breaking strength of 36,287 kg. Refer to Operator's & Safety Handbook for reeving diagram.  
NOTE: For allowable capacities while operating in 3-second wind gust speeds greater than 13.4 m/s and up to 20.1 m/s, refer to Capacity Reduction Factors for wind speed (3-second gust speed) V(z) greater than 13.4m/s.

Lifting Capacities at Zero Degree Boom Angle									
Boom Angle	Main Boom Length in Meters								
	10.9	12.2	15.2	**18.4	21.3	24.4	27.4	30.5	33.5
0°	13,775 (9.2)	11,675 (10.4)	8,145 (13.5)	5,930 (16.6)	4,565 (19.6)	3,535 (22.6)	2,860 (25.7)	2,220 (28.7)	1,770 (31.8)

NOTE: ( ) Reference radii in meters.  
\*\* Boom length is with inner-mid fully extended and outer-mid & fly fully retracted.

FIGURE 2-3

Table 2-4 Example-Capacity Reduction Factors for Wind Speed V(z) Greater than 13.4 m/s - Metric

(Only for lifting with main boom on fully extended outriggers, with or without stowed extension)

For wind speed **V(z)** (3-second gust speed at boom tip height)  $V(z) > 13.4 \text{ m/s} \leq 20.1 \text{ m/s}$ , the Reduced Capacity shall be calculated by multiplying the Published Rated Capacity by the following factors:

Wind Speed $V(z) > 13.4 \text{ m/s}$ $\leq 20.1 \text{ m/s}$	Main Boom Length in Meters								
	10.9	12.2	15.2	18.4	21.0	24.4	27.4	30.5	33.5
Factor	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.7	0.6

Wind resistance area of load,  $Awr_{(load)}$  shall not exceed maximum allowable wind resistance area  $Awr_{(allow)}$ .  
 Maximum allowable wind resistance area,  $[m^2] Awr_{(allow)} = 0.0012 \times \text{calculated reduced capacity in kg}$ .  
 Wind resistance area of load,  $Awr_{(load)}$  = projected wind area  $Ap$  x wind drag coefficient  $Cd$  for the load.  
 For wind resistance Area of load,  $Awr_{(load)} >$  maximum allowable wind resistance area,  $Awr_{(allow)}$  refer to crane Operator Manual.

Table 2-5 Awr Ratio and Permissible Wind Speed V(z) - Metric

Note: Permissible and rated wind speeds in this table are the 3-second gust wind speeds at boom tip height.

Ratio:	1.2	1.4	1.6	1.8	2
	Maximum Permissible Wind Speed (m/s)				
For Rated Capacity at 13.4 m/s	12.2	11.4	10.6	10.0	9.5
For Allowable Capacity at 20.1 m/s	18.3	17.0	15.9	15.0	14.2

**Example and Sample Calculations (metric)**

The following example illustrates how to calculate allowable load while operating in wind speed (3-second wind gust speed) above 13.4 m/s (30 mph) and maximum permissible wind speeds with various combinations of lifted load and wind resistance area.

**NOTE:** Permissible and calculated wind speeds in this example are the **3-second wind gust speeds at boom tip height V(z)**.

**Example 1: Crane Configuration:**

- boom length = 27.4 m,
- load radius = 9 m,
- wind speed is measured at  $V(z) \leq 20.1 \text{ m/s}$ .

From the **Rated Load Chart Example - Metric** (Figure 2-3), at maximum permissible wind speed,  $V(z) = 13.4 \text{ m/s}$ , the rated lifting capacity  $m_{(allow)}$  for this configuration is 15,050 kg.

The maximum allowable wind resistance area of load is:

$$Awr_{(allow)} = 0.0012 \times m_{(load)} \quad (2.4)$$

$$Awr_{(allow)} = 0.0012 \times 15,050 = 18.06 \text{ m}^2$$

**Lifting Limits at wind speed  $V(z) \leq 13.4 \text{ m/s}$**  at this configuration:

- Maximum load 15,050 kg
- Maximum wind resistance area of load 18.06 m<sup>2</sup>

For the allowable wind speed  $> 13.4 \text{ m/s}$  and  $\leq 20.1 \text{ m/s}$ , reduce the allowable load. Per Table 2-4, the Factor for main boom length of 27.4 m is 0.8, the allowable load is:

$$m_{(allow)} = 0.8 \times 15,050 = 12,040 \text{ kg}$$

This reduced capacity load has an allowable wind resistance area of:

$$Awr_{(allow)} = 0.0012 \times 12,040 = 14.45 \text{ m}^2$$

**Lifting Limits at wind speed  $V(z) > 13.4 \text{ m/s}$  and  $\leq 20.1 \text{ m/s}$** , at this configuration:

- Maximum load 12,040 kg
- Maximum wind resistance area of load 14.45 m<sup>2</sup>

At wind speeds greater than 13.4 m/s, it is not permissible to lift a load greater than 12,040 kg, even if the wind resistance area of the load is less than 14.45 m<sup>2</sup>.

Refer to the information from the above crane configuration, examine several load conditions.

**Load example 1.1:**

With known Wind Drag Coefficient of the load **Cd**, and

- load to be lifted of 11,200 kg,
- Projected Wind Area **Ap** = 9.20 m<sup>2</sup>,
- Wind Drag Coefficient **Cd** = 1.5

wind resistance area of load can be estimated as

$$Awr_{(load)} = Ap \times Cd = 9.2 \times 1.5 = 13.8 \text{ m}^2$$

Refer to the above **Lifting Limits at wind speed V(z) > 13.4 m/s and ≤ to 20.1 m/s**. Comparing the load and wind resistant area to the allowable:

- Is the load to be lifted less than allowable load?  
11,200 kg ≤ 12,040 kg YES
- Is **Awr<sub>(load)</sub>** less than **Awr<sub>(allow)</sub>**?  
13.8 m<sup>2</sup> ≤ 14.45 m<sup>2</sup> YES

**Conclusion:** This load is permissible to lift in wind speed up to 20.1 m/s.

**Load example 1.2:**

With unknown Wind Drag Coefficient of the load **Cd**,

- Load to be lifted of 10,000 kg,
- Projected Wind Area **Ap** = 5.45 m<sup>2</sup>,
- Wind Drag Coefficient **Cd** = unknown

**NOTE:** If exact Wind Drag Coefficient is not known, it shall be assumed as 2.4.

- the wind resistance area of load can be estimated as

$$Awr_{(load)} = Ap \times Cd = 5.45 \times 2.4 = 13.08 \text{ m}^2$$

Refer to the above **Lifting Limits at V(z) > 13.4 m/s and ≤ 20.1 m/s**. Comparing the load and wind resistant area to the allowable:

- Is the load to be lifted less than allowable load?  
10,000 kg ≤ 12,040 kg YES
- Is **Awr<sub>(load)</sub>** less than **Awr<sub>(allow)</sub>**?  
13.08 m<sup>2</sup> ≤ 14.45 m<sup>2</sup> YES

**Conclusion:** This load is permissible to lift in wind speed up to 20.1 m/s.

**Load example 1.3a:**

With large wind resistance area of the load **Awr<sub>(load)</sub>**,

- Load to be lifted of 14,000 kg,
- Projected Wind Area **Ap** = 21.85 m<sup>2</sup>,
- Wind Drag Coefficient **Cd** = 1.2

the wind resistance area of load can be estimated as:

$$Awr_{(load)} = Ap \times Cd = 21.85 \times 1.2 = 26.22 \text{ m}^2$$

Refer to the above **Lifting Limits at wind speed V(z) > 13.4 m/s and ≤ 20.1 m/s**. Comparing the load to the allowable:

- Is the load to be lifted less than allowable load?  
14,000 kg ≤ 12,040 kg NO

**Conclusion:** This load is NOT permissible to lift in wind speed up to 20.1 m/s.

Refer to the above **Lifting Limits at wind speed V(z) < 3.4 m/s**. Comparing the load to the allowable:

- Is the load to be lifted less than allowable load?  
14,000 kg ≤ 15,050 kg YES

The maximum permissible wind speed for this load is 13.4 m/s, depending on the wind resistance area of the load.

- Is **Awr<sub>(load)</sub>** less than **Awr<sub>(allow)</sub>**?  
26.22 m<sup>2</sup> ≤ 18.06 m<sup>2</sup> NO

**Conclusion:** This load is NOT permissible to lift in wind speed at 13.4 m/s, but is permitted to lift at a reduced wind speed calculated as follows:

$$\text{Ratio} = \frac{Awr_{(load)}}{Awr_{(allow)}} = \frac{26.22}{18.06} = 1.45$$

From (Table 2-5), the maximum permissible wind speed at ratio of 1.45 (rounded to next higher table value of 1.6) is 10.6 m/s.

**Conclusion:** This load is permissible to lift in wind speed up to 10.6 m/s only.

**Load example 1.3b:**

With large wind resistance area of the load **Awr<sub>(load)</sub>**,

- Load to be lifted of 8,000 kg,
- Projected Wind Area **Ap** = 15.25 m<sup>2</sup>,
- Wind Drag Coefficient **Cd** = 1.3

the wind resistance area of load can be estimated as

$$Awr_{(load)} = Ap \times Cd = 15.25 \times 1.3 = 19.83 \text{ m}^2$$



Refer to the above **Lifting Limits at wind speed  $V(z)$**  > 13.4 m/s and ≤ 20.1 m/s. Comparing the load and wind resistant area to the allowable:

- Is the load to be lifted less than allowable load?  
8,000 kg ≤ 12,040 kg YES
- Is  $Awr_{(load)}$  less than  $Awr_{(allow)}$ ?  
19.83 m<sup>2</sup> ≤ 14.45 m<sup>2</sup> NO

**Conclusion:** This load is NOT permissible to lift in wind speed up to 20.1 m/s, but permitted to lift at a reduced wind speed calculated as follows:

$$\text{Ratio} = \frac{Awr_{(load)} = 19.83}{Awr_{(allow)} = 14.45} = 1.37$$

From (Table 2-5), the maximum permissible wind speed at ratio of 1.37 (rounded to next higher table value of 1.4) is 17.0 m/s.

**Conclusion:** This load is permissible to lift in wind speed up to 17.0 m/s only.

For  
Reference  
Only

Rated Load Chart Example - Non-metric

RATED LIFTING CAPACITIES IN POUNDS  
36 FT. - 110 FT. BOOM  
ON OUTRIGGERS FULLY EXTENDED - 360°

Radius in Feet	#0001								
	Main Boom Length in Feet								
	36	40	50	**60	70	80	90	100	110
10	130,000 (69.5)	90,300 (71.5)	90,300 (75.5)	*62,500 (78)					
12	112,500 (65.5)	90,300 (68.5)	90,300 (73)	62,500 (76.5)	*40,200 (78)				
15	93,250 (60)	90,300 (63.5)	90,250 (69.5)	62,500 (73.5)	40,200 (76)	*40,200 (78)			
20	71,550 (49.5)	71,500 (55)	71,300 (63)	62,500 (68)	40,200 (71.5)	40,200 (74.5)	40,200 (78)	*36,900 (78)	
25	56,650 (38.5)	56,600 (45)	56,350 (56)	53,650 (83)	40,200 (67)	40,200 (70.5)	37,950 (73)	34,900 (75)	*25,150 (78)
30	43,500 (11.5)	44,300 (32)	43,950 (48.5)	43,650 (57.5)	40,200 (62.5)	37,050 (66)	32,750 (69.5)	30,200 (72)	25,150 (74)
35			33,550 (40)	33,700 (51.5)	34,700 (58)	33,550 (62)	28,550 (66)	26,400 (69)	24,700 (71.5)
40			25,800 (28)	26,150 (44.5)	26,300 (52.5)	27,300 (58.5)	25,200 (62.5)	23,300 (66)	21,800 (68.5)
45				20,300 (36.5)	21,450 (47)	22,300 (54)	22,400 (59)	20,700 (62.5)	19,400 (65.5)
50				15,500 (25)	17,400 (41)	18,200 (49)	19,100 (55)	18,550 (59.5)	17,350 (62.5)
55					14,300 (33.5)	15,100 (44)	16,000 (51)	16,400 (56)	15,800 (60)
60					11,000 (23.5)	12,700 (38)	13,550 (46.5)	13,950 (52.5)	14,100 (56.5)
65					9,000 (31.5)	10,000 (41.5)	11,550 (48.5)	11,950 (53.5)	12,300 (58.5)
70						9,010 (22.5)	9,920 (36)	10,250 (44)	10,650 (50)
75							8,510 (29.5)	8,890 (39.5)	9,250 (46)
80							7,260 (21)	7,690 (34.5)	8,050 (42.5)
85								6,620 (28.5)	7,010 (38)
90								5,630 (20)	6,100 (33)
95									5,240 (27)
100									4,480 (19.5)
Minimum boom angle (°) for indicated length (no load)									0
Maximum boom length (ft.) at 0° boom angle (no load)									110

NOTE: ( ) Boom angles are in degrees.  
#RCL operating code. Refer to RCL manual for operating instructions.  
\*This capacity is based on maximum boom angle.  
NOTE: For allowable capacities while operating in 3-second wind gust speeds greater than 30 mph and up to 45 mph, refer to Capacity Reduction Factors for wind speed (3-second gust speed) V(z) greater than 30 mph.

Lifting Capacities at Zero Degree Boom Angle									
Boom Angle	Main Boom Length in Feet								
	36	40	50	**60	70	80	90	100	110
0°	30,350 (30.1)	25,700 (34.2)	17,950 (44.2)	13,050 (54.6)	10,050 (64.2)	7,790 (74.2)	6,300 (84.2)	4,900 (94.2)	3,900 (104.2)

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NOTE: ( ) Reference radii in feet.  
\*\* Boom length is with inner-mid fully extended and outer-mid & fly fully retracted.

FIGURE 2-4

**Table 2-6 Example-Capacity Reduction Factors for Wind Speed V(z) Greater than 30 mph - Non-metric**

(Only for lifting with main boom on fully extended outriggers, with or without stowed extension)

For wind speed **Vz** (3-second gust speed at boom tip height) is greater > 30 mph and ≤ 45 mph, the Reduced Capacity shall be calculated by multiplying the Published Rated Capacity by the following factors:

	Main Boom Length in Feet								
Wind Speed Vz > 30 mph ≤ 45 mph	36	40	50	60	70	80	90	100	110
Factor	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.7	0.5

Wind resistance area of load, **Awr<sub>(load)</sub>**, shall not exceed maximum allowable wind resistance area **Awr<sub>(allow)</sub>**.

Maximum allowable wind resistance area of load, **Awr<sub>(allow)</sub>** = 0.0059 x calculated reduced capacity in lb.

Wind resistance area of load, **Awr<sub>(load)</sub>** = projected wind area **Ap** x wind drag coefficient **Cd** for the load.

For wind resistance area of load, **Awr<sub>(load)</sub>** > maximum allowable wind resistance, **Awr<sub>(allow)</sub>**, refer to crane Operator Manual.

**Table 2-7 Awr Ratio and Permissible Wind Speed V(z) - Non-Metric**

Note: Permissible and rated wind speeds in this table are the 3-second gust wind speeds at boom tip height.

Ratio:	1.2	1.4	1.6	1.8	2
	Maximum Permissible Wind Speed (mph)				
For Rated Capacity@ 30 mph	27.4	25.4	23.7	22.4	21.2
For Allowable Capacity@ 45 mph	41.1	38.0	35.6	33.5	31.8

**Example and Sample Calculations (Non-metric)**

The following example illustrates how to calculate allowable load while operating in wind speed (3-second wind gust speed) above 13.4 m/s (30 mph) and maximum permissible wind speeds with various combinations of lifted load and wind resistance area.

**NOTE:** Permissible and calculated wind speeds in this example are the **3-second wind gust speeds at boom tip height V(z)**.

**Example 2:**

A crane is configured with:

- boom length = 90 ft,
- load radius = 40 ft, and
- wind speed is measured at **V(z) ≤ 45 mph**.

The **Rated Load Chart Example - Non-metric** (Figure 2-4), at maximum permissible wind speed, **V(z) = 30 mph**, the rated lifting capacity **m<sub>(allow)</sub>** for this configuration is 25,200 lb.

The maximum allowable wind resistance area of load is:

$$Awr_{(allow)} = 0.0059 \times m_{(load)} \tag{2.5}$$

$$Awr_{(allow)} = 0.0059 \times 25,200 = 149 \text{ ft}^2$$

**Lifting Limits at wind speed V(z) < 30 mph** at this configuration:

- Maximum load 25,200 lb
- Maximum wind resistance area of load 149 ft<sup>2</sup>

For the allowable wind speed > 30 mph and ≤ 45 mph, reduce the allowable load. , the Factor for a main boom length of 90 ft is 0.8, thus the allowable load is:

$$m_{(allow)} = 0.8 \times 25,200 = 20,160 \text{ lb}$$

This reduced capacity load has an allowable wind resistance area of:

$$Awr_{(allow)} = 0.0059 \times 20,160 = 119 \text{ ft}^2$$

**Lifting Limits at wind speed V(z) > 30 mph and ≤ 45 mph** at this configuration:

- Maximum load 20,160 lb
- Maximum wind resistance area of load 119 ft<sup>2</sup>

Example, wind speeds greater than 13.4 m/s is **NOT** permissible to lift a load greater than 20,160 lb, even if the wind resistance area of the load is less than 119 ft<sup>2</sup>.

Refer to the above crane configuration for the following load conditions:

**Load example 2.1:**

With known Wind Drag Coefficient of the load **Cd**,

- load to be lifted of 19,500 lb,
- Projected Wind Area **Ap** = 70 ft<sup>2</sup>,
- Wind Drag Coefficient **Cd** = 1.5

then the wind resistance area of load can be estimated as

$$Awr_{(load)} = Ap \times Cd = 70 \times 1.5 = 105 \text{ ft}^2$$

Refer to the above **Lifting Limits at wind speed V(z) > 30 mph and ≤ 45 mph**. Comparing the load and wind resistant area to the allowable:

- Is the load to be lifted less than allowable load?  
19,500 lb ≤ 20,160 lb YES
- Is **Awr<sub>(load)</sub>** less than **Awr<sub>(allow)</sub>**?  
105 ft<sup>2</sup> ≤ 119 ft<sup>2</sup> YES

**Conclusion:** This load is permissible to lift in wind speed up to 45 mph.

**Load example 2.2:**

With unknown Wind Drag Coefficient of the load **Cd**,

- Load to be lifted of 18,000 lb,
- Projected Wind Area **Ap** = 45 ft<sup>2</sup>,
- Wind Drag Coefficient **Cd** = unknown

**NOTE:** If exact Wind Drag Coefficient is not known, it shall be assumed as 2.4.

the wind resistance area of load can be estimated as

$$Awr_{(load)} = Ap \times Cd = 45 \times 2.4 = 108 \text{ ft}^2$$

Refer to the above **Lifting Limits at wind speed V(z) > 30 mph and ≤ 45 mph**. Comparing the load and wind resistant area to the allowable:

- Is the load to be lifted less than allowable load?  
18,000 lb ≤ 20,160 lb YES
- Is **Awr<sub>(load)</sub>** less than **Awr<sub>(allow)</sub>**?  
108 ft<sup>2</sup> ≤ 119 ft<sup>2</sup> YES

**Conclusion:** This load is permissible to lift in wind speed up to 45 mph.

**Load example 2.3a:**

With large wind resistance area of the load **Awr<sub>(load)</sub>**,

- Load to be lifted of 22,000 lb,
- Projected Wind Area **Ap** = 180 ft<sup>2</sup>,
- Wind Drag Coefficient **Cd** = 1.2

the wind resistance area of load can be estimated as:

$$Awr_{(load)} = Ap \times Cd = 180 \times 1.2 = 216 \text{ ft}^2$$

Refer to the above **Lifting Limits at wind speed V(z) > 30 mph and ≤ 45 mph**. Comparing the load to the allowable:

- Is the load to be lifted less than allowable load?  
22,000 lb ≤ 20,160 lb NO

**Conclusion:** This load is **NOT** permissible to lift in wind speed up to 45 mph.

Refer to the above **Lifting Limits at wind speed V(z) up to 30 mph**. Comparing the load to the allowable:

- Is the load to be lifted less than allowable load?  
22,000 lb ≤ 25,200 lb YES

The permissible wind speed for this load is 30 mph, depending on the wind resistance area of the load.

- Is **Awr<sub>(load)</sub>** less than **Awr<sub>(allow)</sub>**?  
216 ft<sup>2</sup> ≤ 149 ft<sup>2</sup> NO

**Conclusion:** This load is **NOT** permissible to lift in wind speed at 30 mph, but permitted to lift at a reduced wind speed calculated as follows:

$$\text{Ratio } \frac{Awr_{(load)}}{Awr_{(allow)}} = \frac{216}{149} = 1.45$$

From Table 2-7, the maximum permissible wind speed at ratio of 1.45 (rounded to next higher table value of 1.6) is 23.7 mph.

**Conclusion:** This load is permissible to lift in wind speed up to 23.7 mph only.

**Load example 2.3b:**

With large wind resistance area of the load **Awr<sub>(load)</sub>**,

- Load to be lifted of 12,000 lb,
- Projected Wind Area **Ap** = 125 ft<sup>2</sup>,
- Wind Drag Coefficient **Cd** = 1.3

the wind resistance area of load can be estimated as:

$$Awr_{(load)} = Ap \times Cd = 125 \times 1.3 = 162 \text{ ft}^2$$



Refer to the above **Lifting Limits at wind speed  $V(z) > 30$  mph and  $\leq 45$  mph**. Comparing the load and wind resistant area to the allowable:

- Is the load to be lifted less than allowable load?  
12,000 lb  $\leq$  20,160 lb YES
- Is  $Awr_{(load)}$  less than  $Awr_{(allow)}$ ?  
162 ft<sup>2</sup>  $\leq$  119 ft<sup>2</sup> NO

**Conclusion:** This load is NOT permissible to lift in wind speed up to 45 mph, but permitted to lift at a reduced wind speed calculated as follows:

$$\text{Ratio} \frac{Awr_{(load)}}{Awr_{(allow)}} = \frac{162}{119} = 1.37$$

From Table 2-7, the maximum permissible wind speed at ratio of 1.37 (rounded to next higher table value of 1.4) is 38.0 mph.

**Conclusion:** This load is permissible to lift in wind speed up to 38.0 mph only.

## Lifting Operations

Before lifting, position the crane on a firm surface, properly extend and set the outriggers, and level the crane. Depending on the nature of the supporting surface, adequate cribbing may be required to obtain a larger bearing surface.

The crane is equipped with a bubble level 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 make sure that it is in-line with the center of the boom at all points on the swing circle.

If the boom extension, or auxiliary boom nose is to be used, make sure that the electrical cable and the weight for the Anti-Two-Block Switch are properly installed and the Rated Capacity Limiter (RCL) is programmed for the crane configuration. Refer to the RCL operator manual supplied with the crane.

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.

Make sure that 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, boom extension, 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*.

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

**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.

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 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.

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

Make sure that 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.

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

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.

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. Make sure that the crane's capacity is not exceeded when this occurs.

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.

Using only one hoist at a time when lifting loads is recommended. See "Tilt-Up Panel Lifting" on page 21 for additional lifting instructions.

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 hoist rope.

## 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 person. 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:

- Secure the services of a qualified person to direct the operation.
- Make sure that all signals are coordinated through the lift director or person in charge of the lift.
- Coordinate lifting plans with the operators, designated person, and signal person prior to beginning the lift.
- Maintain communication between all parties throughout the entire operation. If possible, provide approved radio equipment for voice communication between all parties engaged in the lift.
- Use outriggers on cranes so equipped.
- Calculate the amount of weight to be lifted by each crane and attach slings at the correct points for proper weight distribution.
- Make sure that the load lines are directly over the attach points to avoid side loading and transfer of loading from one crane to the other.
- Do not travel. Lift only from a stationary position.

## Lifting Multiple Loads

Grove recommends lifting only one load at a time.

Lifting two or more separately rigged loads at one time is only permitted during steel erection in accordance with 29CFR1926.753 when the following criteria are met:

1926.753(e)(1) A multiple lift shall only be performed if the following criteria are met:

- 1926.753(e)(1)(i) A multiple lift rigging assembly is used;
- 1926.753(e)(1)(ii) A maximum of five members are hoisted per lift;
- 1926.753(e)(1)(iii) Only beams and similar structural members are lifted; and
- 1926.753(e)(1)(iv) All employees engaged in the multiple lift have been trained in these procedures in accordance with § 1926.761(c)(1).
- 1926.753(e)(1)(v) No crane is permitted to be used for a multiple lift where such use is contrary to the manufacturer's specifications and limitations.

1926.753(e)(2) Components of the multiple lift rigging assembly shall be specifically designed and assembled with a maximum capacity for total assembly and for each individual attachment point. This capacity, certified by the manufacturer or a qualified rigger, shall be based on the manufacturer's specifications with a 5 to 1 safety factor for all components.

1926.753(e)(3) The total load shall not exceed:

- 1926.753(e)(3)(i) The rated capacity of the hoisting equipment specified in the hoisting equipment load charts;
- 1926.753(e)(3)(ii) The rigging capacity specified in the rigging rating chart.

1926.753(e)(4) The multiple lift rigging assembly shall be rigged with members:

- 1926.753(e)(4)(i) Attached at their center of gravity and maintained reasonably level;
- 1926.753(e)(4)(ii) Rigged from top down; and
- 1926.753(e)(4)(iii) Rigged at least 7 feet (2.1 m) apart.

1926.753(e)(5) The members on the multiple lift rigging assembly shall be set from the bottom up.

1926.753(e)(6) Controlled load lowering shall be used whenever the load is over the connectors.

## Tilt-Up Panel Lifting

Requirements and recommendations regarding operation and use of Grove cranes are stated on decals and in the Operator Manual provided with each specific model machine. Using the subject crane to perform tilt-up panel lifting with two hoist lines poses new and different hazards than does normal lifting use.

Therefore, the following additional precautions must be taken if it is necessary for the crane to be used to perform tilt-up panel lifting using a crane equipped with two hoists:

- The crane must be set up and operated in accordance with Grove's instructions in the Operator Manual, Load Capacity Chart, and decals affixed to the crane.
- The hoist rope from the main hoist shall be reeved over the main boom nose reeved for two parts of line.
- The hoist rope from the auxiliary hoist shall be reeved over the auxiliary boom nose reeved for one part of line or up to two parts of line depending on the applicable load chart ratings.
- The load shall be connected with the main hoist line connected to the end closest to crane and the auxiliary hoist line connected to the end farthest from the crane.

- The anti-two-block system shall be installed and inspected to confirm that it is active to monitor both hoist lines.
- The RCL hoist selection shall be set to main hoist and two parts of line.
- The wire rope and sheaves shall be inspected prior to and following the lifting operations for chaffing or scrubbing.
- The total gross load shall not exceed 80% of the standard load chart. The operator shall be responsible to control this as the RCL does not have a feature to set reduced lifting limits.
- The auxiliary hoist line shall be considered part of the deducts to determine net allowable load.
- The panel shall be lifted so that the hoist lines are in line with the crane.
- The load shall be controlled to prevent rotation of the load and to make sure that the load stays in line with the boom.
- The load must be balanced with the auxiliary: load line not taking more than half the load at any time during the lift. The RCL will not be providing coverage for the line pull of the auxiliary hoist line.
- The effect of wind loads on the crane and panel shall be taken into consideration. Operations shall be halted if the wind can cause a loss of control in handling the load.
- The main hoist line shall be used to raise the panel into the vertical position.

Make sure that all personnel working on and around the crane are properly trained and thoroughly familiar with operational functions of the crane and safe operating and work practices. Personnel should be thoroughly familiar with regulations and standards governing cranes and their operation. Work practices may vary slightly between government regulations, industry standards, local and job-site rules and employer policies so a thorough knowledge of and compliance with all relevant work rules is necessary.

## Counterweight

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

Do not add material to the counterweight to increase capacity. United States Federal law prohibits modification or additions which affect the capacity or safe operation of the equipment without the manufacturer's written approval. [29CFR 1926.1434]

## Outrigger Lift Off

Regarding "lifting" of an outrigger pad during craning activities, be advised that the rated loads for these cranes, as indicated on the crane's *Load Chart*, do not exceed 85% of the tipping load on outriggers as determined by SAE J765 "Cranes Stability Test Code." An outrigger pad may lift off the ground during operation of the crane within the capacity limits of the *Load Chart*, yet the crane will not have reached instability. The "balance point" for stability testing according to SAE and Grove criteria is a condition of loading wherein the load moment acting to overturn the crane is equal to the maximum moment of the crane available to resist overturning. This balance point or point of instability for a crane does not depend on "lifting" of an outrigger but rather on comparison of the "opposing" load moments.

The occurrence of an outrigger lifting from the ground is often attributed to the natural flex in the crane's frame. This may happen when lifting a load in certain configurations within the capacity limits of the *Load Chart* and is not necessarily an indication of an unstable condition.

Provided the crane is properly set up, the crane is in good working condition, that all operator's aids are properly programmed, that the qualified crane operator adheres to the instructions found in the applicable *Load Chart*, *Operator Manual* and decals on the crane, the crane should not be unstable.

## PILE DRIVING AND EXTRACTING

Pile driving and extracting are applications approved by Grove, provided all equipment is operated within factory guidelines. The following operating requirements must be used during pile driving and extracting with a Grove mobile hydraulic crane:

Pile driving and pile extraction using a mobile crane introduces many variable and unknown factors that must be considered when using a crane for this application. Because of these factors, discretion must be exercised when pile driving or pile extraction is being considered.

It is not the intention of Grove to recommend specific types or makes of pile driving and pile extraction equipment, but rather to advise of the operational requirements to help avoid the detrimental effects that pile driving and pile extraction can have on the crane.

In addition to the operating requirements that are detailed in the operating manuals and on the load capacity chart, pile driving and extracting operations are approved by Grove, provided all guidelines outlined below are followed:

- All pile driving and extracting operations shall be restricted to fully extended outriggers with all tires clear of the ground.

- The combined weight of the driver or extractor, piling, leads, attachments, etc., shall not exceed 80% of the published load chart values for on-outriggers operation.
- The pile driver or pile extractor and attachments shall be kept clear of the boom nose at all times.
- The pile driver and piling shall be suspended from a hoist cable with sufficient line speed to meet or exceed the rate of descent of the driver and piling to preclude impact loading or vibration from being induced into the boom and crane structure.
- Pile driving or extracting shall be restricted to over the main boom only and shall not be permitted over a boom extension.
- Pile extraction using only the crane's hoist line is unsafe and not permitted since load values cannot be accurately determined. Only pile extraction devices that do not transmit vibration or shock loading into the crane are permitted. All possible precautionary measures shall be taken to prevent shock loads or vibration from being imposed on crane components, either directly through the hoist cable or indirectly from ground borne vibration.
- The load lines shall be kept vertical at all times during pile driving and pile extraction operations.
- The operator and other personnel associated with the pile driving and pile extraction operation shall have read and understood all safety standards applicable to crane operations as well as being thoroughly trained in the safe operation of pile driving and extracting equipment.

### Crane Equipment

- Hoists shall be equipped with a cable follower to aid in proper spooling of cable.
- All cable retainer pins and cable guides/retainers shall be in place.
- All boom extensions must be removed from the machine before pile driving or extraction begins.
- All hoist hooks shall be equipped with a positive locking latch.

### Crane Inspection

- In addition to the crane's frequent and periodic inspections, dated daily records shall be maintained

showing inspections were performed on the crane during the time it was used for pile driving or extraction.

- All anti-two-block warning devices and RCL systems shall be inspected daily and verified to be functional.
- All areas of the crane subject to fatigue shall be inspected monthly, and before the crane is to return to lifting service.
- The boom shall be inspected daily to make sure that all wear pads remain in place. Cranes which utilize pinned boom sections shall be inspected daily to make sure that the pinning mechanism operates properly and to check for undue wear at the pins and pinning plates.
- The hoist cable shall be inspected daily to make sure that no chafing or wear is occurring.

### ELECTROCUTION HAZARD

Thoroughly read, understand, and abide by all applicable federal, state, and local regulations regarding operation of cranes near electric power lines or equipment.

**United States federal law prohibits the use of cranes closer than 6 m (20 ft) to power sources up to 350 kV and greater distances for higher voltages unless the line's voltage is known [29CFR1910.180 and 29CFR1926, subpart CC].**

**To avoid death or serious injury, Grove recommends that all parts of crane, boom, and load be kept at least 6 m (20 ft) away from all electrical power lines and equipment less than 350 kV.**



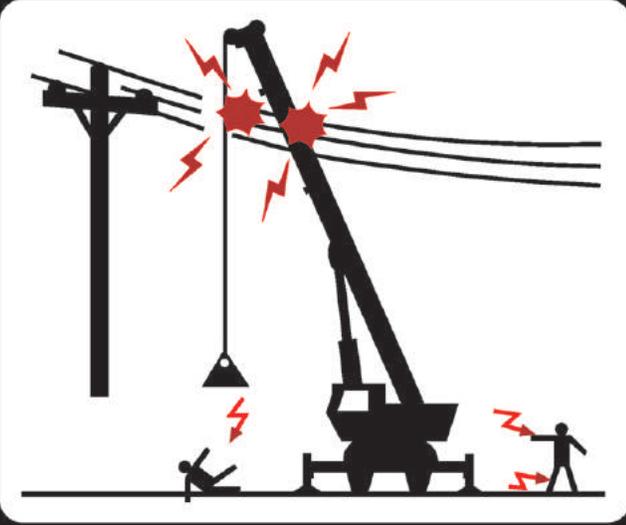
**DANGER**

**Electrocution Hazard!**

Grove cranes are not equipped with all features required to operate within OSHA 29CFR1926.1408, Power Line Safety, Table A clearances when the power lines are energized.

If operation within 3 m (10 ft) of any power lines cannot be avoided, the power utility **must** be notified and the power lines **must** be de-energized and grounded **before** performing any work.

Electrocution **can occur** even without direct contact with the crane.



! DANGER

ELECTROCUTION HAZARD  
 TO AVOID DEATH OR SERIOUS INJURY

Keep **ALL** parts of the crane, rigging and load at least 20 feet (6 meters) away from any energized power line. You **MUST** follow the OSHA requirements set forth in 29CFR 1926.1407 through 1926.1411.

This crane is not designed or equipped for use within 10 feet (3 meters) of energized power lines [Refer to 29CFR1926.1410 Table A]. If operation within 10 feet (3 meters) of any power lines cannot be avoided, the power utility **MUST** be notified and the power lines **MUST** be de-energized and grounded **BEFORE** performing any work.

If contact is ever accidentally made with a power line and any part of this crane, its rigging or load, **NEVER** touch the crane or even approach or come near the crane.

Electrocution **CAN OCCUR** even without direct contact with the crane.

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THIS CRANE IS NOT INSULATED.

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.

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 crane is **not insulated**. Always consider all parts of the load and the crane, including the hoist rope, wire rope, pendant cables, and tag lines, as conductors. You, the operator, are responsible for alerting all personnel of dangers associated with electrical power lines and equipment. 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.

If the load, hoist rope, 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.

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.

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

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

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.

### 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 (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.

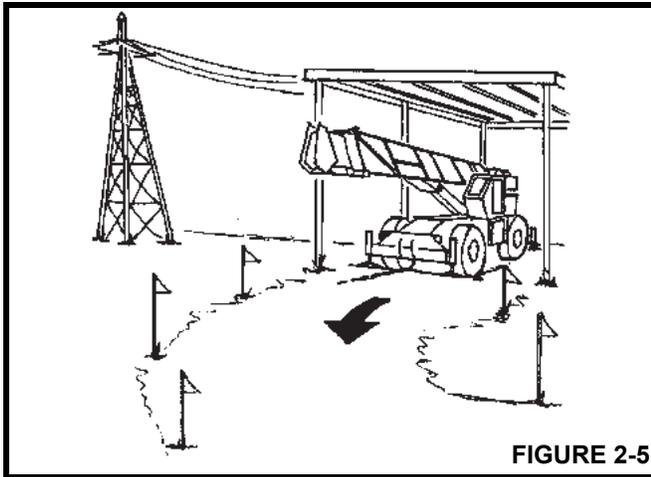


FIGURE 2-5

United States OSHA regulations require a flagman when operating in close proximity to energized power lines.

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 shall 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, or proximity warning devices 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 manual 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 advertised to detect the existence of electricity and not its quantity or magnitude.
- Some proximity devices may 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; 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 conductor (wire) 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 may have remained 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's 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 Grove distributor must be immediately advised of the incident and consulted on necessary inspections and repairs. Thoroughly inspect the hoist rope and all points of contact on the crane. Should the distributor not be immediately available, contact Manitowoc Crane Care. 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 your Grove distributor or Manitowoc Crane Care.

### Special Operating Conditions and Equipment

Never operate the crane during an electrical thunderstorm.

When operating near transmitter/communication towers where an electrical charge can be induced into the crane or load:

- The transmitter shall be deenergized OR,
- Tests shall be made to determine if an electrical charge will be induced into the crane or load.
- The crane must be provided an electrical ground.
- If taglines are used, they must be non-conductive.
- Every precaution must be taken to dissipate induced voltages. Consult a qualified RF (radio frequency) Consultant. Also refer to local, state, and federal codes and regulations.

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 (if equipped) or operator's station.

### Grounding the Crane

The crane may become charged with static electricity. This may occur especially when using outrigger pads made of

plastic or when the outrigger pads are cribbed with insulating material (e.g., wooden planks).



#### WARNING

##### Risk of accidents due to electric shock!

Ground the crane before you start to work with it

- Near strong transmitters (radio transmitters, radio stations, etc.)
- Near high-frequency switching stations
- If a thunder storm is forecast

Use electrically conducting material for grounding.

1. Hammer a metal rod (3, Figure 2-6) (length of approximately 2.0 m (6.6 ft)) at least 1.5 m (5 ft) into the ground.
2. Moisten the soil around the metal rod (3) for better conductivity.
3. Clamp an insulated cable (2) to the metal rod (3), cross-section of at least 16 mm<sup>2</sup> (0.025 in<sup>2</sup>) (AWG 5).
4. Connect the free end of the cable with a clamp (1) to a good electrically conductive location on the frame.

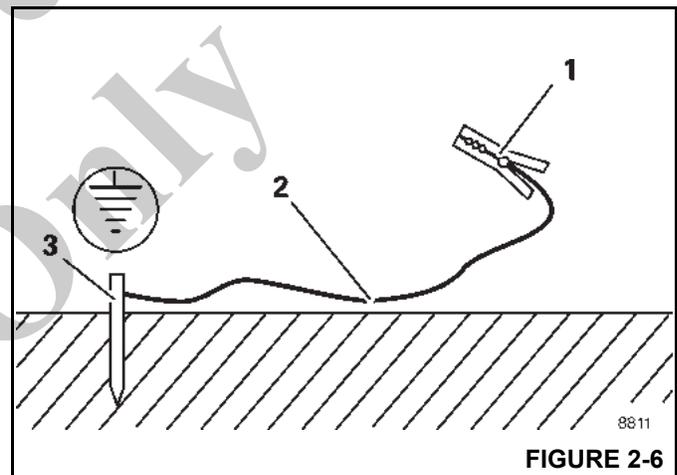


FIGURE 2-6



#### WARNING

##### Risk of accidents due to electric shock!

Make sure that the connections between the cable and the clamp are electrically conductive.

Do not attach the clamp to parts that are screwed on, such as valves, covers or similar parts.

## PERSONNEL HANDLING

The American Society of Mechanical Engineers published the American National Standard entitled, *Personnel Lifting Systems*, ASME B30.23:

This Volume establishes the design criteria, equipment characteristics, and operational procedures that are required when hoisting equipment within the scope of the ASME B30 Standard is used to lift personnel. Hoisting equipment defined by the ASME B30 Standard is intended for material handling. It is not designed, manufactured, or intended to meet the standards for personnel handling equipment, such as ANSI/SIA A92 (Aerial Platforms). The equipment and implementation requirements listed in this Volume are not the same as that established for using equipment specifically designed and manufactured for lifting personnel. Hoisting equipment complying with the applicable Volumes of the ASME B30 Standard shall not be used to lift or lower personnel unless there are no less hazardous alternatives to providing access to the area where work is to be performed. The lifting or lowering of personnel using ASME B30-compliant hoisting equipment is prohibited unless all applicable requirements of this volume have been met.

This standard is consistent with the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) regulations for Construction that state, in 29CFR1926.1431:

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*, ASME B30.8, *Floating Cranes and Floating Derricks*, and in OSHA regulations 29CFR1910.180 for *General Industry* and 29CFR1926.1431 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 must remain at the crane controls at all times when personnel are off the ground.

- 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 must be equipped with a boom angle indicator that is visible to the crane operator.
- The crane's *Load Chart* is affixed at the operator's station and 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 level within one percent of level grade and located on a firm footing. Cranes with outriggers shall have them all deployed following manufacturer's specifications.
- The crane's *Operator Manual* and other operating manuals are at the operator's station and readily accessible to the operator.
- The platform meets the requirements as prescribed by applicable standards and regulations.
- For hoist rope suspended platforms:
  - The crane is equipped with a hook that can be closed and locked, eliminating the throat opening.
  - The crane is equipped with a functional anti-two-block device.
  - The platform is properly attached and secured to the load hook.
- For boom mounted platforms:
  - 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 handle personnel on the loadline unless the requirements of applicable national, state and local regulations and safety codes are met.
- 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.
- NEVER allow anyone on the hoist access platform while traveling.

The following standards and regulations regarding personnel handling 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, 07007-2900.

- or - check online at:

<https://www.asme.org/codes-standards/find-codes-standards>

- *US DOL/OSHA Rules and Regulations* are available by mail from the Superintendent of Documents, PO Box 371954, Pittsburgh, PA, 15250-7954.

## ENVIRONMENTAL PROTECTION

**Dispose of waste properly!** Improperly disposing of waste can threaten the environment.

Potentially harmful waste used in Grove cranes includes, but is not limited to, oil, fuel, grease, coolant, air conditioning refrigerant, filters, batteries, and cloths which have come into contact with these environmentally harmful substances.

Handle and dispose of waste according to local, state, and federal environmental regulations.

When filling and draining crane components, observe the following:

- Do not pour waste fluids onto the ground, down any drain, or into any source of water.
- Always drain waste fluids into leak proof containers that are clearly marked with what they contain.
- Always fill or add fluids with a funnel or a filling pump.
- Immediately clean up any spills.

## MAINTENANCE

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

Grove continues to recommend that cranes be properly maintained, regularly inspected and repaired as necessary. Grove reminds crane owners to make sure that all safety decals are in place and legible. Grove continues to urge crane owners to upgrade their cranes with rated capacity limiter and control lever lockout systems for all lifting operations.

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 manual when performing crane maintenance as well as crane operations.

Keep the crane free of mud, dirt, and grease at all times. 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 *Inspection and Lubrication Service Log*. Any questions regarding procedures and specifications should be directed to your Grove distributor.

## Service and Repairs



### WARNING

#### Fall Hazard!

Working at elevated heights without using proper fall protection can result in severe injury or death.

Always use proper fall protection as required by local, state or federal regulations.

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 manual, and the service manual for this machine. If there is any question regarding maintenance procedures or specifications, contact your Grove distributor for assistance.

**Qualified person** is defined as one who by reason of knowledge, training and experience is thoroughly familiar with the crane's operation and required maintenance as well as the hazards involved in performing these tasks.

**Training and qualification of maintenance and repair personnel are crane owner's responsibility.**

All replacement parts must be Grove approved.

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

### Hydraulic Fluid

- Do not use your hand or any part of your body to check for hydraulic fluid leaks when the engine is running or the hydraulic system is under pressure. Fluid in the hydraulic system can be under enough pressure that it will penetrate the skin, causing serious injury or death. Use a piece of cardboard, or piece of paper, to search

for leaks. Wear gloves to protect your hands from spraying fluid.

- If any hydraulic fluid is injected into the skin, obtain medical attention immediately or gangrene may result.
- Do not attempt to repair or tighten any hydraulic hose or fitting while the engine is running, or when the hydraulic system is under pressure.
- Never disconnect any hydraulic lines unless the boom is fully lowered, the engine is shut off, and the hydraulic pressure is relieved. To relieve hydraulic pressure, stop the engine, turn the ignition switch to RUN and move the hydraulic controls in both directions several times.



### WARNING

#### Pressurized Fluid Hazard!

Hydraulic pressure may still be present in portions of the hydraulic system due to accumulators or trapped circuitry.

- Hot hydraulic fluid will cause severe burns. Wait for the fluid to cool before disconnecting any hydraulic lines.
- Hydraulic fluid can cause permanent eye injury. Wear appropriate eye protection.

#### Moving Parts

- Do not place limbs near moving parts. Amputation of a body part may result. Turn off the engine and wait until the fan and belts stop moving before servicing crane.
- Pinch points, which result from relative motion between mechanical parts, are areas of the machine that can cause personal injury or death. Do not place limbs or your body in contact with pinch points either on or around the machine. Care must be taken to prevent motion between pinch points when performing maintenance and to avoid such areas when movement is possible.
- Do not allow persons to stand near extending or lowering outriggers. Foot crushing could occur.

#### Before maintenance or repairs

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.
- Do not get under a raised boom unless the boom is blocked up safely. Always block up the boom before doing any servicing that requires the boom to be raised.

- 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.

#### 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.
- Consult with Manitowoc Crane Care to determine if load testing is required after a structural repair is performed.

#### Lubrication

The crane must be lubricated according to the manufacturer's 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:

- Follow the manufacturer's recommendations when adding oil to the system. Mixing the wrong fluids could destroy seals, causing component failure.
- Be certain all lines, components, and fittings are tight before resuming operation.

#### Tires



### WARNING

#### Possible equipment damage and/or personal injury!

Driving the crane with a tire and split-rim assembly under inflated at 80% or less of its recommended pressure can cause the wheel and/or tire to fail. Per *OSHA Standard 1910.177(f)(2)*, when a tire has been driven under inflated at 80% or less of its recommended pressure, it must first be completely deflated, removed from the axle, disassembled, and inspected before re-inflation.

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

Make sure that all lug nuts are properly torqued.

Make sure that pneumatic tires are inflated to the proper pressure (refer to the *Load Chart*). When inflating tires, use a tire gauge, clip-on inflator, and extension hose which will permit standing clear of the tire while inflating.

## HOIST ROPE

### Synthetic Hoist Rope

For detailed information concerning synthetic hoist rope, refer to K100™ Synthetic Crane Hoist Line Manual P/N 9828100734 available by contacting Manitowoc Crane Care.

During installation and setup, care must be taken to avoid overlap and crossing of wire rope and synthetic hoist ropes.

Always make daily inspections of the hoist rope, keeping in mind that all hoist rope will eventually deteriorate to a point where it is no longer usable. Refuse to work with worn or damaged hoist rope.

During regular inspections, operator shall make sure that crane surfaces such as wear pads, sheaves, etc have not been damaged in a manner that can then damage the synthetic hoist rope.

**NOTE:** Example; if usage of a wire rope has cut grooves with sharp edges in a wear pad, they need to be addressed before the synthetic hoist rope is used in that same position.

Use **only** the hoist rope specified by Grove as indicated on the crane's *Load Chart*. Substitution of an alternate hoist rope may require the use of a different permissible line pull and, therefore, require different reeving.

**NOTE:** Hoist rope may be purchased by contacting Manitowoc Crane Care.

### Wire Rope

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

- 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.
- For running ropes other than rotation resistant: six (6) broken wires in one rope lay or three (3) broken wires in one strand.
- One valley break where the wire fractures between strands in a running rope is cause for removal.
- Abrasion of the rope resulting in a 5% reduction in the original wire diameter.
- Any kinking, bird caging, crushing, corrosion, or other damage resulting in distortion of the rope structure.
- 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.

- 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.
- Core deterioration, usually observed as a rapid reduction in rope diameter, is cause for immediate removal of the rope.

The following is a brief outline of the basic information required to safely use wire rope.

- Wire ropes wear out. The strength of a rope begins to decrease when the rope is put to use and continues to decrease with each use. Rope will fail if worn-out, overloaded, misused, damaged or improperly maintained.
- The nominal strength, sometimes called catalog strength, of a wire rope applies only to a new, unused rope.
- The nominal strength of a rope should be considered the straight line pull which will actually break a new unused rope. The nominal strength of a rope should never be used as its working load.
- Each type of fitting attached to a rope has a specific efficiency rating which can reduce the working load of the rope assembly or rope system.
- If an operator hoists the hook block up or down too fast when reeved with multiple parts of line and no hook load, the wire rope can bird cage and damage the rope.
- Never overload a rope. This means never use the rope where the load applied to it is greater than the working load determined by the rope manufacturer.
- Never "shock load" a rope. A sudden application of force or load can cause both visible external and internal damage. There is no practical way to estimate the force applied by shock loading a rope. The sudden release of a load can also damage a rope.
- Lubricant is applied to the wires and strands of a wire rope when it is manufactured. The lubricant is depleted when the rope is in service and should be replaced periodically. Refer to the *Service Manual* for more information.
- In the U.S.A., regular inspections of the rope and keeping of permanent records signed by a qualified person are required by OSHA for almost every wire rope application. The purpose of the inspection is to determine whether or not a rope may continue to be safely used on the application. Inspection criteria, including number and location of broken wires, wear and elongation, have been established by OSHA, ANSI,

ASME and similar organizations. See the *Service Manual* for inspection procedures.

When inspecting ropes and attachments, keep all parts of your body and clothing away from rotating hoist drums and all rotating sheaves. Never handle the rope with bare hands.

Some conditions that lead to problems in wire rope systems include:

- Sheaves that are too small, worn or corrugated cause damage to a wire rope.
- Broken wires mean a loss in strength.
- Kinks permanently damage a rope and must be avoided.
- Ropes are damaged by knots. Rope with knots must never be used.
- Environmental factors such as corrosive conditions and heat can damage a wire rope.
- Lack of lubrication can significantly shorten the useful life of a wire rope.
- Contact with electrical wires and resulting arcing will damage a wire rope.
- An inspection should include verification that none of the specified removal criteria for this usage are met by checking for such things as:
  - Surface wear; nominal and unusual.

- Broken wires; number and location.
- Reduction in diameter.
- Rope stretch (elongation).
- Integrity of end attachments.
- Evidence of abuse or contact with another object.
- Heat damage.
- Corrosion.

**NOTE:** A more detailed rope inspection procedure is given in the *Service Manual*.

- ***When a rope has been removed from service because it is no longer suitable for use, it must not be reused on another application.***

#### Installing a new rope

- 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.
- Follow proper instructions for removing rope from a reel.
- Apply back tension to the storage/payoff reel of the new rope to ensure tight, even, spooling onto the hoist drum.
- Operate the new rope—first through several cycles at light load—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.

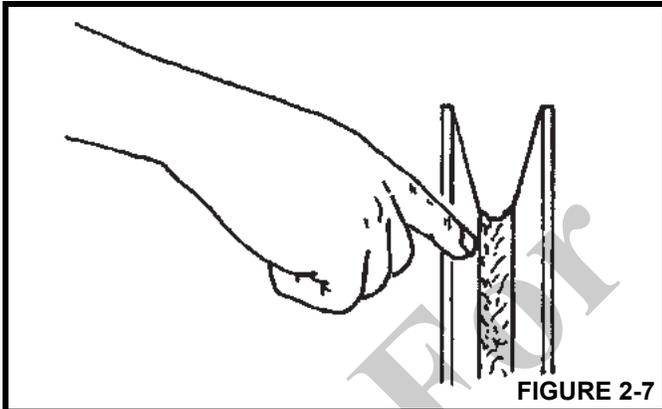
**Sheaves**

FIGURE 2-7

Inspect the boom nose and hook block sheaves for proper operation, excessive wear, and damage every 50 hours or weekly. Inoperable, damaged and/or worn sheaves cause rapid deterioration of rope.

Make sure that sheaves carrying ropes, that can be momentarily unloaded, are equipped with close fitting guards or other devices to guide the rope back into the groove when the load is reapplied. Make sure that sheaves in the lower load block are equipped with close fitting guards that will prevent the ropes from becoming fouled when the block is lying on the ground with loose ropes.

To attain maximum hoist 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.

The use of nylon (polyamide) sheaves, as compared with metallic sheaves, may change the replacement criteria of rotation-resistant hoist rope.

**NOTE:** The use of cast nylon (polyamide) sheaves will substantially increase the service life of 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:

- Wear safety glasses when servicing batteries.
- If equipped, disconnect battery with the battery disconnect switch before disconnecting the ground battery cable. For cranes with a Cummins engine using an engine ECM:
  - a. Make sure that the key switch has been off for 2 minutes.
  - b. Turn the battery disconnect switch to the OFF position.
  - c. Remove the ECM power fuse.
  - d. Remove negative battery cables.
- 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.
- Do not short across the battery posts to check charge. Short circuit, spark, or flame could cause battery explosion.
- If applicable, 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.
- 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.

**Super Capacitor (If Equipped)**

Capacitor 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 capacitor, exercise the following procedures and precautions:

- Wear safety glasses when servicing.
- If equipped, disconnect battery with the battery disconnect switch before disconnecting the ground battery cable. For cranes with a Cummins engine using an engine ECM:
  1. Make sure that the key switch has been off for 2 minutes.
  2. Turn the battery disconnect switch to the OFF position.

3. Remove the ECM power fuse.
4. Remove negative battery cables.
5. Remove positive capacitor cable.
  - Do not short across the capacitor posts to check charge. Short circuit will cause capacitor terminal damage. Spark or flame could cause capacitor explosion.
  - Check capacitor charge level with proper test equipment.

## General Maintenance

Fuel the crane only with the engine turned off. Do not smoke while fueling the crane. Do not store flammable materials on the crane.

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

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.

Do not use ether to start the engine on cranes equipped with intake manifold grid heaters.

The engine can enter into an engine exhaust cleaning mode where the exhaust temperature can be high, make sure that the exhaust is not pointed at materials that can melt, burn, or explode.

## TRANSPORTING THE CRANE

Before transporting the crane, check the suitability of the proposed route with regard to the crane height, width, length, and weight.

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

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

Make sure that the crane is adequately secured to the transporting vehicle.

Do not use the dead end lug (1, (Figure 2-8)) on the boom nose for tying down the boom during transport. Damage to the lug and boom can result from usage as a tie down point.

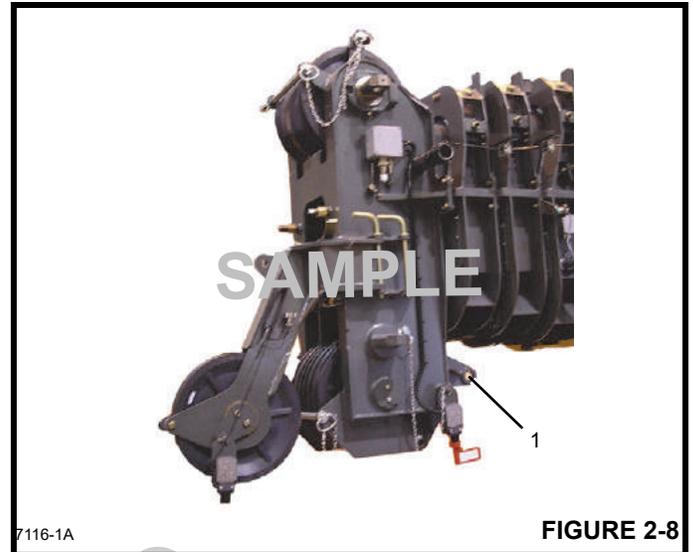


FIGURE 2-8

Before transporting the crane on a road or highway, first check state and local restrictions and regulations.

Either the hook block may be reeved over the main boom nose or the overhaul ball may be reeved over the main boom nose or auxiliary boom nose; the other must be removed. If the hook block or overhaul ball remains reeved on the boom, it must be secured at the tie down on the carrier to prevent swinging.

When using hookblock tie downs, excessive loading can be applied by pulling the cable too tight, particularly when reeved with multiple part lines. When the cable is hooked into the hookblock tie down, the cable should be merely “snugged-up” with adequate slack provided at the center line of sheave to anchor point. Do not draw cable taut. Care must be exercised anytime any crane function is being performed while the cable is hooked into the hookblock tie down.

## TRAVEL OPERATION

Only the crane operator shall occupy the crane when traveling.

When traveling, the boom should be completely retracted and lowered to the travel position and the turntable pin swing lock, if equipped, should be engaged. If equipped with boom rest, lower the boom into the boom rest and engage the turntable lock.

Strictly adhere to the guidelines and restrictions in the *Load Chart* for pick and carry operations.

RT cranes are manufactured without an axle suspension system. Traveling at high speeds, especially on rough ground, may create a bouncing effect that can result in loss of control. If bouncing occurs, reduce travel speed.

**WARNING**  
**Crushing Hazard!**

Death or serious injury could result from being crushed by revolving tires.

Keep clear of revolving tires.

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

Follow the instructions in this manual when preparing the crane for travel.

If using a boom dolly/trailer, thoroughly read and understand all the steps and safety precautions in this manual for setup and travel.

When driving the crane make sure that the cab is down, if equipped with a tilting cab.

Secure the hook block and other items before moving the crane.

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.

Before traveling a crane, check suitability of proposed route with regard to crane height, width, and length.

Never back up without the aid of a signal person to verify the area behind the crane is clear of obstructions and/or personnel.

On cranes equipped with air-operated brakes, do not attempt to move the crane until brake system air pressure is at operating level.

Check load limit of bridges. Before traveling across bridges, make sure that they will carry a load greater than the crane's weight.

If it is necessary to take an RT crane on a road or highway, check state and local restrictions and 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.

Always drive the crane carefully, obeying speed limits and highway regulations.

Stay alert at the wheel.

If equipped, make sure that the hoist access platform hand rail and step are in the travel configuration.

For Reference Only

## Slopes

- Pick and carry on level surfaces only.
- Refer to the *Operation Section* for more detailed information on traveling on slopes.
- Driving across a slope is dangerous, as unexpected changes in slope can cause tip over. Ascend or descend slopes slowly and with caution.
- When operating on a downhill slope, reduce travel speed and downshift to a low gear, to permit compression braking by the engine, and aid the application of the service brakes.

## WORK PRACTICES

### Personal Considerations

Always adjust the seat and lock it in position, and fasten the seat belt securely before you start the engine.

Do not wear loose clothing or jewelry that can get caught on controls or moving parts. Wear the protective clothing and personal safety gear issued or called for by the job conditions. Hard hat, safety shoes, ear protectors, reflective clothing, safety goggles, and heavy gloves may be required.

### Crane Access



#### WARNING

##### Fall Hazard!

Working at elevated heights without using proper fall protection can result in severe injury or death.

Always use proper fall protection as required by local, state or federal regulations.

You must take every precaution to make sure that 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). Use the recommended handholds and steps to maintain a three-point contact when getting on or off the crane.

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

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

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.

Use the hoist access platform (if equipped) when working in the hoist area.

Wear shoes with a highly slip-resistant sole material. Clean any mud or debris from shoes before entering the crane cab/operator's station or climbing onto the crane superstructure. Excessive dirt and debris on the handholds, 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 allow ground personnel to store their personal belongings (clothing, lunch boxes, water coolers, and the like) on the crane. This practice will prevent ground personnel from being crushed or electrocuted when they attempt to access personal belongings stored on the crane.

### Job Preparation

#### Before crane use

- Barricade the entire area where the crane is working and keep all unnecessary personnel out of the work area.
- Make sure that the crane is properly equipped, including access steps, covers, doors, guards, and controls.
- Conduct a visual inspection for cracked welds, damaged components, loose pins/bolts, 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. Inspect for evidence of improper maintenance (consult your *Service Manual*).
- Check for proper functioning of all controls and operator aids (for example, RCL).
- Check all braking (for example, wheel, hoist, and swing brakes) and holding devices before operation.

You must make sure that the outriggers and jack cylinders 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.

Clear all personnel from the outrigger area before extending or retracting the outriggers. Carefully follow the procedures in this *Operator Manual* when extending or retracting the outriggers. Death or serious injury could result from improper crane set up on outriggers.

Be familiar with surface conditions and the presence of overhead obstructions and power lines.

## Working

Operator shall be responsible for all operations under his/her direct control. When safety of an operation is in doubt, operator shall stop the crane's functions in a controlled manner. Lift operations shall resume only after safety concerns have been addressed or the continuation of crane operations is directed by the lift supervisor.

Know the location and function of all crane controls.

Make sure that all persons are away from the crane and the Travel Select Lever is in the "N" (Neutral) position with the Parking Brake engaged before starting the engine.

Sparks from the crane's electrical system and/or engine exhaust can cause an explosion. **Do not** operate this crane in an area with flammable dust or vapors, unless good ventilation has removed the hazard.

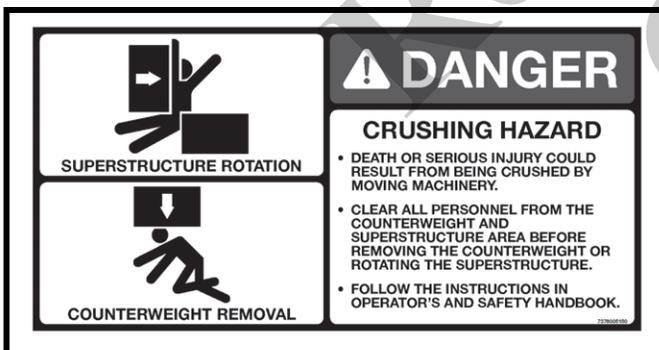
Carbon monoxide fumes from the engine exhaust can cause suffocation in an enclosed area. Good ventilation is very important when operating the crane.

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

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

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

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



Keep unauthorized personnel clear of the working area during operation.

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

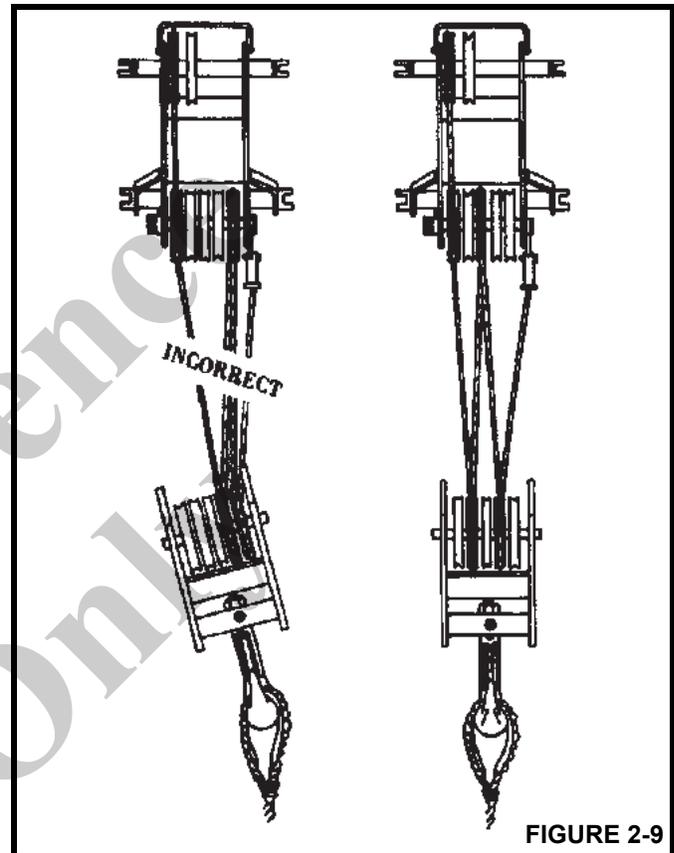
You must always be aware of everything around the crane while lifting or traveling. If you are unable to clearly see in the direction of motion, you must post a look out or signal person before moving the crane or making a lift. Sound the horn to warn personnel

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.

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.

Make sure that the hoist rope is properly routed on the hook block and boom nose (Figure 2-9), and that all rope guards are in place.



## Lifting

Grove Crane recommends lifting only one load at a time. See "Lifting Operations" on page 20.

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. Too few parts of line can result in failure of the hoist rope or hoist. **No less than three wraps of rope** should remain on the hoist drum. When slings, ties, hooks, etc., are used, make sure that they are correctly positioned and secured before raising or lowering the loads.

Make sure that 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.

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

If using a clam bucket, do not exceed 80 percent of the crane's capacity.

Make certain the boom tip is centered directly over the load before lifting.

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

Check the hoist brake by raising the load a few inches, stopping the hoist and holding the load. Make sure that 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.

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. 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 operator's station.

Remember, all rigging equipment must be considered as part of the load. Lifting capacities vary with working areas. If applicable, permissible working areas are listed in the *Load Chart*. When swinging from one working area to another, make sure that *Load Chart* capacities are not exceeded. Know your crane!

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.

Never swing or lower the boom into the carrier cab (if applicable).

Never push or pull loads with the crane's boom. Never drag a load.

Do not subject crane to side loading. A side load can tip the crane or cause it to fail structurally.

If the boom should contact an object, stop immediately and inspect the boom. Remove the crane from service if the boom is damaged.

When lifting a load the boom may deflect causing the load radius to increase—this condition is made worse when the boom is extended. Make sure that the weight of load is within the crane's capacity on *Load Chart*.

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.

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

Make sure that 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.

## Hand Signals

A single 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 ((Figure 2-10)) that have been 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.

Obey a signal to stop from anyone.

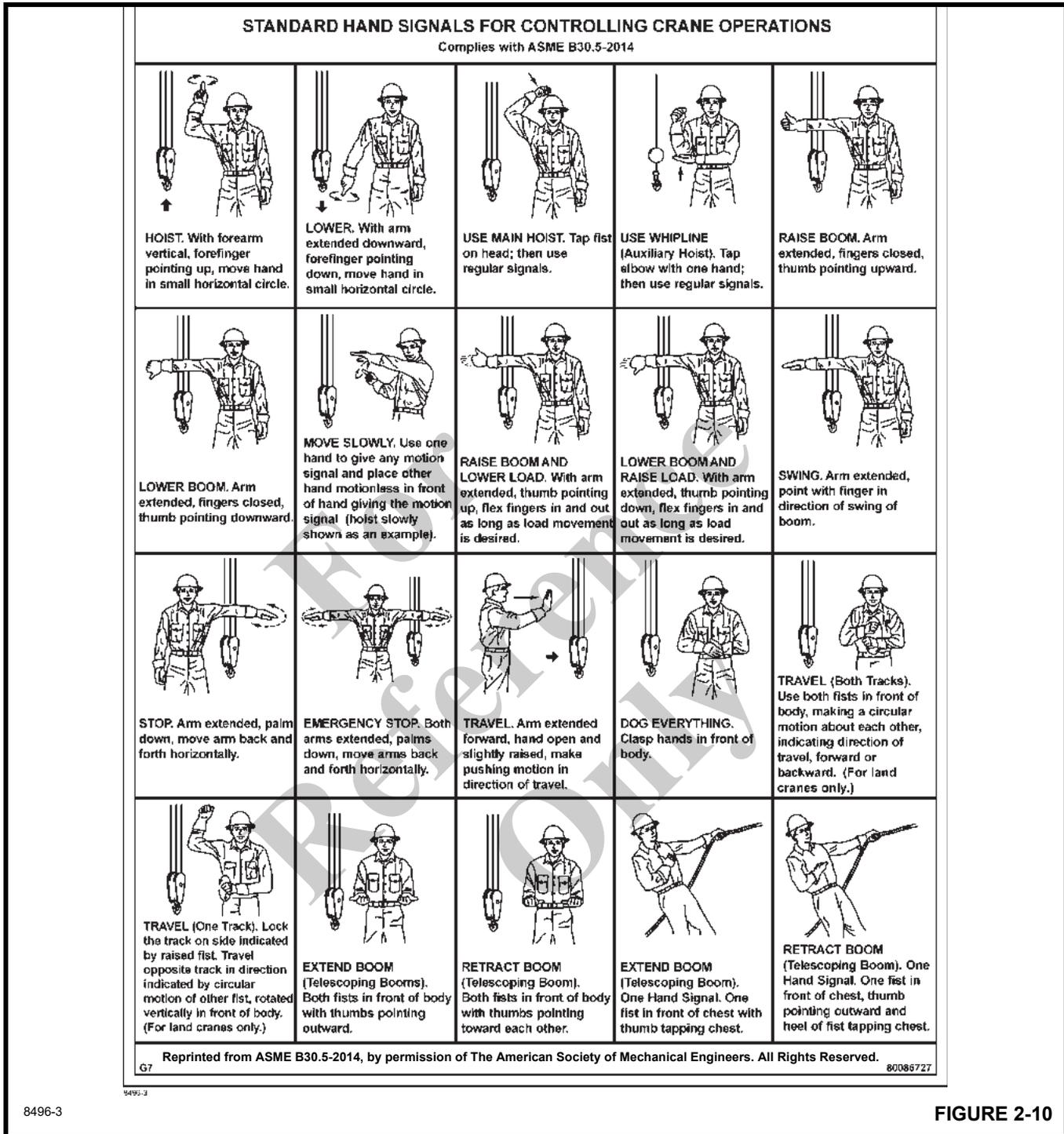


FIGURE 2-10

## BOOM EXTENSION

To avoid death or serious injury, follow the procedures in this manual during erection, stowage, and use of the boom extension.

Install and secure all pins properly.

Control movement of the boom extension at all times.

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



### DANGER

#### Boom Extension Hazard!

To avoid death or serious injury, follow procedures in *Load Chart*, safety, and operation manuals during erection, stowage and use of boom extension. Install and secure all pins properly and control boom extension movement at all times.

Do not remove the pins from the front stowage bracket unless the boom extension is pinned to the right side of the boom nose.

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

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

Stay outside of boom extension sections and lattice work.

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

## PARKING AND SECURING



### DANGER

#### Tipping Hazard!

When parking the crane and leaving it unattended follow the instructions in Section 4 of this manual.

Failure to comply with these instructions may cause death or serious injury.

When parking on a grade, apply the parking brake and chock the wheels.

Section 4 of this manual provides instructions for parking and securing a crane when it is to be left unattended. These instructions are intended to allow the crane to be placed in the most stable and secure position. However, Grove recognizes that certain jobsite conditions may not permit the boom and boom extension of a crane to be fully lowered to the ground. When a qualified person at a jobsite determines

that it is not practical to lower the boom to the ground, we recommend the following additional instructions be followed:

- The crane should be left in the smallest, most stable, valid operational configuration that the job site practically allows.
- The crane can not be left running, with a load on the hook, or with the jib deployed, or in wind conditions in excess of allowed values.
- The boom should be retracted as far as is practical, the crane configured in as stable a configuration as possible (boom angle, superstructure orientation, boom extension angle, etc.)
- In high winds the boom and boom extension should be lowered, or secured. Changing weather conditions including, but not limited to, wind, ice accumulation, precipitation, flooding, lightning, etc., should be considered when determining the location and configuration of a crane when it is to be left unattended.

## SHUT-DOWN

Use the following steps when shutting down the crane:

- Engage the parking brake.
- Fully retract and lower the boom.
- Engage the swing lock pin or 360 degree swing lock (if equipped).
- Disable all crane functions using the crane function Enable/Disable switch (if equipped).
- Place controls in neutral position.
- Shut down the engine and remove the ignition key.
- Wait a minimum of 2 minutes and then turn the battery disconnect switch to the OFF position.
- Chock the wheels, if not on outriggers.
- Lock the operator's cab (if applicable) and install vandal guards, if used.

## COLD WEATHER OPERATION

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

Check operating procedures in this manual for cold weather starting.

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

Clean the crane of all ice and snow.

Allow at least 30 minutes of engine run time for hydraulic oil to warm up.

Plastic components (battery casings, heater controls, dash controls, etc.) are extremely brittle in extreme cold. Use

caution handling and operating these components in sub-zero temperatures, avoiding shock loading.

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 HOOK BLOCKS

The Hook Block Working Load Limit (WLL) is valid between 60°C (140°F) and the low temperature limit given on the hook block identification plate with normal lifting precautions.

Lifting above 75% of the Working Load Limit, at temperatures between the service temperature given on the identification plate and -40°C (-40°F), must be done at a slow and steady rate to avoid stress spikes.

75% of the Working Load Limit must not be exceeded when lifting in temperatures below -40°C (-40°F).

For  
Reference  
Only

## 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 0.00077 cm<sup>3</sup> per cm<sup>3</sup> of volume for 1°C of temperature change (0.00043 in<sup>3</sup> per in<sup>3</sup> 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 7.6 m (25 ft) in which the oil cools 15.5°C (60°F) would retract approximately 196 mm (7 3/4 in) [see Table 2-9 and Table 2-8]. 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. To minimize the effects of thermal contraction or “Stick-slip” it is recommended that the telescope control lever is activated periodically in the extend position to mitigate the effects of cooling oil.

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.

(Table 2-8) and (Table 2-9) have 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.

Reference Only

Table 2-8: Boom Drift Chart (Cylinder length change in inches)

Coeff. = 0.00043 (in <sup>3</sup> /in <sup>3</sup> /°F)											
STROKE	Temperature Change (°F)										
(FT.)	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

Table 2-9 Boom Drift Chart (Cylinder length change in millimeters)

Coeff. = 0.000774 (1/°C)		<i>Metric</i>									
STROKE	Temperature Change (°C)										
(m)	5	10	15	20	25	30	35	40	45	50	55
1.5	6	12	17	23	29	35	41	46	52	58	64
3	12	23	35	46	58	70	81	93	104	116	128
4.5	17	35	52	70	87	104	122	139	157	174	192
6	23	46	70	93	116	139	163	186	209	232	255
7.5	29	58	87	116	145	174	203	232	261	290	319
9	35	70	104	139	174	209	244	279	313	348	383
10.5	41	81	122	163	203	244	284	325	366	406	447
12	46	93	139	186	232	279	325	372	418	464	511
13.5	52	104	157	209	261	313	366	418	470	522	575
15	58	116	174	232	290	348	406	464	522	581	639
16.5	64	128	192	255	319	383	447	511	575	639	702
18	70	139	209	279	348	418	488	557	627	697	766

Length change in mm = Stroke (m) X Temperature Change (°C) X Coeff. (1/°C) X 1000 mm/m

## CRANE STABILITY

The GRT655/655L rubber 360° load chart has a minimum radius of 3 m (9.8 ft) with a load. Without a load, a radius of 2.0 m (6.6 ft) is safe for 360° on rubber. A radius of less than 2.0 m (6.6 ft) must be avoided on rubber 360° because of backward stability considerations.

## HOIST PLATFORM



### DANGER

Do not use platform for hauling passengers. Death or serious injury could occur.

No storage of components are allowed on the platform.

Only one person at a time is allowed on the platform.

## OVERLOAD INSPECTION

When the Rated Capacity Limiter (RCL) system has acknowledged an overload on your crane, you must carry out specified inspections on the crane.

These inspections apply only to overloads up to 50%. For overloads of 50% or higher, crane operation must be

stopped immediately and Crane Care must be contacted for corrective action.

The following illustrations may not be an exact representation of your crane and are to be used for reference only.

## WARNING

### Overload Hazard!

To avoid an accident caused by overload damage to your crane:

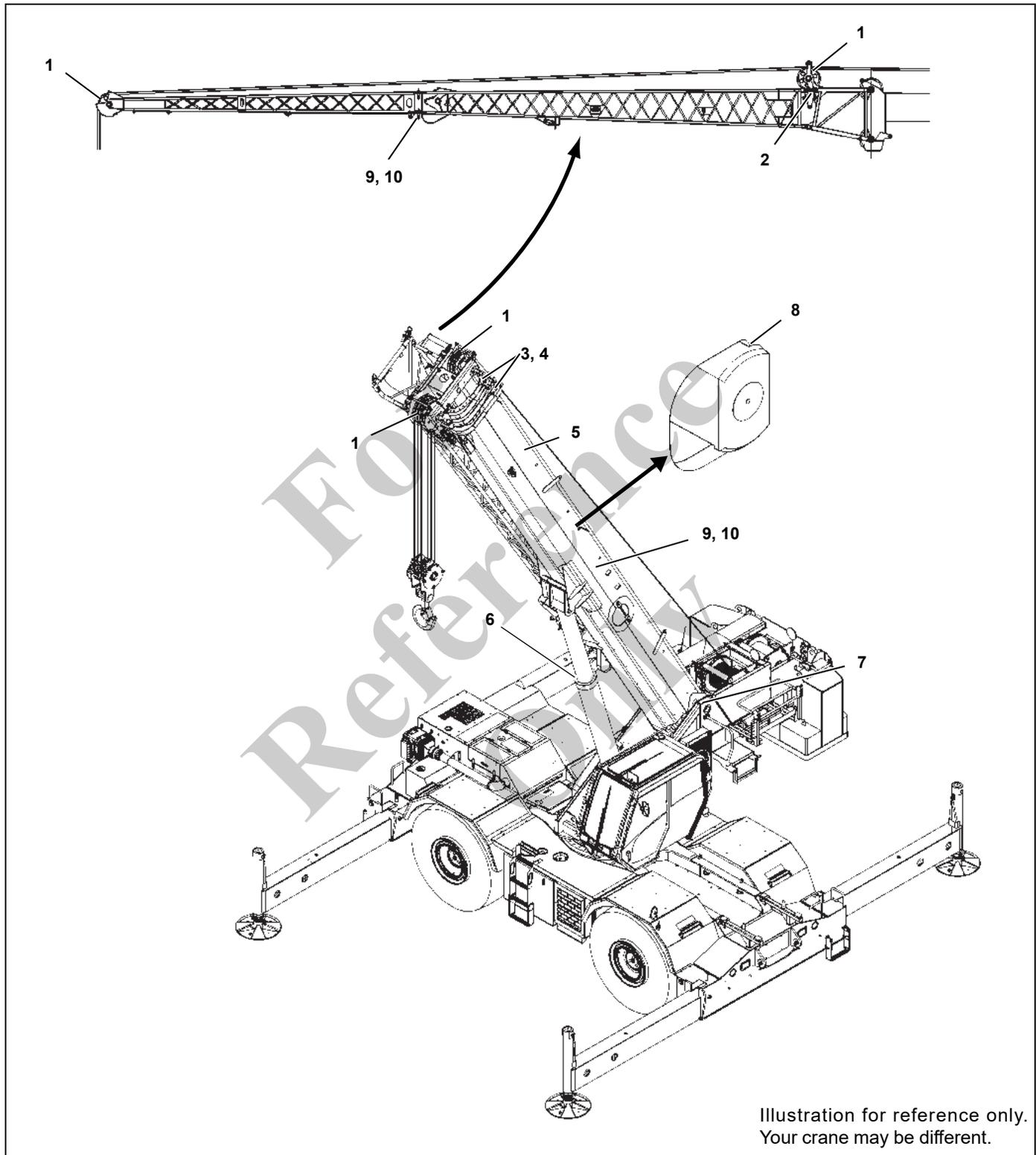
- Perform the inspections outlined in this publication for overloads up to 50%.
- Stop operating the crane and contact Grove Crane immediately for overloads of 50% and higher.

**NOTE:** If your crane is equipped with CraneSTAR, an overload warning will be posted to the web site for review by the crane owner.

Overload warnings do NOT indicate real time events! Warnings could be sent 24 hours (or more) after the actual event.

For Reference Only

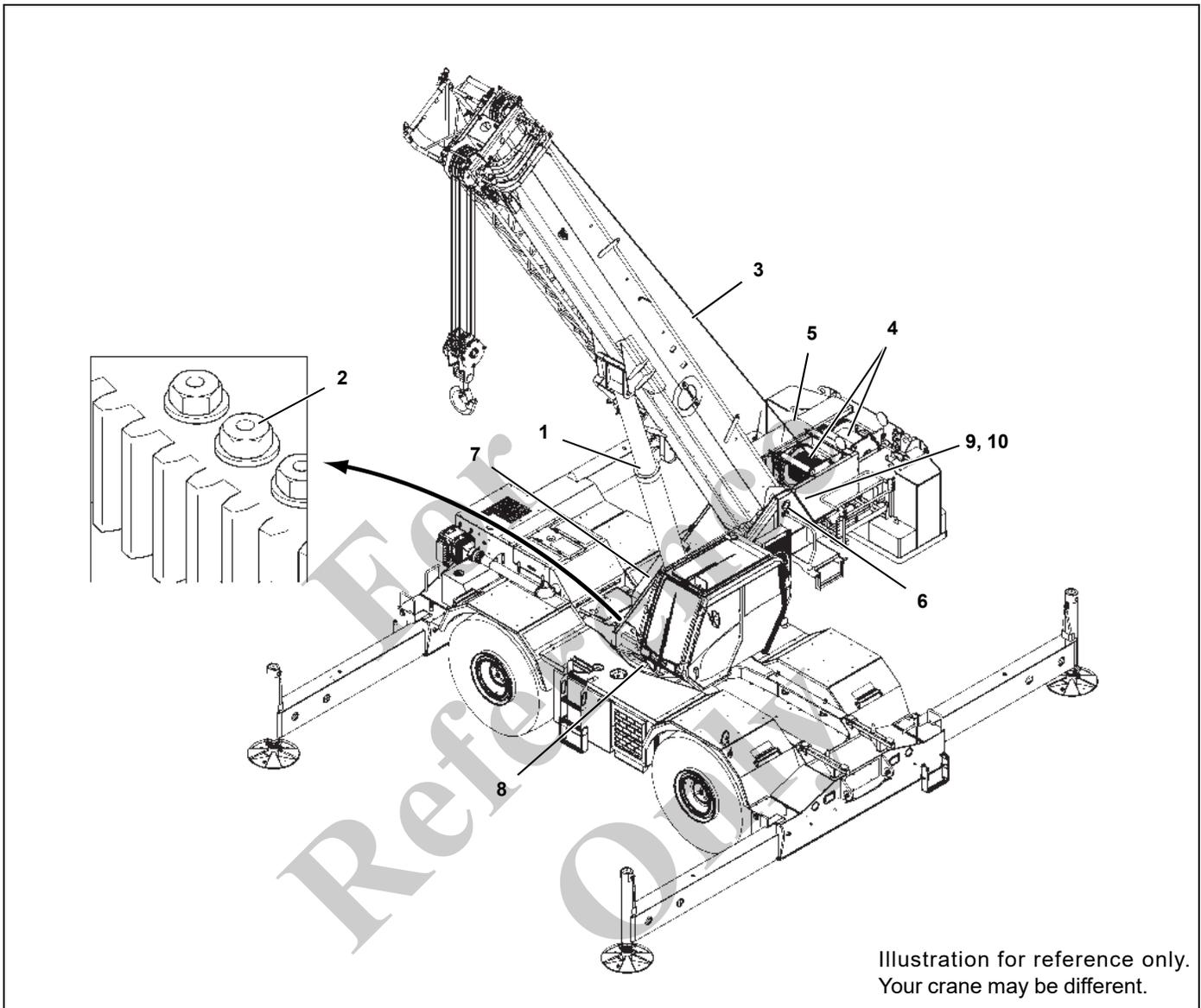
Boom Inspection



**NOTE:** The following checklist includes all features that can be found on Grove cranes. Your crane may not have some features.

<b>Overload less than 25%</b>			
1	Sheaves	Inspect all for damage.	
2	Boom Extension Offset Mechanism/ Cylinder	Inspect for damage/leaks.	
3	Collar-wear pads	Inspect all for damage.	
<b>Overload from 25% to 49%</b>			
1	Sheaves	Inspect all for damage.	
2	Luffing Mechanism/ Cylinder	Inspect for damage/leaks.	
3	Collar-wear pads	Inspect all for damage.	
4	Collar-welds	Inspect all for cracks.	
5	Telescopic Sections	Inspect for bent or twisted sections. Check the boom for straightness.	
6	Lift Cylinder Head Area	Inspect for bends or cracked welds.	
7	Turntable	Inspect for cracked welds.	
8	Locking Area (Pin Booms)	Inspect for elongated holes.	
9	Welds	Inspect for cracks.	
10	Paint	Inspect for cracked paint which could indicate twisted, stretched, or compressed members.	

Superstructure Inspection



**NOTE:** The following checklist includes all features that can be found on Grove cranes. Your crane may not have some features.

<b>Overload less than 25%</b>			
1	Lift Cylinder	Inspect for leaking.	
2	Turntable Bearing	Check bolts for proper torque.	See topic in Swing section of Service Manual.
3	Wire Rope	Inspect all for damage.	See topic in Introduction section of Service Manual.
<b>Overload from 25% to 49%</b>			
1	Lift Cylinder	Inspect for leaking.	
2	Turntable Bearing	Check bolts for proper torque.	See topic in Swing section of Service Manual.
3	Wire Rope	Inspect all for damage.	See topic in Introduction section of Service Manual.
4	Hoist/Drums	Inspect each for damage.	
5	Hoist Brakes	Brakes must hold rated line pull.	
6	Bearing Main Boom Pivot Pin	Inspect for deformation, cracked welds.	
7	Lift Cylinder-lower mount	Inspect pin and welds.	
8	Turntable	Inspect for deformation, cracked welds.	
9	Welds	Inspect for cracks.	
10	Paint	Inspect for cracked paint which could indicate twisted, stretched, or compressed members.	

Carrier Inspection

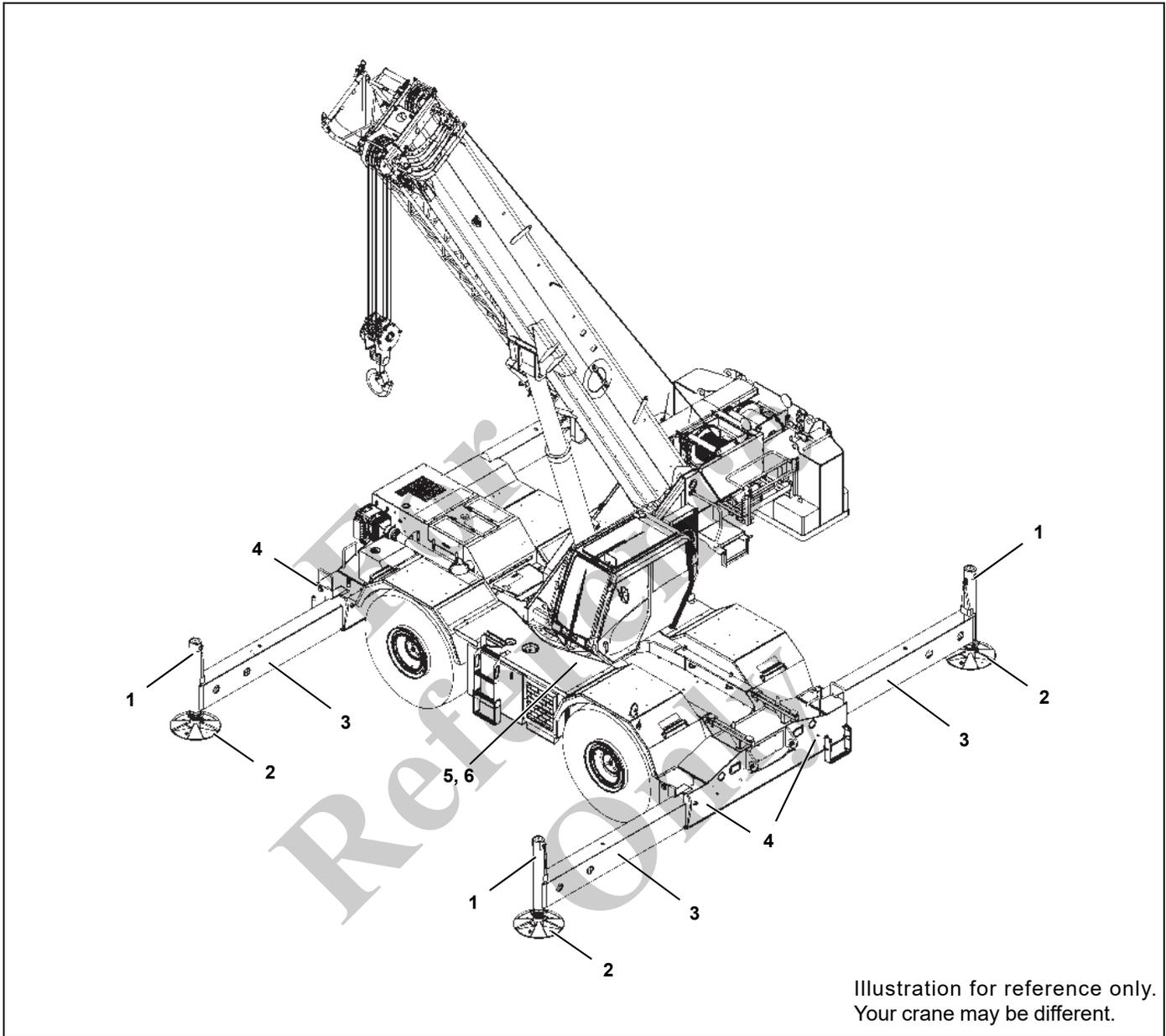


Illustration for reference only.  
Your crane may be different.

**NOTE:** The following checklist includes all features that can be found on Grove cranes. Your crane may not have some features.

<b>Overload less than 25%</b>			
1	Jack Cylinders	Inspect for leaking.	
2	Outrigger Pads	Inspect for deformation and/or cracked welds.	
<b>Overload from 25% to 49%</b>			
1	Jack Cylinders	Inspect for leaking.	
2	Outrigger Pads	Inspect for deformation and/or cracked welds.	
3	Outrigger Beams	Inspect for deformation and/or cracked welds.	
4	Outrigger Boxes	Inspect for deformation and/or cracked welds.	
5	Welds	Inspect for cracks.	
6	Paint	Inspect for cracked paint which could indicate twisted, stretched, or compressed members.	

Reference Only

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Only*

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## SECTION 3 OPERATING CONTROLS

### SECTION CONTENTS

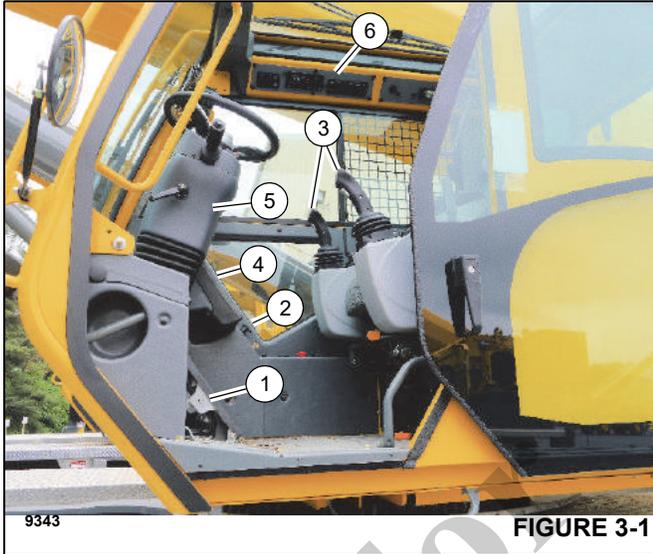
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<b>Overhead Control Panel</b> . . . . .	<b>3-6</b>	Seat Frame Slide Lever . . . . .	3-14
Skylight Wiper Switch . . . . .	3-6	Armrest Adjustment Buttons . . . . .	3-14
Heater/Air Conditioner Fan Speed Switch . . . . .	3-6	Seat Height Adjustment Lever . . . . .	3-14
Heater/Air Conditioner Temperature Control Switch . . . . .	3-6	Front Limit Bypass Switch (Non-CE Certified Cranes) . . . . .	3-14
Heater/Air Conditioner Switch . . . . .	3-6	Limit Bypass Set-Up Switch (CE Certified Cranes) . . . . .	3-15
Fresh Air/Recirculation Air Switch . . . . .	3-6	Emergency Stop Switch . . . . .	3-16
Cab Mounted Work Lights Switch . . . . .	3-6	Level Indicator . . . . .	3-16
Boom Mounted Work Lights Switch (Optional) . . . . .	3-6	Deadman Switches (Optional) (Dual Axis Controllers only) . . . . .	3-16
Crane Function Enable/Disable Switch . . . . .	3-6	Hoist Speed Toggle Switches . . . . .	3-16
Exhaust System Cleaning Switch (Tier 4 Engine Only) . . . . .	3-7	Horn Button . . . . .	3-16
Inhibit Exhaust System Cleaning . . . . .	3-7	Free Swing Button . . . . .	3-16
<b>Operator Display Module and Rated Capacity Limiter Display Module</b> . . . . .	<b>3-8</b>	Cab Door Release Lever . . . . .	3-16
Rated Capacity Limiter Display Module (RDM) . . . . .	3-8	Hoist Rotation Indicators (Not Shown) . . . . .	3-16
Operator Display Module (ODM) . . . . .	3-8	Seat Switch (Not Shown) . . . . .	3-16
Navigation Control Pad . . . . .	3-8	Main Hoist Controller (Single Axis Option) . . . . .	3-16
USB Connector . . . . .	3-9	Boom Lift Controller (Single Axis Option) . . . . .	3-16
RCL Shutdown Warning Indicator (Non-CE Certified Cranes) . . . . .	3-9	Telescope or Auxiliary Hoist Controller (Single Axis Option) . . . . .	3-18
RCL Shutdown Warning Indicator (CE Certified Cranes) . . . . .	3-9	Swing Controller (Single Axis Option) . . . . .	3-18
RCL Early Warning Indicator . . . . .	3-10	Hoist Rotation Indicators (Not Shown) . . . . .	3-18
Anti-Two-Block Indicator . . . . .	3-10	<b>Foot Pedal Controls</b> . . . . .	<b>3-18</b>
		360° Swing Lock Pedal . . . . .	3-18

360° Swing Lock Release Lever . . . . .	3-18	Bridging Switch and Indicator (CE Certified Cranes) . . . . .	3-20
Swing Brake Pedal . . . . .	3-18	RCL Internal Light Bar (Optional) . . . . .	3-21
Telescope Control Pedal . . . . .	3-19	RCL External Light Tower (Optional) . . . . .	3-21
Service Brake Pedal . . . . .	3-19	Strobe Light or Beacon (Optional) . . . . .	3-22
Foot Throttle Pedal . . . . .	3-19	Backup Alarm (Not Shown) . . . . .	3-22
<b>Miscellaneous Controls and Indicators . . . . .</b>	<b>3-19</b>	Emergency Exit . . . . .	3-22
Fuse and Relay Panels . . . . .	3-19	Turntable Swing Pin Lock Control . . . . .	3-22
Buzzer . . . . .	3-19	120V/220V Engine Block Heater and Outlet . . . . .	3-22
Rear Limit Bypass Switch (Non-CE Certified Cranes) . . . . .	3-19	Birdseye Camera (Optional) . . . . .	3-23

For  
Reference  
Only

**CONTROLS AND INDICATORS**

All controls and indicators to operate and monitor crane functions are found inside the crane cab (Figure 3-1).

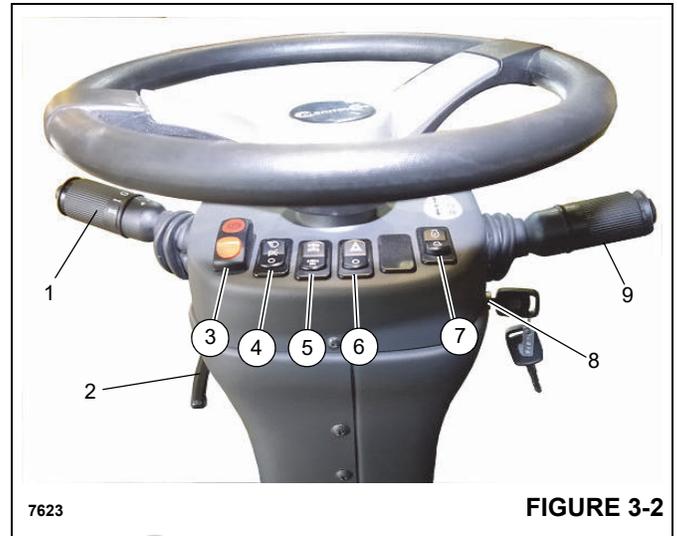


**FIGURE 3-1**

Item	Description
1	Foot Pedals
2	Turntable Swing Pin Lock Control
3	Seat Controllers and Armrest Controls
4	Operator Display Module (ODM) and Rated Capacity Limiter Display Module (RDM)
5	Steering Column
6	Overhead Control Panels

**Steering Column**

The steering column assembly (5, Figure 3-1) is a pedestal style tilt and telescoping steering column. It can tilt rearward 30° or raise vertically 60 mm (2.3 in). It includes the ignition switch and other control switches (Figure 3-2).



**FIGURE 3-2**

Item	Description
1	Turn Signal Lever and Windshield Wiper/Washer/Horn Controls
2	Steering Column Tilt and Telescope Lever
3	Park Brake Control Switch
4	Headlights Switch
5	Drive Axle Selector Switch
6	Hazard Lights Switch
7	Engine Speed Increment/Decrement Switch
8	Ignition Switch
9	Transmission Shift Lever

**Turn Signal Lever and Windshield Wiper/Washer/Headlight/Horn Controls**

Turn Signal Lever and Windshield Wiper/Washer Controls (1, Figure 3-2) are located on the left side of steering column. Pushing the turn signal lever down causes the left front and left rear turn signals to flash. Pushing the turn signal lever up causes the right front and right rear turn signals to flash.

The windshield wiper switch is built into the turn signal lever. The knob of the lever has four positions: J (interval wiping), O, I, and II. Pushing the knob inward energizes the windshield washer pump to spray washer fluid on the windshield. Turning the knob to position I causes the wiper to operate at low speed. Turning the knob to position II causes the wiper to operate at high speed. Turning the knob to position O turns the wiper motor off and automatically returns the wiper to its parked position. Turning the knob to position J causes the wiper to operate intermittently.

Pushing the small button on the end of the lever operates the horn.



## Steering Column Tilt and Telescope Lever

The steering control column can be rotated rearward approximately 30° and telescoped approximately 60 mm (2.3 in). Rotate control lever (2, Figure 3-2) clockwise to lock steering column in place. Rotating lever counterclockwise releases steering column for adjustment.

## Park Brake Control Switch

### CAUTION

#### Avoid Crane Damage!

Do not engage the parking brake while the vehicle is moving. Damage to the crane can occur.

Disengage the parking brake before driving. Damage to the crane can occur.

Park Brake Control Switch (3, Figure 3-2) is located on front of steering column. This two-position rocker switch (ON/OFF) is used to apply and release the parking brake on the drive line. The red Parking Brake Indicator (15, Figure 4-18 and Figure 4-19) on the display comes on (amber) when the brake is applied.

## Headlights Switch

The Headlights Switch (4, Figure 3-2) is located on the front of the steering column. This three-position rocker switch (OFF/Park/Headlight) controls operation of the instrument lights, switch LED's, and the marker lights on the front and rear of the crane. The switch is illuminated when the key is in the ON or Start position.

## Drive Axle Selector Switch

Drive Axle Selector Switch (5, Figure 3-2) is located on the front of the steering column and is illuminated when key is in the ON or Start position. This two-position rocker switch is used to select two-wheel drive (high range) or four-wheel drive (low range).

The switch controls a solenoid valve (energized for two-wheel drive) that operates speed range and axle disconnect cylinders on the transmission.

The drive axle can only be changed when gearshift is in Neutral and brake pedal is pressed.

The Four-Wheel Drive Indicator (19, Figure 4-18 and Figure 4-19) on the Operating Display Module (ODM) comes on (amber) when the crane is in four-wheel drive mode. If the Drive Axle Selector Switch position is changed while the engine is running, and the transmission is not in Neutral and the brake pedal is not pressed, the Four-Wheel Drive

Indicator will flash to indicate the shift from two-wheel drive to four-wheel drive, or four-wheel drive to two-wheel drive, did not occur.

## Hazard Lights Switch

Hazard Lights Switch (6, Figure 3-2) is located on front of the steering column and is a two-position rocker switch (ON/OFF). When switch is positioned ON, four turn signal lights and two turn signal indicator lights on steering column flash at the same time.

## Engine Speed Increment/Decrement Switch

The Engine Speed Increment/Decrement Switch (7, Figure 3-2) is a three position momentary rocker switch with center maintained position being off. Use this switch to adjust engine speed. Press top or bottom of the Increment/Decrement Switch to increase or decrease low engine idle.

Quickly press top of switch one time to go to full engine speed. Quickly press bottom of switch one time to return to low engine idle.

If engine speed is below maximum RPM setting, pressing and holding top of switch will cause engine RPM to slowly increase. Release switch at desired RPM.

If engine speed is above minimum RPM setting, pressing and holding bottom of switch will cause engine RPM to slowly decrease. Release switch at desired RPM.

## Ignition Switch

The Ignition Switch (8, Figure 3-2) is located on the right side of the steering column and under the transmission shift lever (9). The switch is key-operated and has three positions: 0 (OFF), I (RUN), and II (START).

In the OFF position, all electrical power is off except for lights controlled by the Headlights Switch, turn/hazard/stop lights, dome light and work light.

Positioning switch to RUN energizes all electrical components except for the start solenoid and engine ECM; the ignition circuit is also energized.

Positioning switch to START energizes the start relay, which in turn energizes the cranking motor solenoid and cranks the engine for starting. The switch is spring returned from START to RUN. To shut down engine, position switch to OFF.

The Ignition switch has a built-in mechanical anti-restart. If engine does not start after the first attempt, key switch must go to OFF position, then back to START to attempt starting the engine.

**Transmission Shift Lever**

**CAUTION**

**Transmission Damage!**

To prevent transmission damage: shift between two-wheel and four-wheel drive only with crane stopped and transmission in Neutral.

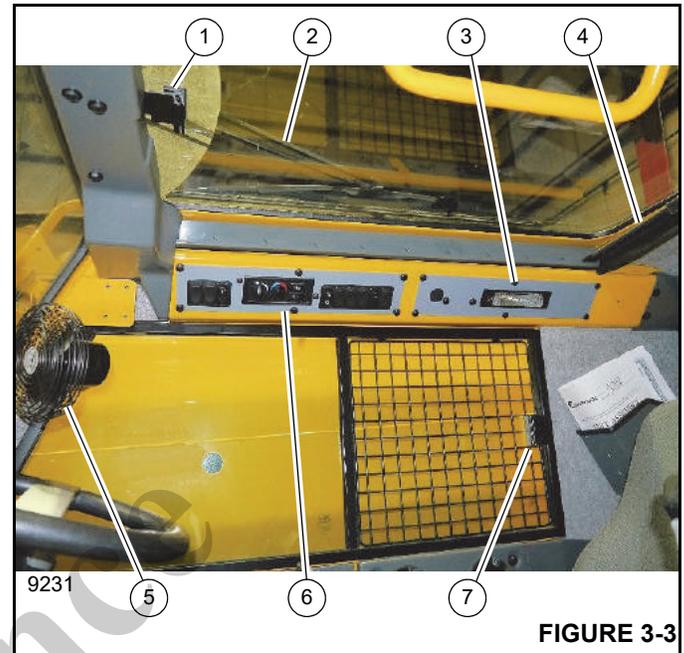
The Transmission Shift Lever (9, Figure 3-2) is located on the right side of the steering column. The control lever operates the transmission selector valve electrically. Positioning the lever up actuates forward and positioning the lever down actuates reverse. When the lever is in neutral, it rests in a detent. To move the lever up or down, pull up on the lever first. To shift the transmission to first, second, or third gear, rotate the knob to I, II, or III.

The Direction/Gear Indicator (11, Figure 4-18 and Figure 4-19) on the Operating Display Module (ODM) displays the chosen direction of travel and gear that the transmission is shifted to.

The transmission has six forward gears and six reverse gears. To use the three low gears, set Drive Axle switch to four-wheel drive. To use the three high gears, set Drive Axle switch to two-wheel drive.

**NOTE:** The transmission will not shift into forward or reverse gear without first pressing and holding the service brake foot pedal prior to moving the transmission shift lever from neutral (center position) to forward (up position) or reverse (down position). Refer to *Traveling — Forward*, page 4-19 and *Traveling — Reverse*, page 4-19 for more detailed information on shifting the transmission.

**CAB OVERHEAD CONTROLS**



**FIGURE 3-3**

Item	Description
1	Skylight Window Latch
2	Skylight Wiper
3	Cab Light
4	Skylight Sunscreen
5	Cab Circulating Fan
6	Overhead Control Panels
7	Right Side Window Latch

**Skylight Window Latch (Non-CE Certified Cranes)**

The Skylight Window Latch (1, Figure 3-3) is at the front of the window. Squeeze latch and slide window to the rear to open. To close, slide window forward until the latch engages.

**Skylight Wiper and Wiper Motor**

The Skylight Wiper (2, Figure 3-3) is controlled by the Skylight Wiper Switch (1, Figure 3-4) and operated by the Wiper Motor.

**Dome Light**

The cab Dome Light (3, Figure 3-3) is on the right rear corner of the cab overhead console and provides illumination in the cab. The dome light is controlled by a switch on the light.

### Skylight Sunscreen

The Skylight Sunscreen (4, Figure 3-3) reduces direct sunlight. The sunscreen is self retracting and can be set to screen all light or adjusted rearward by moving it to notches provided.

### Cab Circulating Fan

The Cab Circulating Fan (5, Figure 3-3) is located on left front side of cab above the window frame. A swivel allows the fan to be rotated and a switch on the fan base controls the fan. The switch has a high, low and off position.

### Right Side Window Latch

Window on the right side of the cab can be opened. Squeeze latch (7, Figure 3-3) to release and slide forward. To close, slide window rearward until latch engages.

## OVERHEAD CONTROL PANEL

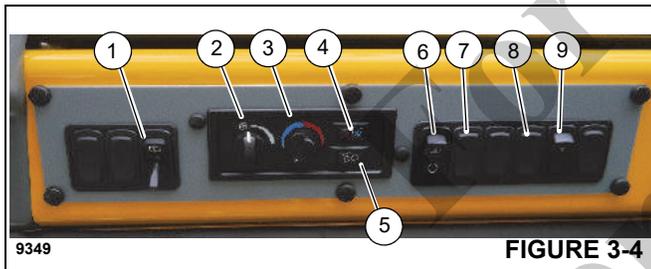


FIGURE 3-4

Item	Description
1	Skylight Wiper Switch
2	Heater/Air Conditioner Fan Speed Switch
3	Heater/Air Conditioning Temperature Control Switch
4	Heater/Air Conditioning Switch
5	Fresh Air/Recirculation Air Switch
6	Cab Mounted Work Lights Switch
7	Boom Mounted Work Lights Switch (Optional)
8	Crane Function Enable/Disable Switch
9	Exhaust System Cleaning Switch (Tier 4 engine only)

### Skylight Wiper Switch

The electrically-operated Skylight Wiper is installed to remove moisture from the skylight. The Skylight Wiper is controlled by the Skylight Wiper Switch (1, Figure 3-4). This switch has 6 speed settings.

### Heater/Air Conditioner Fan Speed Switch

The Heater/Air Conditioner Fan Speed Switch (2, Figure 3-4) controls cab fan speed and volume of heated or cooled air output. Settings are off, low speed, medium speed, and high speed.

### Heater/Air Conditioner Temperature Control Switch

The Heater/Air Conditioner Temperature Control Switch (3, Figure 3-4) controls heating temperature. Turn switch right (clockwise) to open valve for heat. (Heat comes from heated fluid going through the heater coil.) Turn switch left (counterclockwise) to close the valve, reduce fluid flow, and minimize heat.

### Heater/Air Conditioner Switch

The Heater/Air Conditioning Switch (4, Figure 3-4) is used to turn on either the heater or the air conditioner system. Pressing the left side of the switch turns on the heater system and pressing the right side of the switch turns on the air conditioner system.

### Fresh Air/Recirculation Air Switch

The Fresh Air/Recirculation Air Switch (5, Figure 3-4) controls whether outside air is drawn into the cab. Pressing the left side of the switch causes outside air to be drawn into the cab when operating the heater system or air conditioner system. Pressing the right side of the switch causes the air inside the cab to be recirculated, with no outside air being drawn into the cab.

### Cab Mounted Work Lights Switch

The Cab Mounted Work Lights Switch (6, Figure 3-4) controls the work lights mounted on the bottom front of the superstructure cab. Press top of switch to turn work lights on. Press bottom of switch to turn work lights off.

### Boom Mounted Work Lights Switch (Optional)

The Boom Mounted Work Lights Switch (7, Figure 3-4) controls the work lights mounted on the boom base section. Press top of switch to turn work lights on. Press bottom of switch to turn work lights off.

### Crane Function Enable/Disable Switch

The Crane Function Enable/Disable Switch (8, Figure 3-4) is located on the overhead control panel. This momentary switch permits the operator to enable all crane functions at once or disable all crane functions controlled by the controllers on the armrests. Pressing it one time enables all crane functions. Pressing it again disables all crane functions. Disable all crane functions to prevent inadvertent

operation of functions due to bumping the controllers while roading or any other operation.

## Exhaust System Cleaning Switch (Tier 4 Engine Only)



### WARNING

#### Burn/Fire Hazard!

During the cleaning process, the exhaust and tailpipe become very hot. Keep personnel and flammable objects away from the exhaust. Do not park vehicle near flammable objects.

The Exhaust System Cleaning Switch (9, Figure 3-4) is located on the right side of the overhead control panel. This is a three position switch: Initiate Manual Cleaning/Permit Active Cleaning/Inhibit Manual Cleaning.

The exhaust system cleaning process can take place in three different modes:

- **Passive:** Exhaust is hot enough during normal working operation to burn off any hydrocarbon (soot) accumulation
- **Active:** Active cleaning occurs when there is insufficient heat in the exhaust system to convert all the hydrocarbon being collected in the DPF. Exhaust temperatures are raised by injecting a small amount of

fuel. The resulting chemical reaction raises exhaust gas temperatures high enough to oxidize the hydrocarbon from the filter. This is done without operator intervention.

- **Manual:** Manual, or stationary cleaning is the same as active cleaning but takes place when equipment is not being operated. It allows the equipment operator to perform cleaning outside the normal duty cycle.

When required, press the top of the switch to start the manual cleaning process. Set the switch to the center position to let the active cleaning process occur when required. Press the bottom of the switch to inhibit (prevent) the cleaning process from occurring.

- Manual Cleaning  (7649-10)
- Inhibit Cleaning  (7649-11)

Refer to *Exhaust System Cleaning*, page 4-7 for information regarding how and when to clean the exhaust system.

### Inhibit Exhaust System Cleaning

The Inhibit Exhaust System Cleaning Indicator (31, Figure 4-18 and Figure 4-19) is located on the Operator Display Module (ODM). When the Cleaning Switch (9, Figure 3-4) is in the inhibit exhaust system cleaning position, this amber indicator is on and active and manual exhaust system cleaning is prevented.

Reference Only

### OPERATOR DISPLAY MODULE AND RATED CAPACITY LIMITER DISPLAY MODULE

The Rated Capacity Limiter Display Module (RDM) and the Operator Display Module (ODM) (Figure 3-5) are located to the right of the steering column.

Each module consists of a display screen, navigation control pad, warning indicators, a screen brightness sensor, and a USB diagnostic connector.

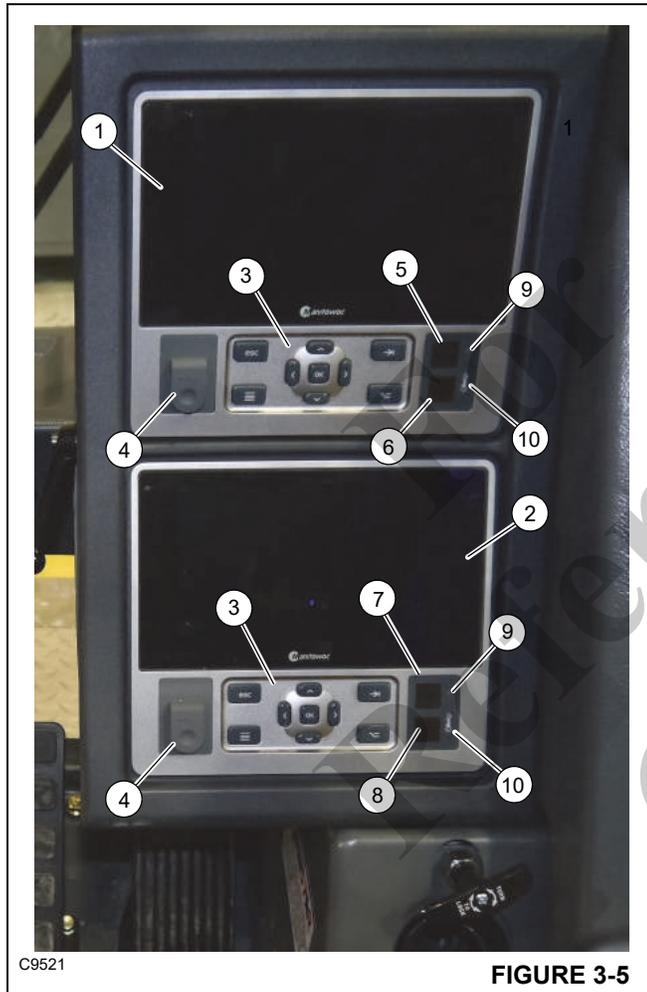


FIGURE 3-5

Item	Description
8	Swing Brake Engaged Indicator
9	Brightness Sensor
10	Internal Temperature Warning Indicator

#### Rated Capacity Limiter Display Module (RDM)

The Rated Capacity Limiter Display Module (RDM) (1, Figure 3-5) allows the operator to easily program the RCL by entering a code number from the Load Chart Manual or by following the RCL setup wizard.

Refer to *Using the Rated Capacity Limiter Display Module (RDM)*, page 4-93 for more information regarding the module's use in the operation of the crane.

#### Operator Display Module (ODM)

The Operator Display Module (ODM) (2, Figure 3-5) allows the operator to do the following:

- Monitor crane performance
- Extend/retract the outriggers
- Choose the different camera views to be displayed on the ODM Main Screen (if equipped with 3-View Camera option)
- Set the working range limits (WRL)
- Set the screen display brightness, units of measure (metric/imperial), and controller settings; and turn the ECO mode on/off
- View engine/transmission fault codes, crane fault codes, software versions installed, and hours of operation for each function

Refer to *Using the Operator Display Module (ODM)*, page 4-35 for more information regarding the module's use in the operation of the crane.

#### Navigation Control Pad

The Navigation Control Pads (3, Figure 3-5) on the Rated Capacity Limiter Display Module (RDM) and the Operator Display Module (ODM) allow the operator to navigate through the function screens for the related module. The control buttons on the two Navigation Control Pads are identical in configuration and perform the same functions.

The Tab Button (2, Figure 3-6) on the ODM's Navigation Control Pad can be pressed to temporarily silence active audible alarms.

Item	Description
1	Rated Capacity Limiter Display Module (RDM)
2	Operator Display Module (ODM)
3	Navigation Control Pad
4	USB Connector
5	RCL Shutdown Warning Indicator
6	RCL Early Warning Indicator
7	Anti Two-Block (A2B) Indicator

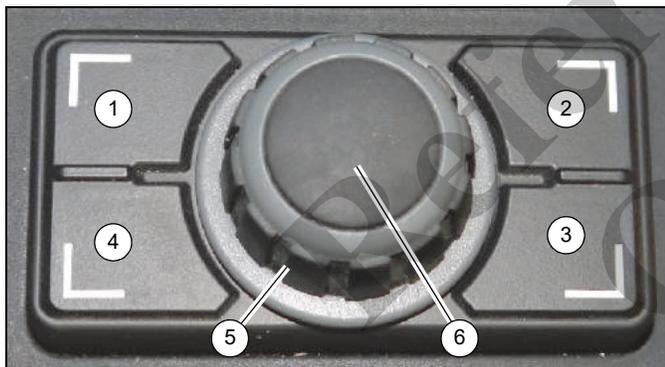


9221-1

Item	Description
1	Escape Button
2	Tab Button
3	Menu Button
4	Left/Right/Up/Down Arrow Buttons
5	OK Button

FIGURE 3-6

The Jog Dial (Figure 3-7), mounted on the right armrest (see *Jog Dial*, page 3-12), can be used to navigate the two modules in a similar manner as the Navigation Control Pads.



9221-2

Item	Description
1	Escape Button
2	Tab Button
3	Screen Toggle Button
4	Menu Button
5	Jog Dial (Rotate dial to move cursor)
6	OK Button (Press Jog Dial to select)

FIGURE 3-7

Refer to *Navigating the Operator Display Module and Rated Capacity Limiter Display Module*, page 4-34 for information on how the Navigational Controls Pads and Jog Dial are used in the operation of the crane.

### USB Connector

A USB Connector is provided (4, Figure 3-5) for the Rated Capacity Limiter Display Module (RDM) and the Operator Display Module (ODM). Each USB Connector is located immediately below and to the left of its related display module screen.

The USB Connector allows a service technician to connect to the display module and update its software or download the data logger, which records certain events that can occur when operating the crane.

### RCL Shutdown Warning Indicator (Non-CE Certified Cranes)

The RCL Shutdown Warning Indicator (5, Figure 3-5) is located immediately below and to the right of the Rated Capacity Limiter Display Module (RDM) screen.

The RCL Shutdown Warning Indicator comes on (red) when the RCL senses a lift that is greater than 100% of capacity for the programmed crane configuration. When the RCL senses a lift that is greater than 100% of capacity, the Crane Control System (CCS) will lockout the boom up/down, telescope extend, and hoist up crane functions, which would worsen the overload condition.

If the load is greater than 100% of capacity, overriding the crane function lockouts is accomplished using either the Limit Bypass Switch (*Front Limit Bypass Switch (Non-CE Certified Cranes)*, page 3-14) or the Limit Bypass Switch (*Rear Limit Bypass Switch (Non-CE Certified Cranes)*, page 3-19).

### RCL Shutdown Warning Indicator (CE Certified Cranes)

The RCL Shutdown Warning Indicator (5, Figure 3-5) is located immediately below and to the right of the Rated Capacity Limiter Display Module (RDM) screen.

The RCL Shutdown Warning Indicator comes on (red) when the RCL senses a lift that is between 100% to 110% of capacity for the programmed crane configuration. When the RCL senses a lift between 100% to 110% of capacity, the crane control system will lockout the boom up/down, telescope extend, and hoist up crane functions, which would worsen the overload condition.

If the load is between 100% to 110% of capacity, overriding the crane function lockouts is accomplished using the Limit Bypass Set-up Switch (refer to *Limit Bypass Set-Up Switch (CE Certified Cranes)*, page 3-15). If the load is greater than 110% of capacity, overriding the crane function lockouts is accomplished using the Limit Bypass Bridging Switch (refer to *Bridging Switch and Indicator (CE Certified Cranes)*, page 3-20).



### RCL Early Warning Indicator

The RCL Early Warning Indicator (6, Figure 3-5) is located immediately below and to the right of the Rated Capacity Limiter Display Module (RDM) screen.

The RCL Early Warning Indicator comes on (amber) when the RCL senses a lift that is between 90% to 100% of capacity for the programmed crane configuration.

### Anti-Two-Block Indicator

The Anti-Two-Block Indicator (7, Figure 3-5) is located immediately below and to the right of the Operator Display Module (ODM) screen.

The Anti-Two-Block Indicator comes on (red) when the anti-two-block system is triggered. When a two-block condition occurs, the crane control system will lock out the hoist up, boom down, and telescope out crane functions, which would worsen the two-block condition. The anti-two-block system locks out the system prior to a two-block condition occurring.

### Swing Brake Engaged Indicator

The Swing Brake Engaged Indicator (8, Figure 3-5) is located immediately below and to the right of the Operator Display Module (ODM) screen. The indicator comes on (amber) when the swing brake is applied and the indicator goes off when the swing brake is released.

The swing brake is automatically released when the swing controller is actuated and the swing brake is automatically applied when the superstructure stops rotating.

### Brightness Sensor

A Brightness Sensor (9, Figure 3-5) is located immediately below and to the right of the Rated Capacity Limiter Display Module (RDM) screen and the Operator Display Module (ODM) screen.

The Brightness Sensors sense the amount of light in the operator cab. As the amount of light inside the cab changes, the Rated Capacity Display Module screen and the Operator Display Module screen will brighten and darken automatically, making the screens easier for the operator to see.

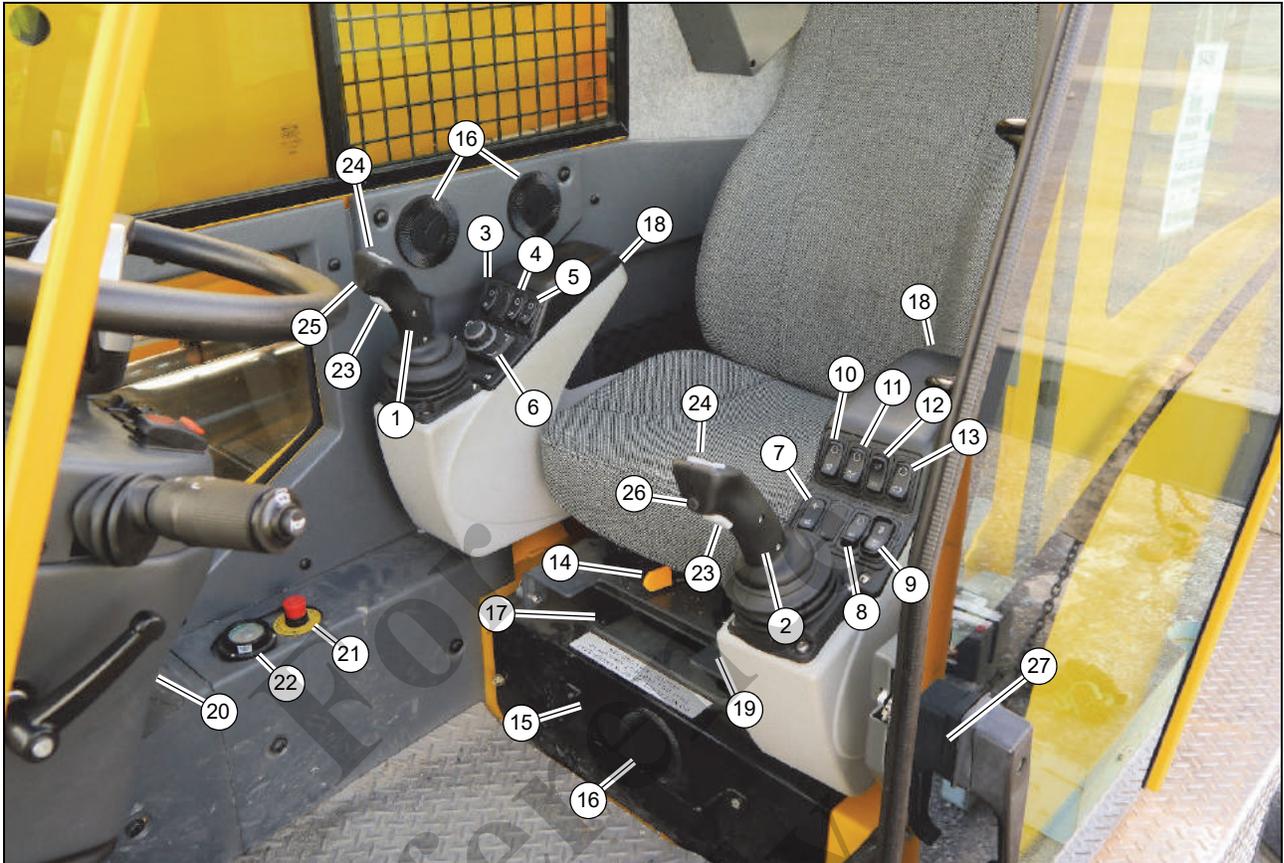
### Internal Temperature Warning Indicator

An Internal Temperature Warning Indicator (10, Figure 3-5) is located immediately below and to the right of the Rated Capacity Limiter Display Module (RDM) screen and the Operator Display Module (ODM) screen.

When the ignition key switch is turned to the I (RUN) position and the internal temperature of either the RDM or the ODM is below  $-30^{\circ}\text{C}$  ( $-22^{\circ}\text{F}$ ), the related module's Internal Temperature Warning Indicator will come on (blue) and the module's screen will remain blank. When the ignition key switch is turned to the I (RUN) position and the internal temperature of either the RDM or the ODM is above  $70^{\circ}\text{C}$  ( $158^{\circ}\text{F}$ ), the related module's Internal Temperature Warning Indicator will come on (red) and the module's screen will remain blank.

For the RDM and ODM screens to come on, their internal temperatures must be between  $-30^{\circ}\text{C}$  ( $-22^{\circ}\text{F}$ ) and  $70^{\circ}\text{C}$  ( $158^{\circ}\text{F}$ ).

CONTROL SEAT ASSEMBLY



9232

FIGURE 3-8

Item	Description	Item	Description
1	Boom Lift/Main Hoist Controller	16	AC/Heater Vents
2	Swing/Telescope or Swing/Auxiliary Hoist Controller	17	Seat Frame Slide Lever
3	Main Hoist Enable/Disable Switch	18	Armrest Adjustment Button (Underside)
4	Boom Up Bypass Switch	19	Seat Height Adjustment Lever
5	Boom Lift Enable/Disable Switch	20	Limit Bypass Switch - Keyed
6	Jog Dial	21	Emergency Stop Switch
7	Outrigger Extend/Retract Switch	22	Level Indicator
8	Differential Lock On/Off Switch (Optional)	23	Deadman Switches (Optional) (Dual Axis Controllers only)
9	Rear Steer Switch	24	Hoist Speed Toggle Switches
10	Auxiliary Hoist Enable/Disable Switch (Optional)	25	Horn Button
11	Boom Telescope Enable/Disable Switch	26	Free Swing Button
12	Cab Tilt Switch	27	Cab Door Release Lever
13	Swing Enable/Disable Switch	28	Hoist Rotation Indicators (Not Shown)
14	Seat Slide Lever	29	Seat Switch (Not Shown)
15	AC/Heater Climate Unit		

## Boom Lift/Main Hoist Controller (Dual Axis)

The Boom Lift/Main Hoist Controller (1, Figure 3-8) is located on the right armrest. Pushing the control lever to the right lowers the boom or pushing the controller to the left raises the boom.

When used for the main hoist, pushing the control lever forward lowers the hoist rope or pulling the controller rearward raises the hoist rope.

Moving the controller in a diagonal direction actuates the two functions simultaneously.

## Swing/Telescope or Swing/Auxiliary Hoist Controller (Dual Axis)

The Swing/Telescope or Swing/Auxiliary Hoist Controller (2, Figure 3-8) is located on the left armrest. The controller controls swing and telescope functions when crane is not equipped with an auxiliary hoist.

When equipped with an auxiliary hoist, the controller controls swing and auxiliary hoist functions. Telescope functions are then controlled through a foot pedal.

If not equipped with an auxiliary hoist, pushing the controller to the left or right provides 360 degree continuous rotation of the superstructure in the desired direction. Pushing the controller forward extends the boom and pulling the controller rearward retracts the boom.

If equipped with an auxiliary hoist, pushing the controller forward lowers the hoist rope and pulling the controller rearward raises the hoist rope.

Moving the controller in a diagonal direction actuates the two functions simultaneously.

## Main Hoist Enable/Disable Switch

The Main Hoist Enable/Disable Switch (3, Figure 3-8) is a momentary switch that is located on the right armrest. Pressing the switch one time enables the main hoist and pressing the switch again disables the main hoist. Pressing the switch twice rapidly enables the main hoist at high speed. Pressing and holding the switch for approximately 2 seconds also enables high speed.

The Main Hoist Enable/Disable Indicator (45, Figure 4-18 and Figure 4-19) on the Operating Display Module (ODM) comes on (green) when the main hoist function is enabled and it goes off when the main hoist function is disabled.

The Main Hoist High Speed Indicator (45, Figure 4-18 and Figure 4-19) on the Operating Display Module (ODM) comes on when the high speed function is enabled.

## Boom Up Bypass Switch

The Boom Up Bypass Switch (4, Figure 3-8) is a momentary two-position rocker switch that is located on the right

armrest. While lift function is enabled and in a RCL lock out condition, pressing and releasing the Boom Up Bypass Switch will enable boom lift up.

The following indicators come on to indicate the limiter is bypassed:

- Bypass 2 Pressed Indicator (3, Figure 4-90) is on constant (only when switch is pressed)
- RCL Bypass Active Indicator (2, Figure 4-90) is on constant
- RCL Shutdown Warning Indicator (5, Figure 3-5) is on constant when capacity is greater than 100%

For CE certified cranes only, the speed of the boom up function is reduced by 50% when actuated. For non-CE Certified cranes, the boom up function operates at normal speed when actuated.

The boom up function lock out is bypassed until one of the following occurs:

- Boom Up Bypass switch is again pressed and released while controllers are in neutral position
- Boom up controller is in neutral position for 10 seconds, and load is greater than 90% capacity and less than or equal to 100% capacity
- Load is reduced to less than 90% of capacity

## Boom Lift Enable/Disable Switch

The Boom Lift Enable/Disable Switch (5, Figure 3-8) is a momentary switch that is located on the right armrest. Pressing the switch one time enables boom up and boom down and pressing the switch again disables boom up and boom down.

The Boom Lift Enable/Disable Indicator (44, Figure 4-18 and Figure 4-19) on the Operating Display Module (ODM) comes on (green) when the boom lift function is enabled and it goes off when the boom lift function is disabled.

## Jog Dial

The Jog Dial (6, Figure 3-8) is located on the right armrest. It is used to select and perform functions through the Operator Display Module (ODM) and the Rated Capacity Display Module (RCM). (Refer to *Navigating the Operator Display Module and Rated Capacity Limiter Display Module*, page 4-34 for more information on its operation).

## Outrigger Extend/Retract Switch

The Outrigger Extend/Retract Switch (7, Figure 3-8) allows the operator to extend and retract the outrigger beams and jacks. The switch is used in combination with the Outrigger Group screen on the Operator Display Module (ODM) to deploy and stow the outriggers (refer to *Outrigger Group*, page 4-55).

When the Operator Display Module (ODM) is set to the Outrigger Group screen, the outrigger beams or jacks are extended by pressing and holding any or all of the four buttons at the Jog Dial or Navigation Control Pad while, at the same time, pressing and holding the front of the Outrigger Extend/Retract Switch switch

The outrigger beams or jacks are retracted by pressing and holding any or all of the four buttons at the Jog Dial or Navigation Control Pad while, at the same time, pressing and holding the rear of the Outrigger Extend/Retract Switch switch

**NOTE:** Pressing and holding the switch will change the ODM screen display to the Outrigger Group screen.

### Differential Lock On/Off Switch (Optional)

The Differential Lock Switch (8, Figure 3-8) is located on the left armrest. It engages the differential lock function for additional traction when Four Wheel Drive is selected. It can be activated for a maximum of 30 seconds at a time.

**NOTE:** Differential lock only operates when the crane is in 4WD mode.

When the differential lock is engaged, the Differential Lock Indicator (20, Figure 4-18 and Figure 4-19) on the Operating Display Module (ODM) comes on (amber).

Pressing and holding the Differential Lock Switch engages the differential lock. Releasing the switch disengages the differential lock. Refer to *Differential Lock Operation (Optional)*, page 4-21 for information on how and when to actuate the differential lock.

### Rear Steer Switch

The Rear Steer Control Switch (9, Figure 3-8) is a three-position, spring centered to off, rocker switch, located on the left armrest. Pressing and holding the rear of the switch turns the rear wheels to the left, causing the crane to turn to the right. Pressing and holding the front of the switch turns the rear wheels to the right, causing the crane to turn to the left. Releasing the switch causes the switch to return to the center off position.

When the rear wheels are not centered, the Rear Wheels Not Centered Indicator (18, Figure 4-18 and Figure 4-19) on the Operating Display Module (ODM) comes on (amber).

If the rear wheels are turned to the left, straighten the rear wheels by pressing the front of the switch (turns the wheels right) until the Rear Wheels Not Centered Indicator goes off. If the rear wheels are turned to the right, straighten the rear wheels by pressing the rear of the switch (turns the wheels left) until the Rear Wheels Not Centered Indicator goes off.

### Auxiliary Hoist Enable/Disable Switch

The Auxiliary Hoist Enable/Disable Switch (10, Figure 3-8) is a momentary switch that is located on the left armrest.

Pressing the switch one time enables the auxiliary hoist and pressing the switch again disables the auxiliary hoist. Pressing the switch twice rapidly enables the auxiliary hoist at high speed. Pressing and holding the switch for approximately 2 seconds also enables high speed.

The Auxiliary Hoist Enable/Disable Indicator (46, Figure 4-18 and Figure 4-19) on the Operating Display Module (ODM) comes on (green) when the auxiliary hoist function is enabled and it goes off when the auxiliary hoist function is disabled.

The Auxiliary Hoist High Speed Indicator (46, Figure 4-18 and Figure 4-19) on the Operating Display Module (ODM) comes on when the high speed function is enabled.

### Boom Telescope Enable/Disable Switch

The Boom Telescope Enable/Disable Switch (11, Figure 3-8) is a momentary switch that is located on the left armrest. Pressing the switch one time enables the boom telescope function and pressing the switch again disables the boom telescope function.

The Telescope Enable/Disable Indicator (43, Figure 4-18 and Figure 4-19) on the Operating Display Module (ODM) comes on (green) when the telescope function is enabled and it goes off when the telescope function is disabled.

### Cab Tilt Switch

The Cab Tilt Switch (12, Figure 3-8) is located on the left armrest. It is a three-position, spring center to off, rocker switch which is used to position the cab upward for easy viewing of an elevated boom and load. Pressing the rear of the switch tilts the cab upward and pressing the front of the switch tilts the cab downward.

When the cab is tilted upward, the Cab Not Fully Lowered Indicator (33, Figure 4-18 and Figure 4-19) on the Operating Display Module (ODM) comes on (amber).

**NOTE:** The cab must be in the fully lowered position for drive functions to be enabled.

### Swing Enable/Disable Switch

The Swing Enable/Disable Switch (13, Figure 3-8) is a momentary switch that is located on the left armrest. Pressing the switch one time enables the swing function and pressing the switch again disables the swing function.

The Swing Enable/Disable Indicator (42, Figure 4-18 and Figure 4-19) on the Operating Display Module (ODM) comes on (green) when the swing function is enabled and it goes off when the swing function is disabled.

## Seat Slide Lever

Pushing the Seat Slide Lever (14, Figure 3-8) to the left and holding allows the seat to be moved forward or backward relative to the armrests. Release the lever when the seat is in the desired position.

## Air Conditioner/Heater Climate Unit

The crane cab Air Conditioner/Heater Climate Unit (15, Figure 3-8) is located in the cab under the operator's seat. The vents (16) are part of the climate unit and can be adjusted to direct the flow of air.

## Seat Frame Slide Lever

Pushing the Seat Frame Slide Lever (17, Figure 3-8) to the left and holding allows the seat and armrests to be moved forward or backward. Release the lever when the seat and armrest are in the desired position.

## Armrest Adjustment Buttons

Left and right armrest and armrest controls can be adjusted using the adjustment buttons (18, Figure 3-8) found under the rear of the armrest. Press the button to allow the entire armrest to rotate; release button at the desired position.

## Seat Height Adjustment Lever

To adjust seat height relative to the armrests, lift height adjustment lever (19, Figure 3-8) and adjust seat as needed. The fore-to-aft incline of the seat can also be adjusted using the adjustment lever.

## Front Limit Bypass Switch (Non-CE Certified Cranes)



### WARNING

#### Overload Hazard!

The Limit Bypass Switch is used to override the RCL system during some rigging activities.

When the Limit Bypass Switch is activated, the operator must make sure that the crane is not overloaded.

Do not operate the crane with the RCL overridden during normal operations.

The Rated Capacity Limiter (RCL) system, when programmed accurately, will lock out the following crane functions—boom up/down, telescope extend, and hoist up—when a lift is attempted at or above the crane's capacity, or when a two-block condition exists. Locking out these functions prevents the overload or two-block condition from worsening. These same crane functions are locked out

initially when starting the crane and before the RCL system has been programmed.

The Front Limit Bypass Switch (20, Figure 3-8) is a three-position, momentary type key switch located on the lower right console. During certain rigging work or to recover the crane, turn the switch clockwise or counterclockwise and hold to bypass the following limiter systems on the crane.

Turning the key switch clockwise and holding bypasses the following limiter systems and their crane function lock outs:

- Anti Two-Block System (boom up/down, telescope extend, hoist up)
- Third Wrap Limiter System (hoist down)

The following indicators come on to indicate the limiters are bypassed:

- Anti Two-Block Indicator is flashing (7, Figure 3-5)
- Third Wrap Indicator is flashing (29, Figure 4-18 and Figure 4-19)

Turning the key switch counterclockwise and holding bypasses the following limiter systems and their crane function lock outs:

- RCL System (boom up/down, telescope extend, hoist up)
- Anti Two Block System (boom up/down, telescope extend, hoist up)
- Third Wrap Limiter System (hoist down)
- Working Range Limiter (WRL) System
- Carrier Avoidance System
- -29°C Temperature Limiter System (optional)

The following indicators come on to indicate the limiters are bypassed:

- Bypass 1 Pressed Indicator is on (3, Figure 4-90)
- RCL Bypass Active Indicator is on (2, Figure 4-90)
- RCL Bypass Status Indicator is on (1, Figure 4-90)
- RCL Shutdown Warning Indicator is flashing (5, Figure 3-5)
- Anti Two-Block indicator is flashing (7, Figure 3-5)
- Third Wrap indicator is flashing (29, Figure 4-18 and Figure 4-19)
- Working Range Limiter (WRL) indicator is flashing (35, Figure 4-18 and Figure 4-19)
- Low Boom Angle Indicator is flashing (27, Figure 4-18 and Figure 4-19)
- -29°C Temperature Limiter Indicator is flashing (21, Figure 4-18 and Figure 4-19)

All crane function lock outs are bypassed while the Limit Bypass switch is held in the actuated position.

### Limit Bypass Set-Up Switch (CE Certified Cranes)



#### WARNING

##### Overload Hazard!

The Limit Bypass Switch prevents the function lock outs from activating.

When the Lift Bypass Switch is activated, the operator must make sure that the crane is not overloaded.

Do not operate the crane with the RCL overridden during normal operations.

The Rated Capacity Limiter (RCL) system, when programmed accurately, will lock out the following crane functions—boom up/down, telescope extend, and hoist up—when a lift is attempted at or above the crane's capacity, or when a two-block condition exists. Locking out these functions prevents the overload or two-block condition from worsening. These same craning functions are locked out initially when starting the crane and before the RCL system has been programmed.

The Limit Bypass Set-up Switch (20, Figure 3-8) is a three-position, momentary type key switch located on the lower right console. During certain rigging work or a to recover the crane, turn the switch clockwise or counterclockwise to bypass the following limiter systems on the crane.

Turning the key switch clockwise and releasing bypasses the following limiter systems and their crane function lock outs:

- Anti Two-Block System (boom up/down, telescope out, hoist up)
- Third Wrap Limiter System (hoist down)

The following indicators come on to indicate the limiters are bypassed:

- Anti Two-Block Indicator is flashing (7, Figure 3-5)
- Third Wrap Indicator is flashing (29, Figure 4-18 and Figure 4-19)

When the switch is turned clockwise and released, all crane functions—boom up/down, telescope out/in, hoist up/down, and swing left/right—will operate at 50% of their normal speeds when actuated.

Turning the key switch counterclockwise and releasing bypasses the following limiter systems and their crane function lock outs:

- RCL System (boom up/down, telescope out, hoist up)
- Working Range Limiter (WRL) system
- Carrier Avoidance System

If the RCL is programmed and active and the limit bypass switch is turned counterclockwise and released, the swing left/right function pressure is reduced to 25% and the boom up/down, hoist up/down, and telescope extend/retract function speeds are reduced to 15% when actuated. If the load exceeds 110% of the crane's capacity, all craning functions will lock out. The following indicators come on to indicate the limiters are bypassed:

- Bypass 1 Pressed Indicator is on (only when in the counterclockwise position) (3, Figure 4-90)
- RCL Bypass Active Indicator is on (2, Figure 4-90)
- RCL Bypass Status Indicator is on (1, Figure 4-90)
- RCL Shutdown Warning Indicator is flashing (5, Figure 3-5)
- Working Range Limiter (WRL) indicator is on (35, Figure 4-18 and Figure 4-19)
- Low Boom Angle Indicator is flashing (27, Figure 4-18 and Figure 4-19)

If the RCL has not been programmed and the limit bypass switch is turned counterclockwise and released, the swing left/right, boom up/down, hoist up/down, and telescope extend/retract functions operate at normal speeds when actuated. The following indicators come on to indicate the limiters are bypassed:

- Bypass 1 Pressed Indicator is on (only when in the counterclockwise position) (3, Figure 4-90)
- RCL Bypass Active Indicator is on (2, Figure 4-90)
- RCL Bypass Status Indicator is on (1, Figure 4-90)
- RCL Shutdown Warning Indicator is on and flashing (5, Figure 3-5)
- Working Range Limiter (WRL) indicator is on (35, Figure 4-18 and Figure 4-19)
- Low Boom Angle Indicator is flashing (27, Figure 4-18 and Figure 4-19)

All craning functions locked out are bypassed until one of the following occurs:

- Limit Bypass Switch is again turned to the counterclockwise position and released while the controllers are in the neutral position
- Controllers are in the neutral position for 10 seconds

## Emergency Stop Switch

The crane Emergency Stop Switch (21, Figure 3-8) is located on the lower right console and is used to shut down the crane's engine. Pushing the red button stops the engine and causes the Emergency Stop Indicator (16, Figure 4-18 and Figure 4-19) on the Operator Display Module (ODM) to come on (red). Rotate and pull out knob to resume normal operation.

## Level Indicator

The Level Indicator (22, Figure 3-8) is located on the lower right console near the Emergency Stop Switch. The indicator provides the operator with a visual aid in determining the levelness of the crane.

## Deadman Switches (Optional) (Dual Axis Controllers only)

Deadman Switches (23, Figure 3-8) are located on the front of both controllers. Either of these switches can be used instead of the seat switch to keep crane functions active.

## Hoist Speed Toggle Switches

The Hoist Speed Toggle Switches (24, Figure 3-8) are thumb operated three-position center spring return switches. Push and hold switch closest to the operator to change hoist speed to high – release switch to return hoist speed to normal. Push and release switch farthest from the operator to change hoist speed to high – push and release switch again to return hoist speed to normal.

## Horn Button

The Horn Button (25, Figure 3-8) is located on the upper front of the right controller. The button sounds the horn during crane operations.

## Free Swing Button

The Free Swing Button (26, Figure 3-8) is located on the upper front of the left controller. Pressing and holding the

Free Swing Button releases the Swing Brake and allows the boom to be centered over the load.

## Cab Door Release Lever

Use the Cab Door Release Lever (27, Figure 3-8) to open and close the cab door from inside the cab.

## Hoist Rotation Indicators (Not Shown)

Hoist Rotation Indicators (28, Figure 3-8) for auxiliary and main hoists are located at mid-stick, facing the operator on each dual-axis hoist controller (1, 2, Figure 3-8). Each indicator is electronically driven by an input signal from a sensor attached to its related hoist and an output signal from a control module. Each hoist controller (1, 2) pulses when its hoist is running so the operator's thumb can sense it.

## Seat Switch (Not Shown)

This switch (29, Figure 3-8) is located within the seat. An operator must be sitting in the seat, enabling the switch, before any crane functions can be activated.

Optional Deadman Switches are available on cranes equipped with Dual Axis Controllers [*Deadman Switches (Optional) (Dual Axis Controllers only)*, page 3-16]. Pressing a Deadman Switch allows the crane functions to remain active when the operator is not sitting in the seat.

## Main Hoist Controller (Single Axis Option)

The Main Hoist Controller (1, Figure 3-9) is located on the right armrest. Pushing the controller forward lowers the hoist rope and pulling the controller rearward raises the hoist rope.

## Boom Lift Controller (Single Axis Option)

The Boom Lift Controller (2, Figure 3-9) is located on the right armrest. Pushing the controller forward lowers the boom and pulling the controller rearward raises the boom.

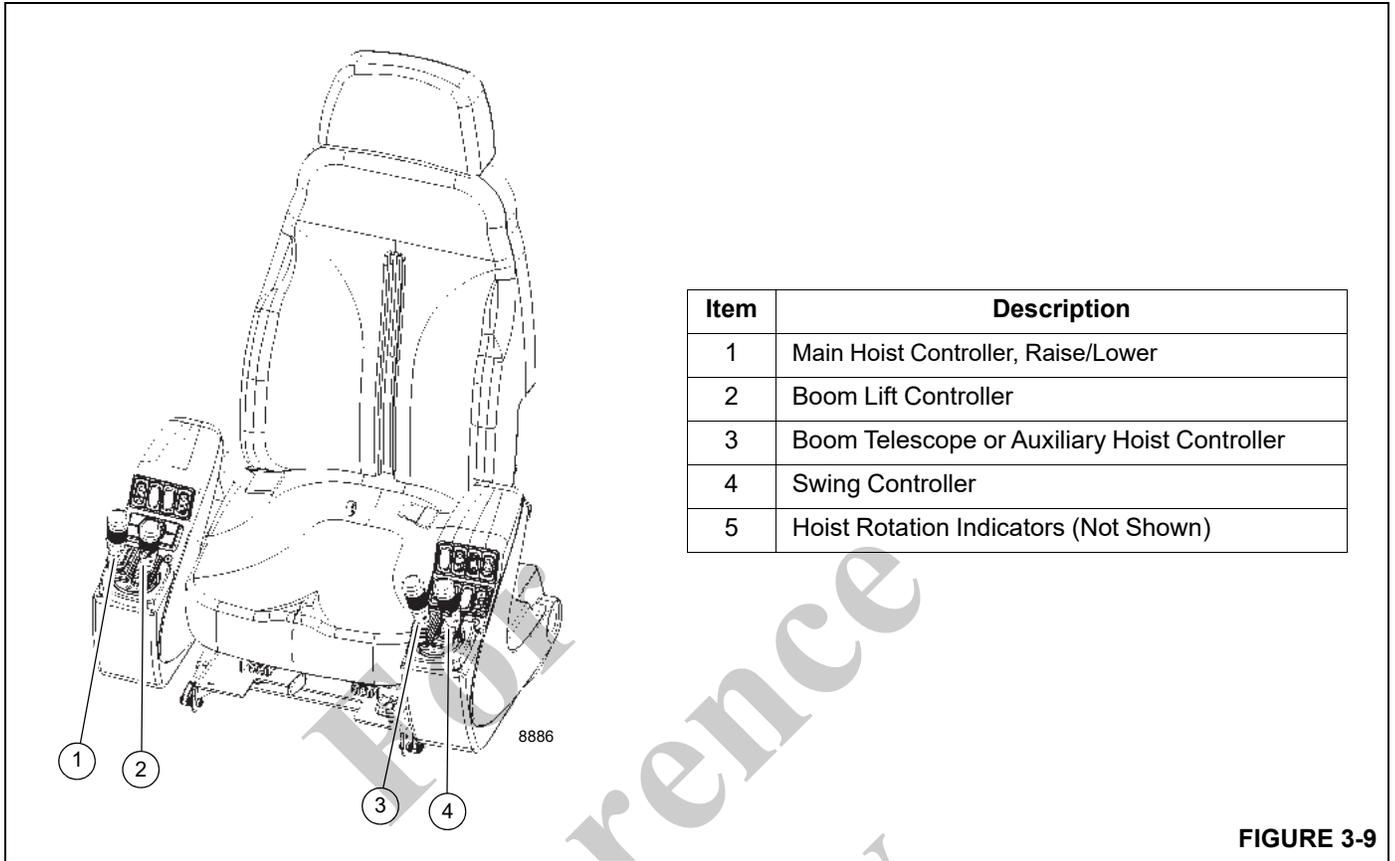


FIGURE 3-9

Reference Only

### Telescope or Auxiliary Hoist Controller (Single Axis Option)

The Telescope or Auxiliary Hoist (Tele or Aux) Controller (3, Figure 3-9) 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 extends the boom and pulling the controller rearward retracts the boom in.

When equipped with an auxiliary hoist, the controller controls auxiliary hoist functions and telescope functions are controlled through a foot pedal. Pushing the controller forward lowers the hoist rope and pulling the controller rearward raises the hoist rope.

### Swing Controller (Single Axis Option)

The Swing Control Lever (4, Figure 3-9) is located on the right armrest. Pushing the controller forward rotates the superstructure clockwise and pulling the controller rearward rotates the superstructure counterclockwise. The superstructure can be continuously rotated 360° in the desired direction.

### Hoist Rotation Indicators (Not Shown)

Hoist Rotation Indicators (5, Figure 3-9) for auxiliary and main hoists are located on top of each single-axis hoist controller (1, 3, Figure 3-9). Each indicator is electronically driven by an input signal from a sensor attached to its related hoist and an output signal from a control module. Each hoist controller (1, 3) pulses when its hoist is running so the operator's thumb can sense it.

### FOOT PEDAL CONTROLS

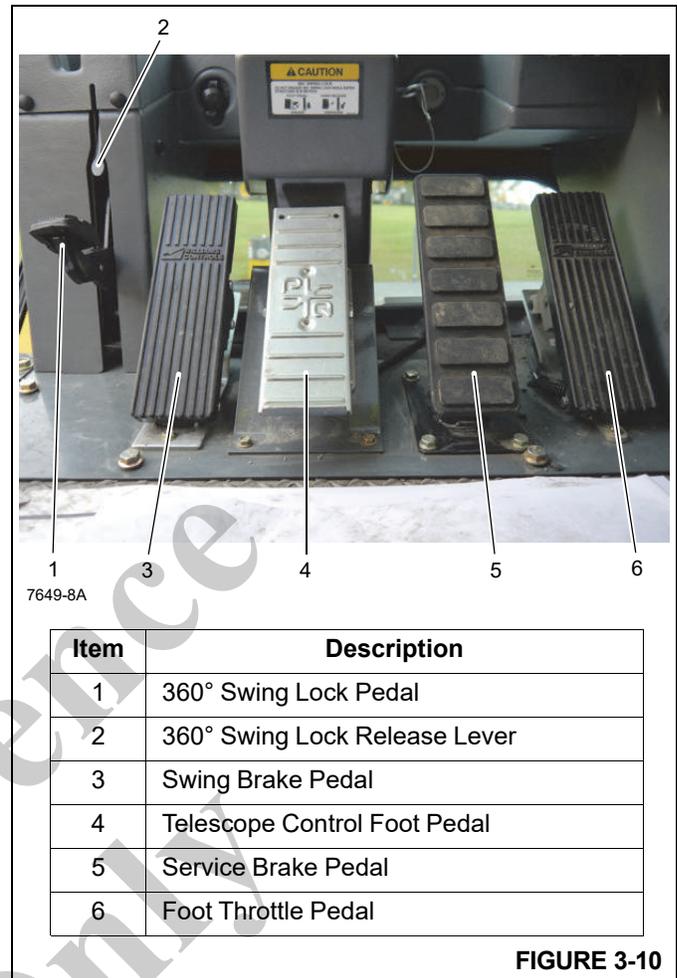


FIGURE 3-10

#### 360° Swing Lock Pedal

The 360° Swing Lock Pedal (1, Figure 3-10) is located on the left side of the cab floor. The pedal activates the swing lock to prevent superstructure from turning.

#### 360° Swing Lock Release Lever

The 360° Swing Lock Release Lever (2, Figure 3-10) is located on the left side of the cab floor, directly above the 360° Swing Lock Pedal (1). Lifting up on the lever releases the 360° swing lock.

#### Swing Brake Pedal

The Swing Brake Pedal (3, Figure 3-10) is located on the left side of the cab floor. It actuates the swing brake to slow or stop swing motion. Braking increases or decreases proportionately with the amount of foot pressure applied to the pedal.

## Telescope Control Pedal

The Telescope Control Pedal (4, Figure 3-10) is located in the middle of the cab floor. Pushing the top of the pedal extends the boom and pushing the bottom of the pedal retracts the boom.

## Service Brake Pedal

The Service Brake Pedal (5, Figure 3-10) is the second pedal from the right on the cab floor. Pressing the pedal applies the service brakes. Braking increases or decreases proportionately with the amount of foot pressure applied to the pedal.

## Foot Throttle Pedal

The Foot Throttle Pedal (6, Figure 3-10) is located on the right side of the floor. It controls engine speed which increases or decreases proportionately with the amount of foot pressure applied to the pedal.

## MISCELLANEOUS CONTROLS AND INDICATORS

### Fuse and Relay Panels

The fuse panel (1, Figure 3-11) is located behind the cab seat on the cab fuse and relay panel assembly.

### Buzzer

The buzzer in the display sounds when the following conditions exist:

- Engine alarms
- Emergency Stop Switch activated
- Low brake pressure
- High hydraulic oil temperature
- High transmission oil temperature
- Low steer pressure condition (CE Certified cranes)
- Hoist minimum wrap condition (Optional — Standard on CE Certified cranes)
- Anti-two-Block alarm

## Rear Limit Bypass Switch (Non-CE Certified Cranes)

### **WARNING** Overload Hazard!

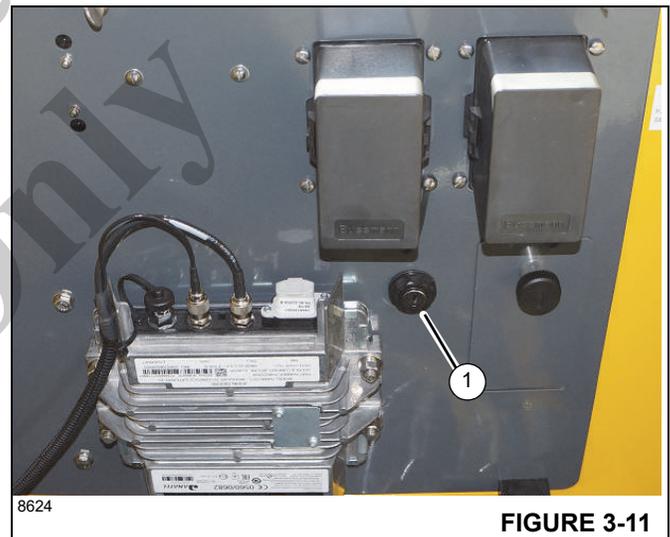
The Limit Bypass Switch prevents the function lock outs from activating.

When the Limit Bypass Switch is activated, the operator must make sure that the crane is not overloaded.

Do not operate the crane with the RCL overridden during normal operations.

The Rated Capacity Limiter (RCL) system, when programmed accurately, will lock out the following crane functions—boom up/down, telescope extend, and hoist up—when a lift is attempted at or above the crane's capacity, or when a two-block condition exists. Locking out these functions prevents the overload or two-block condition from worsening.

The Rear Limit Bypass Switch (1, Figure 3-11) is a two-position, maintained type key switch located behind the operator seat.



During maintenance or troubleshooting work, or to recover the crane, turning the switch clockwise bypasses the following limiter systems and their crane function lock outs:

- RCL System (boom up/down, telescope extend, hoist up)
- Anti Two-Block System (boom up/down, telescope extend, hoist up)
- Third Wrap Limiter System (hoist down)
- Working Range Limiter (WRL) System

- Carrier Avoidance System
- -29°C Temperature Limiter System (optional)

The following indicators come on to indicate the limiters are bypassed:

- Bypass 3 Pressed Indicator is on (3, Figure 4-90)
- RCL Bypass Active Indicator is on (2, Figure 4-90)
- RCL Bypass Status Indicator is on (1, Figure 4-90)
- RCL Shutdown Warning Indicator is flashing (5, Figure 3-5)
- Anti-two-block Indicator is flashing (7, Figure 3-5)
- Third Wrap Indicator is flashing (29, Figure 4-18 and Figure 4-19)
- Working Range Limiter (WRL) Indicator is flashing (35, Figure 4-18 and Figure 4-19)
- Low Boom Angle Indicator is flashing (27, Figure 4-18 and Figure 4-19)
- -29°C Temperature Limiter Indicator is flashing (21, Figure 4-18 and Figure 4-19)

All craning functions locked out are bypassed while the key switch is in the clockwise position.

Overriding the RCL with this switch should only be done by a qualified operator or technician.

**NOTE:** Before powering up the crane, make sure the RCL Override Switch is in the Normal (not Override) position to prevent an error code.

### Bridging Switch and Indicator (CE Certified Cranes)

#### **WARNING** **Overload Hazard!**

The Bridging Switch prevents the function lock outs from activating.

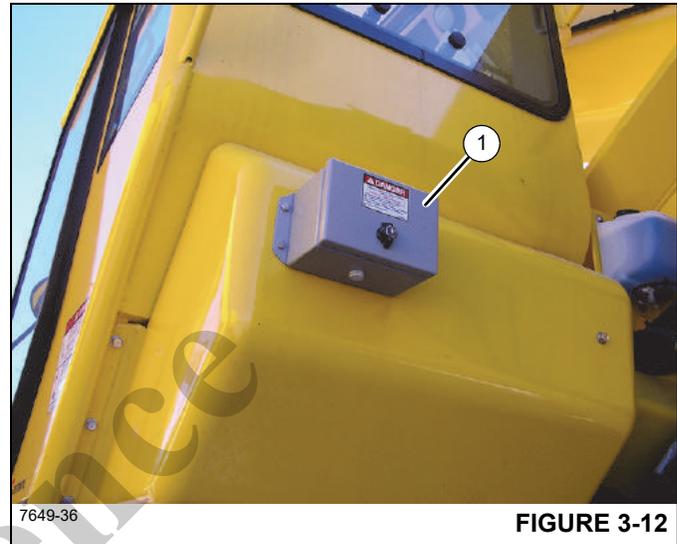
When the Bridging Switch is activated, the operator must make sure that the crane is not overloaded.

Do not operate crane with RCL overridden during normal operations.

The Rated Capacity Limiter (RCL) system, when programmed accurately, will lock out the following crane functions—boom up/down, telescope extend, and hoist up—when a lift is attempted at or above the crane's capacity, or when a two-block condition exists. Locking out these

functions prevents the overload or two-block condition from worsening.

The Bridging Switch is located inside a key-locked single-door enclosure (1, Figure 3-12) attached to the outside rear of the operator's cab. The switch is a two-position momentary rocker switch.



**FIGURE 3-12**

During maintenance or troubleshooting work, or to recover the crane, pressing and releasing the switch bypasses the following limiter systems and their crane function lock outs:

- RCL System (boom up/down, telescope extend, hoist up)
- Working Range Limiter (WRL) System
- Carrier Avoidance System

The following indicators come on to indicate the limiters are bypassed:

- Bypass 3 Pressed Indicator is on (only when pressed and held) (3, Figure 4-90)
- RCL Bypass Active Indicator is on (2, Figure 4-90)
- Working Range Limiter (WRL) Indicator is on (35, Figure 4-18 and Figure 4-19)
- Low Boom Angle Indicator is flashing (27, Figure 4-18 and Figure 4-19)

Upon pressing the Bridging Switch, the swing left/right function pressure is reduced to 25% and the boom down, hoist up, and telescope extend function speeds are reduced to 15% when actuated.

Overriding the RCL with this switch should only be done in an emergency.

All crane function lock outs are bypassed until one of the following occurs:

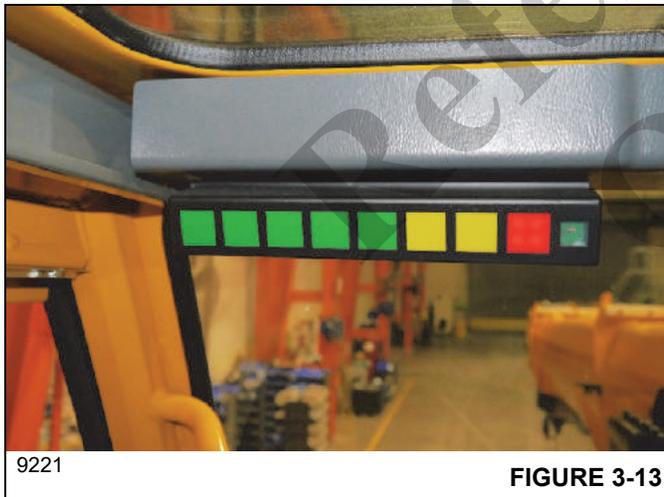
- Bridging Switch is again pressed and released.
- 30 minutes has passed since the Bridging Switch was initially pressed and the controllers are in the neutral position.
- Engine is stopped.

### RCL Internal Light Bar (Optional)

The Rated Capacity Limiter (RCL) Internal Light Bar (Figure 3-13) is located on the upper left hand corner of the crane cab. The RCL Internal Light Bar is an operational aid that warns a crane operator of approaching overload conditions that could cause damage to equipment and personnel.

The lights in the light bar come on in the following manner:

- Green LEDs - when the five green LEDs are lit, the load being lifted is at approximately 90% of the crane's RCL programmed capacity.
- Yellow LEDs - when the yellow LEDs are lit, the load being lifted is between 90% to 100% of the crane's RCL programmed capacity.
- Red LED - when the red LED is lit, the load being lifted is greater than 100% of the crane's RCL programmed capacity.



### RCL External Light Tower (Optional)

The Rated Capacity Limiter (RCL) External Light Tower (Figure 3-14) is located on the outside upper right hand corner of the crane cab. The RCL External Light Tower is an operational aid that warns a crane operator of approaching overload conditions that could cause damage to equipment and personnel.

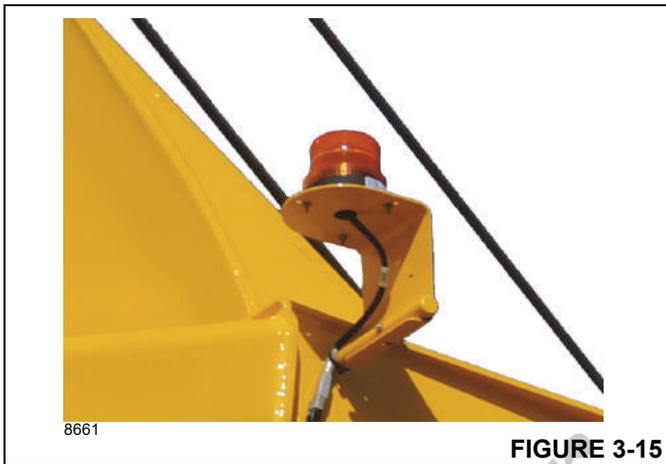
The lights in the light tower come on in the following manner:

- Green LED - when the green LED is on, the load being lifted is less than 90% of the crane's RCL programmed capacity.
- Yellow LED (Constant On) - when the yellow LED is on (constant), the load being lifted is between 90% to 100% of the crane's RCL programmed capacity.
- Yellow LED (Flashing) - when the yellow LED is on (flashing), the load being lifted is between 100% to 110% of the crane's RCL programmed capacity.
- Red LED - when the red LED is on, the load being lifted is greater than 110% of the crane's RCL programmed capacity.



### Strobe Light or Beacon (Optional)

The strobe light or beacon (Figure 3-15) is on the left side of the superstructure. It is on when the ignition switch is on.



### Backup Alarm (Not Shown)

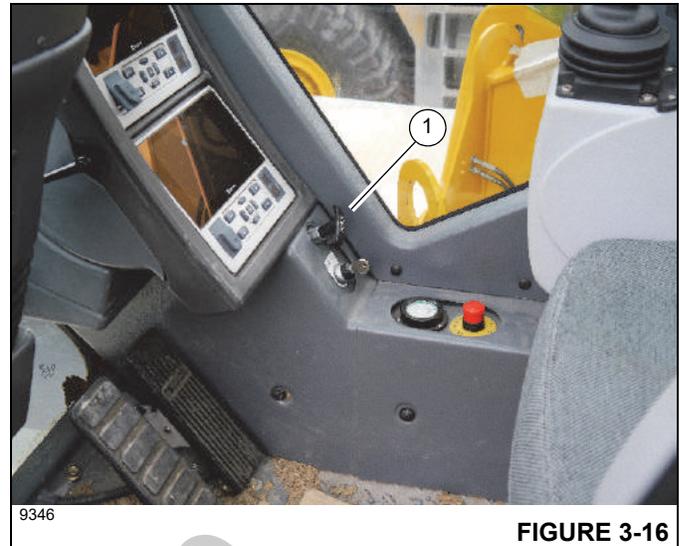
The backup alarm is an audio system used to warn personnel when the crane is backing up. It is activated when the transmission is in the reverse. The backup alarm is installed in the rear outrigger box.

### Emergency Exit

The windshield is the Emergency Exit. In an emergency, if the door is blocked or cannot be opened, push out windshield and escape through opening.

### Turntable Swing Pin Lock Control

The Turntable Swing Lock Pin Control Handle (1, Figure 3-16) is located on the lower right console. When the control handle is pushed down and the superstructure is directly over front of carrier, the swing lock pin drops into the socket on the carrier frame, locking the superstructure in place. When the control handle is pulled up, the pin is pulled out of the socket, unlocking the superstructure.



### 120V/220V Engine Block Heater and Outlet

The crane is equipped with a 120V engine block heater for cold weather operation. The plug for connecting power to the engine block heater is located on the left side of the crane near the battery disconnect switch (Figure 3-17).

An optional 220V engine block heater is available in place of the 120V version.



## Birdseye Camera (Optional)

Refer to *Using the Birdseye Camera (Optional)*, page 4-108 for information on how the Birdseye Camera System operates and how to make changes to the display settings.

The Birdseye Camera is a visual aid for the operator. It provides a view of the area surrounding the crane as if there were a camera mounted directly above the crane.

The Birdseye Camera option includes a hoist camera which shows the remaining rope on the hoists. The hoist camera image (12, Figure 4-19) is shown on the Main Screen of the Operator Display Module (ODM).

The Birdseye Camera uses three cameras, which are mounted to the counterweight, to make one overhead image of the crane surroundings. The image is displayed on the 7 in Birdseye Camera Display (1, Figure 3-18) mounted in the front-right corner of the crane cab above the Rated Capacity Limiter Display Module (RDM) and the Operator Display Module (ODM).



The Birdseye Camera offers four different views:

- Birdseye View

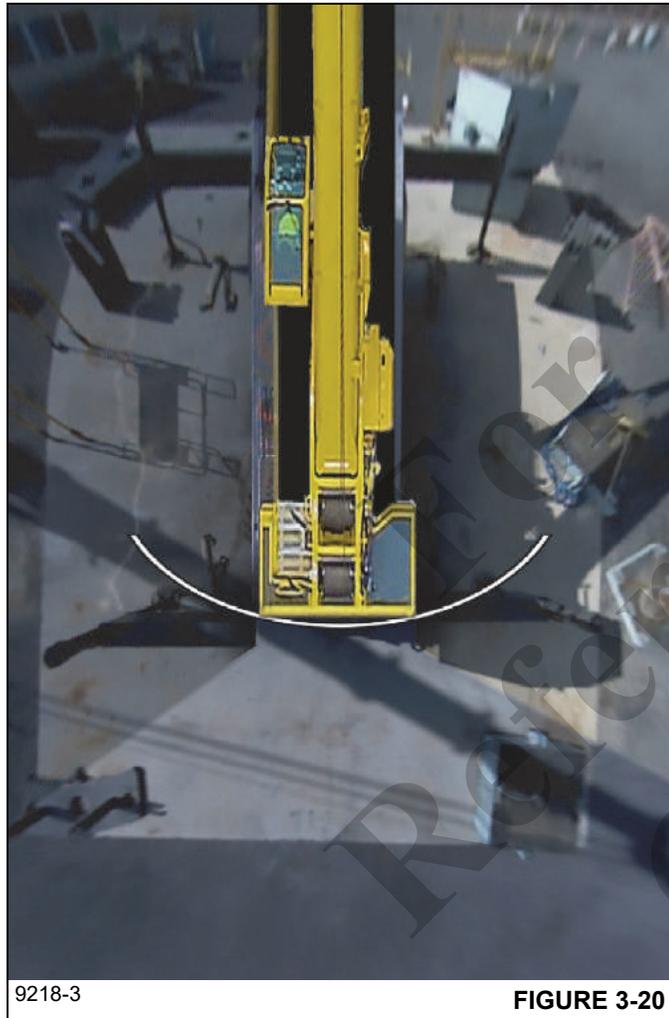
This view is the default view and will appear when the crane's ignition switch is in the On position. The Birdseye View shows an overlay of the crane superstructure along with the overhead image made from the three surrounding cameras (Figure 3-19).



- Birdseye View with Swing Overlay

This view shows the Birdseye View as described previously, but also automatically shows a swing overlay when the swing function is activated (Figure 3-20).

The swing overlay is to be used as an aid to help identify objects that may be in the superstructure's swing path.



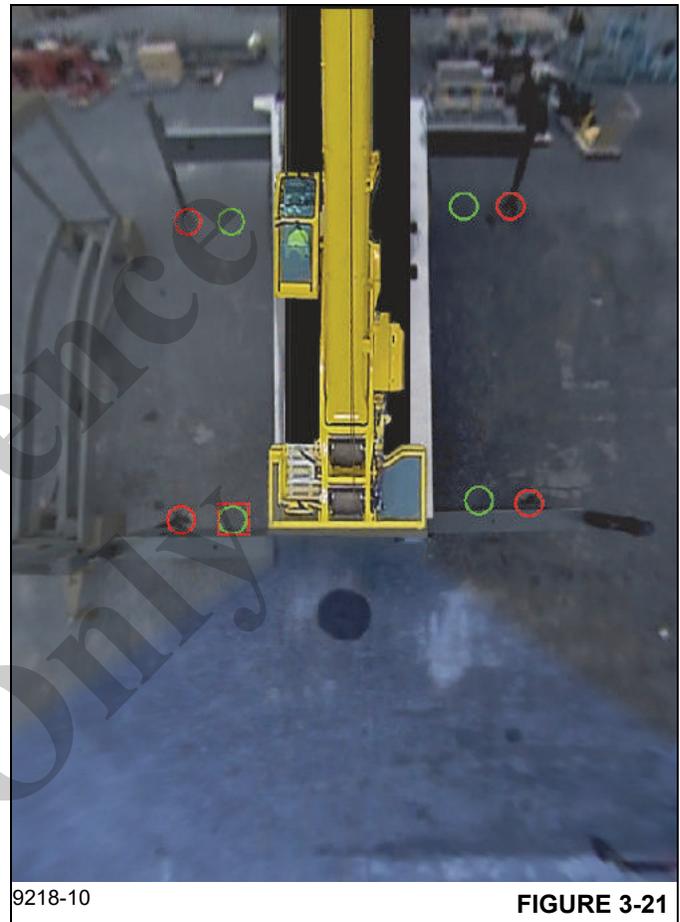
9218-3

FIGURE 3-20

- Birdseye View with Outrigger Pad Target Overlay

This view shows the Birdseye View as described previously, but also automatically shows an outrigger pad target overlay when the superstructure is centered over the front of the crane and the outrigger extend/retract function is activated (Figure 3-21).

The outrigger pad target overlay is to be used as an aid to help identify objects that may interfere with the setting of the outriggers at the mid-extend or full-extend position.

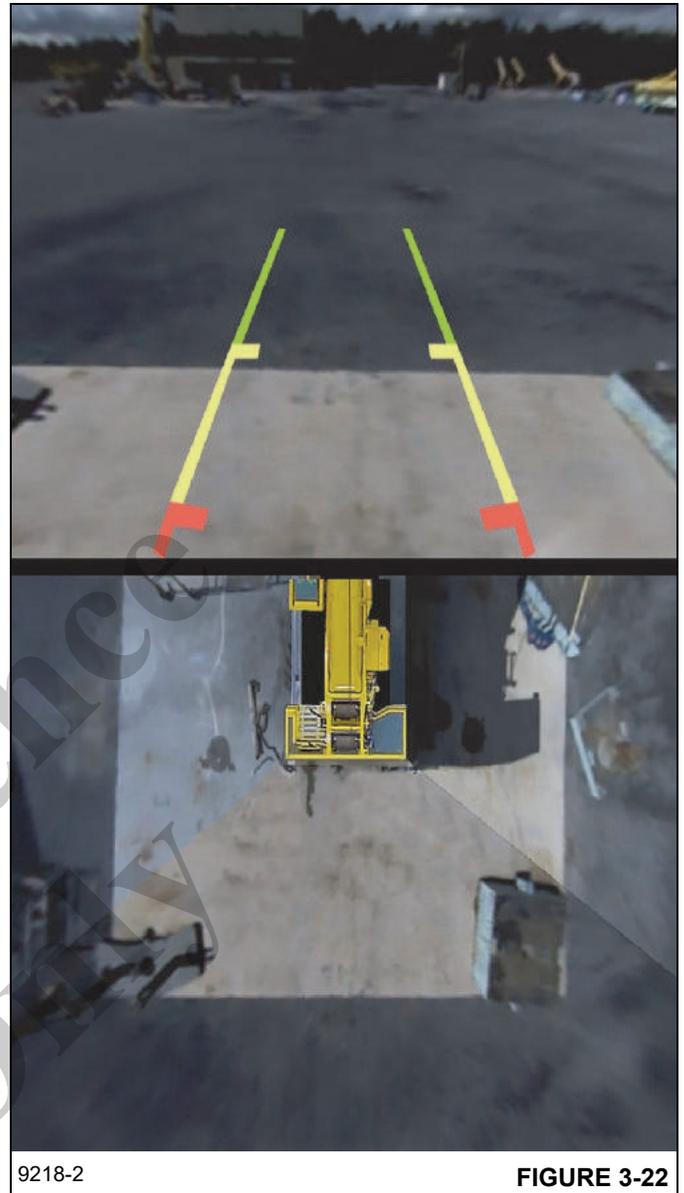


9218-10

FIGURE 3-21

- Reverse View

This view shows a split screen consisting of a partial Birdseye View (overhead) of the rear of the crane and an image looking out the rear of the crane (Figure 3-22). The Reverse View automatically appears when the Transmission Shift Lever is positioned to Reverse.



*For  
Reference  
Only*

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## SECTION 4 OPERATING PROCEDURES

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## 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 *Lubrication and Maintenance*, page 6-1.

The following items are suggested to be checked to make sure the crane is prepared for starting the day's work.

### Fuel Supply

Fill fuel tank and make sure cap is on tight.

### Engine Oil

#### CAUTION

Do not overfill.

Check oil level in the crankcase and make sure it is within the ADD and FULL marks on the dipstick. Do not overfill.

### Engine Coolant



#### DANGER

Do not loosen radiator cap while engine and radiator are hot. Steam or hot coolant will cause severe burns.

Check surge tank coolant level sight gauge and fill to the proper level. Do not overfill. Make sure surge tank cap is secure.

### Batteries

Check battery cables and clamps are tight and not corroded.

### Hydraulic Reservoir and Filter

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

Check breather for cleanliness and make sure it is secure.

### Hoist Rope

Inspect hoist 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 Overhaul 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 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 make sure they are not damaged and are in proper operating condition, especially if they have been subjected to severe stress.

#### Cleaning Seat Belt Webbing

Wash seat belt webbing with mild soap or detergent. Do not use commercial solvents. 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 for severe cuts, foreign objects embedded in treads, and for correct inflation pressures. A tire inflation chart, providing the correct air pressures, is located in the Load Chart Manual in the crane cab.

### Wheels

Maintain proper torque on wheel lugs and check for proper wheel mounting. If equipped with steel or aluminum wheels, re-torque wheels 300 hours after initial installation or any time tires and wheels are removed. Doing this re-seats the lug nuts. Check lug nuts for proper torque every 500 hours thereafter.

### Axle Oscillation Lock Outs Operation

The following procedure should be used to periodically check the axle oscillation system and make sure it is in proper working condition.

1. Make sure tires are inflated to recommended pressure. Refer to *Load Chart Book* in the crane cab for proper inflation pressures.
2. With hook unloaded, boom fully retracted and centered over the front at no more than a 10° to 15° boom angle, position crane on a block or curb so one rear tire is

approximately 15 to 30 cm (6 to 12 in) above the level of the opposite tire.

3. Slowly swing superstructure to left or right until axle oscillation lock out valve is activated. This will lock rear axle out of level. Do not swing beyond tire track.
4. After engaging swing brake, slowly drive off of block or curb and stop. Rear tires should both be touching the road surface and opposite front tire should be light or slightly off road surface.
5. Release swing brake and swing superstructure until it is centered over the front. If axle oscillation lock out valve is functioning properly, crane will re-level itself; if valve is not working properly, crane will not re-level itself.



## DANGER

### Tipping Hazard!

Do not operate crane if axle oscillation lock out system is not functioning properly.

Failure to comply with this warning may result in death or serious injury.

If rear axle does not lock or unlock properly, do not operate the crane until the lock out system has been evaluated and repaired as necessary.

## Accessories

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

## Daily Lubrication

Make sure all components requiring daily lubrication have been serviced. Refer to *Lubrication and Maintenance*, page 6-1.

## Boom

Before extending boom, make sure large access cover on side of boom base section is installed.

## Air Cleaner

Check filter restriction indicator (Tier 3 models only). Check filter and tubing for security.

## Air Intake Restriction Monitoring (AIRM) Communications System (Tier 4 Only)

The Tier 4 engine includes the Cummins AIRM Communications System. This calculates real-time air filter restriction at operational flow rate using the temperature and pressure input from the TBAP sensor, which is included on the Direct Flow air cleaner.

When the air filter becomes dirty and should be replaced, a maintenance fault is generated and the Engine Warning Indicator (23, Figure 4-18 and Figure 4-19) flashes for a period of time at every key on. Replace the air filter at the next maintenance interval.

If the air filter continues to become more dirty, a severe warning fault is generated and the Engine Warning Indicator comes on (constant). A progressive engine derate will occur to protect the engine from damage.

The generated fault codes can be viewed on the Operator Display Module (ODM) (refer to *Viewing the Engine Fault Codes*, page 4-92).

## Preload Check

After crane has been readied for service, an operational check of all crane functions (with no load applied) should be performed. Refer to *Craning Functions*, page 4-24 for details as to how to operate the different crane functions.

Preload check is as follows:

## CAUTION

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

1. Extend and set outriggers and level crane.
2. Raise, lower, and swing boom right and left at least 45°.
3. Fully telescope boom out and back in at 75°, 35°, and 0° boom angles, ensuring all sections extend and retract properly.
4. With boom fully retracted and at maximum boom angle, lower the hook block/overhaul ball to near ground level. Fully extend the boom while keeping the block/ball at near ground level.



## CAUTION

### Hoist Rope Damage Hazard!

Hoist rope that is not properly tensioned can cause rope diving, which could result in rope damage.

Always properly tension the hoist rope by spooling as much of the rope onto the hoist with as much load available and allowable as indicated by the *Load Chart*.

5. With a load applied, fully retract the boom while keeping the hook block/overhaul ball at near ground level.

Once boom is fully retracted, raise block/ball up to boom tip.

If block/ball rotates more than 90° during this procedure, turn dead-end becket one revolution opposite the

direction that the block/ball rotates as the fall length increases. Repeat as necessary until block/ball rotates no more than 90°.

## Using Your Load Chart

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

**NOTE:** Refer to Figure 4-1 for terms to know in determining lifting capacities.

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

The left column is the load radius, which is the distance from axis of crane rotation to load center of gravity. The top row

lists various boom lengths from fully retracted to fully extended (with swingaway boom 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 required boom angle (in degrees) for that load.

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

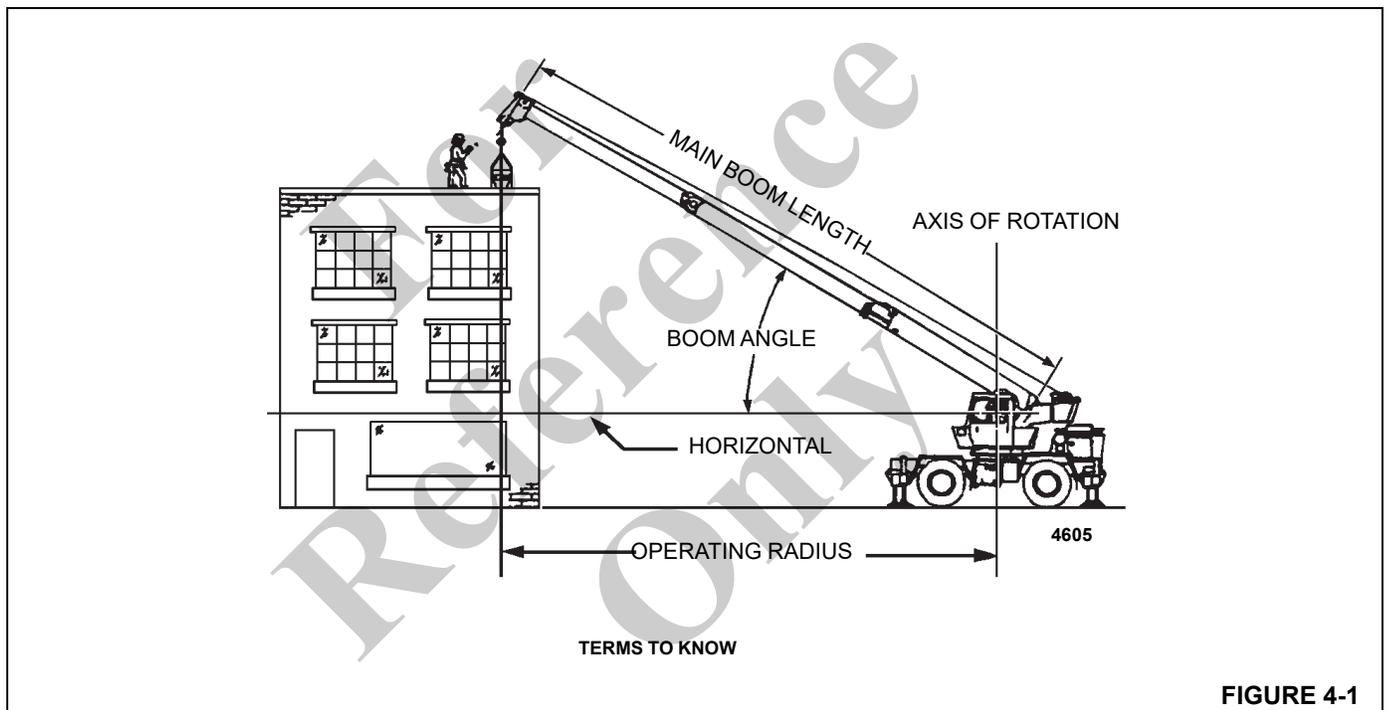


FIGURE 4-1

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

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 Grove load handling devices such as hook blocks, overhaul balls, boom extension sections, etc., which must be considered as part of the load. 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:** Information in the following paragraph is an example only of how to compute a lift. Numbers may not match load chart in the crane cab.

Example: A concrete beam weighing 2268 kg (5000 lb) 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) to reach a height of 9.1 m (30 ft) at a radius of 15.2 m (50 ft).

First check the crane for load handling devices. In our example, the crane is equipped with a auxiliary boom nose (rooster sheave) and a five ton overhaul ball. The rooster sheave is 50 kg (110 lb), and the overhaul ball is 78 kg (172 lb) for a total of 128 kg (282 lb). The lift requires slings and spreader bars weighing 159 kg (350 lb) which makes the total weight for the load handling devices 286 kg (632 lb).

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 lb) on outriggers over-front and 2254 kg (4970 lb) on outriggers 360 degrees.

Subtract load handling weight of 632 lb from load capacity of 3601 kg (7940 lb) and 2254 kg (4970 lb). The result is a weight capacity of 3315 kg (7308 lb) over-the-front and 1968 kg (4338 lb) for 360 degrees.

We are restricted in making the lift over-front only, with a boom angle of about 29 degrees.

## 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 applicable engine manufacturer's manual for detailed procedures).

### Jump Starting Hazard

Do not attempt to jump start the crane.

## CAUTION

It is strongly recommended that the batteries not be "jumped" with a different vehicle, portable power pack, etc. The surge of power from these sources can irreparably damage the various electronic controls and computer systems. Jump starting the crane batteries with a different vehicle while the engine is running can damage the donor vehicle electronics as well if done improperly.

This crane has multiple computer systems (crane control, RCL, engine and transmission control) that are highly susceptible to voltage/amperage surges in the electrical system.

The batteries should be completely disconnected from the crane electrical system and charged using a battery charger of appropriate voltage level or replace the batteries with fully charged batteries. Refer to *Charging the Batteries*, page 4-6.

### Charging the Batteries

When charging the batteries, do not turn on the battery charger until the charging leads have been connected to the battery(s). Also, if the battery(s) are found to be frozen, do not attempt to charge them. Remove the battery(s) from the crane, allow them to thaw, and then charge the battery(s) to full capacity.

"Slow charging" is preferred to "fast charging". Fast charging saves time but risks overheating the battery(s). Slow charging at six (6) amps or less develops less heat inside the battery and breaks up the sulfate on the battery plates more

efficiently to bring the battery up to full charge. The use of a "smart charger" that automatically adjusts the charging amperage rate should be used.

### Start-Up Procedure



## DANGER

Diesel engine exhaust can be harmful to your health. Only operate 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 two minutes before attempting another start.

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

1. Make an under-the-hood inspection for fuel, oil, and coolant leaks, worn drive belts, and trash build-up.
2. Use the correct grade of oil in the crankcase for the prevailing temperature to prevent hard cranking.
3. Make sure diesel fuel has a cloud point of 6°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.
4. Make sure Battery Disconnect Switch handle (1) (Figure 4-2) is in the ON position.

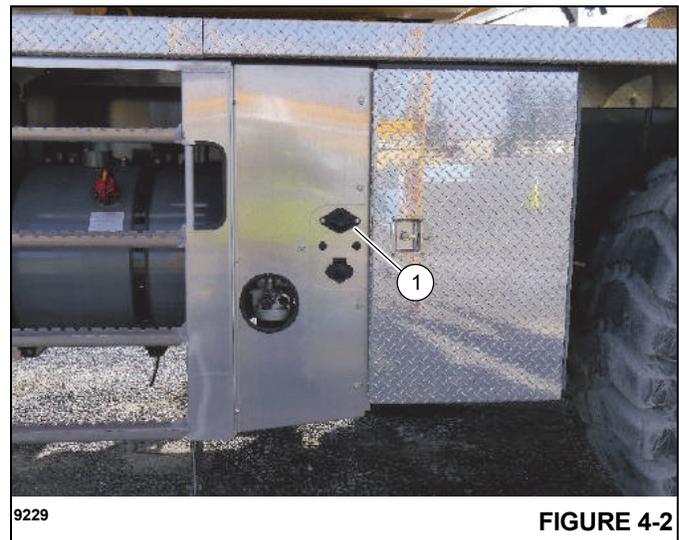


FIGURE 4-2

5. Make sure emergency stop switch is not pressed.
6. Make sure parking brake is set to On position the transmission shift lever is positioned to Neutral.

**NOTE:** Engine will not crank unless transmission shift lever is in neutral.

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

7. Turn ignition switch clockwise to position I (RUN).

The Engine Warning Indicator (23, Figure 4-18 and Figure 4-19) and the Engine Stop Indicator (22, Figure 4-18 and Figure 4-19) will come on and go off in sequence after approximately two seconds (as a check).

If the Engine Wait-to-Start Indicator (14, Figure 4-18 and Figure 4-19) is on, do not crank engine until the indicator goes off.

If the Engine Warning Indicator or the Engine Stop Indicator remains on, correct the malfunction before cranking the engine.

8. Sound the horn by pressing the button on the right controller or by pressing the button on the end of the turn signal lever on the steering column.
9. Turn the ignition switch clockwise to position II (START) and release immediately when the engine starts.

Do not push or hold the throttle pedal down. The ECM automatically provides the proper amount of fuel to start the engine.

---

### CAUTION

If the Engine Warning Indicator or the Engine Stop Indicator is on, immediately stop the engine and correct the malfunction.

---

10. Warm up engine and all crane components following the procedures under *Crane Warm-up Procedures*, page 4-11.

### Idling 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 valves, pistons and rings; and rapid accumulation of sludge in the engine. These conditions become worse in colder climates.

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

### Engine High Idle

Idling the engine for long periods of time results in the degradation of engine oil and damage to engine components, as described under *Idling Engine*, page 4-7.

To reduce these adverse effects, the Crane Control System (CCS) will automatically increase the engine idle speed to approximately 1200 rpm when the following conditions are met for a period of 5 minutes:

- Transmission is in neutral
- Parking brake is engaged
- Brake pedal is not pressed
- Engine speed is less than 1125 rpm
- Controllers are not actuated
- Engine coolant temperature is below 71°C (160°F)
- Manual exhaust system cleaning process has not been initiated
- Automatic exhaust system cleaning process is not active

The crane control system will automatically return the engine idle speed to its usual setting when one of the following conditions occur:

- Transmission is shifted to forward or reverse
- Parking brake is disengaged
- Brake pedal is pressed
- Controller is actuated
- Engine coolant temperature rises above 79°C (175°F)
- Exhaust System Cleaning Switch is set to the Manual Cleaning position
- Exhaust system cleaning process is active

### Racing Engine

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

### Exhaust System Cleaning

#### *When to Manually Clean the Exhaust System*

The Diesel Particulate Filter (DPF) Clogged Indicator (30, Figure 4-18 and Figure 4-19) is located in the Operator Display Module (ODM). This indicator comes on (amber) when the exhaust system requires cleaning.

When the DPF Clogged indicator comes on or flashes, start the manual cleaning process at the next opportune time.

The indicator will come on (constant) during the early stages of required cleaning. If this condition continues, the indicator will begin to flash and a slight engine derate will occur.

If the exhaust system continues to clog, the Engine Warning Indicator (23, Figure 4-18 and Figure 4-19) will come on in addition to the Diesel Particulate Filter Clogged Indicator (30, Figure 4-18 and Figure 4-19) and a severe engine derate will occur.

These above conditions can only occur if cleaning has been inhibited or a manual cleaning was interrupted.

### Initiating the Manual Exhaust Cleaning Process

To manually clean the exhaust system, do the following:

#### **WARNING** **Burn/Fire Hazard!**

During the cleaning process, the exhaust and tailpipe become very hot. Keep personnel and flammable objects away from the exhaust. Do not park vehicle near flammable objects.

1. Make sure crane is not parked near flammable objects.
2. Set up a safe area around the crane's exhaust; remove tools, rags, grease, or any debris from engine exhaust area.
3. Set transmission lever to the neutral position.
4. Engage the crane parking brake,
5. Release the service brake and throttle pedals.
6. With engine idling, press the top of the Exhaust System Cleaning Switch (refer to *Exhaust System Cleaning Switch (Tier 4 Engine Only)*, page 3-7) to start manual cleaning.

Within 5 seconds the engine speed will increase to 1000 to 1400 rpm. The engine will continue to run at this speed for up to 45 minutes.

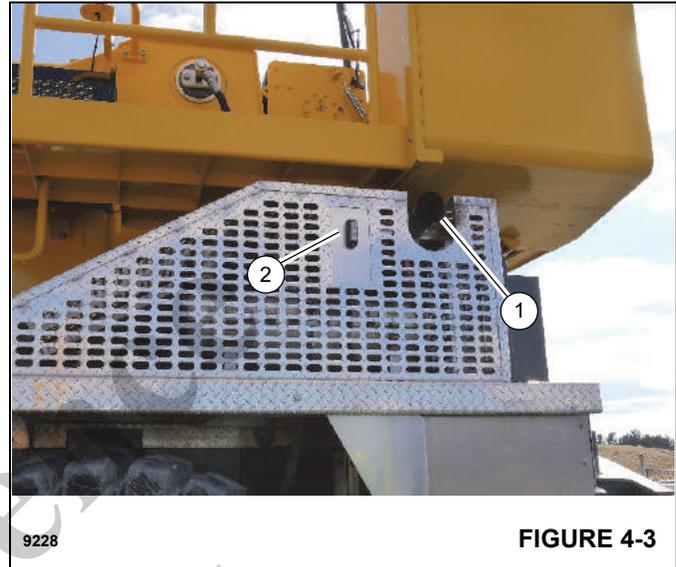
As a warning, a strobe light (2, Figure 4-3) near the exhaust pipe (1, Figure 4-3) will flash during exhaust system cleaning.

Pressing the brake or throttle pedal during cleaning or pressing the bottom (Inhibit Manual Cleaning) of the Exhaust

System Cleaning Switch will interrupt the manual cleaning process.

Make sure the crane and surrounding area are monitored during manual cleaning. If any unsafe condition occurs, shut off engine immediately.

Engine will return to normal idle speed when the manual cleaning process is complete.



**FIGURE 4-3**

### Inhibiting the Exhaust System Cleaning

To inhibit, or prevent, the exhaust system entering the active cleaning mode or to stop the exhaust cleaning process that was manually initiated, press the bottom of the Exhaust System Cleaning Switch (refer to *Exhaust System Cleaning Switch (Tier 4 Engine Only)*, page 3-7). The Inhibit Exhaust System Cleaning Indicator (31, Figure 4-18 and Figure 4-19), located on the Operator Display Module (ODM), will come on (amber) and the active and manual modes of exhaust system cleaning are prevented.

### Shutdown Procedure

1. Allow engine to run at fast idle speed for about five minutes to avoid high internal heat rise and allow for heat dissipation.
2. Turn ignition switch counter-clockwise to 0 (OFF) position.
3. Drain fuel filter-water separator.

## Battery Disconnect



The battery disconnect switch is located on the battery box cover on the left side of the crane. To disconnect the batteries, turn battery disconnect switch to the OFF position. If necessary, lock the battery disconnect in the OFF position using a padlock. Turn switch to the ON position to connect the batteries.

## COLD WEATHER OPERATION

The following recommendations are for operating Grove cranes in regions with ambient temperatures below  $-9^{\circ}\text{C}$  ( $15^{\circ}\text{F}$ ) which are considered arctic.

**NOTE:** Additional information regarding engine cold weather operation is available through your Cummins dealer/service center under Service Bulletin 3379009.

Use particular care to make sure cranes operated in very cold temperatures are operated and maintained in accordance with procedures provided by Grove. Always make sure there is adequate lubrication during system warm-up. Regardless of crane lubricant viscosity, always follow cold weather warm-up procedures described in the section *Crane Warm-up Procedures*, page 4-11. For proper cold weather lubricants, refer to the section *Arctic Lubricants and Conditions*, page 6-4.

If in doubt of suitability for a specific fluid or lubricant, check with an authorized Grove distributor or Manitowoc Crane Care. Cranes should have appropriate hydraulic oil, lubricants, and other auxiliary items required for operation in arctic temperatures.

Grove Crane recommends the crane be equipped with the following cold weather accessories:

### Down to $-29^{\circ}\text{C}$ ( $-20^{\circ}\text{F}$ ) Package

- Battery heater
- Transmission heater
- In-line fuel heater
- Engine hood insulation
- Fan clutch
- Radiator shutters
- Air diverter
- Diesel fired cab heater
- Cold weather alternator
- Fluids suitable to  $-29^{\circ}\text{C}$  ( $-20^{\circ}\text{F}$ )
  - Arctic windshield washer fluid
  - Arctic fuel

### Down to $-40^{\circ}\text{C}$ ( $-40^{\circ}\text{F}$ ) Package

- Coolant heater (to circulate warm coolant through heaters and engine)
- Transmission heater
- Hydraulic swivel heater
- Battery heater
- In-line Fuel heater
- Engine hood insulation
- Fan clutch
- Radiator shutters
- Air diverter
- Diesel fired cab heater
- Cold weather alternator
- Super-capacitor starting system
- Fluids suitable to  $-40^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$ ):
  - Arctic windshield washer fluid
  - Arctic fuel

Individual crane functions should be operated to make sure they are sufficiently warmed prior to performing a lift. Allow at least 30 minutes of engine run time for warm up.

For crane operation below  $-40^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$ ), derate load chart capacities by 6.60% for each degree Celsius or by 3.67% for each degree Fahrenheit below  $-40^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$ ).

Operation of cranes at full rated capacities in ambient temperatures below  $-9^{\circ}\text{C}$  ( $15^{\circ}\text{F}$ ) should be accomplished only by competent operators who possess the skill, experience, and dexterity to make sure smooth operation. Shock loading shall be avoided.

## Coolant Heater

A diesel fueled coolant heater circulates warm coolant through engine and crane components when operating during arctic temperatures. The coolant heater should be activated 2 hours before starting the crane to allow sufficient time to preheat fluids and assist with easy start-up conditions.



### WARNING

#### Explosion Hazard!

Before switching on, check if heater can be operated at current site of the crane. There is a danger of explosion when using heater around combustible objects! Do not park vehicle near objects that are flammable.

Use caution near heater exhaust tailpipe as it will also become very hot.

**NOTE:** Operation of heater is NOT allowed:

- At locations where flammable gas or vapors are found or can be formed (example: at fuel stations and chemical factories)
- At locations where explosive dust is found or can be formed (example: coal, wood or grain dust).
- There is a risk of suffocation when using the heater!
- Do not operate heater in enclosed spaces (example: garages).

To activate heater, make sure fuel supply valve from heater fuel reservoir is turned to the ON position. Make sure battery disconnect switch is turned to the ON position and push the activation button at the heater control panel. A green light will come on indicating system is activated. The start-up and shutdown cycles may take approximately 2 minutes for initialization. Make sure coolant, transmission heater, swivel, battery heater, in-line fuel pump, in-line fuel heater, and hydraulic reservoir heater are heating properly.

To deactivate heater, push button at heater control panel. The green light will go off indicating system is deactivated. Shutdown cycle takes approximately 2 minutes.

**NOTE:** Accelerated discharging of battery will occur when crane engine is switched off. If heater is operated with crane engine stopped, batteries will need to be recharged after a short period of time.

## Radiator Shutters

When starting engine, radiator shutters close and then reopen when coolant temperature reaches 71°C (160°F).

## Auxiliary Cab Heater

The crane cab is heated with an auxiliary air heating system that runs independently of the engine. Heat is generated by burning fuel taken from the heater fuel reservoir.

To heat the operator's cab, activate the auxiliary diesel heater and adjust temperature control switch mounted in the overhead panel. The heating system fan delivers warm air into an air distribution box. Air is circulated according to control settings and then delivered into the cab by a fan through various air extraction and air delivery vents.

Do not cover vents with bags, articles of clothing or any other objects. Keep hot air inlet and hot air outlet free of dirt and foreign material. Soiled or blocked hot air lines may cause overheating, and result in damage.

The crane auxiliary cab heater can be operated when engine is running or stopped as part of the programmable auxiliary heating system. Maximum cab temperature is achieved by running only the auxiliary heater and using the standard cab heater fan when engine is sufficiently warmed up. The standard hot water crane cab heater can also be turned on after engine has started and is warmed to operating temperature.

**NOTE:** When using heater at high altitudes, factory heater setting must be re-calibrated for proper heater operation.

- Heating at altitudes up to 1,500 m (4,900 ft)  
Unlimited heating is possible
- Heating at altitudes over 1,500 m - 3,000 m (4,900 ft - 9,900 ft):

Heating is possible for short periods at this altitude (example: driving over a mountain pass or taking a break while traveling between job sites).

During longer stays, (example: construction job project), the fuel supply must be adjusted to the altitude or the heater will malfunction. This can be done by installing an air pressure sensor kit (Grove part number 90037674). Contact an authorized Grove distributor or Manitowoc Crane Care for additional assistance.

**NOTE:** Accelerated discharging of battery will occur when crane engine is switched off. If heater is operated with crane engine stopped, batteries will need to be recharged after a short period of time.

## Battery Heater

An in-line battery coolant heater circulates warm coolant under the battery when temperature is below -9°C (15°F). The battery coolant heater should be activated 2 hours before starting the crane to allow sufficient time to preheat batteries and provide easy start-up conditions.

Make sure battery heater coolant valve is turned OFF in ambient temperatures above -9°C (15°F).

### Air Diverter

An air diverter directs warmed air collected from under the engine hood when temperature is below -9°C (15°F) to preheat the air intake going to the engine.

Make sure air diverter is switched to outside air intake in 0 ambient temperatures above -9°C (15°F).

### Super Capacitor

The super capacitor provides additional cranking during cold weather startup. The super capacitor is connected to the standard batteries with an isolation relay. The positive relay feed is activated when the key is in the crank and run positions. The super capacitor allows the starter to be cranked for 30 seconds then cycled off for 60 seconds before cranking again until the engine starts.

If crane has been left with battery disconnected for an extended period of time, super capacitor will need up to 30 minutes to charge before having full cranking capacity.

Capacitor charge can be measured by the following:

- Set battery disconnect to ON position.
- Press black button located on top of capacitor:
- If light flashes green, capacitor is charging and may not successfully start machine.
- If light is solid green, capacitor is charged and ready for starting.

Any other color or flash pattern may indicate an error. Refer to decal located on capacitor.

### Diesel Fuel

Diesel fuel with low temperature characteristics is required to operate the engine when ambient temperatures get near or below 0°C (32°F). Refer to the applicable engine manual for proper specifications.

Use correct grade of fuel for prevailing temperature. Diesel fuel should have a cloud point of 6°C (10°F) less than the lowest expected temperature. In case of emergency, kerosene may be added to the fuel to bring the cloud point down to the required temperature. This will minimize clogging of filters and small passages by wax crystals. Addition of kerosene is NOT recommended for general use. Refer to *Arctic Lubricants and Conditions*, page 6-4 of this operator manual.

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### CAUTION

#### Engine Damage Hazard!

If Ultra Low Sulfur fuel is not used in engines that require it, engine performance will quickly deteriorate and the engine may stop running. The engine warranty will also be voided.

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### Operation Below -40°C (-40°F)

For crane operation below -40°C (-40°F), derate load chart capacities by 6.60% for each degree Celsius or by 3.67% for each degree Fahrenheit below -40°C (-40°F).

### CRANE WARM-UP PROCEDURES

The following procedures must be followed to properly warm different crane components before operating crane.

**NOTE:** For temperatures below -9°C (15°F), refer to arctic lubricants and conditions in the Operator and Service Manuals.

Before starting crane, make sure appropriate lubricants are used for ambient temperatures in which the crane will operate (a list of lubricants and temperature ranges can be found in the Lubrication section of your crane's *Operator Manual*, by contacting your local Grove distributor, or by contacting Manitowoc Crane Care directly).

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### CAUTION

#### Crane Damage Hazard!

Operating crane with incorrect lubricants and fluids for the prevailing ambient temperature and/or failing to adequately warm crane before cold weather operation can lead to a failure of a crane component or system.

Always use Grove recommended lubricants and fluids for prevailing ambient temperature. Properly start and warm crane using cold weather procedures found in this Operator Manual and supplement before operating crane at full load.

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## Engine

### Warm-up Procedures for All Temperature Ranges:

1. After starting, allow engine to idle for 3 to 5 minutes before operating with a load.
2. Cold Engine Startup: After allowing engine to warm by idling it for 3 to 5 minutes, slowly increase engine speed to provide adequate lubrication to bearings and to allow oil pressure to stabilize.

## Transmission

For full-load functionality, a minimum sump temperature of 20°C (68°F) is required. Operating the transmission with a sump temperature less than 20°C (68°F) is limited to:

- operating in the neutral gear or
- driving with an unloaded crane while not exceeding 1500 engine RPM and not exceeding half throttle.

### Warm-up Procedures for Rough Terrain (RT) Cranes:

1. Setup crane on outriggers.
2. Engage transmission with four-wheel drive selected (if equipped) and allow crane to run at idle until the temperature of the transmission sump reaches 20°C (68°F).

**NOTE:** Warm-up operation of four-wheel drive transmission engaged in two-wheel drive only could cause transmission damage.

### Alternate Warm-up Procedures for Rough Terrain (RT) Cranes:

1. Engage parking brake and apply service brake.
2. Shift transmission into the highest gear and increase engine speed to 1500 for 15 seconds, then allow engine speed to return to idle.
3. Repeat Step 2 until the temperature of the transmission sump reaches 20°C (68°F).

## Hoist

Warm-up procedures are recommended at every startup and required at ambient temperatures below 4°C (40°F).

### Warm-up Procedures - Standard Hydraulic Oil:

1. Without operating the hoist function, warm the hydraulic oil (see *Hydraulic Oil System*, page 4-12).
2. Once hydraulic system is warm, operate the unloaded hoist, in both directions, at low speeds several times to prime all hydraulic lines with warm hydraulic oil and to circulate gear lubricant through the planetary gear sets.

### Warm-up Procedures - Cold Weather Hydraulic Oil:

Operate the unloaded hoist, in both directions, at low speeds several times to circulate gear lubricant through the planetary gear sets.

## Swing Drive and Turntable Bearing

### Warm-up Procedures for Temperatures Above -7°C (20°F):

1. Setup crane on fully extended outriggers, with boom fully retracted and near maximum boom angle with no load applied.
2. Rotate superstructure at a speed of less than one RPM for at least one complete revolution in one direction, then rotate superstructure at a speed of less than one RPM for at least one complete revolution in opposite direction.

### Warm-up Procedures for Temperatures Below -7°C (20°F):

1. Setup crane on fully extended outriggers, with boom fully retracted and near maximum boom angle with no load applied.
2. Rotate superstructure at a speed of less than one-half RPM for at least two complete revolutions in one direction, then rotate superstructure at a speed of less than one-half RPM for at least two complete revolutions in the opposite direction.

## Axles

### Warm-up Procedures for Temperatures Below -35°C (-30°F):

1. Setup crane on outriggers.
2. Engage transmission with four-wheel drive selected (if equipped) and allow crane to run at idle until transmission sump temperature reaches normal operating temperature.

**NOTE:** Warm-up operation of four-wheel drive transmission engaged in two-wheel drive only could cause transmission damage.

## Hydraulic Oil System

### Operating Limits and Warm-up Procedures:

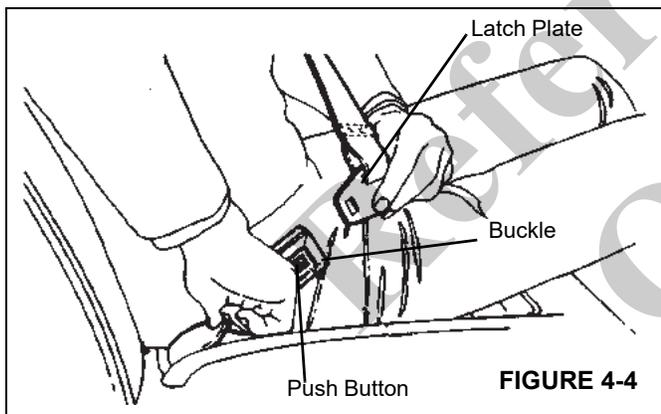
**NOTE:** Ambient temperatures between -10°C and -40°C (15°F and -40°F) require the use of a cold weather hydraulic oil (refer to cold weather lubricants in the section *Lubrication and Maintenance*, page 6-1). With cold weather hydraulic oil installed, warming the hydraulic oil before operating the crane is not required.

- **Hydraulic Oil Temperatures from 4°C to -10°C (40°F to 15°F):** Crane operation, less hoist, without a load is allowed with medium engine speed and medium function speed (controller position) until fluid reaches at least 10°C (50°F). It is then recommended that all crane functions be cycled to remove cold fluid from all components and cylinders of the hydraulic system. If any unusual sound comes from the crane's hydraulic pumps or motors, stop operation and engine immediately and contact a Grove distributor.
- **Hydraulic Oil Temperatures from 10°C to 4°C (50°F to 40°F):** Crane operation, less hoist, with a load is allowed with medium engine speed and medium function speed (controller position) until fluid reaches at least 10°C (50°F).
- **Hydraulic Oil Temperatures from 95°C to 10°C (200°F to 50°F):** Crane operation with a load is allowed with no restrictions.

Hydraulic oil temperature above 95°C (200°F): No crane operation is allowed. Let hydraulic oil cool by running engine at idle with no functions actuated.

## DRIVING THE CRANE

### Seat Belts



1. Before fastening a seat belt, always adjust driver's seat to position in which you will drive.
2. Pull belt across your lap and push latch plate into buckle until it clicks (Figure 4-4).

3. To reduce risk of sliding under belt during a collision, position belt across your lap as low on your hips as possible and pull it toward door to a snug fit.

## Traveling — General



### WARNING Accidental Operation Hazard!

Before traveling, make sure that all crane functions are fully disabled by pressing the Crane Function Enable/Disable Switch. Disabling the crane functions will prevent accidental operation of the craning functions due to hitting the controllers while traveling.

Owner/lessee must take appropriate measures to make sure all persons operating or working with affected models are in compliance with Grove U.S. L.L.C. recommendations. Operator of the crane assumes responsibility for determining suitability of traveling on a slope. Traveling on a slope should only be attempted under the controlled conditions specified in this publication, and must be conducted with the utmost diligence and care to ensure the safety of all personnel performing the operation and/or working around the crane.

When driving on roadways, the operator must follow all applicable regulations and/or restrictions.

Although Rough Terrain cranes are specifically designed for rough terrain, the operator should be extremely cautious and aware of terrain operating conditions.



### WARNING Tipping Hazard!

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

Do not drive crane with boom off center because automatic oscillation lock out will occur, making the crane subject to tipping on uneven surfaces. Center the boom over the front, disable swing functions, and engage Turntable Lock Pin.

Fully retract boom and ensure swingaway jib is properly stowed and secured.

**CAUTION****Machine Damage Hazard!**

Do not travel with an empty hook in a position where it can swing freely (except where noted). Remove hook block and/or overhaul ball from hoist rope and stow securely or make sure hook block or overhaul ball is properly secured to tie down provided for that purpose.

Do not drive crane with lift cylinder bottomed. At a minimum, position boom to horizontal.

Fully retract outrigger beams and jacks and properly store pads.

Disengage pumps (if applicable) for extended traveling.

- Use four-wheel drive only when greater traction is necessary. (Refer to *Four-Wheel Drive Operation*, page 4-20 for operating instructions.)
- Make sure outrigger beams and jacks are fully retracted with pads properly stowed.
- Conduct all travel with assistance of a ground person to warn operator of any change in terrain conditions.

**Traveling — Towing/Pulling****CAUTION****Machine Damage Hazard!**

Grove Crane recommends towing or pulling another vehicle with the optional pintle hook (if equipped) or by attaching at a point no higher than the pintle hook height, or severe damage may occur to the drivetrain.

Do not tow or pull by attaching to the tie-down lugs unless the attaching point is no higher than the pintle hook height.

Use four-wheel drive when greater traction is necessary to avoid severe damage to the drivetrain.

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

To avoid severe damage to the drive train while using the crane to tow or pull another vehicle, follow these recommendations:

- Make sure boom is in a horizontal position and not elevated above 0°.

- Make sure outrigger beams and jacks are fully retracted with the pads properly stowed.
- Tow or pull on open ground when possible.
- Connect to the optional pintle hook (if equipped) or attach cables/straps to the crane at a point no higher than the pintle hook height.
- Use four-wheel drive when greater traction is necessary. (Refer to *Four-Wheel Drive Operation*, page 4-20 for operating instructions.)
- Should the crane become mired down, use a tow truck or tractor to free the vehicle. Severe damage to the drivetrain may occur if the operator attempts to free the crane unassisted.
- Conduct all travel with the assistance of a ground person to warn the operator of any changing conditions in the terrain being traversed.

**Traveling — Being Towed/Pulled**

Grove Crane recommends connecting to a pintle hook (if equipped) or evenly attaching to the tie-down lugs when being towed by another vehicle.

**CAUTION****Machine Damage Hazard!**

It is recommended to attach cables/straps to the optional pintle hook (if equipped) or by attaching at a point no higher than the pintle hook height if being towed by another vehicle.

Do not attach to the tie-down lugs unless the attaching point is no higher than the pintle hook height.

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

- Make sure boom is in a horizontal position and not elevated above 0°.
  - Make sure outrigger beams and jacks are fully retracted with pads properly stowed.
- To avoid severe damage to drive train while crane engine is disabled:
- Disconnect drivelines.
  - Disengage parking brake by manually turning parking brake adjustment until axle turns free.

**DANGER****Run-away Crane Hazard!**

Disabling parking brake may result in crane rolling away freely without the ability of the operator to stop the crane.

Make sure that the crane is attached to an adequately sized tow vehicle before disabling the parking brake.

Death or serious injury and damage to machinery could result from moving machinery.

- Secure steering to prevent turning while towing.
- Conduct all travel with assistance of a ground person to warn operator of any changing conditions in terrain being traversed.

**Traveling on Slopes**

Crane operators must exercise caution whenever operating the crane on uneven surfaces. Travel on slopes is permitted if the following conditions are met.

**General Conditions**

- Travel must be on an improved surface or hard-packed dry earth. Crane operators are required to inspect the surface for good tire adhesion.
- All boom sections must be fully retracted.
- Boom extension must be in stowed position or removed from the crane (if traveling with an erected boom extension, follow the requirements under the section *Traveling with Boom Extension Erected*, page 4-18)
- Boom must be positioned over the front of the crane. Boom angle must be as follows:
  - For fore/aft travel on grades less than 15%, the maximum allowable boom angle is 20°.
  - For fore/aft travel on grades greater than 15%, the boom angle must be limited to horizontal (0°).
  - For side slope travel on grades less than 10%, the maximum allowable boom angle is 20°.
  - For side slope travel on grades greater than 10%, the boom angle must be limited to horizontal (0°).

- Swing brake must be applied and turntable lock pin engaged.
- Either the hook block may be reeved over the main boom nose, or the overhaul ball may be reeved over the main boom nose or auxiliary boom nose; the other must be removed. If hook block or overhaul ball remains reeved on the boom, it must be secured at the tie down on the carrier to prevent swinging.
- Tires must be inflated to the recommended pressure for pick and carry operations.
- Hydraulic tank must be filled to specified level. Fuel tank must be over half full.
- Engine and transmission fluids must be filled to the specified levels.
- Axle differentials and planetary hub fluids must be filled to the specified levels.
- No loads may be supported by the boom (i.e., no pick and carry loads) while traversing a slope.
- All cribbing or other non-standard accessories must be removed from the crane.
- Avoid holes, rocks, extremely soft surfaces, and any other obstacles that might subject crane to undue stresses and possible overturn.
- Operator is to check for changing road conditions and utilize a ground person if deemed necessary.

**Slope Limitations - Fore/Aft Travel**

- When traversing a fore/aft slope that is less than or equal to 15% (8.5°), follow the normal crane travel procedures outlined in this manual.
- When traversing a fore/aft slope that is greater than 15% (8.5°) and less than 25% (14°), transmission shall be in four-wheel drive. If crane must be parked, make sure the transmission is in 4-wheel drive and the wheels are chocked.
- When traversing a fore/aft slope that is equal to or greater than 25% (14°), use an assist vehicle and shift the crane's transmission to four-wheel drive. Do not park crane on a slope equal to or greater than 25% (14°).
- Travel on a fore/aft slope greater than 30% (16°), such as ramps, is permitted for short distances at low speed. Consideration must be given for the terrain at the end of the slope (for example, does the terrain level out so that the crane can stop).

- For mine applications and similar, where the slopes and the travel distance can be significant, brake fade must be taken into consideration. For extended travel, check cold tire pressure before start. (Refer to tire inflation chart in Load Chart Book.) After every one hour of travel time, regardless of ambient temperature, stop and allow tires to cool for at least 30 minutes. At destination, tires must be allowed to cool to ambient temperature before crane lifting on rubber.
- For slope limitations when traveling with an elevated boom or an erected boom extension and inserts, refer to the specific traveling instructions in this section.

**Slope Limitations - Side Slope Travel:**

- Side slope shall not exceed 15% (8.5°).

Operator should carefully consider the conditions and travel at the appropriate speed given the condition and should not exceed the maximum speeds in the following tables taking into consideration both fore/aft slopes and side slope.

For  
Reference  
Only

Table 4-1 Fore and Aft Travel - No Load

Crane Condition	0 - 15% (0 - 8.5°)	15 - 25% (8.5 - 14°)	25 - 29% (14 - 16.7°)	30% + (16.7° +)
Two-Wheel Drive	Yes, no restrictions up to 37 kph (23 mph)	No	No	No
Four-Wheel Drive/Low Range	Yes, up to 10 kph (6 mph)	Yes, up to 10 kph (6 mph)	Yes, up to 5 kph (3 mph)	Yes, up to 1.6 kph (1 mph)
Park using Park Brake only	Yes	No	No	No
Park using Park Brake, Chock Wheels, and Four-Wheel Drive		Yes	No, do not park on slopes greater than 25%	No, do not park on slopes greater than 25%
Assist Vehicle Required for Braking and Propulsion	No	No	Yes	Yes
Short Distance Travel allowed (on ramps)				Yes, but do not park on slopes greater than 25%
Consider Brake Fade possibility if traveling long distance	Yes	Yes	Yes	Yes

Table 4-2 Side Slope Travel - No Load

Crane Condition	0 - 5% (0 - 2.9°)	5 - 10% (2.9 - 5.7°)	10 - 15% (5.7 - 8.5°)	15% + (8.5° +)
Two-Wheel Drive	Yes, up to 37 kph (23 mph)	Yes, up to 15 kph (9 mph)	No	No
Four-Wheel Drive/Low Range	Yes, up to 10 kph (6 mph)	Yes, up to 10 kph (6 mph)	Yes, up to 1.6 kph (1 mph)	No

Owner/lessee must take appropriate measures ensure that all persons operating or working with affected models are complying with these Grove Crane recommendations. Crane operator assumes responsibility for determining suitability of traveling on a slope.

Traveling on a slope should only be attempted under controlled conditions specified in these guidelines, and must

be conducted with the utmost diligence and care to make sure safety of all personnel performing the operation and/or working around the crane.

Should operator need to traverse slopes outside the criteria defined in the above guidelines, contact Grove Crane for further guidance.

## Traveling with Elevated Boom



### WARNING

#### Overhead Objects Hazard

Contacting overhead objects while driving crane may result in death, severe injury, and/or equipment damage. Traveling with boom elevated should only be attempted under controlled conditions specified in this section.

Exercise caution whenever driving crane with boom elevated. Travel with the boom elevated is permitted as long as the following steps are followed.

- Limit travel to firm, level surfaces (if traveling on slopes, follow the requirements under the section *Traveling on Slopes*, page 4-15).
- Inspect route of travel before moving crane. Pay particular attention to any changing conditions of terrain being traversed. Avoid any overhead obstructions.
- Travel must be performed in a controlled fashion.
- Do not exceed a speed of 24 km/h (15 mph).
- Inflate tires to recommended pressure for travel operations.
- When using towing attachments, boom must remain horizontal.
- Fully retract all boom sections.
- Refer to *Traveling with Boom Extension Erected*, page 4-18 if boom extension is in the erected position.
- Position boom over front of crane.
- Engage swing brake and turntable lock pin.
- Hook block may be reeved over the main boom nose. Overhaul ball may be reeved over the main boom nose or auxiliary boom nose. Block and ball may be suspended below the boom nose. It is also acceptable to secure the block or ball to carrier tie down point to prevent swinging if necessary.
- Limit boom angle to a maximum of 20°.
- Do not support any load from the boom (see Pick and Carry Load chart for limitations for this application).
- Remove all cribbing or other non-standard accessories from crane.
- Avoid holes, rocks, extremely soft surfaces and any other obstacles that might subject crane to undue stresses and possible overturn.

- Make sure adequate clearance to any overhead obstructions crane may be required to travel beneath.
- Make sure all personnel involved in the operation and those working around crane are aware of any hazards that may be encountered and are trained how to avoid them.

## Traveling with Boom Extension Erected

- Stinger section shall be pinned in the fully retracted position.
- Main Boom shall be fully retracted.
- 7.92 m (26 ft) boom extension shall be erected at minimum (0 deg) offset.
- Jobsite travel shall be only on firm, level surface (if traveling on slopes, follow the requirements under the section *Traveling on Slopes*, page 4-15).
- Maximum travel speed: 2.5 mph.
- Main boom angle shall be between 0 degree and 30 degrees.
- Counterweight shall be installed.
  - Auxiliary hoist or IPO counterweight must be installed.
- Boom shall be directly over front. Swing lock shall be engaged.
- Tires shall be properly inflated.
- RCL shall be programmed to On Rubber, Pick and Carry, Boom Centered Over Front.
- Hook block must be removed from main boom nose.
- Overhaul ball may be reeved over boom extension, hanging 0.9 m (3 ft) below sheave.

## Extended Travel

Depending upon the tire manufacturer, the higher inflation pressures normally specified for lifting on rubber are not recommended for site to site traveling over extended distances. The higher static/creep 8 kph (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 mi).

### CAUTION

#### Tire Damage Hazard!

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

## Traveling — Forward

---

### CAUTION

#### Machine Damage Hazard!

Engage turntable lock pin for travel. Failure to engage lock pin may allow superstructure to swing uncontrolled, damaging machine and/or property.

---

**NOTE:** Cab must be in the fully lowered position for the drive functions to operate. If cab is not in the fully lowered position, the Cab Not Fully Lowered Indicator is on (33, Figure 4-18 and Figure 4-19)

1. With Transmission Shift Lever in neutral (N) position and the parking brake set, start engine and allow it to adequately warm up.
  2. Press Service Brake Foot Pedal.
- 



### WARNING

#### Run-away Crane Hazard!

Releasing the parking brake while the low service brake pressure indicator is on and the buzzer is sounding, indicating service brakes are inoperable, may result in the crane rolling away freely without the ability of operator to stop crane.

Never release parking brake while low service brake pressure indicator is on and buzzer is sounding.

---

3. Disengage parking brake.
  4. Position Drive Axle Switch to two-wheel high or four-wheel low.
- 

### CAUTION

Use four-wheel drive only when more traction is required.

---

5. Lift Transmission Shift Lever up out of detent and push lever to the forward (F) position. Rotate the Transmission Shift Lever Knob to the first (1) gear position. Gear selection "F1" appears in the Operator

Display Module (ODM) to indicate forward propulsion and first (1) gear have been selected.

**NOTE:** If Service Brake Foot Pedal is not pressed before shifting to a gear, the gear selection will flash in the Operator Display Module (ODM) until Transmission Shift Lever is returned to the neutral (N) position. Transmission will not shift.

6. Release Service Brake Foot Pedal and press Foot Throttle Pedal until maximum first gear speed is reached. Rotate Transmission Shift Lever Knob to the second (II) gear position to continue to increase speed. For additional speed, continue shifting to a higher gear.
- 

### CAUTION

#### Possible Machine Damage!

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

---

## Traveling — Reverse

**NOTE:** Cab must be in the fully lowered position for the drive functions to operate. If cab is not in the fully lowered position, the Cab Not Fully Lowered Indicator is on (33, Figure 4-18 and Figure 4-19)

Traveling in reverse is similar to traveling forward, except for shifting Transmission Shift Lever to reverse (R). Refer to *Traveling — Forward*, page 4-19.

---

### CAUTION

#### Machine Damage Hazard!

Engage turntable lock pin for travel. Failure to engage lock pin may allow superstructure to swing uncontrolled, damaging machine and/or property.

---

### CAUTION

#### Possible Machine Damage!

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

---

## Steering

Steering is accomplished by the steering wheel and the rear steer switch (9, Figure 3-8). These two controls, used individually or together, provide front wheel steering, rear wheel steering, four-wheel steering, and crabbing capabilities (Figure 4-5).

### 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.

### Rear Wheel Steering



## WARNING

### Rollover Hazard!

Operate rear steer ONLY at slow speeds. Operation of rear steer at high speed may result in loss of steering control and/or rollover of the crane. Death or serious injury could occur.

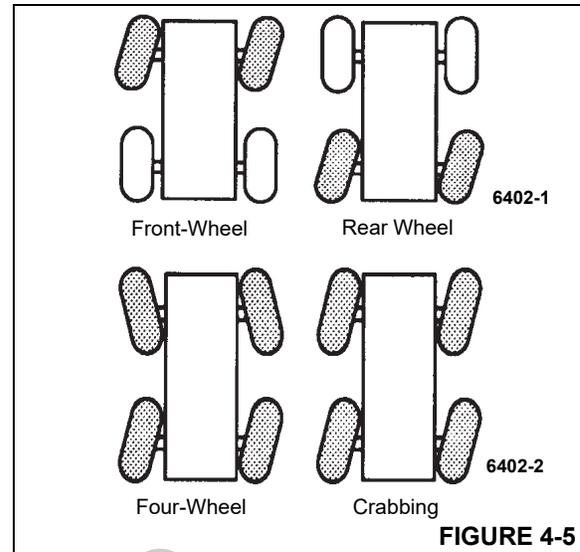
Rear wheel steering is controlled by the Rear Steer Control Switch. Moving control switch to the desired position activates the rear steer cylinders, steering crane in the selected direction.

### Four Wheel Steering

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

### Crab Steering

Crabbing is accomplished with the steering wheel and Rear Steer Control Switch. Depending 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 crane forward or backward in a crabbing manner.



## Four-Wheel Drive Operation

### CAUTION

#### Machine Damage Hazard!

Do not tow or pull in 1st gear with Drive Axle Selector Switch in two-wheel drive position. Severe damage to drive train will result. Always engage four-wheel drive.

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

### CAUTION

#### Possible Machine Damage!

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

1. Stop crane by pressing Service Brake Foot Pedal.
2. Position Transmission Shift Lever to neutral (N) position.
3. Position Drive Axle Selector Switch to four-wheel drive.

**NOTE:** If Drive Axle Selector Switch is positioned to four-wheel drive, Service Brake Foot Pedal is not pressed, and Transmission Shift Lever is not in neutral (N) position Four-Wheel Drive Indicator will flash and four-wheel drive function will not engage.

4. Select gear speed and direction of travel with Transmission Shift Lever and Knob.
5. Drive crane following *Traveling — Forward*, page 4-19.
6. Return Drive Axle Selector Switch to two-wheel drive position as soon as two-wheel traction will suffice and crane motion has stopped. Service Brake Foot Pedal must be pressed and Transmission Shift Lever must be in Neutral (N) position to shift from four-wheel drive to two-wheel drive.

## Differential Lock Operation (Optional)

### CAUTION

#### Unexpected Operation!

When using differential lock, steering characteristics may be affected.

Try to use four-wheel drive to gain adequate traction before using differential lock.

Do not operate differential lock when traveling downhill; at speeds above 16.1 km/h (10 mph); on hard, dry surfaces; and/or during axle spin-out.

**NOTE:** Differential lock will not operate unless Drive Selector Switch is in four-wheel drive position.

### General

The purpose of the differential lock is to provide maximum traction and control on poor road or highway surfaces. When differential locks are actuated, the clutch collar completely locks the differential case, gearing, and axle shafts together, maximizing traction to both wheels of each axle. The lock position will also protect against spinout.

When normal driving conditions exist (during periods of good traction), differential locks should not be actuated. Axles should be allowed to operate with differential action between both wheels.

Obey the following precautions when engaging/disengaging the differential lock function.

1. Lock/unlock differentials only when vehicle is standing still or moving at a constant low speed with wheels not slipping.

### CAUTION

#### Possible Machine Damage!

When driving on hard, dry surfaces with differentials locked, do not turn the wheels. Damage to drive line components can result.

Do not lock differentials when wheels are slipping. Damage to differentials can result.

2. When traveling with differentials locked, do not deviate from a straight path more than absolutely necessary.
3. Locked differentials cause crane's turning radius to increase, creating an understeer condition. Use caution, good judgment, and drive at low speeds when operating vehicle with locked differentials.

4. Lock differentials only when maximum traction is needed on poor road or highway surfaces.



### CAUTION

#### Possible Loss of Vehicle Stability!

Do not lock differentials when vehicle is traveling down steep grades and traction is minimal.

5. Always unlock differentials when need for maximum traction has passed or when traveling on good road or highway surfaces.

### Operation

The differential lock function should preferably be engaged when crane is stationary but may be engaged when moving, if the following conditions are met:

- Crane is moving very slowly (creep speed).
- Wheels are not slipping at time of engagement.

Engage differential locks by doing the following:

1. Press and hold the Axle Differential Lock Control Switch in the locked position with crane stationary or moving at a slow speed.

If moving at a slow speed, let up momentarily on the Foot Throttle Pedal to relieve torque on the differential gearing. This will fully engage differential locks.

**NOTE:** When differentials are locked, the Axle Differential Locked Indicator (20, Figure 4-18 and Figure 4-19) is on.

2. Proceed over poor road condition cautiously.

When adverse condition has passed, disengage differential locks by doing the following:

1. Release the Axle Differential Lock Control Switch, allowing it to return to the unlocked position while maintaining a slow speed.
2. Let up momentarily on the Foot Throttle Pedal to relieve torque on the differential gearing, allowing differential to fully unlock.

**NOTE:** When differentials are unlocked, Axle Differential Locked Indicator will go off.

3. Resume driving at a normal speed using good driving judgment.

### High Speed Glide (Optional)

Before operating the High Speed Glide System the following conditions must be met.

1. The boom must be fully retracted.
2. The boom must be elevated approximately 15 degrees.
3. There must be no load on the hook.

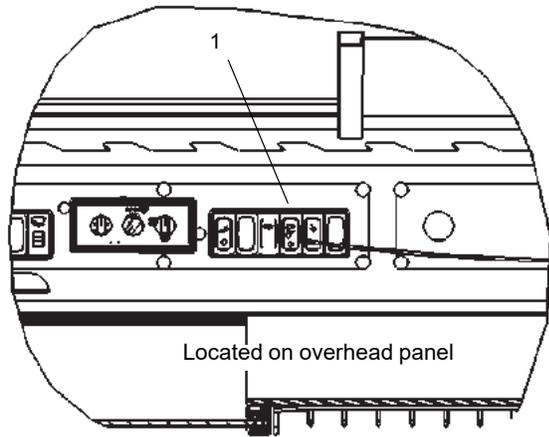
After the above conditions are met, place the high speed glide switch in the engaged position.

The High Speed Glide switch (1, Figure 4-6) is located on the overhead console. It is a two position (ON/OFF) switch.

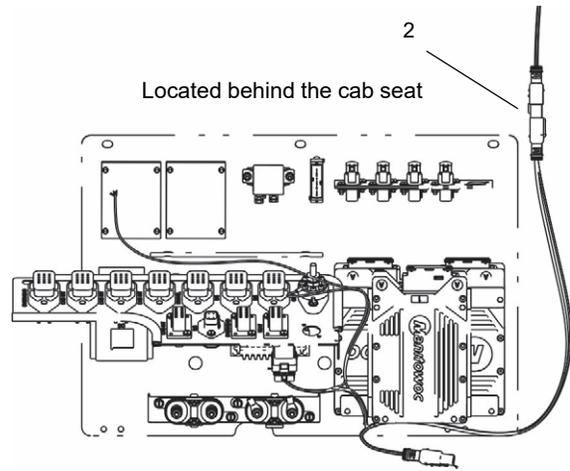
Position the switch to ON to allow the high speed glide components to use the lift cylinder as a shock absorber to the boom (instead of a rigid cylinder), which prevents the boom from “porpoising” (bouncing sharply up and down) at high vehicle speeds. A red LED light illuminates when the switch is in the ON position. When the light illuminates, begin travel. Place the switch in the OFF position when high speed glide is not needed.

**NOTE:** If the system does not function properly, check the 5 amp fuse (2, Figure 4-6) located in the cab which protects the circuit.

For  
Reference  
Only



8853-1



9686

Typical Illustration are for identification reference only. View may not look the same.



8853-2

3



8853-3

4

Item	Description
1	Switch - High Speed Glide
2	Fuse - 5 Amp
3	Accumulator
4	Lift Cylinder

FIGURE 4-6

## CRANING FUNCTIONS

### Controller Operation

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

**NOTE:** Always operate controllers with slow, even pressure.

### Proper Crane Leveling

If a crane is not level within 1% of grade, allowable capacities must be reduced. Therefore, whether lifting on rubber or outriggers, it is essential the crane is level to within 1% of grade. The bubble level indicator provided on the crane is calibrated to be accurate within 1% of grade.

To properly level the crane, the boom must be positioned over front of the crane, fully lowered to horizontal and fully retracted and the cab must be in its fully lowered position. Raise and level crane following instructions for *Using the Outriggers*, page 4-24.

A working crane may settle during lifting operations. Frequently check the crane for level. When rechecking the crane for level, the boom must be positioned over the front of the crane, fully lowered to horizontal and fully retracted and the cab must be in its fully lowered position. If necessary, relevel the crane following instructions for *Using the Outriggers*, page 4-24.

### Bubble Level Indicator Adjustment

The Level Indicator should be checked periodically. If it is suspected that the Level Indicator is out of adjustment, verify and adjust the level as follows:

1. Position crane on a firm, level surface.
2. Fully lower the cab.
3. Extend and set outriggers. Level crane, as indicated by the level indicator, using the outriggers.
4. Place a miracle pointer level, carpenter level, or similar type device on a machined surface such as the turntable bearing or bearing mounting surfaces.

5. Using the outriggers, level crane as indicated on the leveling device used in step 3.
6. Using level indicator mounting screws, adjust level indicator to show level.

### Using the Outriggers

Outriggers are extended and retracted from the Operator Display Module (ODM) in the cab [refer to *Using the Operator Display Module (ODM)*, page 4-35].



#### 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 extended and set in the proper position corresponding to the load capacity chart to be used. Mid extended outriggers must also be locked in position.

---

## Setting the Outriggers

**NOTE:** ECO mode does not work when operating the outriggers.

1. Enable the outrigger functions by doing the following:
  - Engage the Parking Brake.
  - Engage the four-wheel drive
  - Engage the swing brake
  - Disable all crane functions
2. Position the outrigger pads directly out from each outrigger to where the outriggers will be properly extended.
3. If required, extend the outrigger beams to the mid-extend or fully extended position using the Outrigger Extend/Retract Switch and the Operator Display Module (refer to *Outrigger Extend/Retract Switch*, page 3-12 and *Extending/Retracting the Outrigger Beams*, page 4-56).

Refer to *Engaging the Outrigger Mid-Extend Lock Pin*, page 4-26 if the crane is to be operated with the outriggers at the mid-extend position.



### **DANGER**

#### **Tipping Hazard!**

All four outrigger beams must be deployed to one of three positions before beginning operation, which include fully retracted, mid-extend, or fully extended. Do not operate the crane with the outriggers in any other position.

**NOTE:** To assist in setting the outriggers, cranes equipped with the optional Birdseye Camera system will show an outrigger pad target overlay on the overhead camera view that appears on the Birdseye Camera Display in the operator cab [refer to *Birdseye Camera (Optional)*, page 3-23].

**NOTE:** More than one outrigger beam can be extended at a time. To make sure each outrigger is fully extended, repeat step 3 for each outrigger after a multi-outrigger extension.

4. Extend the outrigger jacks using the Outrigger Extend/Retract Switch and the Operator Display Module.

Extend each outrigger jack until the locking levers of the pad engage the jack cylinder barrel.

**NOTE:** More than one jack can be extended at a time.

5. Extend front jacks approximately 8 to 10 cm (3 to 4 in).
6. Extend rear jacks approximately 8 to 10 cm (3 to 4 in).

**NOTE:** Make sure tilting cab is in the lowered position before leveling machine.

7. Repeat steps 5 and 6 until all tires are clear of the ground and crane is level as indicated by the level indicator located on the right side of the cab.

**NOTE:** If it is suspected the level indicator is out of adjustment, verify and adjust the level using the procedures under *Bubble Level Indicator Adjustment*, page 4-24.



### **DANGER**

#### **Tipping Hazard!**

The mid-extend outrigger beam lock pin must be engaged before operating on any beam from the mid-extend position.

For cranes not equipped with an Outrigger Monitoring System (OMS), the operator must select the proper rigging code from the load chart and RCL program for the outrigger position selected. The OMS will NOT change the rigging code to match the existing outrigger position.

## **Outrigger Monitoring System (OMS) (Optional—Standard in North America and European Union Countries)**

The Outrigger Monitoring System (OMS) aids the operator in accurately programming the Rated Capacity Limiter (RCL) by automatically identifying the horizontal position of each outrigger beam. The OMS uses four sensors, one per outrigger beam, to indicate when an outrigger beam is positioned to one of three pre-defined locations, including fully retracted, mid-extend, and fully extended.

Outrigger setup is the same for cranes equipped with OMS; refer to *Setting the Outriggers*, page 4-25.

If crane is setup on outriggers and “On Outriggers” is selected when programming the RCL, then the OMS indicates to the RCL the horizontal position of each of the four outrigger beams. If the outrigger beam configuration programmed by the operator does not match that which is detected by the Outrigger Monitoring System, an outrigger beam over-ride warning screen will appear [refer to *Overriding the Outrigger Monitoring System (only for Cranes in North America and European Union Countries)*, page 4-103]. The RCL does not lock-out the crane or select a different load chart based on the outrigger beam position that is identified by the OMS.

## Engaging the Outrigger Mid-Extend Lock Pin

**NOTE:** It may be necessary to jog the Outrigger Extend/Retract Switch slightly to get proper pin engagement.

1. With outriggers fully retracted, turn locking pin 90° from its stowed position (Figure 4-7) and allow pin to slip into the lock position (Figure 4-8).
2. Slowly extend outrigger beam until the locking pin drops into the hole in top of the outrigger beam, which secures the outrigger beam at the mid-extend position.



Mid-Extend Pin in Stowed Position

9329-1

**FIGURE 4-7**



Mid-Extend Pin in Locked Position

9329-2

**FIGURE 4-8**

## Stowing the Outriggers

1. Enable the outrigger functions by doing the following:
  - Engage the Parking Brake.
  - Engage the four-wheel drive
  - Engage the swing brake
  - Disable all crane functions
2. Retract the rear outrigger jacks using the Outrigger Extend/Retract Switch and the Operator Display Module. Retract the rear outrigger jacks until they have adequate clearance to remove the outrigger pads.
3. Retract the front outrigger jacks using the Outrigger Extend/Retract Switch and the Operator Display Module (ODM). Retract the front outrigger jacks until they have adequate clearance to remove the outrigger pads.



### DANGER

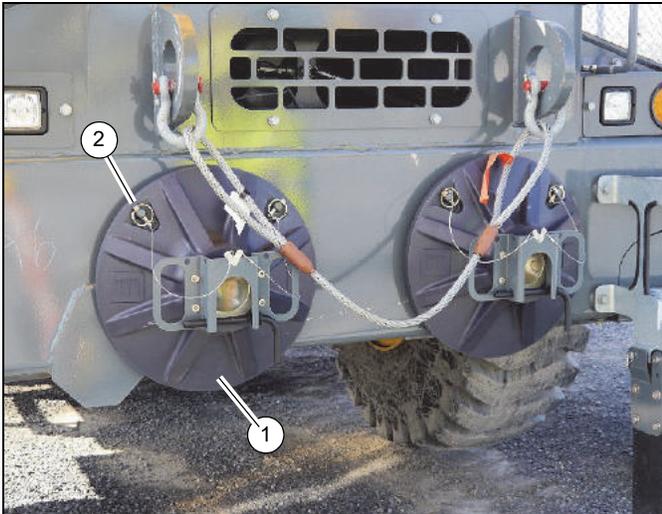
Keep feet and hands clear of outrigger pads when unlocking the pads from the jacks.

4. Release locking levers and allow outrigger pads to drop to the ground.
5. Continue to retract jacks until all four jacks are fully retracted.
6. If required, fully retract the outrigger beams using the Outrigger Extend/Retract Switch and the Operator Display Module.

Disengage the Mid-Extend Lock Pin if outriggers beams are at the mid-extend position (refer to *Stowing the Outrigger Mid-Extend Lock Pin*, page 4-27).

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

7. Stow outrigger pads (Figure 4-9).



9230

Item	Description
1	Outrigger Pad Assembly
2	Quick Pin with Lanyard

FIGURE 4-9

### Stowing the Outrigger Mid-Extend Lock Pin

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

1. From its locked position (Figure 4-10), lift the locking pin upward and turn 90° to the stowed position (Figure 4-11)
2. Continue to extend or retract the outrigger beam to the desired position (fully retracted or fully extended).



Mid-Extend Pin in Locked Position

9329-2

FIGURE 4-10



Mid-Extend Pin in Stowed Position

9329-1

FIGURE 4-11

### Swinging the Boom and Superstructure

**! DANGER**  
Crushing Hazard!

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

Make sure the area around the boom, turntable and counterweights are clear of all obstructions and personnel before swinging.

### CAUTION

Never push or pull swing controller through neutral to the opposite direction to stop swing motion. Automatic swing brake is activated by the controller to stop swing rotation.

**NOTE:** The swing brake automatically disengages when the swing controller is moved from the center (neutral) position and it re-engages when the controller is returned to the center position.

The Swing Brake Engaged Indicator (8, Figure 3-5) on the Operator Display Module (ODM) comes on (amber) when the swing brake is engaged and goes off when the swing brake is disengaged.

**NOTE:** Cranes equipped with the optional Birdseye Camera system will show a swing overlay on the overhead camera view that appears on the 7 in Birdseye Camera Display in the operator cab [refer to *Birdseye Camera (Optional)*, page 3-23].

**NOTE:** Always operate controller with a slow, even pressure.

Dual Axis Controllers

1. Press the Swing Enable/Disable Switch to enable the swing function.

The Swing Enable Indicator (42, Figure 4-18 and Figure 4-19) will come on (green).

2. Push controller on left armrest to the right and hold to swing right (rotates turntable clockwise) or push controller to the left and hold to swing left (rotates turntable counterclockwise).
3. To stop swinging, let controller return to the center (neutral) position and apply the swing brake with the Swing Brake Pedal (refer to *Swing Brake Pedal*, page 3-18).

Single Axis Controller (Optional)

1. Press the Swing Enable/Disable Switch to enable the swing function.

The Swing Enable Indicator (42, Figure 4-18 and Figure 4-19) will come on (green).

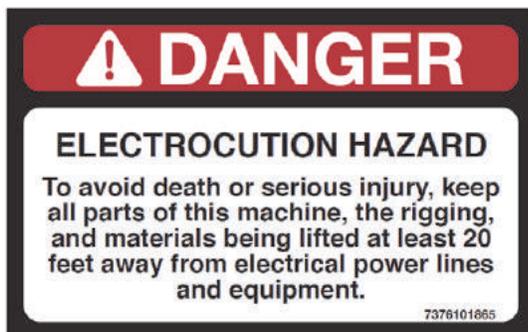
2. Push outer controller on left armrest forward and hold to swing right (rotates turntable clockwise) or pull controller rearward and hold to swing left (rotates turntable counterclockwise).
3. To stop swinging, let swing controller return to the center (neutral) position and apply the swing brake with the Swing Brake Pedal.

**Elevating and Lowering the Boom**

***Elevating the Boom***

 **DANGER**  
**Crushing Hazard!**

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



Dual Axis Controllers

1. Press the Boom Lift Enable/Disable Switch to enable the boom lift function.

The Boom Lift Enable Indicator (44, Figure 4-18 and Figure 4-19) will come on (green).

2. Push controller on right hand armrest to the left and hold to raise the boom.
3. When boom angle gets to the desired elevation, let controller return to the center (neutral) position to stop boom lift function.

Single Axis Controller (Optional)

1. Press the Boom Lift Enable/Disable Switch to enable the boom lift function.

The Boom Lift Enable Indicator (44, Figure 4-18 and Figure 4-19) will come on (green).

2. Pull inner controller on right armrest rearward and hold to raise the boom.
3. When boom angle gets to the desired elevation, let controller return to the center (neutral) position to stop boom lift function.

***Lowering the Boom***

 **DANGER**  
**Crushing and/or Tipping Hazard!**

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

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

**DANGER**  
**Two-Block Hazard!**

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

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

**CAUTION**

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

Dual Axis Controllers

1. Press the Boom Lift Enable/Disable Switch to enable the boom lift function.

The Boom Lift Enable Indicator (44, Figure 4-18 and Figure 4-19) will come on (green).

2. Push controller on right armrest to the right and hold to lower the boom.
3. When boom angle gets to the desired elevation, let controller return to the center (neutral) position to stop boom lower function.

Single Axis Controller (Optional)

1. Press the Boom Lift Enable/Disable Switch to enable the boom lift function.

The Boom Lift Enable Indicator (44, Figure 4-18 and Figure 4-19) will come on (green).

2. Push inner controller on right armrest forward and hold to lower the boom.
3. When boom angle gets to the desired elevation, let controller return to the center (neutral) position to stop boom lower function.

**Telescoping the Boom**

**NOTE:** Telescope function is controlled by a foot pedal or optionally by left hand controller.

***Extending the Boom*****DANGER**  
**Crushing Hazard!**

Check *Load Chart* for maximum load at a given radius, boom angle, and length before extending boom with a load.

**DANGER****Two-Block Hazard**

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

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

Dual Axis Controller

1. Press the Telescope Enable/Disable Switch to enable the boom telescope function.

The Telescope Enable Indicator (43, Figure 4-18 and Figure 4-19) will come on (green).

2. Push controller on left armrest forward and hold to extend the boom.
3. When boom gets to the desired length, let controller return to the center (neutral) position to stop extending the boom.

Single Axis Controller (Optional)

1. Press the Telescope Enable/Disable Switch to enable the boom telescope function.

The Telescope Enable Indicator (43, Figure 4-18 and Figure 4-19) will come on (green).

2. Push inner controller on left armrest forward and hold to extend the boom.
3. When boom gets to the desired length, let controller return to the center (neutral) position to stop extending the boom.

Foot Pedal

1. Press the Telescope Enable/Disable Switch to enable the boom telescope function.

The Telescope Enable Indicator (43, Figure 4-18 and Figure 4-19) will come on (green).

2. Press the top of the Telescope Control Pedal and hold to extend the boom.
3. When boom gets to the desired length, let foot pedal return to the center (neutral) position to stop extending the boom.

***Retracting the Boom*****DANGER**  
**Crushing Hazard!**

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

Dual Axis Controller

1. Press the Telescope Enable/Disable Switch to enable the boom lift function.

The Telescope Enable Indicator (43, Figure 4-18 and Figure 4-19) will come on (green).

2. Push controller on left armrest rearward and hold to retract the boom.

- When boom gets to the desired length, let controller return to the center (neutral) position to stop retracting the boom.

#### Single Axis Controller (Optional)

- Press the Telescope Enable/Disable Switch to enable the boom lift function.

The Telescope Enable Indicator (43, Figure 4-18 and Figure 4-19) will come on (green).

- Push inner controller on left armrest rearward and hold to retract the boom.
- When boom gets to the desired length, let controller return to the center (neutral) position to stop retracting the boom.

#### Foot Pedal

- Press the Telescope Enable/Disable Switch to enable the boom lift function.

The Telescope Enable Indicator (43, Figure 4-18 and Figure 4-19) will come on (green).

- Press the bottom of the Telescope Control Pedal and hold to retract the boom.
- When boom gets to the desired length, let foot pedal return to the center (neutral) position to stop retracting the boom.

### **Lowering and Raising the Main Hoist Rope**



#### **DANGER** **Crushing Hazard!**

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



#### **DANGER** **Crushing Hazard!**

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

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

### **Lowering the Main Hoist Rope**

#### Dual Axis Controllers

- Press the Main Hoist Enable/Disable Switch to enable the main hoist function.

The Main Hoist Enable Indicator (45, Figure 4-18 and Figure 4-19) will come on (green).

- Push controller on right armrest forward and hold to lower the main hoist rope.
- When hook block/overhaul ball gets to the desired height, let controller return to the center (neutral) position to stop lowering the main hoist rope.

**NOTE:** When the main hoist controller is pushed forward to lower the rope, the Hoist Rotation Indicator (28, Figure 3-8) pulses and the Main Hoist Lower Indicator (45, Figure 4-18 and Figure 4-19) comes on to indicate to the operator that the main hoist is operating.

#### Single Axis Controller (Optional)

- Press the Main Hoist Enable/Disable Switch to enable the main hoist function.

The Main Hoist Enable Indicator (45, Figure 4-18 and Figure 4-19) will come on (green).

- Push outer controller on right armrest forward and hold to lower the main hoist rope.
- When hook block/overhaul ball gets to the desired height, let controller return to the center (neutral) position to stop lowering the main hoist rope.

**NOTE:** When the main hoist controller is pushed forward to lower the rope, the Hoist Rotation Indicator (5, Figure 3-9) pulses and the Main Hoist Lower Indicator (45, Figure 4-18 and Figure 4-19) comes on to indicate to the operator that the main hoist is operating.

### **Raising the Main Hoist Rope**



#### **DANGER** **Two-Block Hazard!**

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

Dual Axis Controllers

1. Press the Main Hoist Enable/Disable Switch to enable the main hoist function.

The Main Hoist Enable Indicator (45, Figure 4-18 and Figure 4-19) will come on (green).

2. Pull controller on right armrest rearward and hold to raise the main hoist rope.
3. When hook block/overhaul ball gets to the desired height, let controller return to the center (neutral) position to stop raising the main hoist rope.

**NOTE:** When the main hoist controller is pulled rearward to raise the rope, the Hoist Rotation Indicator (28, Figure 3-8) pulses and the Main Hoist Raise Indicator (45, Figure 4-18 and Figure 4-19) comes on to indicate to the operator that the main hoist is operating.

Single Axis Controller (Optional)

1. Press the Main Hoist Enable/Disable Switch to enable the main hoist function.

The Main Hoist Enable Indicator (45, Figure 4-18 and Figure 4-19) will come on (green).

2. Pull outer controller on right armrest rearward and hold to raise the main hoist rope.
3. When hook block/overhaul ball gets to the desired height, let controller return to the center (neutral) position to stop raising the main hoist rope.

**NOTE:** When the main hoist controller is pulled rearward to raise the rope, the Hoist Rotation Indicator (5, Figure 3-9) pulses and the Main Hoist Raise Indicator (45, Figure 4-18 and Figure 4-19) comes on to indicate to the operator that the main hoist is operating.

**Lowering and Raising the Auxiliary Hoist Rope****DANGER****Crushing Hazard!**

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

**DANGER****Crushing Hazard!**

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

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

**Lowering the Auxiliary Hoist Rope**Dual Axis Controllers

1. Press the Auxiliary Hoist Enable/Disable Switch to enable the auxiliary hoist function.

The Auxiliary Hoist Enable Indicator (46, Figure 4-18 and Figure 4-19) will come on (green).

2. Push controller on left armrest forward and hold to lower the auxiliary hoist rope.
3. When hook block/overhaul ball gets to the desired height, let controller return to the center (neutral) position to stop lowering the auxiliary hoist rope.

**NOTE:** When the auxiliary hoist controller is pushed forward to lower the rope, the Hoist Rotation Indicator (28, Figure 3-8) pulses and the Auxiliary Hoist Lower Indicator (46, Figure 4-18 and Figure 4-19) comes on to indicate to the operator that the auxiliary hoist is operating.

Single Axis Controller (Optional)

1. Press the Auxiliary Hoist Enable/Disable Switch to enable the auxiliary hoist function.

The Auxiliary Hoist Enable Indicator (46, Figure 4-18 and Figure 4-19) will come on (green).

2. Push inner controller on left armrest forward and hold to lower the auxiliary hoist rope.
3. When hook block/overhaul ball gets to the desired height, let controller return to the center (neutral) position to stop lowering the auxiliary hoist rope.

**NOTE:** When the auxiliary hoist controller is pushed forward to lower the rope, the Hoist Rotation Indicator (5, Figure 3-9) pulses and the Auxiliary Hoist Lower Indicator (46, Figure 4-18 and Figure 4-19) comes on to indicate to the operator that the auxiliary hoist is operating.

Raising the Auxiliary Hoist Rope**DANGER****Two-Block Hazard!**

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

Dual Axis Controllers

1. Press the Auxiliary Hoist Enable/Disable Switch to enable the auxiliary hoist function.

The Auxiliary Hoist Enable Indicator (46, Figure 4-18 and Figure 4-19) will come on (green).

2. Pull controller on left armrest rearward and hold to raise the auxiliary hoist rope.
3. When hook block/overhaul ball gets to the desired height, let controller return to the center (neutral) position to stop raising the auxiliary hoist rope.

**NOTE:** When the auxiliary hoist controller is pulled rearward to raise the rope, the Hoist Rotation Indicator (28, Figure 3-8) pulses and the Auxiliary Hoist Raise Indicator (46, Figure 4-18 and Figure 4-19) comes on to indicate to the operator that the auxiliary hoist is operating.

Single Axis Controller (Optional)

1. Press the Auxiliary Hoist Enable/Disable Switch to enable the auxiliary hoist function.

The Auxiliary Hoist Enable Indicator (46, Figure 4-18 and Figure 4-19) will come on (green).

2. Pull inner controller on left armrest rearward and hold to raise the auxiliary hoist rope.
3. When hook block/overhaul ball gets to the desired height, let controller return to the center (neutral) position to stop raising the auxiliary hoist rope.

**NOTE:** When the auxiliary hoist controller is pulled rearward to raise the rope, the Hoist Rotation Indicator (5, Figure 3-9) pulses and the Auxiliary Hoist Raise Indicator (46, Figure 4-18 and Figure 4-19) comes on to indicate to the operator that the auxiliary hoist is operating.

Selecting the Hoist Speed Range**CAUTION**

Do not change speeds while hoist is active.

On dual axis controllers and single axis controllers (optional), the high speed hoist function can be enabled by doing one of the following:

- With the main hoist function disabled, hold the Main Hoist Enable/Disable Switch for 1.5 seconds to enable the main hoist function at high speed.
- With the auxiliary hoist function disabled, hold the Auxiliary Hoist Enable/Disable Switch for 1.5 seconds to enable the auxiliary hoist function at high speed.
- or -
- With the main hoist function disabled, double-click the Main Hoist Enable/Disable Switch to enable the main hoist function at high speed.
- With the auxiliary hoist function disabled, double-click the Auxiliary Hoist Enable/Disable Switch to enable the auxiliary hoist function at high speed.

**NOTE:** When the main or auxiliary hoist function is enabled at high speed, the respective Main Hoist High Speed Indicator (45, Figure 4-18 and Figure 4-19) or Auxiliary Hoist High Speed Indicator (46, Figure 4-18 and Figure 4-19) will come on.

On dual axis controllers only, press and release the outside (farthest from operator) of the respective Hoist Speed Toggle Switch to enable high speed (maintained state). Press and hold the inside (closest to operator) of the switch to temporarily enable high speed (momentary state) and release the switch to disable the high speed.

## STOWING AND PARKING

When parking crane, do the following:



### DANGER

#### Tipping Hazard!

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.

1. Remove load from hook.
2. Fully retract all boom sections.
3. Lower boom to normal travel position.
4. Engage swing brake and swing lock pin.
5. Retract all jack cylinders and outrigger beams.
6. Park crane on a stable surface.

### CAUTION

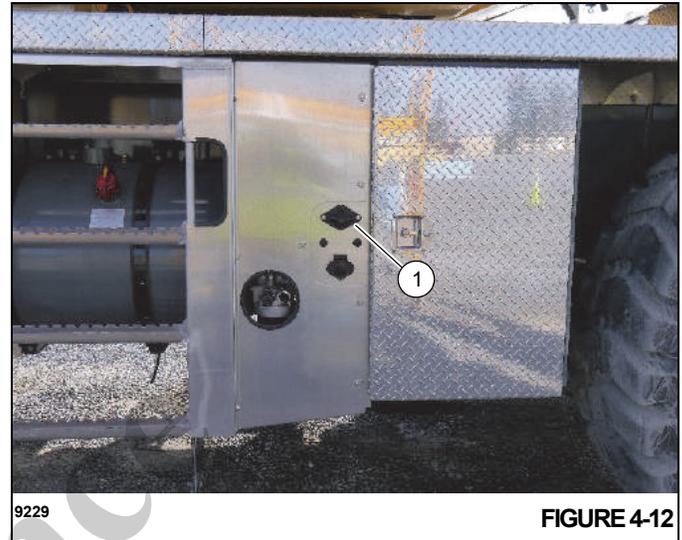
#### Avoid Crane Damage!

Do not engage the parking brake while the vehicle is moving. Damage to the crane can occur.

Disengage the parking brake before driving. Damage to the crane can occur.

7. Apply parking brakes and if necessary, chock wheels.
8. Make sure all operating controls are in neutral position.
9. Shut down engine following proper procedures specified in this *Operator Manual* and applicable engine manual.
10. Remove keys.

11. Close and lock, if applicable, all windows, covers, and doors.
12. Set battery disconnect switch (1, Figure 4-12) to OFF position if machine will be inactive for over 24 hours.



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FIGURE 4-12

## LEAVING CRANE UNATTENDED



### WARNING

#### Tipping Hazard!

Changing weather conditions including, but not limited to, wind, ice accumulation, precipitation, flooding, lightning, etc. should be considered when determining the location and configuration of a crane when it is to be left unattended.

Failure to comply with these instructions may cause death or serious injury.

The configuration in which the crane should be left while unattended shall be determined by a qualified, designated individual familiar with the job site, configuration, conditions, and limitations.

**NAVIGATING THE OPERATOR DISPLAY MODULE AND RATED CAPACITY LIMITER DISPLAY MODULE**

For a description the Operator Display Module and Rated Capacity Limiter Display Module (ODM and RDM), refer to *Operator Display Module and Rated Capacity Limiter Display Module*, page 3-8

The Operator Display Module and Rated Capacity Limiter Display Module (ODM and RDM) each have an integral Navigation Control Pad (Figure 4-13) which allows the operator to navigate through the function screens for that module. The buttons on the two Navigation Control Pads are identical in configuration and perform the same navigational functions.



9221-1

Item	Description
1	Escape Button
2	Tab Button
4	Menu Button
5	Left/Right/Up/Down Arrow Buttons
6	OK Button

**FIGURE 4-13**

The Jog Dial (Figure 4-14), mounted on the right armrest, can also be used to navigate the Operator Display Module (ODM) and the Rated Capacity Limiter Display Module (RDM) in a similar manner:

- Rotating the Jog Dial performs the same function as pressing the Left/Right/Up/Down Arrow Buttons on the Navigational Control Pads
- Pressing the Jog Dial performs the same function as pressing the OK Button on the Navigation Control Pads
- Pressing one of the four buttons surrounding the Jog Dial performs the same function as pressing the respective button surrounding the Arrow and OK Buttons on the Navigational Control Pads

The Jog Dial can control one display module at a time. A Jog Dial Status Indicator (47, Figure 4-18 and Figure 4-19)

appears in the lower left corner of either the ODM or RDM to indicate to the operator which display module is being controlled by the Jog Dial at that time. The Screen Toggle Button (3, Figure 4-14) is used to switch between controlling the ODM or RDM.

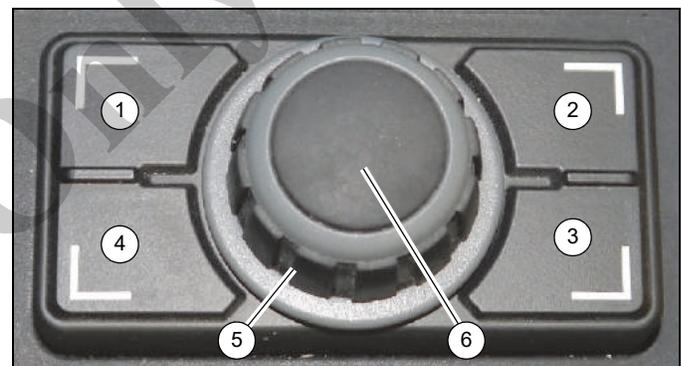
The ODM has a Main Screen and a Menu Screen. The operator can return to the Main Screen by pressing the Escape Button (1, Figure 4-13 and Figure 4-14) or to the Menu Screen by pressing the Menu Button (4, Figure 4-13 and Figure 4-14).

The RDM has a Setup Screen and a Menu Screen. The operator can return to the Setup Screen by pressing the Escape Button (1, Figure 4-13 and Figure 4-14) or he can return to the Menu Screen by pressing the Menu Button (4, Figure 4-13 and Figure 4-14).

**NOTE:** When setting the outriggers using the Outrigger Extend/Retract function screen, the Escape Button and Menu Button perform outrigger functions (refer to *Outrigger Group*, page 4-55)

Rotating the Jog Dial or pressing the Arrow Buttons allow the operator to select the different function icons that are found on the Main Screens and Menu Screens of the ODM and RDM. When a function icon is selected, the icon will turn orange in color.

The Tab Button (2, Figure 4-13) on the ODM's Navigation Control Pad can be pressed to temporarily silence active audible alarms.



9221-2

Item	Description
1	Escape Button
2	Tab Button
3	Screen Toggle Button
4	Menu Button
5	Jog Dial (Rotate dial to move cursor)
6	OK Button (Press Jog Dial to select)

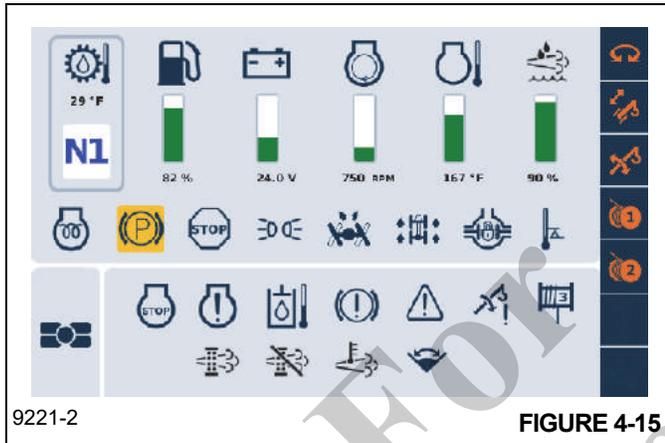
**FIGURE 4-14**

## USING THE OPERATOR DISPLAY MODULE (ODM)

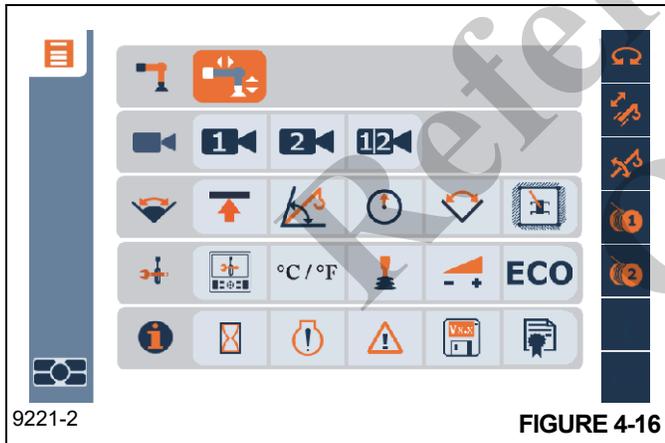
**NOTE:** Refer to *Operator Display Module (ODM)*, page 3-8 for additional information.

The Operator Display Module (ODM) has two primary screens:

### 1. Main Screen (refer to *Main Screen*, page 4-35)



### 2. Menu Screen (refer to *Menu Screen*, page 4-53)

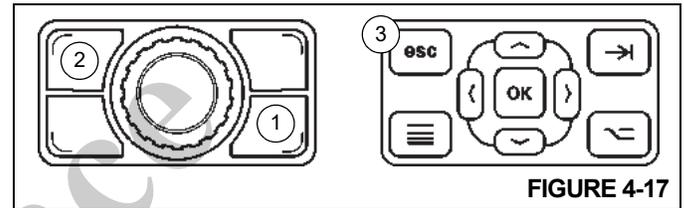


## Main Screen

The Main Screen (Figure 4-18 and Figure 4-19) appears on the ODM (lower screen) when the key switch is initially set to the ON position.

Navigating back to the Main Screen can be accomplished by performing one of the following:

- Press the Screen Toggle Button (1, Figure 4-17) at the Jog Dial to select the ODM screen control, then press the Escape Button (2).
- or -
- Press the Escape Button (3, Figure 4-17) on the Navigation Control Pad at the ODM.

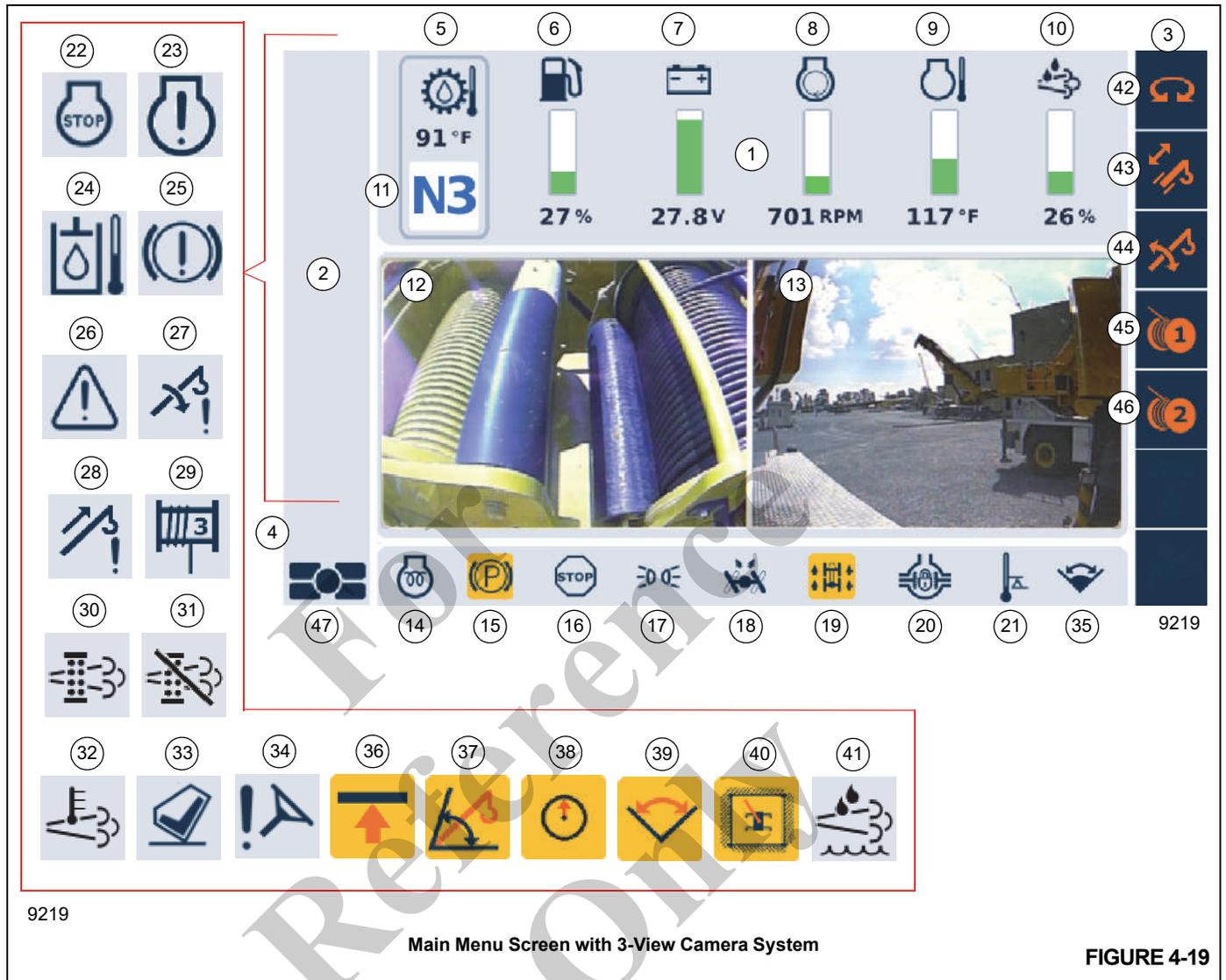


There are two different Main Screen layouts, one for cranes not equipped with the optional 3-View camera System (Figure 4-18) and one for cranes equipped with the 3-View Camera System (Figure 4-19).

The Main Screen is separated into the following areas:

- **Status Area** (1, Figure 4-18 and Figure 4-19) (refer to *Status Area*, page 4-39)
- **Alerts Area** (2, Figure 4-18 and Figure 4-19) (refer to *Alerts Area*, page 4-43)
- **Status Bar** (3, Figure 4-18 and Figure 4-19) (refer to *Status Bar*, page 4-49)
- **Active Screen Indicator Area** (4, Figure 4-18 and Figure 4-19) (refer to *Active Screen Indicator Area*, page 4-53)





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Main Menu Screen with 3-View Camera System

FIGURE 4-19

Item	Description	Item	Description
1	Status Area	25	Low Brake Pressure Indicator
2	Alerts Area	26	Crane Fault Indicator
3	Status Bar	27	Low Boom Angle Indicator
4	Active Screen Indicator Area	28	Telescope Lockout Indicator
5	Transmission Temperature Indicator	29	Third Wrap Indicator (Optional)
6	Fuel Level Indicator	30	Diesel Particulate Filter Indicator (Tier 4 only)
7	Battery Voltage Indicator	31	Inhibit Exhaust System Cleaning Indicator (Tier 4 only)
8	Engine Speed Indicator	32	High Exhaust System Temperature (HEST) Indicator (Tier 4 only)
9	Engine Coolant Temperature Indicator	33	Cab Not Fully Lowered Indicator
10	Diesel Exhaust Fluid (DEF) Level Indicator (Tier 4 only)	34	Low Steering System Pressure Indicator (CE cranes)
11	Direction/Gear Indicator	35	Working Range Limiter (WRL) Indicator
12	Hoist Camera (optional)	36	Working Range Limiter (WRL) Boom Height Indicator
13	Right-side Camera (optional)	37	Working Range Limiter (WRL) Boom Angle Indicator
14	Engine Wait-to-Start Indicator	38	Working Range Limiter (WRL) Radius Indicator
15	Parking Brake Indicator	39	Working Range Limiter (WRL) Swing Angle Indicator
16	Emergency Stop Indicator	40	Working Range Limiter (WRL) Virtual Walls Indicator
17	Marker/Position/Side Lights Indicator	41	Diesel Exhaust Fluid (DEF) Level Indicator (Tier 4 only)
18	Rear Wheels Not Centered Indicator	42	Swing Enable/Disable Indicator
19	Four-Wheel Drive Indicator	43	Telescope Enable/Disable Indicator
20	Differential Lock Indicator (optional)	44	Boom Lift Enable/Disable Indicator
21	-29°C Temperature Indicator	45	Main Hoist Enable/Disable Indicator
22	Engine Stop Indicator	46	Auxiliary Hoist Enable/Disable Indicator (optional)
23	Engine Warning Indicator	47	Active Screen Indicator
24	Hydraulic Oil Temperature Indicator		

**Status Area**

The following are the icons which appear in the Status Area (1, Figure 4-18 and Figure 4-19) of the ODM Main Screen:

Item	Description	Graphic	Explanation
5	<b>Transmission Oil Temperature Indicator</b>		Indicates the transmission oil temperature in the selected unit of measure (°C / °F).
	<b>High Transmission Oil Temperature Indicator (Red)</b>		Indicates the transmission oil is above 121°C (250°F) and is too high. When the indicator comes on (red), the warning buzzer will sound. When safe to do so, move the crane to a location where it can be parked and secured, then let transmission oil cool by running engine at idle. Red indicator will go off when transmission oil temperature drops below 115°C (239°F).
6	<b>Fuel Level Indicator</b>		Indicates the fuel level as a percentage.
	<b>Low Fuel Level Indicator (Amber)</b>		Indicates the fuel level is between 5% full and 15% full.
	<b>Low Fuel Level Indicator (Red)</b>		Indicates the fuel level is below 5% full.
7	<b>Battery Voltage Indicator</b>		Indicates the battery voltage when the engine is off and the charging voltage when the engine is running.
	<b>Low Battery Voltage Indicator (Red)</b>		Indicates the alternator has failed and is not charging the battery. Stop the engine and correct the malfunction.
8	<b>Engine Speed Indicator</b>		Indicates the engine speed in revolutions per minute (RPM).
	<b>Engine Over-speed Indicator (Red)</b>		Indicates the engine speed is above 3750 rpm and is too high. Apply the service brake to reduce travel speed and engine RPM, or shift to higher gear.

Item	Description	Graphic	Explanation
9	Engine Coolant Temperature Indicator		Indicates engine coolant temperature in the selected unit of measure (°C / °F).
	High Engine Coolant Temperature Indicator (Amber)		Indicates the engine coolant temperature is between 93°C (200°F) and 107°C (225°F), and is too high. Safely stop the lifting operations, land and secure any load being lifted. If possible, retract and lower the boom. Shut down and secure the crane.
	High Engine Coolant Temperature Indicator (Red)		Indicates the engine coolant temperature is above 107°C (225°F) and is too high. Safely stop the lifting operations, land and secure any load being lifted. If possible, retract and lower the boom. Shut down and secure the crane.
10	Diesel Exhaust Fluid (DEF) Level Indicator (Tier 4 only)		Indicates the DEF level is above 10% full (0.83 gal).
	Low Diesel Exhaust Fluid (DEF) Level Indicator (Tier 4 only) (Amber - Constant On)		Indicates the DEF level is between 0% full (0.0 gal) and 10% full (0.83 gal). If the DEF tank is not filled, after some time the Engine Warning Indicator will come on (constant).
	Low Diesel Exhaust Fluid (DEF) Level Indicator (Tier 4 only) (Amber - Flashing)		Indicates the DEF tank is empty. If the DEF tank is not filled, an engine derate will occur. If the operator continues to run the engine and the DEF fluid tank is not filled, after some time the Engine Stop Indicator will come on (constant) and a more severe engine derate will occur. If the operator continues to run the engine and the DEF fluid tank is not filled, after some time the Engine Stop Indicator will begin to flash. Engine shutdown will occur approximately 30 seconds after the Engine Stop Indicator begins to flash.
11	Direction/Gear Indicator		Indicates if the transmission is in neutral (N), forward (F), or reverse (R) and what gear is selected (1, 2, or 3).
12	Hoist Camera	--	Hoist camera view shows remaining rope on hoists
13	Right-side Camera	--	Right-side camera view shows area to the right, rear of the crane. This view is mirrored to simulate a right side rear-view mirror.

Item	Description	Graphic	Explanation
14	Engine Wait-to-Start Indicator		Indicates the outside ambient temperature is warm enough that preheating of the air inside the air-intake manifold is not required. Engine can be started.
	Engine Wait-to-Start Active Indicator (Amber)		Indicates the outside ambient temperature is low and preheating of the air inside the air-intake manifold is required. Do not start engine until indicator goes off (refer to <i>Engine Operation</i> , page 4-6).
15	Parking Brake Indicator		Indicates the Parking Brake Control Switch is positioned to off and the parking brake is not applied.
	Parking Brake Active Indicator (Amber)		Indicates the Parking Brake Control Switch is positioned to on and the parking brake is applied (refer to <i>Park Brake Control Switch</i> , page 3-4).
16	Emergency Stop Indicator		Indicates the Emergency Stop Switch is pulled out.
	Emergency Stop Active Indicator (Red)		Indicates the Emergency Stop Switch is pushed in. When the indicator comes on (red), the warning buzzer will sound (refer to <i>Emergency Stop Switch</i> , page 3-16).
17	Marker/Position/Side Lights Indicator		Indicates the Headlights Switch is positioned to Off and the marker, position, and side lights are off.
	Marker/Position/Side Lights Active Indicator (Amber)		Indicates the Headlights Switch is positioned to Marker Lights or Headlights and the marker, position, and side lights are on (refer to <i>Headlights Switch</i> , page 3-4).
18	Rear Wheels Not Centered Indicator		Indicates the rear wheels are centered.
	Rear Wheels Not Centered Indicator (Amber)		Indicates the rear wheels are not centered (refer to <i>Rear Steer Switch</i> , page 3-13 and <i>Steering</i> , page 4-20).

Item	Description	Graphic	Explanation
19	<b>Four-Wheel Drive Indicator</b>		Indicates the transmission is shifted to two-wheel high (refer to <i>Drive Axle Selector Switch</i> , page 3-4).
	<b>Four-Wheel Drive Engaged Indicator (Amber)</b>		Indicates the transmission is shifted to four-wheel low (refer to <i>Drive Axle Selector Switch</i> , page 3-4). Indicator will flash if the crane is shifted between two-wheel high and four-wheel low and the brake pedal is not depressed and the transmission is not in neutral.
20	<b>Differential Lock Indicator</b>		Indicates the Differential Lock Switch is set to the UN-LOCK position and the carrier differential lock located on each axle are open.
	<b>Differential Lock Engaged Indicator (Amber)</b>		Indicates the Differential Lock Switch is set to the LOCK position and the carrier differential lock located on each axle are closed (refer to <i>Differential Lock On/Off Switch (Optional)</i> , page 3-13). When in the LOCK position there is no differential action between the wheels.
21	<b>-29C° (-20°F) Temperature Indicator (Optional)</b>		Indicates the ambient temperature is above -29°C (-20°F).
	<b>Below -29C° (-20°F) Temperature Indicator (Red)</b>		Indicates the ambient temperature is below -29°C (-20°F). All crane functions are locked out.

**Alerts Area**

The following icons can appear in the Alerts Area (2, Figure 4-18 and Figure 4-19) of the ODM Main Screen.

These icons will appear in the bottom Alerts Area of the ODM Main Screen for cranes not equipped with the optional 3-View Cameras and in the left Alerts Area of the ODM Main Screen for cranes equipped with the optional 3-View Cameras.

Item	Description	Graphic	Explanation
22	Engine Stop Indicator		Indicates there are no active engine errors/faults.
	Engine Stop Active Indicator (Red)		Indicates there is one or more active engine faults. When the indicator comes on (red), the warning buzzer will sound. Safely stop the lifting operations, land and secure any load being lifted. If possible, retract and lower the boom. Shut down and secure the crane. Access the fault codes through the Menu Screen of the ODM (refer to <i>Menu Screen</i> , page 4-53).
23	Engine Warning Indicator		Indicates there are no active engine faults.
	Engine Warning Active Indicator (Amber)		Indicates there is one or more active engine faults. Access the fault codes through the Menu Screen of the ODM (refer to <i>Menu Screen</i> , page 4-53). Correct malfunction as soon as possible.
24	Hydraulic Oil Temperature Indicator		Indicates hydraulic oil temperature is below 87.8°C (190°F).
	High Hydraulic Oil Temperature Indicator (Red)		Indicates the hydraulic oil temperature exceeds 87.8°C (190°F). The warning buzzer will sound. Safely stop crane operation and let hydraulic oil cool by running engine at idle with no functions actuated.
25	Low Brake Pressure Indicator		Indicates the hydraulic pressure in the dual brake accumulator charge valve is within normal operating requirements.
	Low Brake Pressure Active Indicator (Red)		Indicates the hydraulic pressure in the dual brake accumulator charge valve is below normal operating requirements. When the indicator comes on (red), the warning buzzer will sound. Do not drive crane until brake pressure malfunction is corrected.

Item	Description	Graphic	Explanation
26	Crane Fault Indicator		Indicates there are no crane fault codes.
	Crane Fault Active Indicator (Red)		Indicates there is one or more crane faults. When the indicator comes on (red), the warning buzzer will sound. Access the fault codes through the Menu Screen of the ODM (refer to <i>Menu Screen</i> , page 4-53).
27	Low Boom Angle Indicator		Indicates the boom is outside the carrier avoidance area.
	Low Boom Angle Indicator (Amber - Constant On)		Indicates the boom has reached the carrier avoidance area. When the indicator comes on (amber), the warning buzzer will sound. The crane system will lock out the boom down and swing left or right crane functions. In an emergency situation, a Limit Bypass Switch can be used to over-ride the crane function lock outs (refer to <i>Operating Controls</i> , page 3-1 for information on the different bypass switches).
	Low Boom Angle Indicator (Amber - Flashing))		Indicates the carrier avoidance area lock-out functions are over-riden by way of a limit bypass switch.
28	Telescope Lockout Indicator		Indicates that the pressure in the telescope extend circuit is acceptable for the given boom length.
	Telescope Lockout Active Indicator (Amber - Constant On)		Indicates that the pressure in the telescope extend circuit is too high for the given boom length. The crane control system will reduce the system pressure and eventually stop the telescope extend function to protect boom components. If the boom is not fully extended, the load must be relieved from the crane before continuing to extend the boom.
29	Third Wrap Indicator (Optional)		Indicates the number of wraps of rope on the main hoist or auxiliary hoist (optional) is above the minimum required.
	Third Wrap Indicator (Red)		Indicates the minimum number of wraps of rope required has been reached on the main hoist, auxiliary hoist (optional), or both. When the indicator comes on (red), the warning buzzer will sound. The crane system will lock-out the hoist down and telescope out crane functions.

Item	Description	Graphic	Explanation
30	Diesel Particulate Filter Indicator (Tier 4 only)		Indicates the exhaust system does not require cleaning.
	Diesel Particulate Filter Clogged Indicator (Tier 4 only) (Amber)		Indicates the exhaust system requires cleaning. Stop and perform a manual exhaust system cleaning [refer to <i>Exhaust System Cleaning Switch (Tier 4 Engine Only)</i> , page 3-7].
31	Inhibit Exhaust System Cleaning Indicator (Tier 4 only)		Indicates the Exhaust System Cleaning Switch is set to the Inhibit Cleaning position, which prevents the exhaust cleaning process from automatically occurring.
	Inhibit Exhaust System Cleaning Indicator (Tier 4 only) (Amber - Flashing)		Indicates the Exhaust System Cleaning Switch is set to the Inhibit Cleaning position, but the exhaust system requires cleaning. Stop and perform a manual exhaust system cleaning (refer to <i>Exhaust System Cleaning Switch (Tier 4 Engine Only)</i> , page 3-7)
	Inhibit Exhaust System Cleaning Indicator (Tier 4 only) (Amber - Constant On)		Indicates the Exhaust System Cleaning Switch is set to the Inhibit Cleaning position, but the exhaust system requires cleaning immediately. Stop and perform a manual exhaust system cleaning (refer to <i>Exhaust System Cleaning Switch (Tier 4 Engine Only)</i> , page 3-7).
32	High Exhaust System Temperature (HEST) Indicator (Tier 4 only)		Indicates the exhaust temperature is below 675°C (1247°F).
	High Exhaust System Temperature (HEST) Active Indicator (Tier 4 only) (Red)		Indicates the exhaust temperature is above 675°C (1247°F) during the exhaust system cleaning process. Indicator remains on until the temperatures falls below 625°C (1157°F).
33	Cab Fully Lowered Indicator		Indicates the cab is in the fully lowered position.
	Cab Not Fully Lowered Active Indicator (Amber)		Indicates the cab is not in the fully lowered position (refer to <i>Cab Tilt Switch</i> , page 3-13). Drive functions are disabled when this indicator is on.

Item	Description	Graphic	Explanation
34	<b>Steering System Pressure Indicator (CE cranes)</b>		Indicates the steering system pressure is normal [above 690 KPa (100 psi)].
	<b>Low Steering System Pressure Active Indicator (CE cranes) (Red)</b>		Indicates the steering system pressure is below normal operating pressure [below 690 KPa (100 psi)]. When the indicator comes on (red), the warning buzzer will sound. Do not drive the crane until malfunction is corrected.
35	<b>Working Range Limiter (WRL) Indicator</b>		Indicates all working range limiters are off.
	<b>Working Range Limiter (WRL) Indicator (Green)</b>		Indicates one or more working range limiters are defined.
	<b>Working Range Limiter (WRL) Bypassed Indicator (Amber - Flashing)</b>		Indicates a WRL lock out function is bypassed by way of a Limit Bypass Switch.
36	<b>Working Range Limiter (WRL) Boom Height Warning Indicator (Amber)</b>		Indicates the boom tip height is within 3.1 m (10 ft) of the boom height limit setpoint. The warning buzzer slowly beeps when the boom tip is within 3.1 m (10 ft) of the boom height limit setpoint and changes to a fast beep when the boom tip is within 1.5 m (5 ft) of the boom height limit setpoint.
	<b>Working Range Limiter (WRL) Boom Height Stop Indicator (Red)</b>		Indicates the boom tip height is at the boom height limit setpoint. The warning buzzer is on (constant). For cranes that are equipped with the WRL Lock Out Function, the telescope out and boom up crane functions are locked out.
37	<b>Working Range Limiter (WRL) Boom Angle Warning Indicator (Amber)</b>		Indicates the boom angle is within 10° of a boom angle limit setpoint. The warning buzzer slowly beeps when the boom angle is within 10° of the boom angle limit setpoint and changes to a fast beep when the boom tip is within 5° of the boom height limit setpoint.
	<b>Working Range Limiter (WRL) Boom Angle Stop Indicator (Red)</b>		Indicates the boom angle is at a boom angle limit setpoint. The warning buzzer is on (constant). For cranes that are equipped with the WRL Lock Out Function, the boom up or boom down crane function is locked out, depending upon which limit is reached.

Item	Description	Graphic	Explanation
38	<b>Working Range Limiter (WRL) Radius Warning Indicator (Amber)</b>		Indicates the boom radius is within 3.1 m (10 ft) of a radius limit setpoint. The warning buzzer slowly beeps when the boom radius is within 3.1 m (10 ft) of the radius limit setpoint and changes to a fast beep when the radius is within 1.5 m (5 ft) of the radius limit setpoint.
	<b>Working Range Limiter (WRL) Radius Stop Indicator (Red)</b>		Indicates the radius is at a radius limit setpoint. The warning buzzer is on (constant). For cranes that are equipped with the WRL Lock Out Function, the boom up and telescope in, or boom down and telescope out, crane functions are locked out, depending upon which limit is reached.
39	<b>Working Range Limiter (WRL) Swing Angle Warning Indicator (Amber)</b>		Indicates the swing angle is within 20° of a swing angle limit setpoint. The warning buzzer slowly beeps when the swing angle is within 20° of the swing angle limit setpoint and changes to a fast beep when the swing angle is within 5° of the swing angle limit setpoint. For cranes that are equipped with the WRL Lock Out Function, when the swing angle is within 20° of the swing angle lock out setpoint, the swing function commanded by the controller may be reduced or suspended depending upon the weight of the load and the swing speed. Warning Due to the free-swing characteristic of the crane's superstructure, the boom and load can potentially swing past the swing angle setpoint, even if the swing function commanded by the controller is reduced or suspended (locked out) by the WRL. This can happen for several reasons, including how level the crane is and environmental conditions, such as wind speed.
	<b>Working Range Limiter (WRL) Swing Angle Stop Indicator (Red)</b>		Indicates the swing angle is at a swing angle limit setpoint. The warning buzzer is on (constant). For cranes that are equipped with the WRL Lock Out Function, the swing left or swing right crane function is locked out, depending upon which limit is reached.
40	<b>Working Range Limiter (WRL) Virtual Walls Warning Indicator (Amber)</b>		Indicates the boom tip is within 6.1 m (20 ft) of a virtual wall that has been set. The warning buzzer slowly beeps when the boom tip is within 6.1 m (20 ft) of a virtual wall and changes to a fast beep when the boom tip is within 1.5 m (5 ft) of a virtual wall.
	<b>Working Range Limiter (WRL) Virtual Walls Stop Indicator (Red)</b>		Indicates the boom tip is at a virtual wall that has been set. The warning buzzer is on (constant). For cranes that are equipped with the WRL Lock Out Function, the telescope out, boom down, and swing left or swing right crane functions are locked out.

The following Diesel Exhaust Fluid Level Indicator appears in the left Alerts Area of the ODM on all function screens except the Main Screen.

Item	Description	Graphic	Explanation
	<b>Diesel Exhaust Fluid Level Indicator (Tier 4 only)</b>		Indicates the DEF level is above 10% full (0.83 gal).
41	<b>Low Diesel Exhaust Fluid Level Indicator (Tier 4 only) (Amber - Constant On)</b>		Indicates the DEF level is between 0% full (0.0 gal) and 10% full (0.83 gal). If the DEF tank is not filled, after some time the Engine Warning Indicator will come on (constant).
	<b>Low Diesel Exhaust Fluid Level Indicator (Tier 4 only) - (Amber - Flashing)</b>		Indicates the DEF tank is empty. If the DEF tank is not filled, an engine derate will occur. If the operator continues to run the engine and the DEF fluid tank is not filled, after some time the Engine Stop Indicator will come on (constant) and a more severe engine derate will occur. If the operator continues to run the engine and the DEF fluid tank is not filled, after some time the Engine Stop Indicator will begin to flash. Engine shutdown will occur approximately 30 seconds after the Engine Stop Indicator begins to flash.

For Reference Only

**Status Bar**

The following are the icons which can appear in the Status Bar (3, Figure 4-18 and Figure 4-19) of the ODM Main Screen:

Item	Description	Graphic	Explanation
42	<b>Swing Disabled Indicator</b>		Indicates the swing function is disabled (refer to <i>Crane Function Enable/Disable Switch</i> , page 3-6 and <i>Swing Enable/Disable Switch</i> , page 3-13).
	<b>Swing Standby Indicator (Amber - Constant On)</b>		Indicates the swing left or right function is enabled, but is in a standby mode due to the operator not being seated (causing seat switch to open). The swing function is re-enabled by either sitting in the operator seat or by actuating a dead-man switch on the left or right dual axis controllers [refer to <i>Deadman Switches (Optional) (Dual Axis Controllers only)</i> , page 3-16].
	<b>Swing Standby Indicator (Amber - Flashing)</b>		Indicates the swing function is actuated (controller actuated) when the swing function is changed from disabled to enabled. Allow controller to return to its neutral position, then re-enable the swing function.
	<b>Swing Enabled Indicator (Green)</b>		Indicates the swing function is enabled (refer to <i>Crane Function Enable/Disable Switch</i> , page 3-6 and <i>Swing Enable/Disable Switch</i> , page 3-13).
43	<b>Telescope Disabled Indicator</b>		Indicates the telescope function is disabled (refer to <i>Crane Function Enable/Disable Switch</i> , page 3-6 and <i>Boom Telescope Enable/Disable Switch</i> , page 3-13).
	<b>Telescope Standby Indicator (Amber - Constant On)</b>		Indicates the telescope function is enabled, but is in a standby mode due to the operator not being seated (causing seat switch to open). The telescope function is re-enabled by either sitting in the operator seat or by actuating a dead-man switch on the left or right dual axis controllers [refer to <i>Deadman Switches (Optional) (Dual Axis Controllers only)</i> , page 3-16].
	<b>Telescope Standby Indicator (Amber - Flashing)</b>		Indicates the telescope extend or retract function is actuated (controller actuated) when the telescope function is changed from disabled to enabled. Allow controller to return to its neutral position, then re-enable the telescope function.
	<b>Telescope Enabled Indicator (Green)</b>		Indicates the telescope function is enabled (refer to <i>Crane Function Enable/Disable Switch</i> , page 3-6 and <i>Boom Telescope Enable/Disable Switch</i> , page 3-13).

Item	Description	Graphic	Explanation
	<b>Boom Lift Disabled Indicator</b>		Indicates the boom lift function is disabled (refer to <i>Crane Function Enable/Disable Switch</i> , page 3-6 and <i>Boom Lift Enable/Disable Switch</i> , page 3-12).
44	<b>Boom Lift Standby Indicator (Amber - Constant On)</b>		Indicates the boom lift function is enabled, but is in a standby mode due to the operator not being seated (causing seat switch to open). The boom lift function is re-enabled by either sitting in the operator seat or by actuating a dead-man switch on the left or right dual axis controllers [refer to <i>Deadman Switches (Optional) (Dual Axis Controllers only)</i> , page 3-16].
	<b>Boom Lift Standby Indicator (Amber - Flashing)</b>		Indicates the boom up or down function is actuated (controller actuated) when the boom lift function is changed from disabled to enabled. Allow controller to return to its neutral position, then re-enable the boom lift function.
	<b>Boom Lift Enabled Indicator (Green)</b>		Indicates the boom lift function is enabled (refer to <i>Crane Function Enable/Disable Switch</i> , page 3-6 and <i>Boom Lift Enable/Disable Switch</i> , page 3-12).

For Reference Only

Item	Description	Graphic	Explanation
	<b>Main Hoist Disabled Indicator</b>		Indicates the main hoist function is disabled (refer to <i>Crane Function Enable/Disable Switch</i> , page 3-6 and <i>Main Hoist Enable/Disable Switch</i> , page 3-12).
	<b>Main Hoist Standby Indicator (Amber - Constant On)</b>		Indicates the main hoist function is enabled, but is in a standby mode due to the operator not being seated (causing seat switch to open). The main hoist function is re-enabled by either sitting in the operator seat or by actuating a dead-man switch on the left or right dual axis controllers [refer to <i>Deadman Switches (Optional) (Dual Axis Controllers only)</i> , page 3-16].
	<b>Main Hoist Standby Indicator (Amber - Flashing)</b>		Indicates the main hoist function is actuated (controller actuated) when the main hoist function is changed from disabled to enabled. Allow controller to return to its neutral position, then re-enable the main hoist function.
45	<b>Main Hoist Enabled Indicator (Green)</b>		Indicates the main hoist function is enabled (refer to <i>Crane Function Enable/Disable Switch</i> , page 3-6 and <i>Main Hoist Enable/Disable Switch</i> , page 3-12).
	<b>Main Hoist Raise Indicator (Green)</b>		Indicates the main hoist rope is being reeled in.
	<b>Main Hoist Lower Indicator (Green)</b>		Indicates the main hoist rope is being let out.
	<b>Main Hoist High Speed Indicator (Green)</b>		Indicates the main hoist function and the high speed function are enabled.

Item	Description	Graphic	Explanation
	<b>Auxiliary Hoist Disabled Indicator</b>		Indicates the auxiliary hoist (optional) function is disabled (refer to <i>Crane Function Enable/Disable Switch</i> , page 3-6 and <i>Auxiliary Hoist Enable/Disable Switch</i> , page 3-13).
	<b>Auxiliary Hoist Standby Indicator (Amber - Constant On)</b>		Indicates the auxiliary hoist (optional) function is enabled, but is in a standby mode due to the operator not being seated (causing seat switch to open).  The auxiliary hoist function is re-enabled by either sitting in the operator seat or by actuating a dead-man switch on the left or right dual axis controllers [refer to <i>Deadman Switches (Optional) (Dual Axis Controllers only)</i> , page 3-16].
	<b>Auxiliary Hoist Standby Indicator (Amber - Flashing)</b>		Indicates the auxiliary hoist function is actuated (controller actuated) when the auxiliary hoist function is changed from disabled to enabled.  Allow controller to return to its neutral position, then re-enable the auxiliary hoist function.
46	<b>Auxiliary Hoist Enabled Indicator (Green)</b>		Indicates the auxiliary hoist (optional) function is enabled (refer to <i>Crane Function Enable/Disable Switch</i> , page 3-6 and <i>Auxiliary Hoist Enable/Disable Switch</i> , page 3-13).
	<b>Auxiliary Hoist Raise Indicator (Green)</b>		Indicates the auxiliary hoist rope is being reeled in.
	<b>Auxiliary Hoist Lower Indicator (Green)</b>		Indicates the auxiliary hoist rope is being let out.
	<b>Auxiliary Hoist High Speed Indicator (Green)</b>		Indicates the auxiliary hoist function and the high speed function are enabled.

**Active Screen Indicator Area**

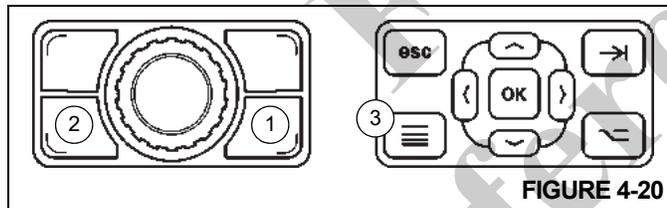
The following icon can appear in the Active Screen Indicator Area (4, Figure 4-18 and Figure 4-19) of the ODM Main Screen:

Item	Description	Graphic	Explanation
47	Active Screen Indicator		Indicates the ODM screen is being controlled by the Jog Dial. Refer to <i>Navigating the Operator Display Module and Rated Capacity Limiter Display Module</i> , page 4-34.

**Menu Screen**

The Menu Screen (Figure 4-21) of the ODM is accessed by doing one of the following:

- Press the Screen Toggle Button (1, Figure 4-20) at the Jog Dial to select the ODM screen control, then press the Menu Button (2).
- or -
- Press the Menu Button (3, Figure 4-20) on the Navigation Control Pad at the ODM.



**FIGURE 4-20**

The ODM Menu Screen has the following menu items for operating the crane:

- **Outrigger Group** (4, Figure 4-21) (refer to *Outrigger Group*, page 4-55, for detailed information)
  - Extending/Retracting the Outriggers
- **Camera Group (Optional)** (6, Figure 4-21) (refer to *Camera Group (Optional)*, page 4-59, for detailed information)
  - Setting the Camera 1 View
  - Setting the Camera 2 View
  - Setting the Camera 1/2 View

- **Working Range Limiter Group** (10, Figure 4-21) (refer to *Working Range Limiter Group*, page 4-61, for detailed information)
  - Setting the Boom Height Limit
  - Setting the Boom Angle Limit
  - Setting the Radius Limit
  - Setting the Slew Angle Limit
  - Creating Virtual Walls
- **Tools Group** (16, Figure 4-21) (refer to *Tools Group*, page 4-83, for detailed information)
  - Setting the Display Screen Brightness
  - Setting the Units of Measure (Metric/Imperial)
  - Setting the Controller Sensitivity
  - Setting the Controller Function Speed
  - Setting ECO Mode to On/Off
- **Information Group** (22, Figure 4-21) (refer to *Information Group*, page 4-89, for detailed information)
  - Viewing the Hours of Operation
  - Viewing the Engine/Transmission Fault Codes
  - Viewing the Crane Fault Codes
  - Viewing the Software Versions
  - Viewing the Legal Notice

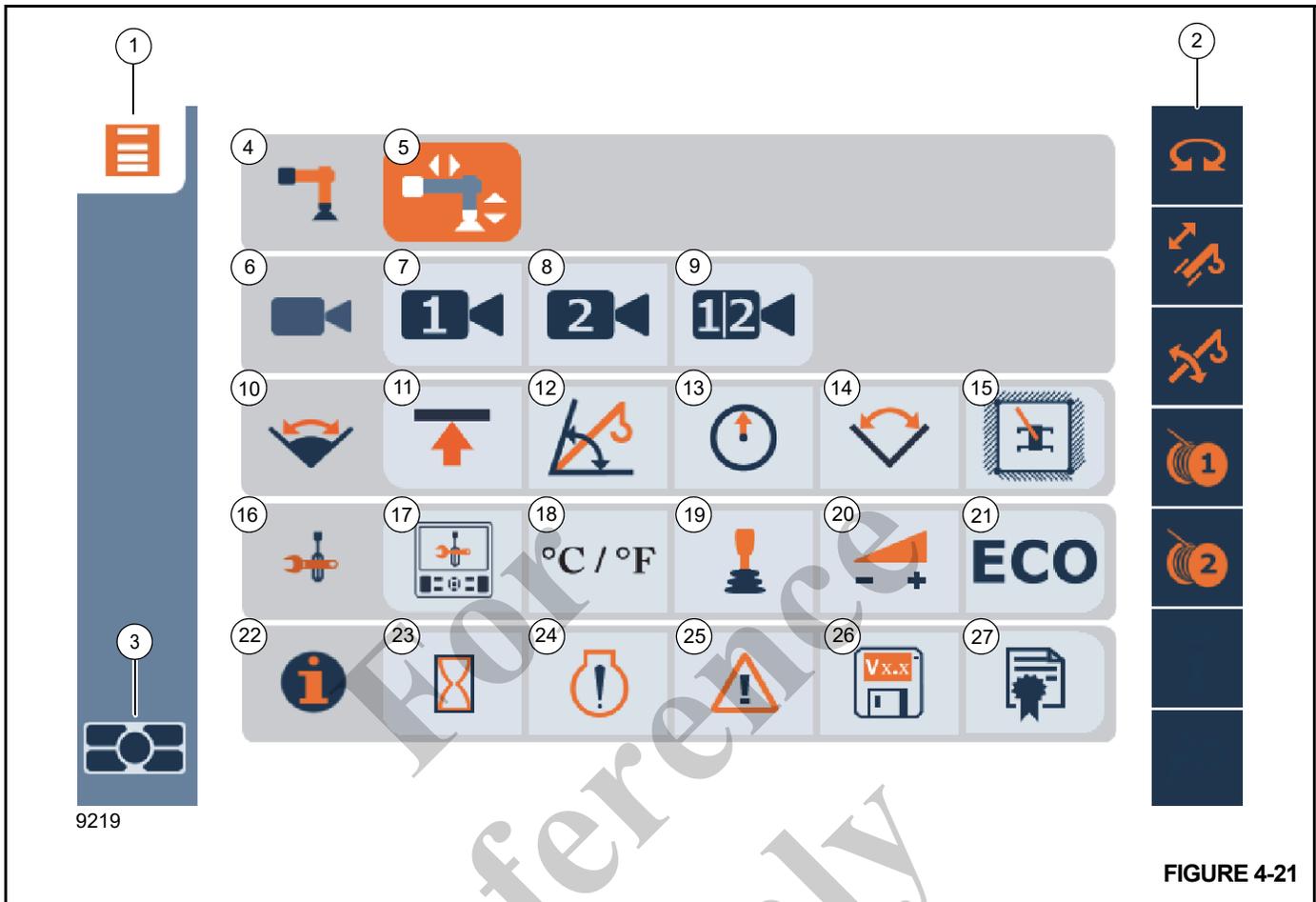
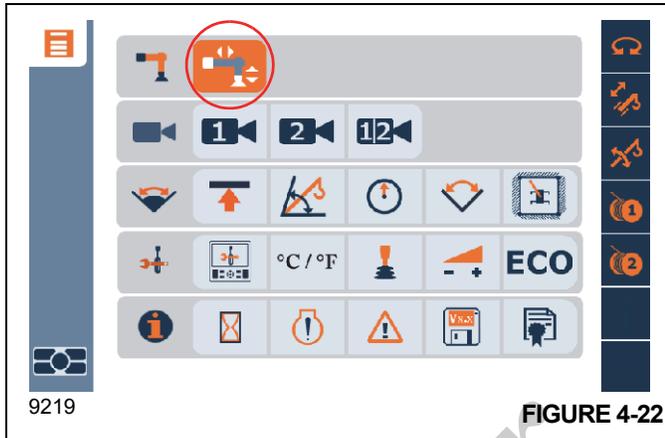


FIGURE 4-21

Item	Description	Item	Description
1	Menu Screen Indicator	15	WRL Virtual Wall Limit Icon
2	Status Indicator Bar	16	Tools Group Icon
3	Active Screen Indicator	17	Display Screen Brightness Icon
4	Outrigger Group Icon	18	Units of Measure Icon
5	Outrigger Extend/Retract Icon	19	Controller Sensitivity Icon
6	Camera Group Icon	20	Controller Function Speed Icon
7	Camera View 1 Icon	21	ECO Mode Icon
8	Camera View 2 Icon	22	Information Group Icon
9	Camera View 1/2 Icon	23	Operating Hours Icon
10	Working Range Limiter (WRL) Group Icon	24	Engine Fault Code Icon
11	WRL Boom Height Limit Icon	25	Crane Fault Code Icon
12	WRL Boom Angle Limit Icon	26	Software Revision Icon
13	WRL Radius Limit Icon	27	Legal Notice Icon
14	WRL Swing Angle Limit Icon		

### Outrigger Group

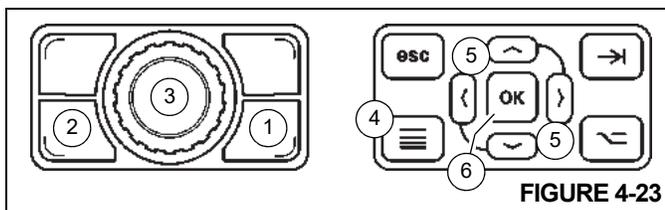
The Outrigger Extend/Retract function icon (Figure 4-22) under the Outrigger Group is used to extend and retract the outrigger beams and jacks.



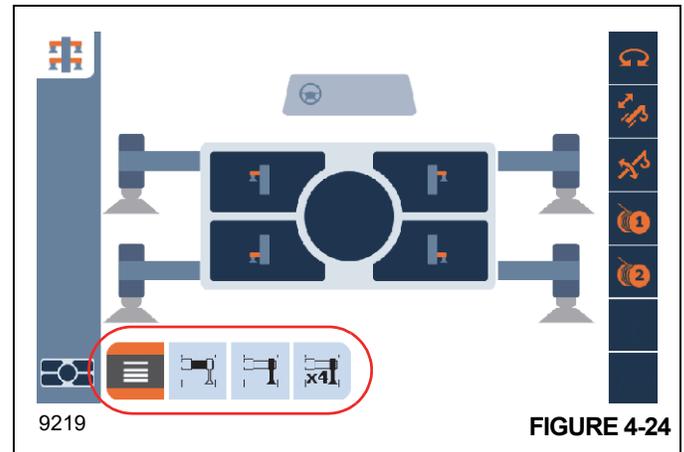
#### Accessing the Outrigger Extend/Retract Function Screen

Access the Outrigger Extend/Retract function screen (Figure 4-24) of the ODM by doing one of the following:

- Press the Screen Toggle Button (1, Figure 4-23) at the Jog Dial to select the ODM screen control.  
Press the Menu Button (2) to go to the Menu Screen.  
Using the Jog Dial (3), select the Outrigger Extend/Retract function icon (Figure 4-22), then press the Jog Dial (3).  
- or -
- Press the Menu Button (4, Figure 4-23) on the Navigation Control Pad at the ODM to go to the Menu Screen.  
Using the Arrow Buttons (5), select the Outrigger Extend/Retract function icon (Figure 4-22), then press the OK Button (6).



The Outrigger Extend/Retract function screen will appear:



Icon	Description
	Menu Screen icon - not selected
	Menu Screen icon - selected
	O/R Beams icon - not selected
	O/R Beams icon - selected
	O/R Beams icon - active
	O/R Jacks icon - not selected
	O/R Jacks icon - selected

Icon	Description
	O/R Jacks icon - active
	O/R Jacks x4 icon - not selected
	O/R Jack x4 icon - selected
	O/R Jack x4 icon - active

**Extending/Retracting the Outrigger Beams**

**NOTE:** Refer to *Setting the Outriggers*, page 4-25 for complete procedures to extend and retract the O/R beams and jacks.

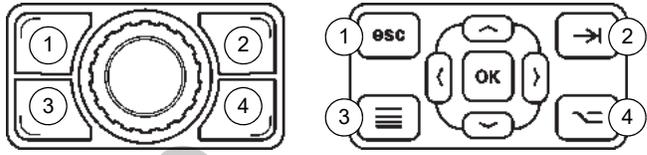
To extend or retract the O/R beams, perform the following procedure:

1. Using the Jog Dial, or the Arrow Buttons at the Navigation Control Pad, select the O/R Beam icon (Figure 4-24) (icon will turn orange when selected).
2. Press the Jog Dial, or the OK Button at the ODM, to make the O/R Beam icon active (icon will turn green when active).
3. To extend the O/R beams, position the Outrigger Extend/Retract Switch (refer to *Outrigger*

*Extend/Retract Switch*, page 3-12) to the extend position, then press and hold any or all of the four buttons at the Jog Dial or the Navigation Control Pad (Figure 4-25).

To retract the O/R beams, position the Outrigger Extend/Retract Switch to the retract position, then press and hold any or all of the four buttons at the Jog Dial or the Navigation Control Pad.

**NOTE:** The O/R beam positions correspond to the four buttons at the Jog Dial and the ODM Navigation Control Pad (Figure 4-25 and Figure 4-26).



Item	Description
1	Left-Front Beam
2	Right-Front Beam
3	Left-Rear Beam
4	Right-Rear Beam

**FIGURE 4-25**

When a button at the Jog Dial or Navigation Control Pad is pressed and held, the corresponding O/R beam image turns orange to indicate that it is active. An arrow appears to indicate whether the beam is extending or retracting. The following example (Figure 4-26) shows the Left-Front O/R beam is extending or retracting:

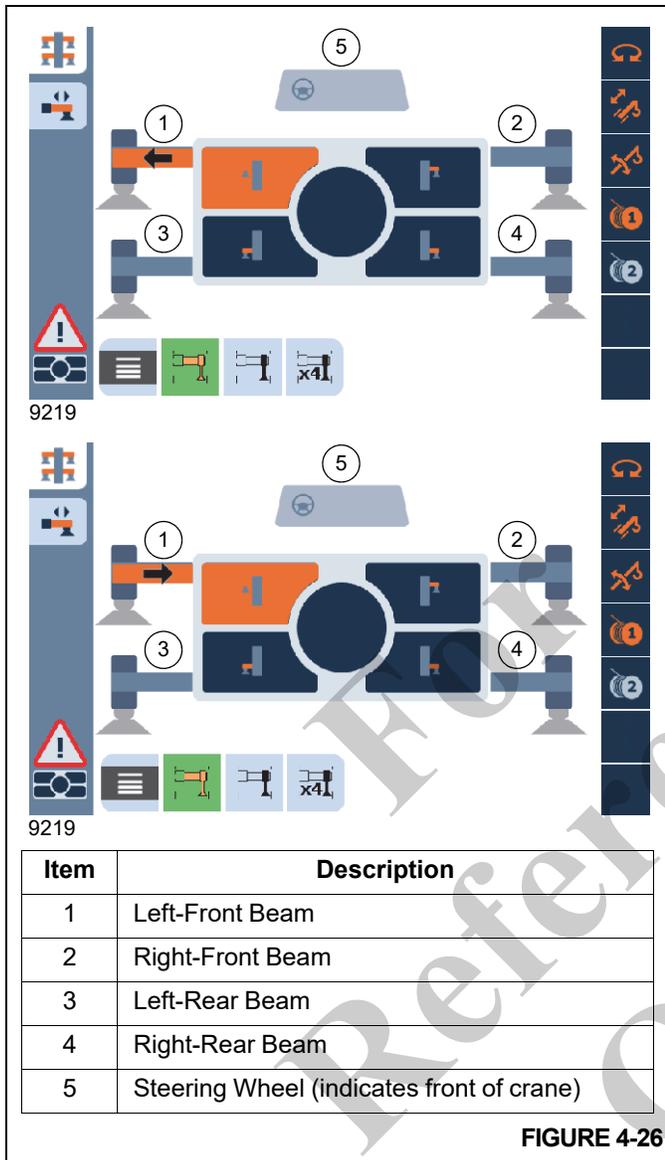


FIGURE 4-26

**Extending/Retracting the Outrigger Jacks - Individually**

**NOTE:** Refer to *Setting the Outriggers*, page 4-25 for complete procedures to extend and retract the O/R beams and jacks.

To extend or retract the O/R jacks individually, perform the following procedure:

1. Using the Jog Dial, or the Arrow Buttons at the Navigation Control Pad, select the O/R Jack icon (icon will turn orange when selected).
2. Press the Jog Dial, or the OK Button at the ODM, to make the O/R Jack icon active (icon will turn green when active).
3. To extend the O/R jacks, position the Outrigger Extend/Retract Switch (refer to *Outrigger Extend/Retract Switch*, page 3-12) to the extend position, then press and hold any or all of the four buttons at the Jog Dial or Navigation Control Pad.

To retract the O/R jacks, position the Outrigger Extend/Retract Switch to the retract position, then press and hold any or all of the four buttons at the Jog Dial or Navigation Control Pad.

**NOTE:** The O/R jack positions correspond to the four buttons at the Jog Dial and the ODM Navigation Control Pad (Figure 4-27 and Figure 4-28).

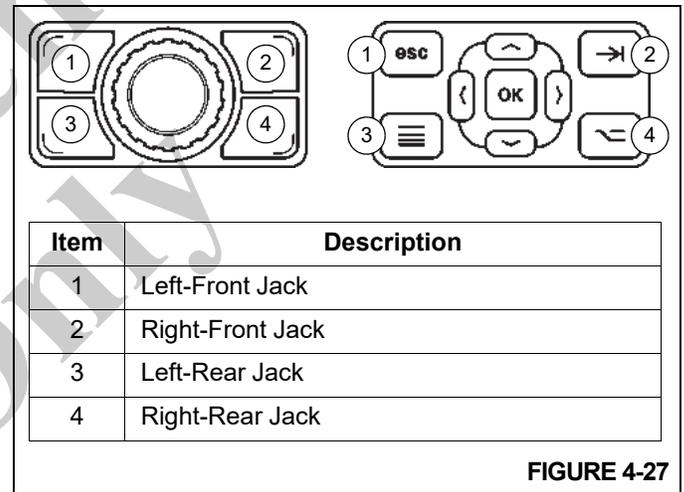
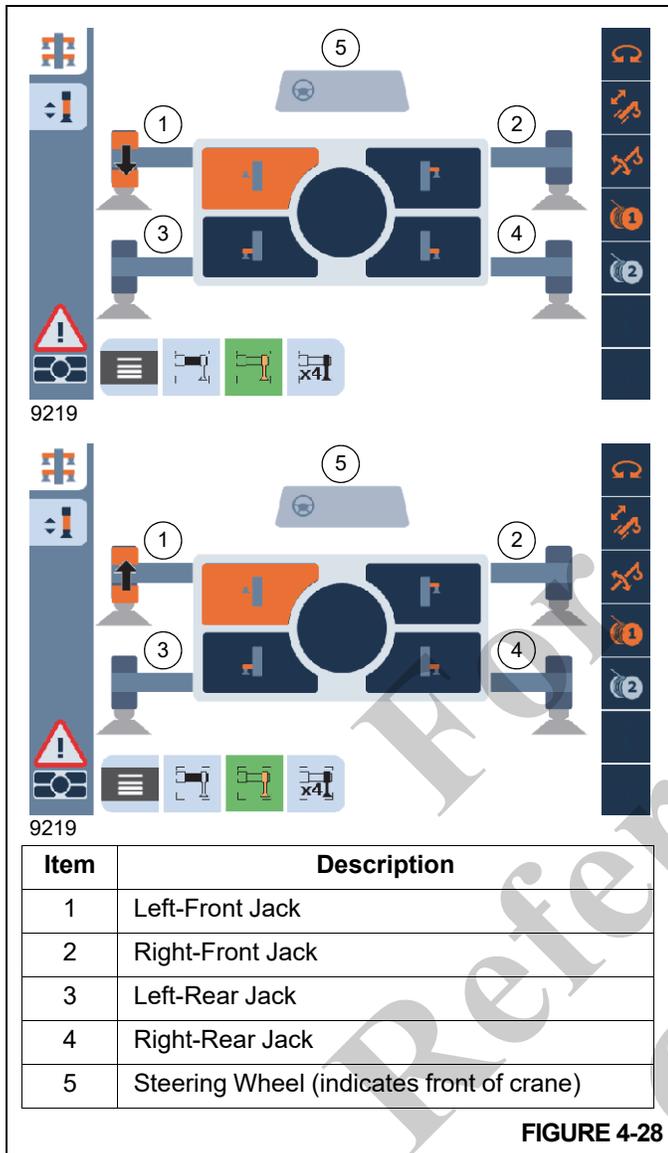


FIGURE 4-27

When a button at the Jog Dial or Navigation Control Pad is pressed and held, the corresponding O/R jack image turns orange to indicate that it is active. An arrow appears to indicate whether the jack is extending or retracting. The following example (Figure 4-28) shows the Left-Front O/R jack is extending or retracting:



**Extending/Retracting the Outrigger Jacks - x4**

**NOTE:** Refer to *Setting the Outriggers*, page 4-25 for complete procedures to extend and retract the O/R beams and jacks.

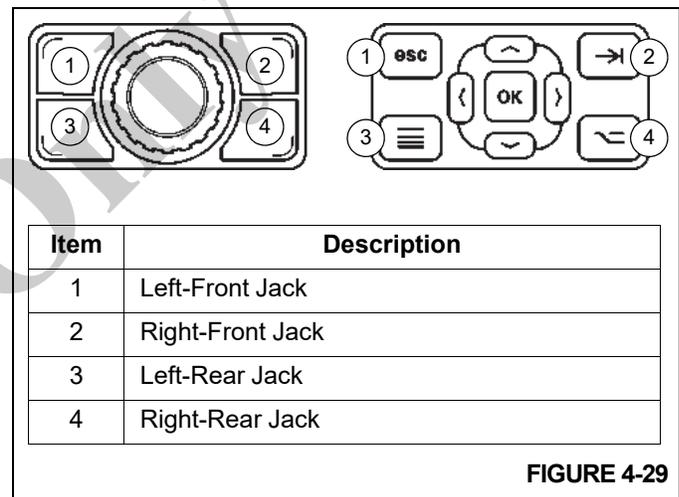
To extend or retract all four O/R jacks at the same time, perform the following procedure:

1. Using the Jog Dial, or the Arrow Buttons at the Navigation Control Pad, select the O/R Jack x4 icon (icon will turn orange when selected).
2. Press the Jog Dial, or the OK Button at the ODM, to make the O/R Jack x4 icon active (icon will turn green when active).
3. To extend all four O/R jacks at the same time, position the Outrigger Extend/Retract Switch (refer to *Outrigger Extend/Retract Switch*, page 3-12) to the extend position, then press and hold the Jog Dial or OK Button at the Navigation Control Pad.

To retract all four O/R jacks at the same time, position the Outrigger Extend/Retract Switch to the retract position, then press and hold the Jog Dial or OK Button at the Navigation Control Pad.

**NOTE:** While the Outrigger Jack Extend/Retract x4 icon is active, individual outrigger jacks can be extended or retracted by positioning the Outrigger Extend/Retract Switch to the desired direction, then pressing and holding one of the four buttons at the Jog Dial or Navigation Control Pad (Figure 4-29).

The O/R jack positions correspond to the four buttons at the Jog Dial and the ODM Navigation Control Pad.



When extending or retracting all four outrigger jacks at the same time, the four O/R jack images turn orange to indicate that they are active. Arrows appear to indicate whether the jacks are extending or retracting. The following example (Figure 4-30) shows all four outrigger jacks are extending or retracting:

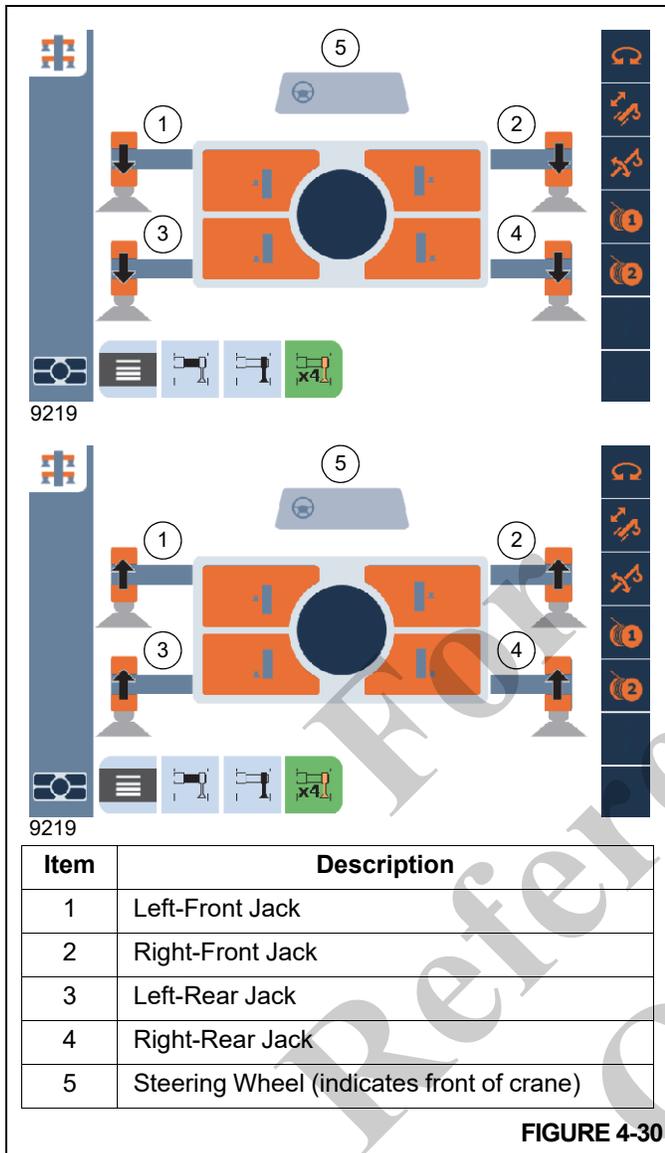


FIGURE 4-30

**Exiting the Outrigger Extend/Retract Function Screen**

Exit the Outrigger Extend/Retract function screen of the ODM by doing one of the following:

- Press the Screen Toggle Button (1, Figure 4-31) at the Jog Dial to select the ODM screen control.

Using the Jog Dial (2), select the Menu icon (Figure 4-32) (icon will turn orange), then press the Jog Dial (2).

- or -

- Using the Arrow Buttons (3, Figure 4-31), select the Menu icon (Figure 4-32) (icon will turn orange), then press the OK Button (4).

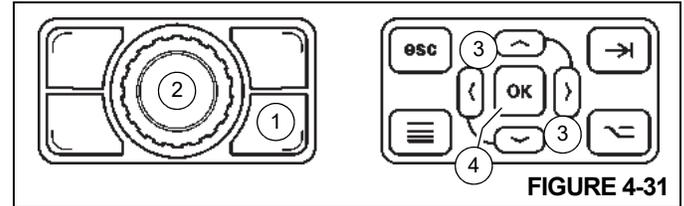


FIGURE 4-31

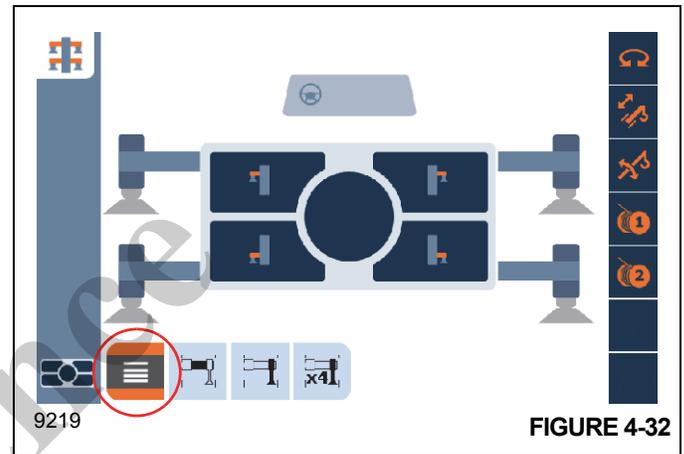


FIGURE 4-32

**Camera Group (Optional)**

The Camera Group is made up of three camera function icons (Figure 4-33):

- Camera View 1 (Hoist) icon
- Camera View 2 (Right Side) icon
- Camera Views 1/2 (Hoist and Right Side) icon

These camera function icons are used to set which camera view is displayed on the Main Screen of the ODM.

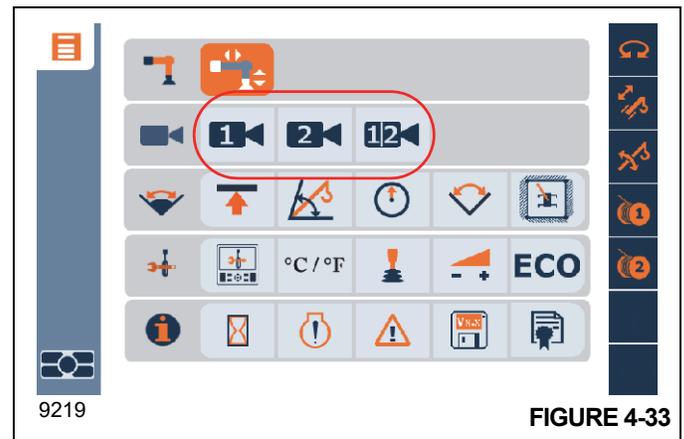


FIGURE 4-33

Icon	Description
	Camera View 1 icon - not selected
	Camera View 1 icon - selected
	Camera View 2 icon - not selected
	Camera View 2 icon - selected
	Camera View 1/2 icon - not selected
	Camera View 1/2 icon - selected

**Selecting a Camera View**

Select a Camera function icon by doing one of the following:

- Press the Screen Toggle Button (1, Figure 4-34) at the Jog Dial to select the ODM screen control.

Press the Menu Button (2) to go to the Menu Screen.

Using the Jog Dial (3), select one of the Camera Group function icons (icon will turn orange) (Figure 4-33), then press the Jog Dial (3) to make the camera view active.

- or -

- Press the Menu Button (4, Figure 4-34) on the Navigation Control Pad at the ODM to go to the Menu Screen.

Using the Arrow Buttons (5), select one of the Camera Group function icons (icon will turn orange)

(Figure 4-33), then press the OK Button (6) to make the camera view active.

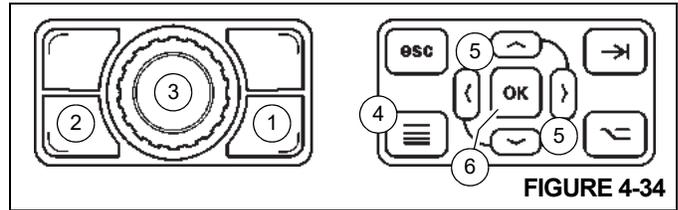
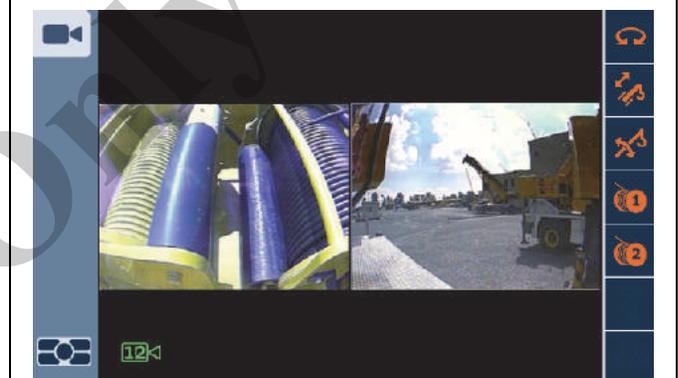


FIGURE 4-34

Upon selecting a camera view from the Menu Screen and pressing the Jog Dial or OK Button, the ODM will switch to the corresponding Camera View Screen (Figure 4-35).



9219 Example: Camera View 1 Screen Active



9219 Example: Camera View 1 and 2 Screen Active

FIGURE 4-35

The active camera view is also displayed on the Main Screen of the ODM (Figure 4-36).

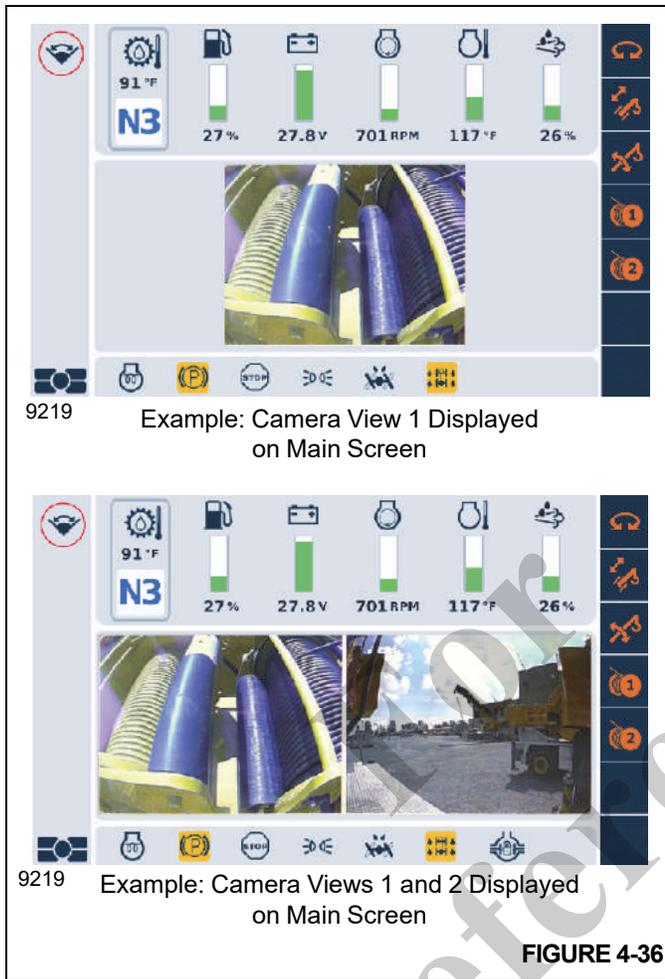


FIGURE 4-36

**Exiting the Camera View Screen**

Perform one of the following procedures to exit the Camera View Screen and navigate to the Main Screen or Menu Screen:

- Press the Screen Toggle Button (1, Figure 4-37) at the Jog Dial to select the ODM screen control, then press the Escape Button (2) for the Main Screen or the Menu Button (3) for the Menu Screen.
- or -
- Press the Escape Button (4, Figure 4-37), on the Navigation Control Pad at the ODM, for the Main Screen or the Menu Button (5) for the Menu Screen.

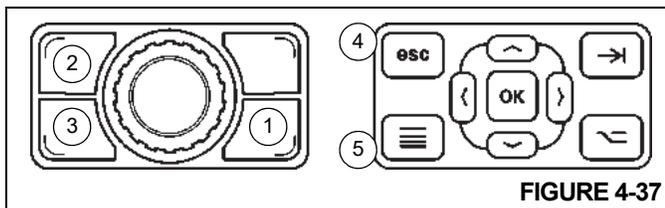


FIGURE 4-37

**Working Range Limiter Group**

**Introduction**

The Working Range Limiter (WRL) is a feature of the crane control system that allows the operator to define obstacles or limits for crane operation. With obstacles and limits accurately defined, the WRL will aid the operator in identifying when the boom and/or load is nearing an obstacle by giving both visual and audible alerts.



**DANGER**

For standard cranes (cranes that are not equipped with the WRL Lock Out Function), the WRL system is an audio/visual indicator only. The system will not stop the movement of the crane when the limit is reached. The operator must continue to control and stop the movement of the crane when alerted by the WRL indicator.

If the crane's WRL is configured with the Lock Out Function, the crane functions can be affected to slow and stop with respect to the programed limits.

The following limitations are available for the WRL:

- Height Limitation: boom height limit can be defined for a maximum boom elevation.
- Boom Angle Limitation: boom angle limits can be defined for a minimum and maximum boom angle.
- Radius Limitation: boom radius limits can be defined for minimum and maximum radius working zones.
- Swing Limitation: swing angle limits for swing left and swing right directions can be defined.
- Virtual Wall Limitation: up to five virtual walls can be defined to be jobsite objects or warning zones.

**NOTE:** The Working Range Limiter feature is an operator aid, it can provide enhanced jobsite awareness. However, it is not expected to be the sole source of this awareness, and all appropriate techniques such as other personnel providing visual guidance to the crane operator are to be employed.

In addition, when the WRL Lock Out Function is enabled, crane functions are expected to be used with the same caution as if the lock out capability was not present. In particular, it must be noted that the swing function has a coasting or free-swing characteristic that will not be affected by the slow-down and lock out of the swing function.

Turning off the power to the control system disables any WRL limitations.

**WRL Limitations Overview**

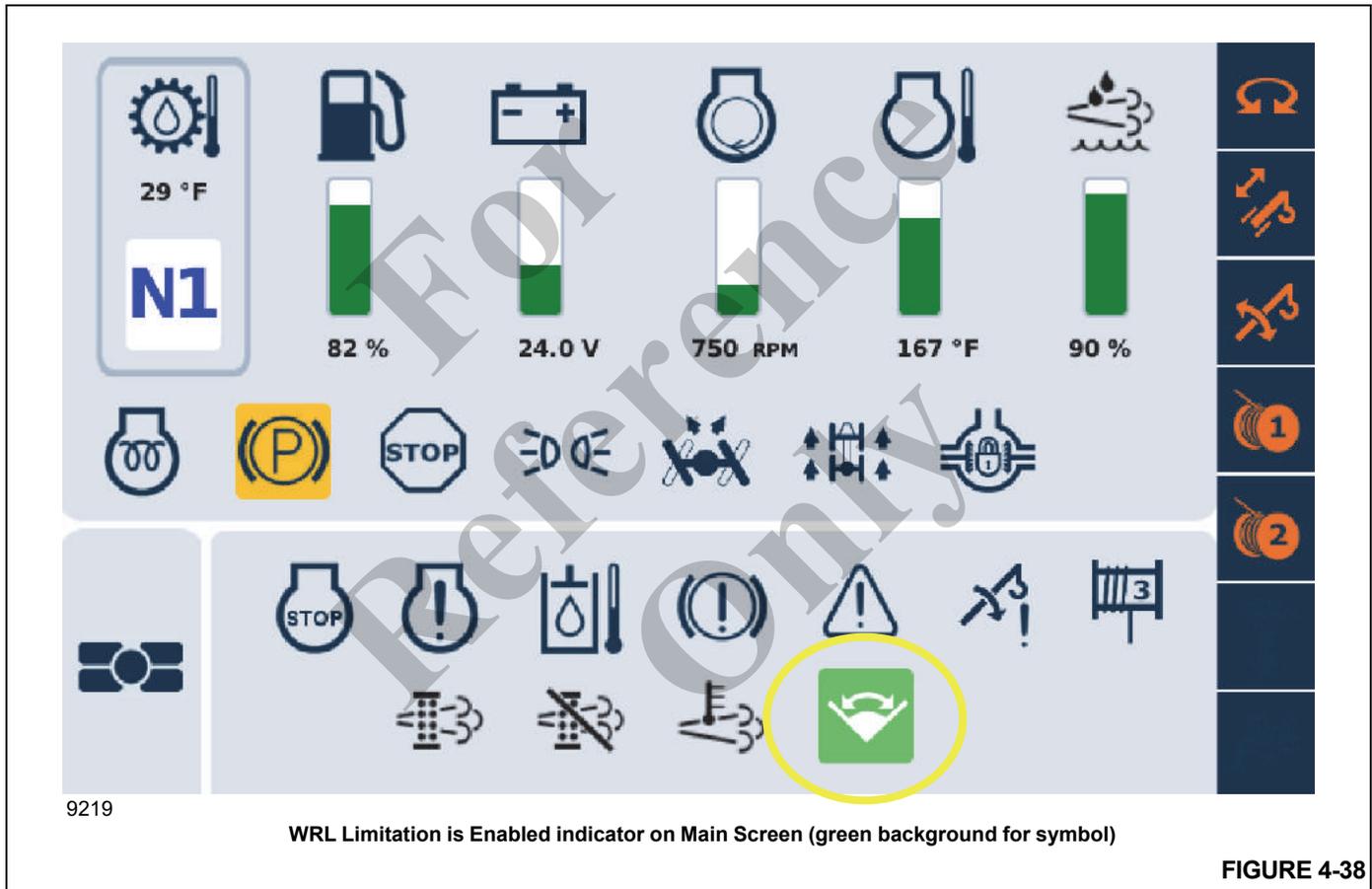
For each of the limitations, the limitation must first be ENABLED within the WRL feature of the crane control system software. This is done with particular screens and buttons on the Operating Display Module. Once the limitation is enabled, then it can be DEFINED (in terms of specific angles, locations, etc.). This is also done with the screen and buttons on the Operating Display Module, as well as usually operating the boom to define particular locations.

With the limitation enabled and defined, the control system can then provide the needed feedback and warnings. When the crane is in such a position to cause warning, then the WRL limitation is considered to be ACTIVE.

In summary, to turn on a limit within the WRL, the following steps must be performed:

1. Enable the Limitation
2. Define the Limitation

When any limitation is enabled (but none are active), the Main Screen shows an indicator. Figure 4-38 shows the Main Screen with the Working Range Limiter (WRL) Indicator, which has a green-colored background. If no limitations are enabled, then this same symbol is shown, but without the green-colored background (thus appearing similar to other non-highlighted symbols on the screen).



When a limitation is active, the Main Screen shows an indicator for the limitation (in addition to audible alarms and potentially effects on the crane functions). Figure 4-39 shows the Main Screen example with the height limitation active. There are similar symbols for the other limitations. Table 4-3 shows the boom angle limitation active symbol, the radius

limitation active symbol, the swing limitation active symbol, and the virtual wall limitation active symbol. If there are multiple limitations active (such as a swing limitation and a height limitation), then the appropriate symbols are cycled on the display with a time interval.

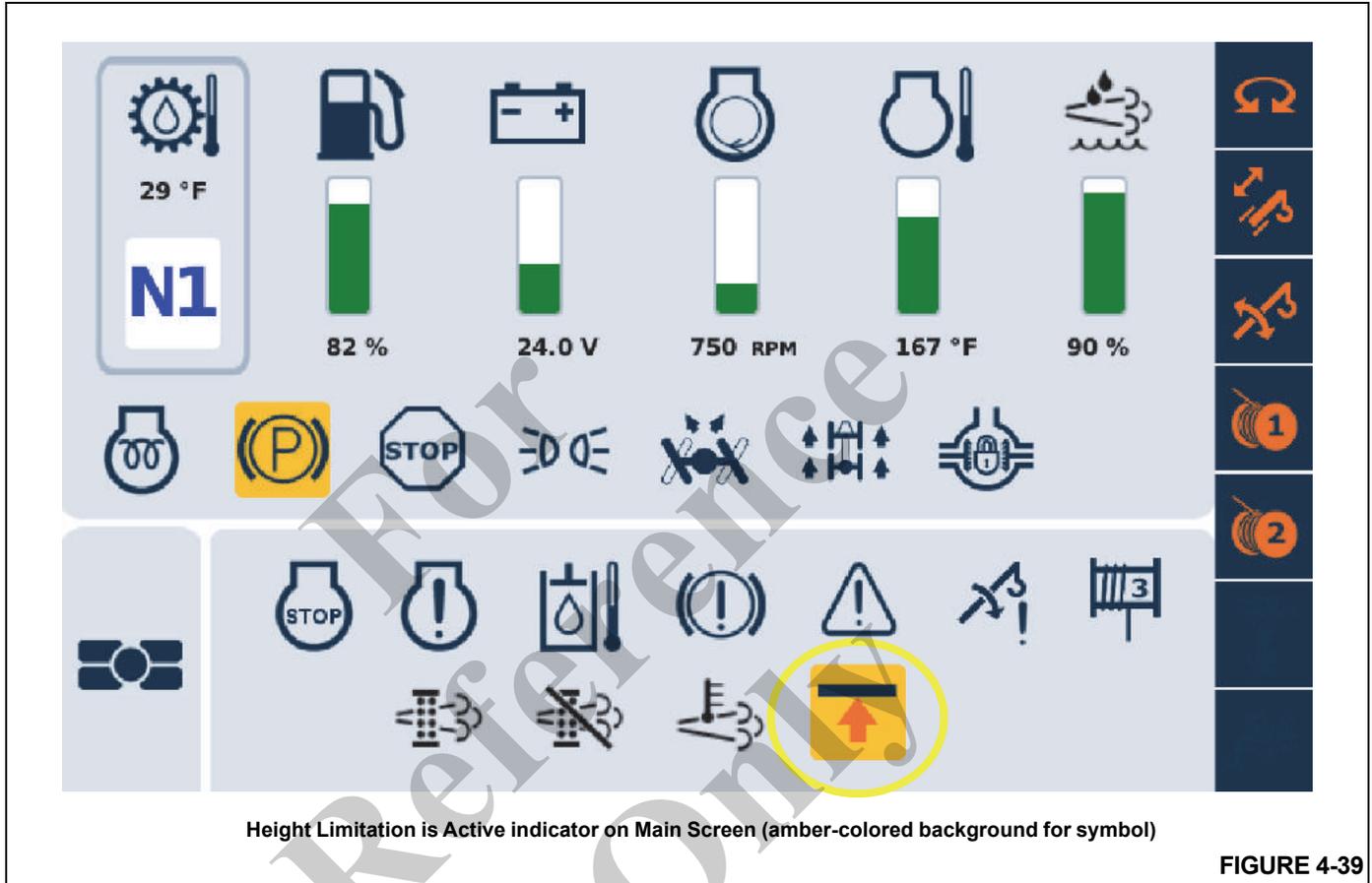


Table 4-3 Active Indicator Symbols

Symbol	Description
	Boom Height Warning Indicator (Amber)
	Boom Angle Warning Indicator (Amber)
	Radius Warning Indicator (Amber)

Symbol	Description
	Swing Angle Warning Indicator (Amber)
	Virtual Walls Warning Indicator (Amber)

When a limitation is active, the warning buzzer inside the cab will sound. Table 4-4 indicates the behavior of the warning buzzer for the various limitations.

**Table 4-4 Alarm Characteristics**

LIMITATION	POSITION	ALARM
Height Limitation	10 ft before limit	Slow beeping
	5 ft before limit	Fast beeping
	At limit	Constant sound
Boom Angle	10 deg before limit	Slow beeping
	5 deg before limit	Fast beeping
	At limit	Constant sound
Radius	10 ft before limit	Slow beeping
	5 ft before limit	Fast beeping
	At limit	Constant sound
Swing	20 deg before limit	Slow beeping
	5 deg before limit	Fast beeping
	At limit	Constant sound
Virtual wall	20 ft before limit	Slow beeping
	5 ft before limit	Fast beeping
	At limit	Constant sound

The warning buzzer can be silenced using the Tab button on the Navigation Control Pad. Refer to item 1 in Figure 4-40. It can be silenced once the boom is no longer moving. When boom motion is sensed again by the control system, the warning buzzer is sounded again.

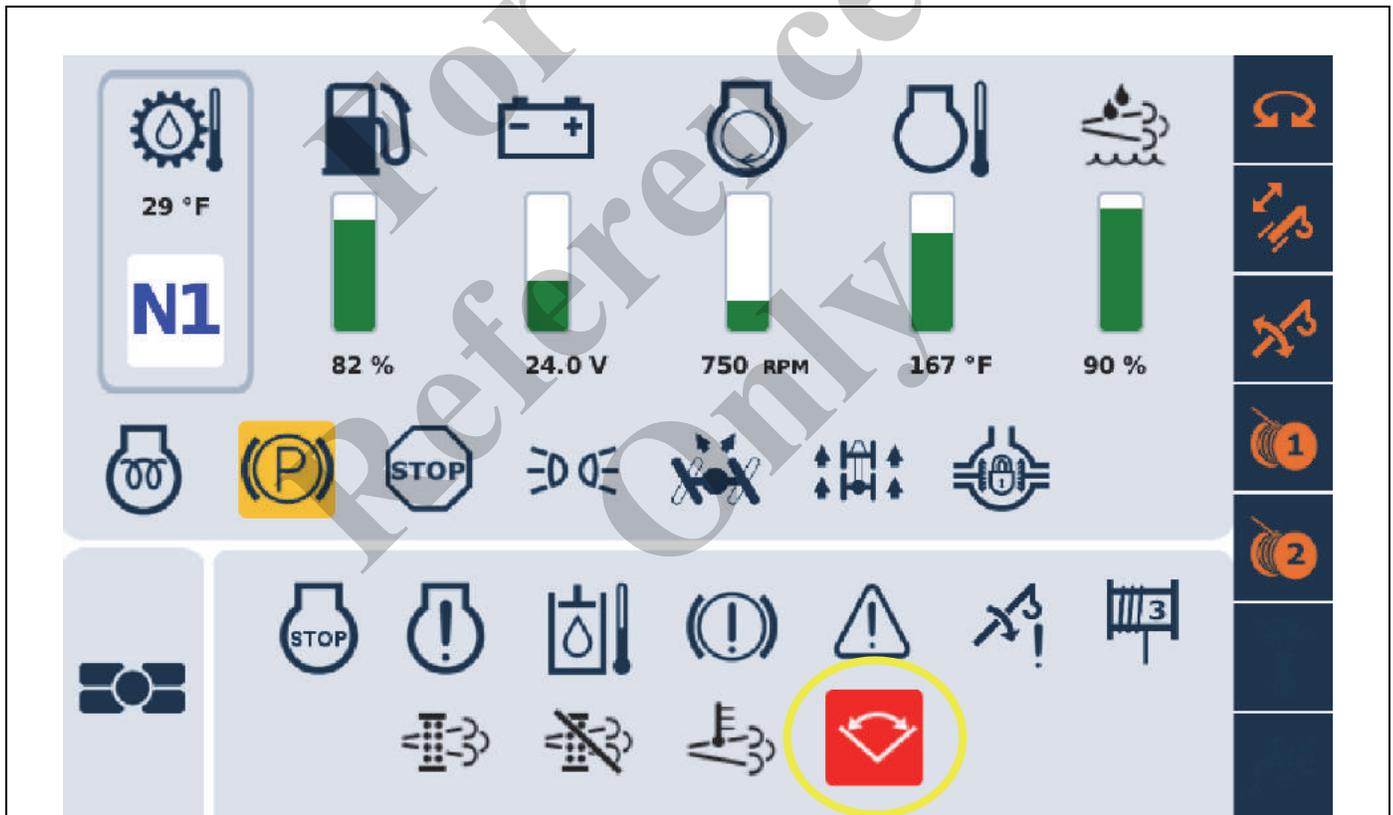
When a limit is reached, the Main Screen shows an indicator for this condition (again in addition to audible alarms and potential effects on the crane functions). Figure 4-41 shows the Main Screen where the swing limit has been reached. There are similar symbols for the other limitations. Table 4-5 shows the boom angle limitation stop symbol, the radius limitation stop symbol, the height limitation stop symbol, and the virtual wall limitation stop symbol. If multiple limitations have been reached (such as a swing limitation and a height limitation), then the related symbols are cycled on the Main Screen with a time interval.



9221-1

FIGURE 4-40

Item	Description
1	Tab Button
2	OK Button



Swing Limit has been Reached indicator on Main Screen (red color for symbol)

8797-7

FIGURE 4-41

Table 4-5 Limit Reached Indicator Symbols

Symbol	Description
	Swing Angle Stop Indicator (Red)
	Boom Angle Stop Indicator (Red)
	Radius Stop Indicator (Red)

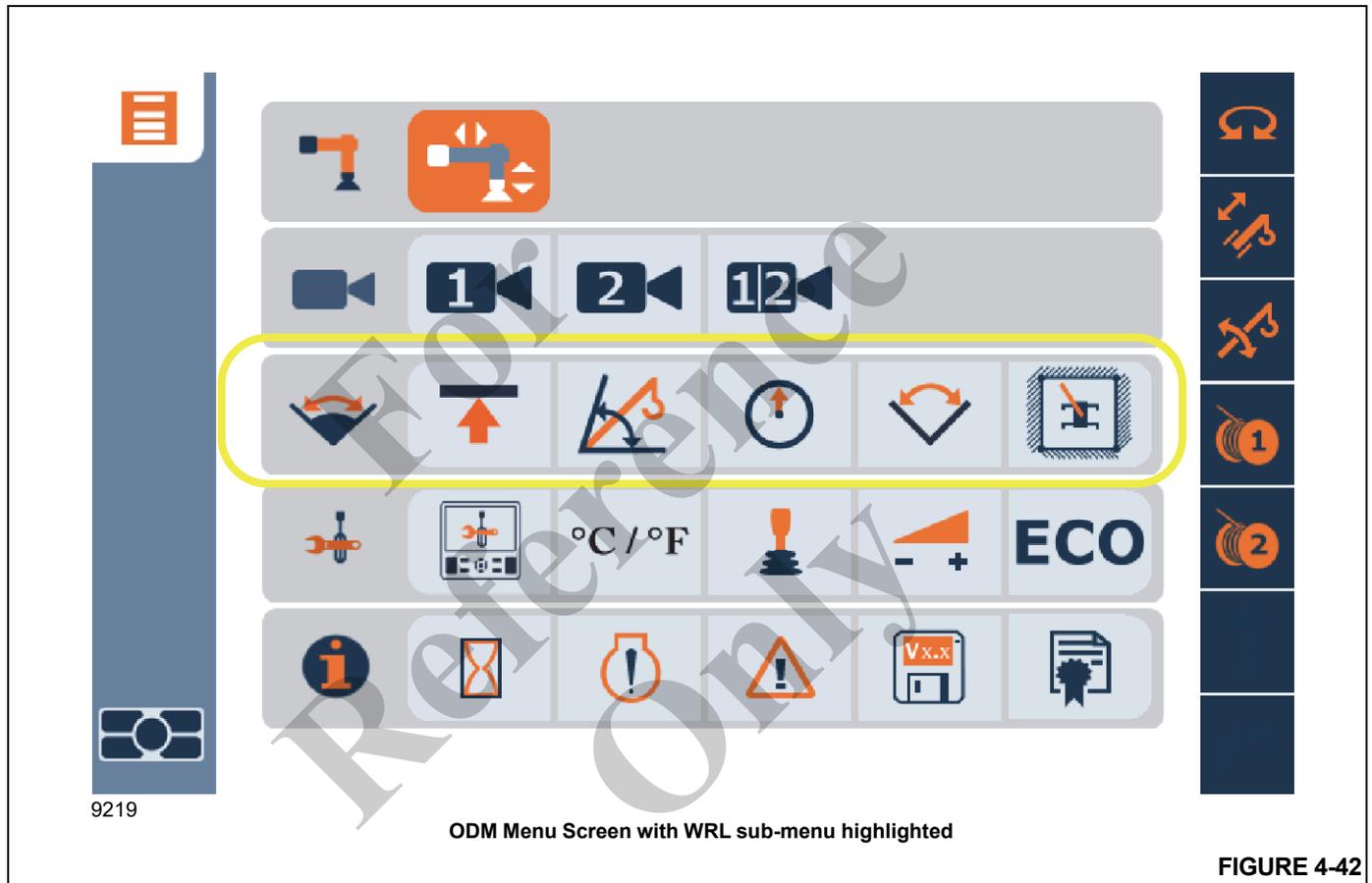
Symbol	Description
	Boom Height Stop Indicator (Red)
	Virtual Walls Stop Indicator (Red)

For Reference Only

**Accessing a WRL Limitation Screen**

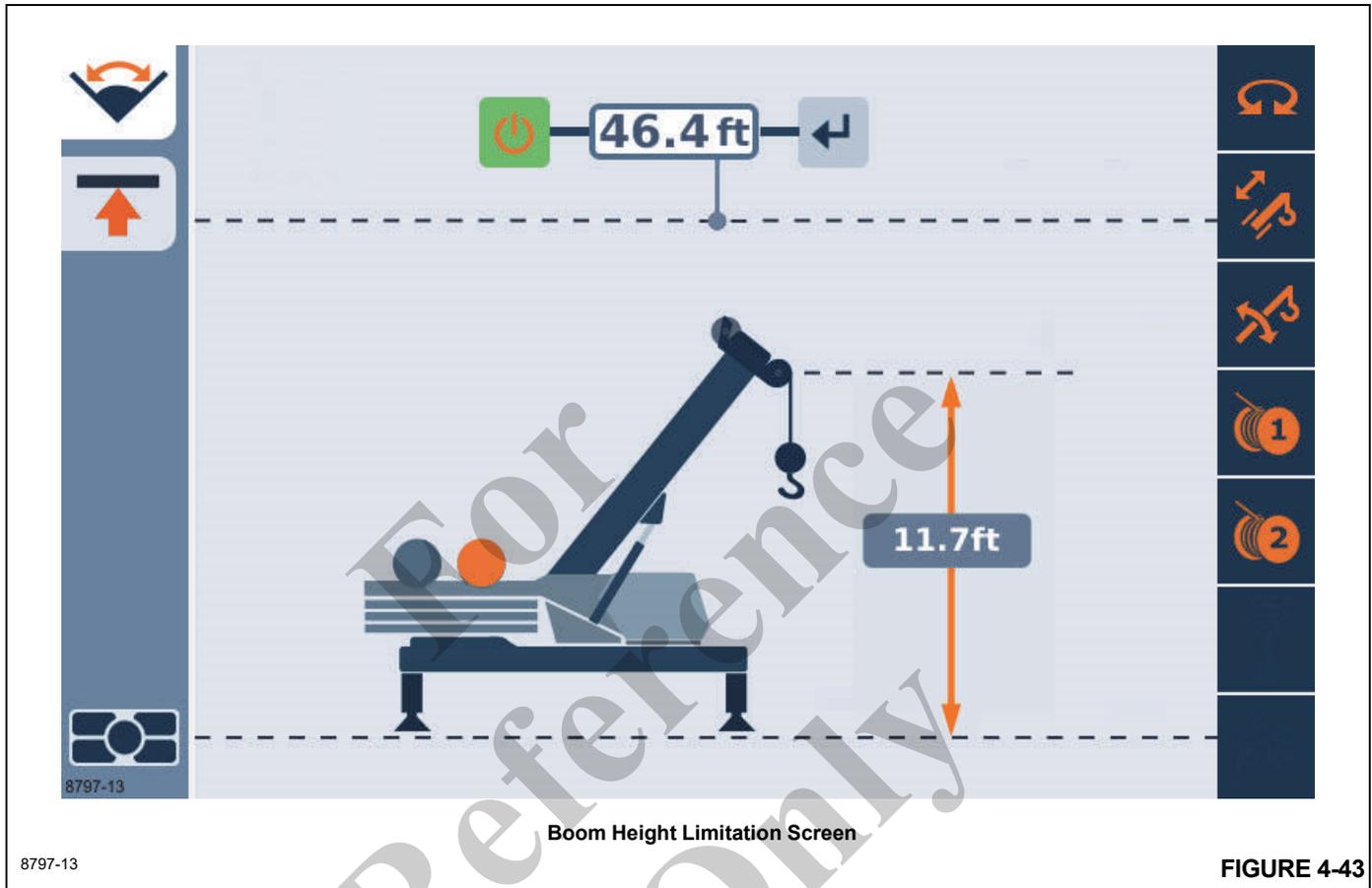
The WRL Group is made up of five WRL function icons. To enable and define a limitation, access the related WRL function icon in the WRL Group (Figure 4-42).

- Boom Height Limit icon (refer to *Setting the Boom Height Limitation*, page 4-68)
- Boom Angle Limit icon (refer to *Setting the Boom Angle Limitation*, page 4-71)
- Radius Limit icon (refer to *Setting the Radius Limitation*, page 4-74)
- Swing Angle Limit icon (refer to *Setting the Swing Angle Limitation*, page 4-77)
- Virtual Wall Limit icon (refer to *Setting a Virtual Wall Limitation*, page 4-80)



**Setting the Boom Height Limitation**

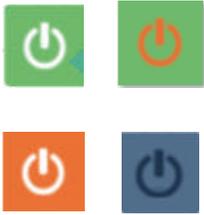
If the Boom Height Limitation is selected from the menu of WRL limitations, then the Boom Height Limitation Screen will be shown (Figure 4-43).



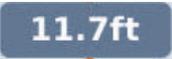
Using the Left Arrow and Right Arrow function on the Navigation Control Pad or the Jog Dial changes the object highlighted on the screen. As the arrow keys are pressed, the highlight will move between the objects, with the color orange typically meaning that the object is selected and can be affected by subsequent actions. In Figure 4-43, one can

see that the  symbol is selected since it has the orange color highlighting. Table 4-6 shows the objects available on the Boom Height Limitation Screen.

Table 4-6 Screen Symbols

Symbol	Description
	<p>Lock Out symbol and Alarm/Warning symbol - These symbols will not appear if the WRL is configured for only the Lock Out Function or only the Alarm/Warning Function. Standard cranes are configured for only the Alarm/Warning Function. Cranes configured for both functions, Lock Out and Alarm/Warning, give the operator the ability to toggle between these two symbols, which indicate the selection for the Lock Out Function (top symbol) or the Alarm/Warning Function (bottom symbol). The selection for this configuration is toggled with an OK button (2, Figure 4-40).</p>
	<p>Enable symbol - this symbol is used to enable or disable the limitation. The selection for this option is changed with an OK button (2, Figure 4-40). The symbols shown on the top (green background) indicate that the limitation is enabled. The symbols shown on the bottom (not green background) indicate that the limitation is disabled.</p>
	<p>Limitation Value - this is the current limitation value (the RCL tip height; which is a distance above a ground level). If the limitation is enabled, and this symbol on the screen is highlighted (orange color), after using the OK button, the value can be changed to be higher or lower with the Up Arrow and Down Arrow function on the display or jog dial. The OK button (2, Figure 4-40) is used to begin and complete the value entry. It can also be changed by accepting the current crane position (see next symbol). If the limitation value is below the minimum allowed, a fault will be generated, and a fault symbol will appear on the display.</p>
	<p>Accept Crane Position symbol - If the limitation is enabled, this symbol allows the acceptance of the current crane position to be the limitation value (current tip height becomes height limitation). If this symbol is highlighted (as shown here with orange background), and the crane position is accepted with an OK button, then the value shown in the Limitation Value is updated to be the current crane position. If the limitation value is below the minimum allowed, a fault will be generated, and a fault symbol will appear on the display.</p>

In addition to the symbols that can be highlighted by the arrow functions, the following is shown on the screen:

Symbol	Description
	<p>Current Crane Position - this value shown on the screen is the current crane position tip height value. It is the same value shown in the RCL screen.</p>

**Boom Height Limitation Procedure by Crane Position**

To define and enable the Boom Height Limitation using the crane current tip height as the limitation, the following steps are used:

1. Position the crane to have the desired position.
2. The Height Limitation Screen (Figure 4-43) is to be shown on the display.
3. For cranes configured with both the Alarm/Warning Function and the Lock Out Function, choose the desired function by doing the following:
  - a. By default, the Lock Out Function is selected. If this is the desired function, skip to Step 4. If not, use the Left Arrow or Right Arrow function to highlight the Lock Out Function symbol.
  - b. Use the OK button (item 2, Figure 4-40) to change the Lock Out Function option to the Alarm/Warning Function option.
4. Use the Right Arrow function to highlight the Enable symbol.
5. Use an OK button to set the symbol to the limitation being enabled - it will have the green color when enabled (note that based on past limitation settings, alarms may begin at this point).
6. Use the Right Arrow function twice to skip the Limitation Value and then highlight the Accept Crane Position symbol (refer to Table 4-6). Use an OK button (item 2, Figure 4-40) to accept the current crane position (such as the 11.7 ft value shown in Figure 4-43) to be the Limitation Value. The Limitation Value should now be updated on the screen. Note that the boom is now at the limitation, so alarms are most likely sounding. The boom can now be moved away from the current tip height to stop the alarm. Refer to Table 4-4 for how the alarm performs. Refer to Figure 4-40 for the button to cancel an audible alarm (once boom motion has stopped).
7. The Height Limitation is now defined and enabled. Crane operations can be resumed with the WRL working with this specified limitation.

**Boom Height Limitation Procedure by Value**

To define and enable the Boom Height Limitation using a manually entered value of tip height as the limitation, the following steps can be used:

1. The Boom Height Limitation Screen (Figure 4-43) is to be shown on the display.
2. Use the Right Arrow function once to highlight the Enable symbol (refer to Table 4-6).
3. Use an OK button to set the symbol to the limitation being enabled — it will have the green color when enabled (note that based on past limitation settings, alarms may begin at this point).
4. Use the Right Arrow function once to highlight the Limitation Value. Use an OK button to begin entering the value. Use the Up Arrow or the Down Arrow to change the value (in tenths) to the desired tip height value. Use an OK button (item 2, Figure 4-40) to finish entering the value. Note that the boom may now be at the limitation (depending on the value entered), so alarms may be active. The boom can now be moved away from the current tip height to stop the alarm, if needed. Refer to item 1, Figure 4-40 for the button to cancel an audible alarm (once boom motion has stopped).
5. The Boom Height Limitation is now defined and enabled. Crane operations can be resumed with the WRL working with this specified limitation.

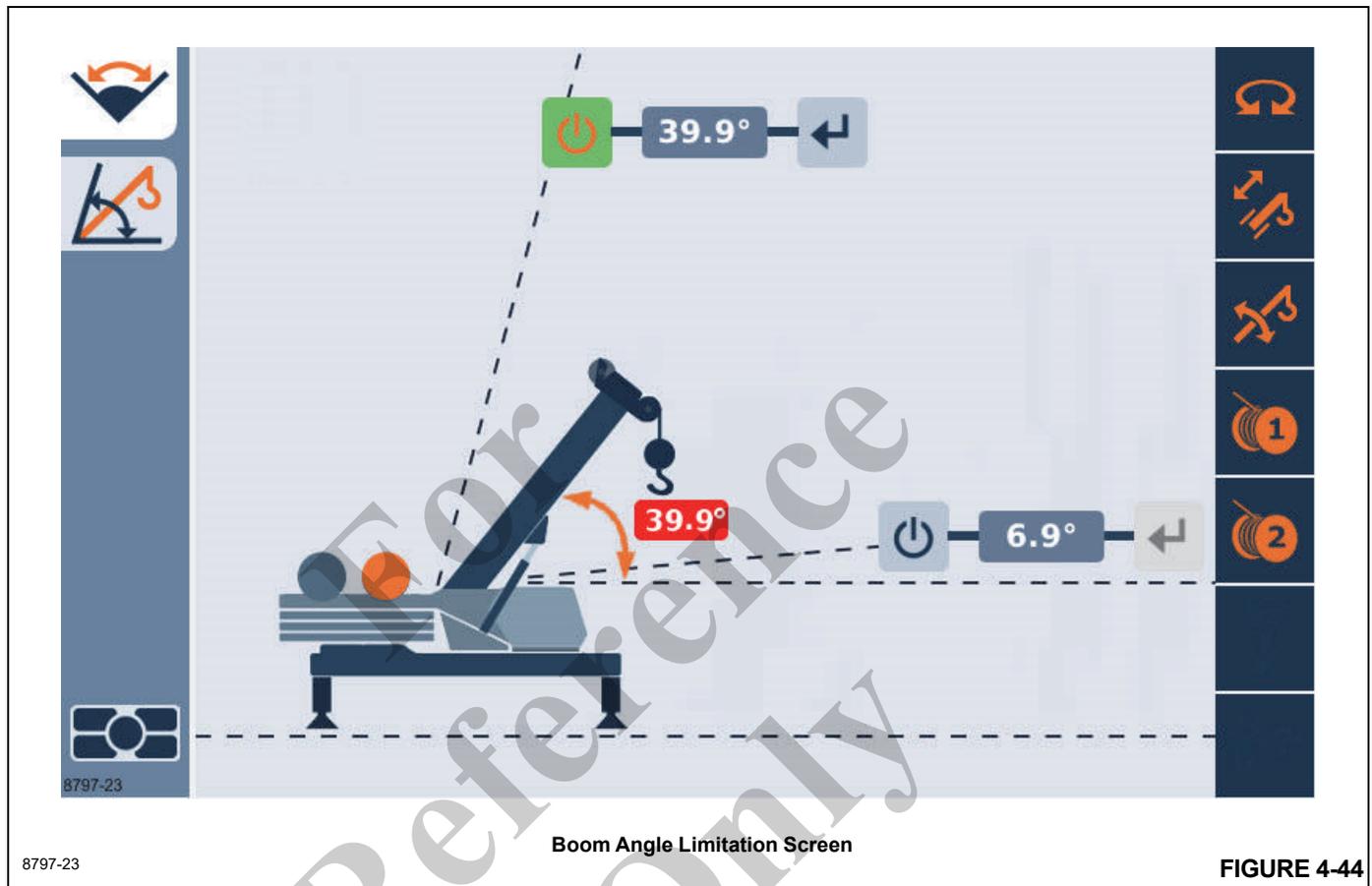
**Boom Height Limitation Disable Procedure**

To disable an active Height Limitation, the following steps can be used (note that turning off the power to the control system also disables the WRL limitations):

1. The Boom Height Limitation Screen (Figure 4-43) is to be shown on the display.
2. Use the Left Arrow and/or Right Arrow function to highlight the Enable symbol (refer to Table 4-6).
3. Use an OK button (item 2, Figure 4-40) to set the symbol to the limitation being disabled—it will not have the green color when it is disabled.

**Setting the Boom Angle Limitation**

If the Boom Angle Limitation is selected from the menu of WRL limitations, the Boom Angle Limitation Screen will be shown (Figure 4-44).



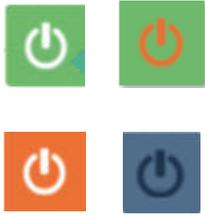
Boom Angle Limitation Screen

FIGURE 4-44

Using the Left Arrow and Right Arrow function on the Navigation Control Pad or the Jog Dial changes the object highlighted on the screen. As the arrow keys are pressed, the highlight will move between the objects, with the color orange typically meaning that the object is selected and can be affected by subsequent actions. In Figure 4-44, one can

see that the  symbol for the maximum boom angle is selected since it has the orange color highlighting. Table 4-7 shows the objects available on the Boom Angle Limitation Screen. Note that the boom angle cannot be typed in (as is possible with the Height Limitation).

Table 4-7 Screen Symbols

Symbol	Description
	<p>Lock Out symbol and Alarm/Warning symbol - These symbols will not appear if the WRL is configured for only the Lock Out Function or only the Alarm/Warning Function. Standard cranes are configured for only the Alarm/Warning Function. Cranes configured for both functions, Lock Out and Alarm/Warning, give the operator the ability to toggle between these two symbols, which indicate the selection for the Lock Out Function (top symbol) or the Alarm/Warning Function (bottom symbol). The selection for this configuration is toggled with an OK button (2, Figure 4-40).</p>
	<p>Enable symbol (2X) - these symbols are used to enable or disable the boom up or boom down limitation (which one is indicated by the position of the symbol on the screen - symbol near the high boom angle is for boom up and the one near the low boom angle is for boom down). The selection for this option is changed with an OK button (2, Figure 4-40). The symbols shown on the top (green background) indicate that the limitation is enabled. The symbols shown on the bottom (not green background) indicate that the limitation is disabled.</p>
	<p>Accept Crane Position symbol (2X) - If the limitation is enabled, these symbols allow the acceptance of the current crane position to be the limitation value (again which one is indicated by the position of the symbol on the screen). If this symbol is highlighted (as shown here with orange background), and the crane position is accepted with an OK button (2, Figure 4-40), then the value shown in the related Limitation Value is updated to be the current crane position. Also, if the limitation value is beyond allowable limits, a fault will be generated, and a fault symbol will appear on the display.</p>

In addition to the symbols that can be highlighted by the arrow functions, the following are shown on the screen:

Symbol	Description
	<p>Boom Up Limitation Value - this value is the currently specified boom angle limitation value for Boom Up.</p>
	<p>Boom Down Limitation Value - this value is the currently specified boom angle limitation value for Boom Down.</p>
	<p>Current Crane Position - this value shown on the screen is the current crane position boom angle value. It is the same value shown in the RCL screen. Note that in this example, the boom angle is at the limit, and for that reason it would be seen highlighted in red.</p>

**Boom Up Limitation Procedure by Crane Position**

To define and enable the Boom Up Limitation using the crane current boom angle as the limitation, the following steps can be used:

1. Position the crane to have the desired position.
2. The Boom Angle Limitation Screen (Figure 4-44) is to be shown on the display.
3. For cranes configured with both the Alarm/Warning Function and the Lock Out Function, choose the desired function by doing the following:
  - a. By default, the Lock Out Function is selected. If this is the desired function, skip to Step 4. If not, use the Left Arrow or Right Arrow function to highlight the Lock Out Function symbol.
  - b. Use the OK button (item 2, Figure 4-40) to change the Lock Out Function option to the Alarm/Warning Function option.
4. Use the Right Arrow function to highlight the Enable symbol (refer to Table 4-7).
5. Use an OK button to set the symbol to the limitation being enabled—it will have the green color when enabled (note that based on past limitation settings, alarms may begin at this point).
6. Use the Right Arrow function once to highlight the upper boom angle Accept Crane Position symbol (refer to Table 4-7). Use an OK button (item 2, Figure 4-40) to accept the current crane position (such as the 39.9 deg value shown in Figure 4-44) to be the Limitation Value. The Limitation Value should now be updated on the screen. Note that the boom is now at the limitation, so alarms are most likely sounding. The boom can now be moved away from the current boom angle to stop the alarm. Refer to Table 4-4 for how the alarm performs. Refer to Figure 4-40 for the button to cancel an audible alarm (once boom motion has stopped).
7. The Boom Up Limitation is now defined and enabled. Crane operations can be resumed with the WRL working with this specified limitation.

**Boom Down Limitation Procedure by Crane Position**

To define and enable the Boom Down Limitation using the crane current boom angle as the limitation, the following steps can be used:

1. Position the crane to have the desired position.
2. The Boom Angle Limitation Screen (Figure 4-44) is to be shown on the display.

3. For cranes configured with both the Alarm/Warning Function and the Lock Out Function, choose the desired function by doing the following:
  - a. By default, the Lock Out Function is selected. If this is the desired function, skip to Step 4. If not, use the Left Arrow or Right Arrow function to highlight the Lock Out Function symbol.
  - b. Use the OK button (item 2, Figure 4-40) to change the Lock Out Function option to the Alarm/Warning Function option.
4. Use the Right Arrow function to skip the Boom Up Limitation symbols and then highlight the Boom Down Enable symbol (refer to Table 4-7).
5. Use an OK button (item 2, Figure 4-40) to set the symbol to the limitation being enabled—it will have the green color when enabled (note that based on past limitation settings, alarms may begin at this point).
6. Use the Right Arrow function once to highlight the lower boom angle Accept Crane Position symbol (refer to Table 4-7). Use an OK button to accept the current crane position (such as the 6.9 degree value shown in Figure 4-44) to be the Limitation Value. The Limitation Value should now be updated on the screen. Note that the boom is now at the limitation, so alarms are most likely sounding. The boom can now be moved away from the current boom angle to stop the alarm. Refer to Table 4-4 for how the alarm performs. Refer to Figure 4-40 for the button to cancel an audible alarm (once boom motion has stopped).
7. The Boom Down Limitation is now defined and enabled. Crane operations can be resumed with the WRL working with this specified limitation.

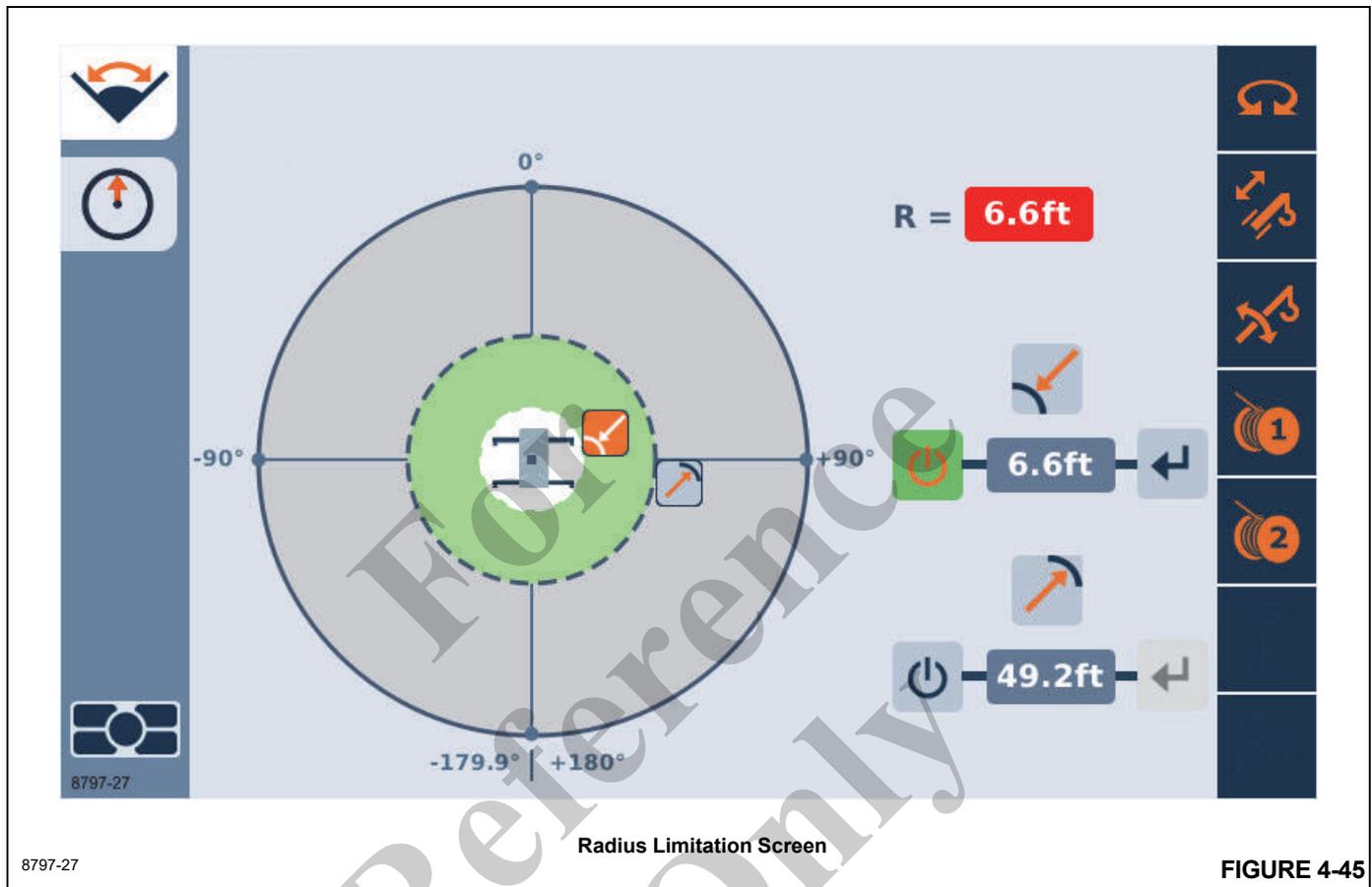
**Boom Up/Down Limitation Disable Procedure**

To disable an active Boom Up or Boom Down Limitation, the following steps are to be used (note that turning off the power to the control system also disables the WRL limitations):

1. The Boom Up/Down Limitation Screen (Figure 4-44) is to be shown on the display.
2. Use the Left Arrow and/or Right Arrow function to highlight the desired Enable symbol (refer to Table 4-7).
3. Use an OK button to set the symbol to the limitation being disabled - it will not have the green color when it is disabled.

**Setting the Radius Limitation**

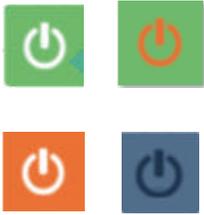
If the Radius Limitation is selected from the menu of WRL limitations, the Radius Limitation Screen will be shown (Figure 4-45).



Using the Left Arrow and Right Arrow function on the Navigation Control Pad or the Jog Dial changes the object highlighted on the screen. As the arrow keys are pressed, the highlight will move between the objects, with the color orange typically meaning that the object is selected and can be affected by subsequent actions. In Figure 4-45, one can

see that the  symbol for minimum radius is selected since it has the orange color highlighting. Table 4-8 shows the objects available on the Radius Limitation Screen. Note that the radius cannot be typed in (as is possible with the Height Limitation).

Table 4-8 Screen Symbols

Symbol	Description
 	<p>Lock Out symbol and Alarm/Warning symbol - These symbols will not appear if the WRL is configured for only the Lock Out Function or only the Alarm/Warning Function. Standard cranes are configured for only the Alarm/Warning Function. Cranes configured for both functions, Lock Out and Alarm/Warning, give the operator the ability to toggle between these two symbols, which indicate the selection for the Lock Out Function (top symbol) or the Alarm/Warning Function (bottom symbol). The selection for this configuration is toggled with an OK button (2, Figure 4-40).</p>
	<p>Enable symbol (2X) - these symbols are used to enable or disable the inner and outer radius limitation; which one is indicated by orange highlight of a symbol shown next to the inner or outer radius circle with the crane graphic.</p> <p>The selection for the enable/disable option is changed with an OK button. The symbols shown on the top (green background) indicate that the limitation is enabled. The symbols shown on the bottom (not green background) indicate that the limitation is disabled.</p>
	<p>Accept Crane Position symbol (2X) - If the limitation is enabled, these symbols allow the acceptance of the current crane position to be the limitation value (again which one is indicated by the position of the symbol on the screen). If this symbol is highlighted (as shown here with orange background), and the crane position is accepted with an OK button, then the value shown in the related Limitation Value is updated to be the current crane position. If the limitation value is beyond allowable limits, a fault will be generated, and a fault symbol will appear on the display.</p>
	<p>This is the inner or minimum radius limitation indicator.</p>
	<p>This is the outer or maximum radius limitation indicator.</p>

In addition to the symbols that can be highlighted by the arrow functions, the following are shown on the screen:

Symbol	Description
	<p>Inner Radius Limitation Value - this value is the currently specified hook radius limitation value for Inner or minimum Radius.</p>
	<p>Outer Radius Limitation Value - this value is the currently specified hook radius limitation value for Outer or maximum Radius.</p>
	<p>Current Crane Position - this value shown on the screen is the current crane position hook radius value. It is the same value shown in the RCL screen. Note that in this example, the radius is at a limit, and for that reason it would be shown highlighted in red.</p>

### Inner Radius Limitation Procedure by Crane Position

To define and enable the Inner Radius Limitation using the crane current hook radius as the limitation, the following steps can be used:

1. Position the crane to have the desired position.
2. The Radius Limitation Screen (Figure 4-45) is to be shown on the display.
3. For cranes configured with both the Alarm/Warning Function and the Lock Out Function, choose the desired function by doing the following:
  - a. By default, the Lock Out Function is selected. If this is the desired function, skip to Step 4. If not, use the Left Arrow or Right Arrow function to highlight the Lock Out Function symbol.
  - b. Use the OK button (item 2, Figure 4-40) to change the Lock Out Function option to the Alarm/Warning Function option.
4. Use the Right Arrow function to highlight the inner radius Enable symbol.
5. Use an OK button (item 2, Figure 4-40) to set the symbol to the limitation being enabled — it will have the green color when enabled (note that based on past limitation settings, alarms may begin at this point).
6. Use the Right Arrow function once to highlight the inner radius Accept Crane Position symbol (refer to Table 4-8). Use an OK button to accept the current crane position (such as the 6.6 ft value shown in Figure 4-45) to be the Limitation Value. The Limitation Value should now be updated on the screen. Note that the boom is now at the limitation, so alarms are most likely sounding. The boom can now be moved away from the current radius to stop the alarm. Refer to Table 4-4 for how the alarm performs. Refer to Figure 4-40 for the button to cancel an audible alarm (once boom motion has stopped).
7. The Inner Radius Limitation is now defined and enabled. Crane operations can be resumed with the WRL working with this specified limitation.

### Outer Radius Limitation Procedure by Crane Position

To define and enable the Outer Radius Limitation using the crane current hook radius as the limitation, the following steps can be used:

1. Position the crane to have the desired position.
2. The Radius Limitation Screen (Figure 4-45) is to be shown on the display.
3. For cranes configured with both the Alarm/Warning Function and the Lock Out Function, choose the desired function by doing the following:
  - a. By default, the Lock Out Function is selected. If this is the desired function, skip to Step 4. If not, use the Left Arrow or Right Arrow function to highlight the Lock Out Function symbol.
  - b. Use the OK button (item 2, Figure 4-40) to change the Lock Out Function option to the Alarm/Warning Function option.
4. Use the Right Arrow function to skip the Inner Radius symbols and then highlight the Outer Radius Enable symbol.
5. Use an OK button to set the symbol to the limitation being enabled—it will have the green color when enabled (note that based on past limitation settings, alarms may begin at this point).
6. Use the Right Arrow function once to highlight the outer radius Accept Crane Position symbol (refer to Table 4-8). Use an OK button to accept the current crane position (such as the 49.2 ft value shown in Figure 4-45) to be the Limitation Value. The Limitation Value should now be updated on the screen. Note that the boom is now at the limitation, so alarms are most likely apparent. The boom can now be moved away from the current radius to cease the alarm. Refer to Table 4-4 for how the alarm performs. Refer to Figure 4-40 for the button to cancel an audible alarm (once boom motion is no longer apparent).
7. The Outer Radius Limitation is now defined and enabled. Crane operations can be resumed with the WRL working with this specified limitation.

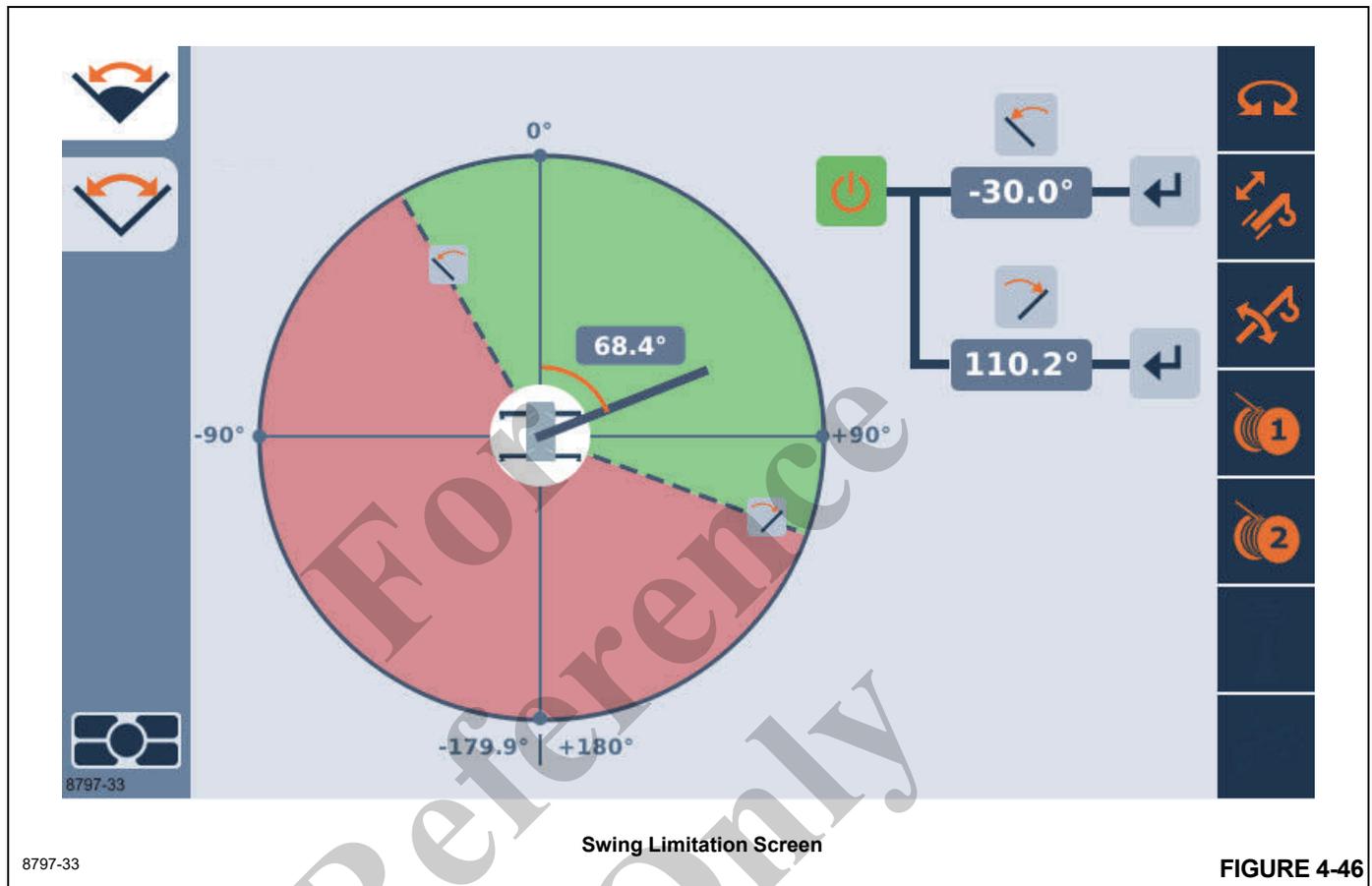
### Radius Limitation Disable Procedure

To disable an active Inner or Outer Radius Limitation, the following steps are to be used (note that turning off the power to the control system also disables the WRL limitations):

1. The Radius Limitation Screen (Figure 4-45) is to be shown on the display.
2. Use the Left Arrow and/or Right Arrow function to highlight the desired Enable symbol (refer to Table 4-8).
3. Use an OK button to set the symbol to the limitation being disabled - it will not have the green color when it is disabled.

**Setting the Swing Angle Limitation**

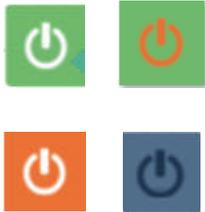
If the Swing Limitation is selected from the menu of WRL limitations, the Swing Limitation Screen will be shown (Figure 4-46).



Using the Left Arrow and Right Arrow function on the Navigation Control Pad or the Jog Dial changes the object highlighted on the screen. As the arrow keys are pressed, the highlight will move between the objects, with the color orange typically meaning that the object is selected and can be affected by subsequent actions. In Figure 4-46, one can

see that the  symbol is selected since it has the orange color highlighting. Table 4-9 shows the objects available on the Swing Limitation Screen.

Table 4-9 Screen Symbols

Symbol	Description
	<p>Lock Out symbol and Alarm/Warning symbol - These symbols will not appear if the WRL is configured for only the Lock Out Function or only the Alarm/Warning Function. Standard cranes are configured for only the Alarm/Warning Function. Cranes configured for both functions, Lock Out and Alarm/Warning, give the operator the ability to toggle between these two symbols, which indicate the selection for the Lock Out Function (top symbol) or the Alarm/Warning Function (bottom symbol). The selection for this configuration is toggled with an OK button (2, Figure 4-40).</p>
	<p>Enable symbol - this symbol is used to enable or disable the swing limitation. Note that swing left and swing right limitations will both be enabled or disabled. The selection for this option is changed with an OK button. The symbols shown on the top (green background) indicate that the limitation is enabled. The symbols shown on the bottom (not green background) indicate that the limitation is disabled.</p>
	<p>Accept Crane Position symbol (2X) - If the limitation is enabled, these symbols allow the acceptance of the current crane position to be the limitation value; which one is indicated by the position of the symbol on the screen - the top one is for swing left and the bottom one is for swing right.</p> <p>If an Accept Crane Position symbol is highlighted (as shown here with orange background), and the crane position is accepted with an OK button, then the value shown in the related Limitation Value is updated to be the current crane position (which is shown on the screen near the crane symbol). Note that the swing angle cannot be typed in (as is possible with the Height Limitation). Also, if the limitation value is beyond allowable limits, a fault will be generated, and a fault symbol will appear on the display.</p>
	<p>This is the swing right indicator.</p>
	<p>This is the swing left indicator.</p>

In addition to the symbols that can be highlighted by the arrow functions, the following are shown on the screen:

Symbol	Description
	<p>Swing Left Limitation Value - this value is the currently specified swing angle limitation value for swinging left.</p>
	<p>Swing Right Limitation Value - this value is the currently specified swing angle limitation value for swinging right.</p>
	<p>Current Crane Position - this value shown on the screen is the current swing angle value. It is the same value shown in the RCL screen.</p>

### Swing Limitation Procedure by Crane Position

To define and enable the Swing Limitation using the crane position to indicate the swing left and right limitation, the following steps can be used:

1. Position the crane to have the desired swing angle position for the swing left limitation.
2. The Swing Limitation Screen (Figure 4-46) is to be shown on the display.
3. For cranes configured with both the Alarm/Warning Function and the Lock Out Function, choose the desired function by doing the following:
  - a. By default, the Lock Out Function is selected. If this is the desired function, skip to Step 4. If not, use the Left Arrow or Right Arrow function to highlight the Lock Out Function symbol.
  - b. Use the OK button (item 2, Figure 4-40) to change the Lock Out Function option to the Alarm/Warning Function option.
4. Use the Right Arrow function to highlight the Enable symbol (refer to Table 4-9).
5. Use an OK button to set the symbol to the limitation being enabled—it will have the green color when enabled (note that based on past limitation settings, alarms may begin at this point).
6. Use the Right Arrow function once to highlight the swing left Accept Crane Position symbol (refer to Table 4-9). Use an OK button to accept the current crane position (such as the 68.4 deg value shown in Figure 4-46) to be the Limitation Value. The Limitation Value for swing left should now be updated on the screen. Note that the boom is now at the limitation, so alarms are most likely sounding. The boom can now be moved away from the current swing angle to stop the alarm. Refer to Table 4-4 for how the alarm performs. Refer to Figure 4-40 for the button to cancel an audible alarm (once boom motion has stopped).
7. Position the crane to have the desired swing angle position for the swing right limitation. If lock out option is being used, past settings may prevent swinging to the

next desired limitation position. The over-ride switch would be used to allow the motion, if this is acceptable.

8. Use the Down Arrow function once to highlight the swing right Accept Crane Position symbol (refer to Table 4-9). Use an OK button to accept the current crane position to be the Limitation Value. The Limitation Value for swing right should now be updated on the screen. Again, note that the boom is now at the limitation, so alarms are most likely sounding. The boom can now be moved away from the current swing angle to stop the alarm.
9. The Swing Limitation is now defined and enabled. Crane operations can be resumed with the WRL working with this specified limitation.

### Swing Limitation Disable Procedure

To disable an active Swing Limitation, the following steps are to be used (note that turning off the power to the control system also disables the WRL limitations):

1. The Swing Limitation Screen (Figure 4-46) is to be shown on the display.
2. Use the Left Arrow and/or Right Arrow function to highlight the Enable symbol.
3. Use an OK button to set the symbol to the limitation being disabled - it will not have the green color when it is disabled.

### Swing Limitation with Lock Out Function Enabled

For cranes that are equipped with the WRL Lock Out Function, when the swing angle is within 20° of the swing angle lock out setpoint, the swing function commanded by the controller may be reduced or suspended depending upon the weight of the load and the swing speed.

#### Warning

Due to the free-swing characteristic of the crane's superstructure, the boom and load can potentially swing past the swing angle setpoint, even if the swing function commanded by the controller is reduced or suspended (locked out) by the WRL. This can happen for several reasons, including how level the crane is and environmental conditions, such as wind speed.

### Setting a Virtual Wall Limitation

If the Virtual Wall Limitation is selected from the menu of WRL limitations, then the Virtual Wall Limitation Screen will be shown (Figure 4-47).

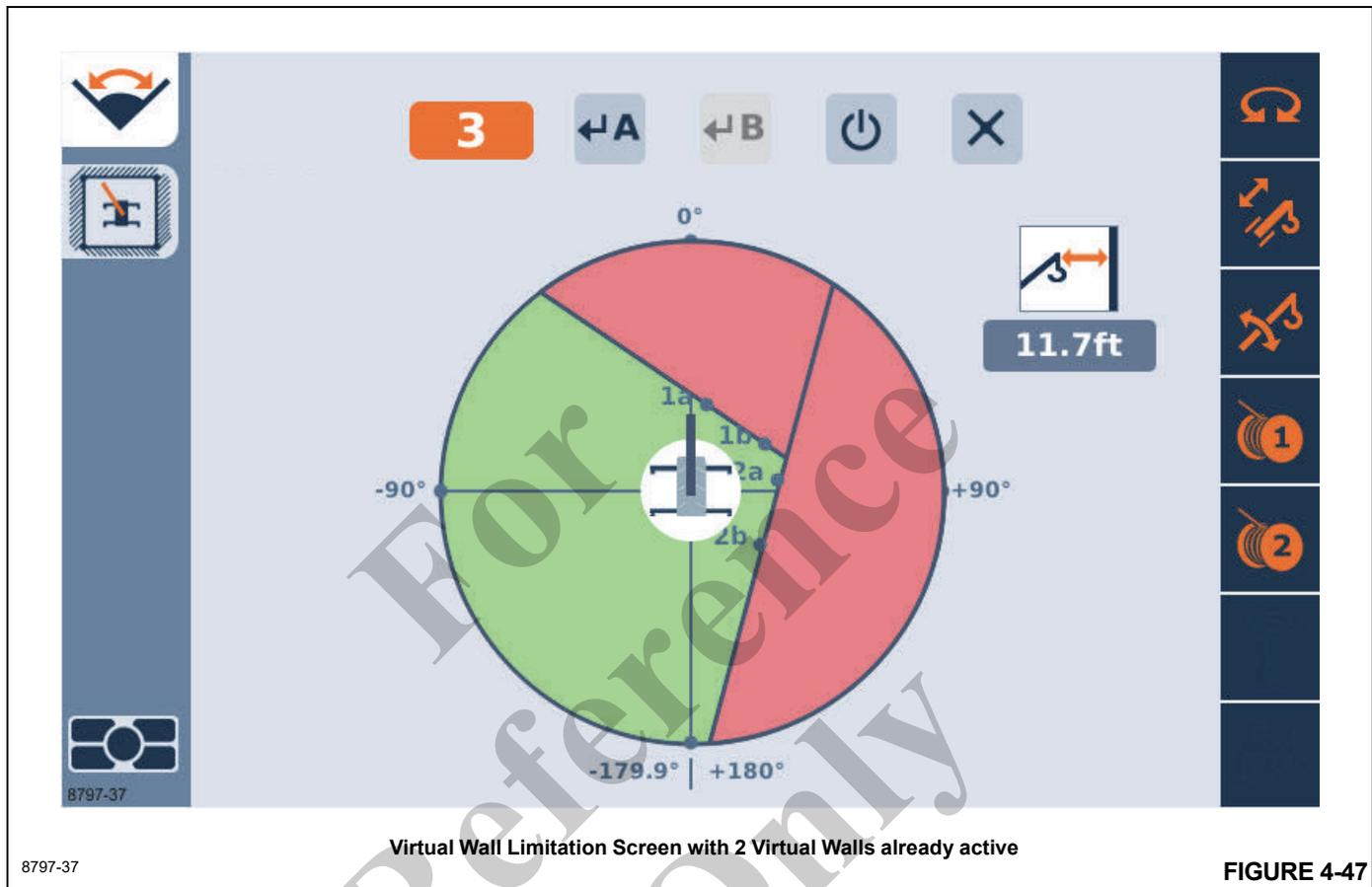
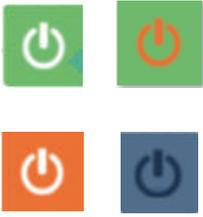


FIGURE 4-47

Using the Left Arrow and Right Arrow function on the Navigation Control Pad or the Jog Dial changes the object highlighted on the screen. As the arrow keys are pressed, the highlight will move between the objects, with the color orange typically meaning that the object is selected and can

be affected by subsequent actions. In Figure 4-47, one can see that the wall number symbol is selected since it has the orange color highlighting. Table 4-10 shows the objects available on the Virtual Wall Limitation Screen.

Table 4-10 Screen Symbols

Symbol	Description
	<p>Lock Out symbol and Alarm/Warning symbol - These symbols will not appear if the WRL is configured for only the Lock Out Function or only the Alarm/Warning Function. Standard cranes are configured for only the Alarm/Warning Function. Cranes configured for both functions, Lock Out and Alarm/Warning, give the operator the ability to toggle between these two symbols, which indicate the selection for the Lock Out Function (top symbol) or the Alarm/Warning Function (bottom symbol). The selection for this configuration is toggled with an OK button (2, Figure 4-40).</p>
	<p>Enable symbol - this symbol is used to enable or disable the limitation. The selection for this option is changed with an OK button. The symbols shown on the top (green background) indicate that the limitation is enabled. The symbols shown on the bottom (not green background) indicate that the limitation is disabled.</p>
	<p>Virtual Wall Number - this is used to indicate the virtual wall that is being defined or altered (there can be up to 5 virtual walls). If the limitation is enabled, and this symbol is highlighted (orange background), the value can be changed with the Up Arrow and Down Arrow function on the display or jog dial (using an OK button to begin and complete the value entry).</p>
	<p>Accept Crane Position Point A symbol - If the limitation is enabled, this symbol allows the acceptance of the current crane position (in terms of hook radius and swing angle) to be the first point (Point A) of a line that defines the position and orientation of the virtual wall. If this symbol is highlighted (as shown here with orange background), and the crane position is accepted with an OK button, then the Point A is considered defined.</p>
	<p>Accept Crane Position Point B symbol - If the limitation is enabled, this symbol allows the acceptance of the current crane position (in terms of hook radius and swing angle) to be the second point (Point B) of a line that defines the position and orientation of the virtual wall. If this symbol is highlighted (as shown here with orange background), and the crane position is accepted with an OK button, then the Point B is considered defined. Note that if the Point A and Point B are not in allowable positions, a fault will be generated, and a fault symbol will appear on the display. For instance, the 2 points may not be so close to each other that a virtual wall is not clearly defined; the 2 points should be at least 10 ft apart).</p>
	<p>Remove Virtual Wall symbol - If the limitation is enabled, and this symbol is highlighted (orange background), this symbol removes the definition of the current wall.</p>

In addition to the symbols that can be highlighted by the arrow functions, the following are shown on the screen:

Symbol	Description
	<p>Wall Proximity Value - this value is the approximate distance from the boom nose to the nearest wall. It becomes a negative value when the boom is protruding beyond the boundary of the wall.</p>

### First Virtual Wall Procedure

To define and enable the first Virtual Wall (assuming no Virtual Walls are already defined), the following steps can be used:

1. The Virtual Wall Limitation Screen (Figure 4-47) is to be shown on the display (and in this case there would not be any virtual walls shown as defined or active).
2. For cranes configured with both the Alarm/Warning Function and the Lock Out Function, choose the desired function by doing the following:
  - a. By default, the Lock Out Function is selected. If this is the desired function, skip to Step 3. If not, use the Left Arrow or Right Arrow function to highlight the Lock Out Function symbol.
  - b. Use the OK button (item 2, Figure 4-40) to change the Lock Out Function option to the Alarm/Warning Function option.
3. Position the crane so that the hook is located at the position to define the first point of the Virtual Wall (Point A).
4. Use the Right Arrow function to highlight the Accept Crane Position Point A symbol (refer to Table 4-10).
5. Use an OK button to accept the current crane position to be Point A. The location of the point should now be shown on the screen with a label of '1a'.
6. Position the crane so that the hook is located at the position to define the second point of the Virtual Wall (Point B). The 2 points may not be so close to each other that a virtual wall is not clearly defined. The 2 points should be at least 10 ft apart.
7. Use the Right Arrow function, if needed, to highlight the Accept Crane Position Point B symbol (refer to Table 4-10).
8. Use an OK button to accept the current crane position to be Point B. The location of the point should now be shown on the screen with a label of '1b'. The screen should also show a maroon-colored "forbidden zone" for the area beyond the Virtual Wall (such as for 2 such walls in Figure 4-47). Use a visual inspection of the screen and the area around the crane to verify that the Virtual Wall is providing the desired zone correctly. Also, note that the boom is now at the virtual wall limitation, so alarms are most likely sounding. The boom can now be moved away from the wall to stop the alarm. Refer to Table 4-4 for how the alarm performs. Refer to Figure 4-40 for the button to cancel an audible alarm (once boom motion has stopped).
9. The Virtual Wall #1 is now defined and enabled. Crane operations can be resumed with the WRL working with this specified limitation. Note that the Virtual Wall

Number on the display increments to 2 so that it is ready to define a subsequent virtual wall, if so desired.

### Subsequent Virtual Wall Procedure

To define and enable further Virtual Walls (such as Virtual Wall 2 through 5), the following steps can be used:

1. The Virtual Wall Limitation Screen (similar to Figure 4-47) is to be shown on the display.
2. Use the Right Arrow function to highlight the Virtual Wall Number (refer to Table 4-10).
3. If the wall number shown is not the correct number for the new wall (note that it increments automatically when the previous wall was defined), use an OK button (item 2, Figure 4-40) to allow modifying the value. Use the Up/Down Arrows to alter the Virtual Wall number to the desired value. Use an OK button to finish entering the value.
4. Position the crane so that the hook is located at the position to define the first point of the Virtual Wall (Point A).
5. Use the Right Arrow function to highlight the Accept Crane Position Point A symbol (refer to Table 4-10).
6. Use an OK button to accept the current crane position to be Point A. The location of the point should now be shown on the screen with a label that shows the wall number and the letter 'a'.
7. Position the crane so that the hook is located at the position to define the second point of the Virtual Wall (Point B). The 2 points may not be so close to each other that a virtual wall is not clearly defined. The 2 points should be at least 10 ft apart.
8. Use the Right Arrow function, if needed, to highlight the Accept Crane Position Point B symbol (refer to Table 4-10).
9. Use an OK button to accept the current crane position to be Point B. The location of the point should now be shown on the screen with a label. The screen should also show another maroon-colored "forbidden zone" for the area beyond the Virtual Wall. Use a visual inspection of the screen and the area around the crane to verify that the Virtual Walls are providing the desired zone correctly. Again, note that the boom is now at the virtual wall limitation, so alarms are most likely sounding. The boom can now be moved away from the wall to stop the alarm. Refer to Table 4-4 for how the alarm performs. Refer to Figure 4-40 for the button to cancel an audible alarm (once boom motion has stopped).
10. The multiple Virtual Walls are now defined and enabled. Crane operations can be resumed with the WRL working with this specified limitation.

**Virtual Wall Limitation Disable Procedure**

To disable the active Virtual Wall Limitation, the following steps can be used:

1. The Virtual Wall Limitation Screen (Figure 4-47) is to be shown on the display.
2. Use the Right Arrow function to highlight the Virtual Wall Number (refer to Table 4-10).
3. If the wall number shown is not the correct number for wall to be disabled, use an OK button (item 2, Figure 4-40) to allow modifying the value. Use the Up/Down Arrows to change the Virtual Wall number to the desired value. Use an OK button to finish entering the value.
4. Use the Left Arrow and/or Right Arrow function to highlight the Enable symbol (refer to Table 4-10).
5. Use an OK button to toggle the symbol to the limitation being disabled - it will not have the green color when it is disabled.

**Delete Virtual Wall Limitation Procedure**

To delete a Virtual Wall the following steps can be used:

1. The Virtual Wall Limitation Screen (Figure 4-47) is to be shown on the display.
2. Use the Right Arrow function to highlight the Virtual Wall Number (refer to Table 4-10).
3. If the wall number shown is not the correct number for wall to be deleted, use an OK button to allow modifying the value. Use the Up/Down Arrows to change the Virtual Wall number to the desired value. Use an OK button to finish entering the value.
4. Use the Left Arrow and/or Right Arrow function to highlight the Remove Virtual Walls symbol (the 'X' or refer to Table 4-10). Use an OK button to delete the wall.

**Tools Group**

The Tools Group is made up of the following function icons (Figure 4-48):

- **Display Screen Brightness icon**  
(refer to *Setting the Display Screen Brightness*, page 4-84)
- **Units of Measure (Metric/Imperial) icon**  
(refer to *Setting the Units of Measure*, page 4-84)
- **Controller Sensitivity icon**  
(refer to *Setting the Controller Sensitivity*, page 4-85)
- **Controller Function Speed icon**  
(refer to *Setting the Controller Function Speed*, page 4-87)

- **ECO Mode On/Off icon**  
(refer to *Setting ECO Mode to On/Off*, page 4-88)

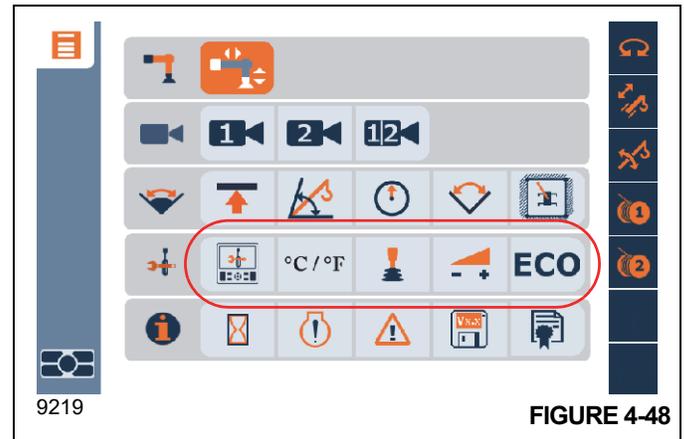


FIGURE 4-48

Icon	Description
	Display Screen Brightness icon - not selected
	Display Screen Brightness icon - selected
	Units of Measure icon - not selected
	Units of Measure icon - selected
	Controller Sensitivity icon - not selected
	Controller Sensitivity icon - selected
	Controller Speed icon - not selected
	Controller Speed icon - selected

Icon	Description
	ECO Mode icon - not selected
	ECO Mode icon - selected

**Accessing a Tools Group Function Screen**

Access a Tools Group function screen (Figure 4-48) by doing one of the following:

- Press the Screen Toggle Button (1, Figure 4-49) at the Jog Dial to select the ODM screen control.  
Press the Menu Button (2) to go to the Menu Screen.  
Using the Jog Dial (3), select one of the Tools Group function icons (icon will turn orange), then press the Jog Dial (3).  
- or -
- Press the Menu Button (4, Figure 4-49) on the Navigation Control Pad at the ODM to go to the Menu Screen.  
Using the Arrow Buttons (5), select one of the Tools Group function icons (icon will turn orange), then press the OK Button (6).

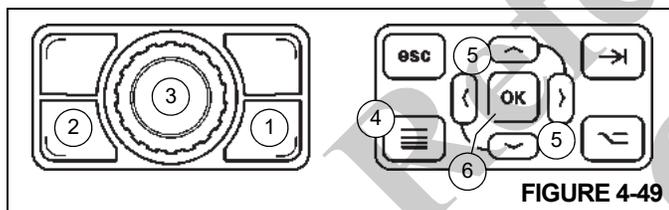


FIGURE 4-49

**Exiting a Tools Group Function Screen**

Perform one of the following procedures to exit a Tools Group function screen and navigate to the Main Screen or Menu Screen:

- Press the Screen Toggle Button (1, Figure 4-50) at the Jog Dial to select the ODM screen control, then press the Escape Button (2) for the Main Screen or the Menu Button (3) for the Menu Screen.  
- or -
- Press the Escape Button (4, Figure 4-50), on the Navigation Control Pad at the ODM, for the Main Screen or the Menu Button (5) for the Menu Screen.

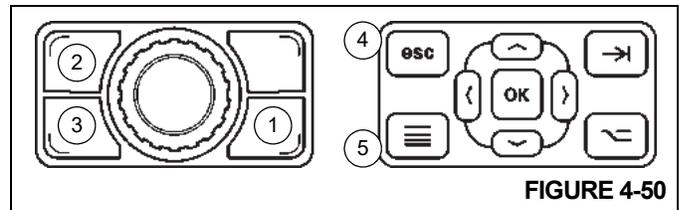


FIGURE 4-50

**Setting the Display Screen Brightness**

The Display Screen Brightness function screen (Figure 4-51) allows the operator to adjust the brightness of the ODM and RDM screens.

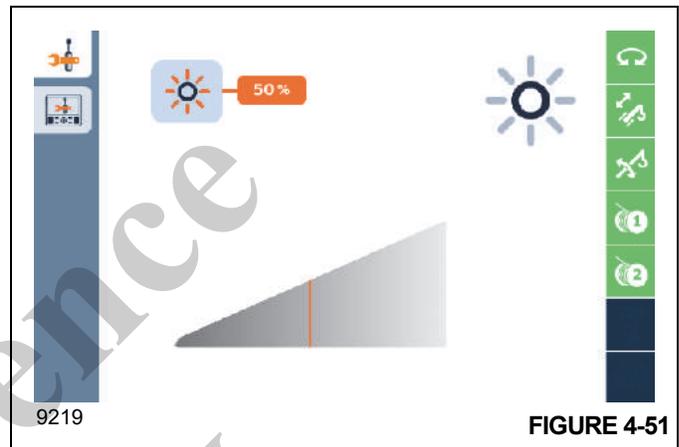


FIGURE 4-51

Press the Jog Dial or OK Button on the Navigation Control Pad, then use the Jog Dial or Arrow Buttons to increase or decrease the screen brightness. The following example (Figure 4-52) shows the display brightness increased from the default setting of 50% to 70%.

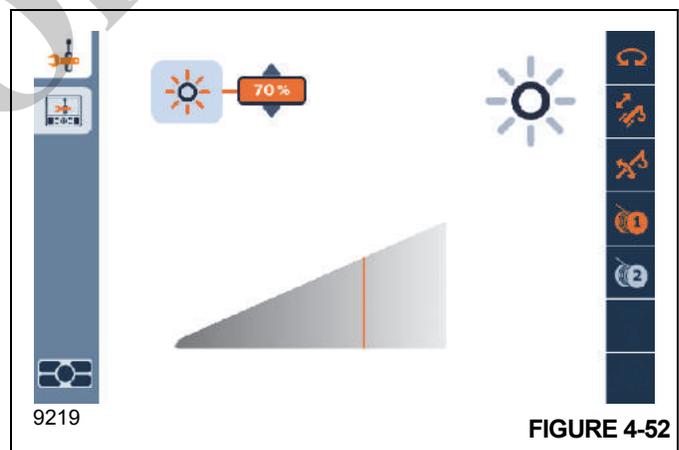
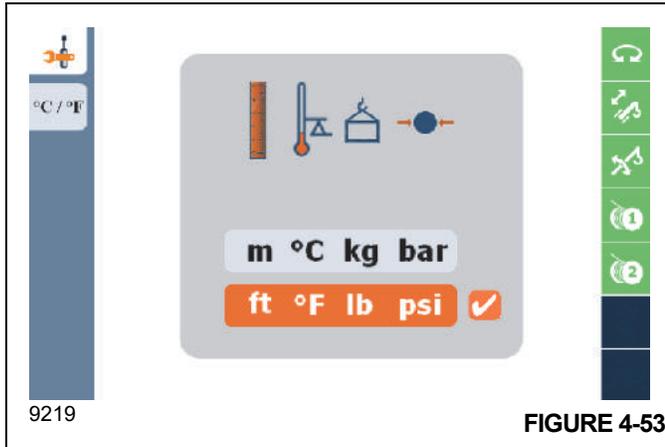


FIGURE 4-52

**Setting the Units of Measure**

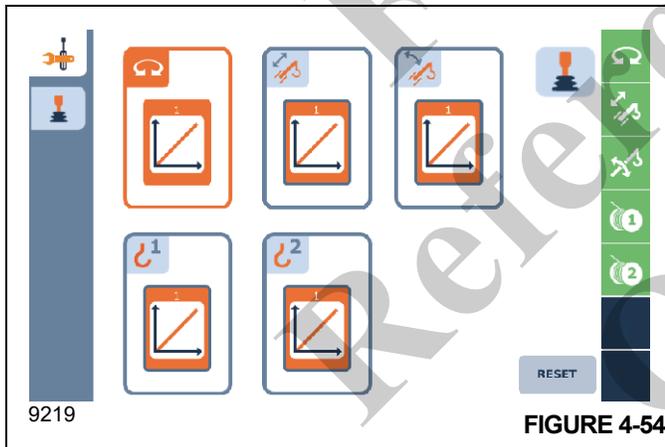
The Units of Measure function screen (Figure 4-53) allows the operator to select the units of measure that is used throughout the ODM and RDM screens.

Use the Jog Dial or Arrow Buttons on the Navigation Control Pad to select the desired unit of measure, then press the Jog Dial or the OK Button.



**Setting the Controller Sensitivity**

The Controller Sensitivity function screen (Figure 4-54) allows the operator to adjust the sensitivity of the controllers and foot pedal (optional).

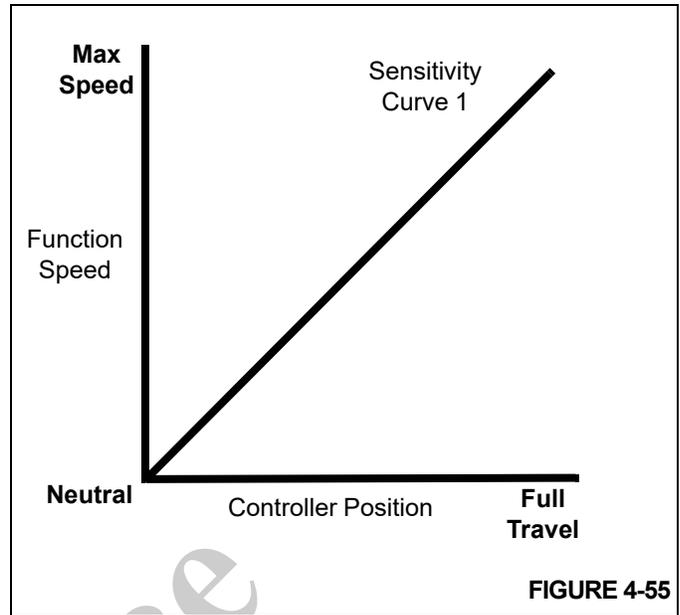


Icon	Description
	Swing Function Sensitivity icon - active
	Telescope Function Sensitivity icon - not selected
	Telescope Function Sensitivity icon - selected
	Telescope Function Sensitivity icon - active
	Boom Lift Function Sensitivity icon - not selected
	Boom Lift Function Sensitivity icon - selected
	Boom Lift Function Sensitivity icon - active
	Main Hoist Function Sensitivity icon - not selected

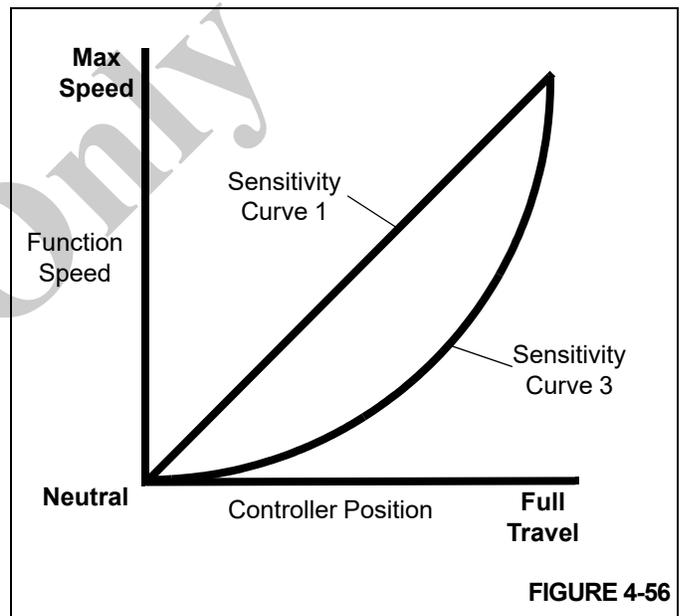
Icon	Description
	Swing Function Sensitivity icon - not selected
	Swing Function Sensitivity icon - selected

Icon	Description
	Main Hoist Function Sensitivity icon - selected
	Main Hoist Function Sensitivity icon - active
	Auxiliary Function Sensitivity icon - not selected
	Auxiliary Hoist Function Sensitivity icon - selected
	Auxiliary Hoist Function Sensitivity icon - active

Five different sensitivity curves are available to select from (curves 1 through 5). Sensitivity curve 1 is the default curve and causes the function speed to increase or decrease equally with an equal amount of movement of the controller (Figure 4-55).

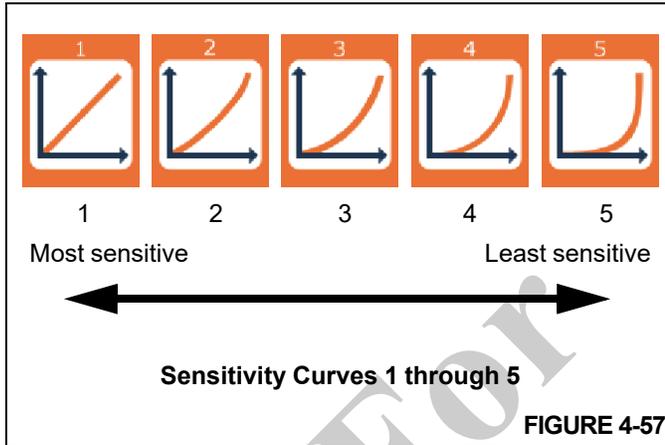


Selecting a sensitivity curve of 2 through 5 causes the function speed to be reduced, from the default sensitivity curve 1, relative to the same controller position over the full travel of the controller (Figure 4-56). Sensitivity curve 1 (default) is the most sensitive and sensitivity curve 5 is the least sensitive (Figure 4-55).



Adjust the sensitivity of a controller function by doing the following:

- Using the Jog Dial or Arrow Buttons on the Navigation Control Pad, select the controller function icon that is to be adjusted (icon will turn orange).
- Press the Jog Dial or OK Button on the Navigation Control Pad to make the controller function icon active (icon background will turn gray).
- Using the Jog Dial or the Up/Down Arrow Buttons, select one of the five possible sensitivity curves (Figure 4-57).



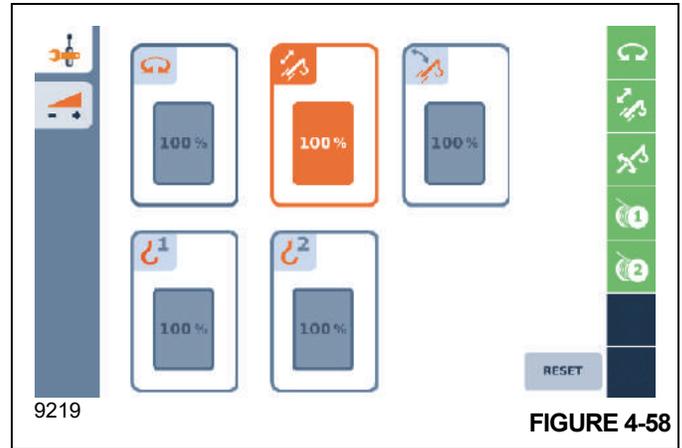
- Press the Jog Dial or OK Button on the Navigation Control Pad to accept the new setting.

Select the Reset icon on the Controller Sensitivity function screen and press the Jog Dial or the OK Button to set the sensitivity on both controllers and the foot pedal (optional) back to the factory default settings.

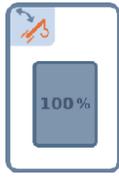
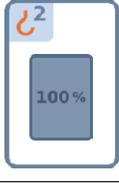
**Setting the Controller Function Speed**

The Controller Function Speed screen (Figure 4-58) allows the operator to adjust the crane function speeds relative to the positions of the controllers and the foot pedal (optional). Adjustment is made as a percentage of full rated speed.

A setting of 100% results in the crane function moving at full rated speed relative to the position of the controller or foot pedal (optional). A setting of 75% results in the crane function moving at 75% of full rated speeds throughout the range of the controller or foot pedal.



Icon	Description
	Swing Function Speed icon - not selected
	Swing Function Speed icon - selected
	Swing Function Speed icon - active
	Telescope Function Speed icon - not selected
	Telescope Function Speed icon - selected

Icon	Description
	Telescope Function Speed icon - active
	Boom Lift Function Speed icon - not selected
	Boom Lift Function Speed icon - selected
	Boom Lift Function Speed icon - active
	Main Hoist Function Speed icon - not selected
	Main Hoist Function Speed icon - selected
	Main Hoist Function Speed icon - active
	Auxiliary Hoist Function Speed icon - not selected

Icon	Description
	Auxiliary Hoist Function Speed icon - selected
	Auxiliary Hoist Function Speed icon - active

Adjust the speed of a controller function by doing the following:

1. Using the Jog Dial or Arrow Buttons on the Navigation Control Pad, select the controller function icon that is to be adjusted (icon will turn orange).
2. Press the Jog Dial or OK Button on the Navigation Control Pad to make the controller function icon active (icon background will turn gray).
3. Using the Jog Dial or the Up/Down Arrow Buttons, adjust the percentage to the desired setting.

Adjustments are made in 1% increments/decrements. To quickly make large adjustments, hold the Jog Dial down while rotating it.

4. Press the Jog Dial or OK Button on the Navigation Control Pad to accept the new setting.

Select the Reset icon on the Controller Speed function screen and press the Jog Dial or the OK Button to set the speed of both controllers and the foot pedal (optional) back to the factory default settings of 100%.

**Setting ECO Mode to On/Off**

In Economy (ECO) Mode the crane software will control the throttle command to the engine. Based on the state of the crane and inputs from the throttle pedal and the Increment/Decrement Switch, ECO mode will reduce the throttle command when crane functions are not being used. This is intended to encourage the operator to run crane functions with enough power provided by the engine and reduce the fuel consumption when the crane is not doing any work.

**NOTE:** ECO mode only works when actuating craning functions and does not work when operating the outriggers.

When ECO mode is allowed to change the throttle command the crane operator will observe the following:

- When any crane function is being commanded from approximately 0 to 15% of controller input, the software will increase the throttle command from idle to a predetermined throttle command defined by the operator.
- When all crane functions are not being commanded for approximately 3 seconds, the ECO mode software will reduce the throttle to idle.

**Terminology**

Term	Definition
Disabled ECO Mode	ECO mode is OFF (throttle command percent is always 0% in this mode)
Enabled ECO mode	ECO mode is ON and can be operated at commanded throttle percentage
Active ECO mode	ECO mode has commanded a throttle percent greater than 0% (Must be enabled to become active)
Inactive ECO mode	ECO mode is enabled and the command throttle percentage is 0%
Throttle Setpoint (Setpoint)	The throttle percentage set by crane operator by pressing the Increment/Decrement Switch in the superstructure cab.

**Requirements**

ECO mode can be enabled by the crane operator on the Operating Display Module (ODM). The default is for ECO mode to be disabled when shipped from the factory. Once enabled, the system stays enabled until disabled through the ODM.

**NOTE:** ECO mode stays disabled (or enabled) independent of ignition key cycles and disconnect switch cycles.

The ODM screen that is used to enable ECO mode must contain the following information:

- Actual throttle command to the engine
- ECO mode Throttle percent setpoint
- ECO mode status (enabled, disabled, active, and inactive)

When enabled the throttle setpoint will be set to the ECO mode Throttle percent setpoint unless the operator has previously set it to a higher value using the Increment / Decrement switch.

The operator can increase the throttle command using the throttle pedal independent if ECO mode is active or inactive.

ECO mode is forced to inactive when the crane transmission is being shifted to Forward or Reverse, or all crane functions are disabled.

When active, ECO mode will ramp the throttle percent from 0 to setpoint when any crane function command goes above 5% command. Once ECO mode output is at the setpoint, the output will stay at the setpoint until no crane functions are being commanded for 3 seconds. Then the ECO mode throttle command is to be set to 0% (step down).

**NOTE:** Ramp time for increasing throttle percent is 2 seconds from 0% to 100% throttle (slope = 50% per second).

**Operation**

- Crane is able to idle at 700 RPM when crane functions are not enabled.
- Crane idles at 950 RPM when any crane function has been enabled.
- Operating Display menu allows operator to turn on “ECO Mode” and set the operating engine speed for the crane.
- When operator turns ECO mode ON:
  - Crane ramps engine from idle to operating speed using the first 15% of the controller movement to control the ramp.
  - Crane maintains operating RPM while crane functions are active and for a period of 3 seconds after crane functions go inactive.
  - Crane ramps engine speed back down to idle point.

**Benefits**

- Less noise and less fuel consumption versus maintaining crane at fixed “operating speed”.
- Set point for engine operating speed is easily changed by the operator.
- Operator can command additional engine speed at any time using the accelerator pedal.

**Information Group**

The Information Group is made up of the following function icons (Figure 4-59):

- **Operating Hours icon**  
(refer to *Viewing the Operating Hours*, page 4-91)
- **Engine Fault Code icon**  
(refer to *Viewing the Engine Fault Codes*, page 4-92)
- **Crane Fault Code icon**  
(refer to *Viewing the Crane Fault Codes*, page 4-93)
- **Software Revision icon**  
(refer to *Viewing the Software Revisions*, page 4-93)

- **Legal Notice icon**  
(refer to *Viewing the Legal Notice*, page 4-93)

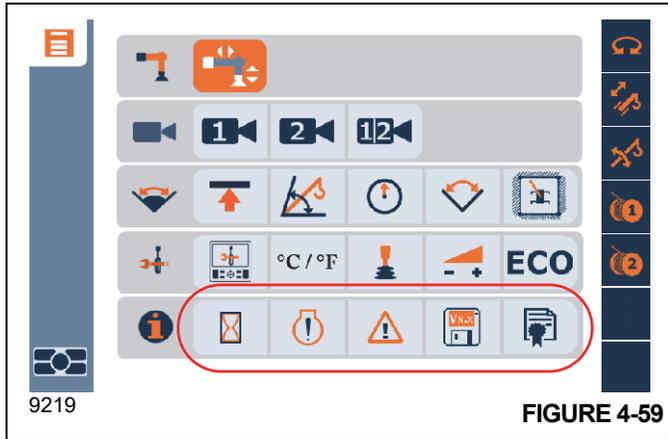


FIGURE 4-59

Icon	Description
	Legal Notice icon - not selected
	Legal Notice icon - selected

**Accessing an Information Group Function Screen**

Access an Information Group function screen (Figure 4-59) by doing one of the following:

- Press the Screen Toggle Button (1, Figure 4-60) at the Jog Dial to select the ODM screen control.

Press the Menu Button (2) to go to the Menu Screen.

Using the Jog Dial (3), select one of the Information Group function icons (icon will turn orange), then press the Jog Dial (3).

- or -

- Press the Menu Button (4, Figure 4-60) on the Navigation Control Pad at the ODM to go to the Menu Screen.

Using the Arrow Buttons (5), select one of the Information Group function icons (icon will turn orange), then press the OK Button (6).

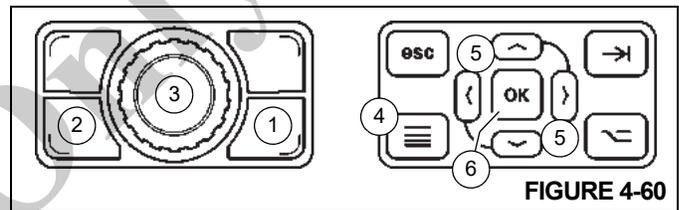


FIGURE 4-60

Icon	Description
	Operating Hours icon - not selected
	Operating Hours icon - selected
	Engine Fault Code icon - not selected
	Engine Fault Code icon - selected
	Crane Fault Code - not selected
	Crane Fault Code - selected
	Software Revision icon - not selected
	Software Revision icon - selected

**Exiting an Information Group Function Screen**

Perform one of the following procedures to exit an Information Group function screen and navigate to the Main Screen or Menu Screen:

- Press the Screen Toggle Button (1, Figure 4-61) at the Jog Dial to select the ODM screen control, then press the Escape Button (2) for the Main Screen or the Menu Button (3) for the Menu Screen.

- or -

- Press the Escape Button (4, Figure 4-61), on the Navigation Control Pad at the ODM, for the Main Screen or the Menu Button (5) for the Menu Screen.

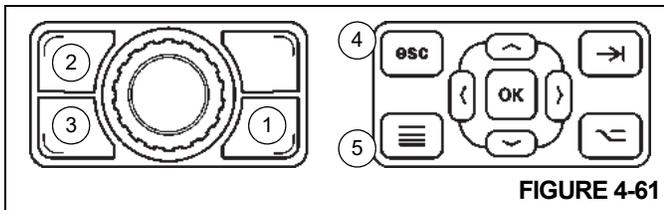


FIGURE 4-61

**Viewing the Operating Hours**

The Operating Hours function screen (Figure 4-62) displays the total accumulated operating hours for the different crane functions as well as offers a resettable trip meter for each crane function.

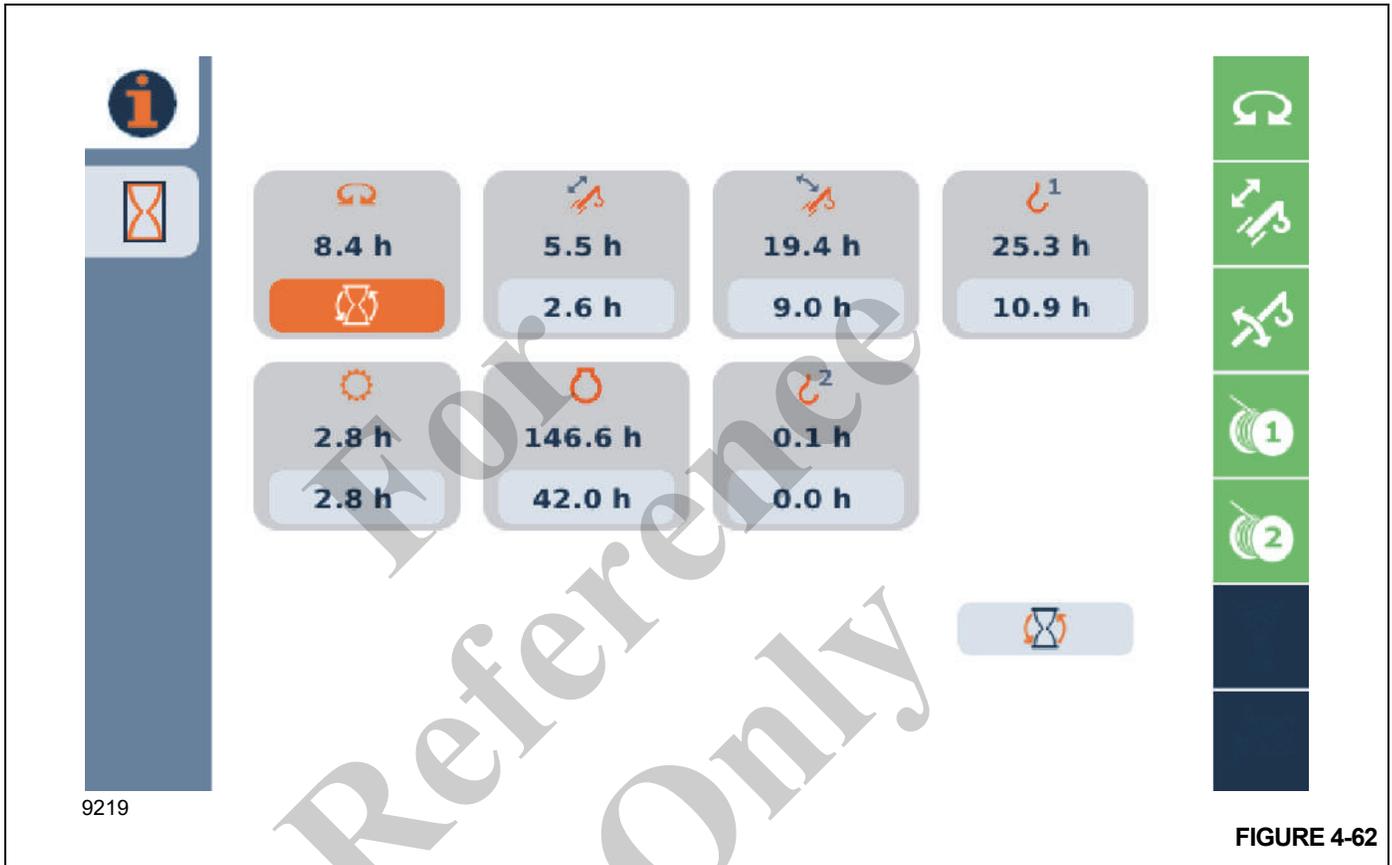


FIGURE 4-62

Icon	Description
	Swing Operating Hours icon - not selected
	Swing Operating Hours icon - selected
	Boom Telescope Operating Hours icon - not selected

Icon	Description
	Boom Telescope Operating Hours icon - selected
	Boom Lift Operating Hours icon - not selected
	Boom Lift Operating Hours icon - selected

Icon	Description
	Main Hoist Operating Hours icon - not selected
	Main Hoist Operating Hours icon - selected
	Transmission Operating Hours icon - not selected
	Transmission Operating Hours icon - selected
	Engine Operating Hours icon - not selected
	Engine Operating Hours icon - selected
	Auxiliary Hoist (optional) Operating Hours icon - not selected
	Auxiliary Hoist (optional) Operating Hours icon - selected
	Reset All icon - not selected
	Reset All icon - selected

Reset the trip meter for a crane function by doing the following:

- Using the Jog Dial or Arrow Buttons (1, Figure 4-63) on the Navigation Control Pad, select the hours under the crane function icon that is to be reset (hours will turn to an orange hour-glass).
- Press the Jog Dial (1) or OK Button (2) on the Navigation Control Pad to reset the hours to zero (0).

**NOTE:** Allow up to 8 seconds for the trip meter to reset to 0.0 hours.

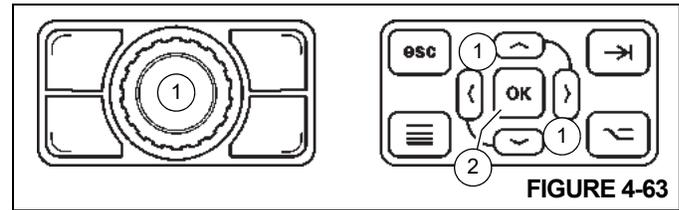


FIGURE 4-63

To reset all crane function operating hours to zero (0), select the Reset All icon (icon will turn orange) on the Operating Hours function screen and press the Jog Dial or the OK Button.

**Viewing the Engine Fault Codes**

The Engine Fault Code function screen (Figure 4-64) displays active engine fault codes.

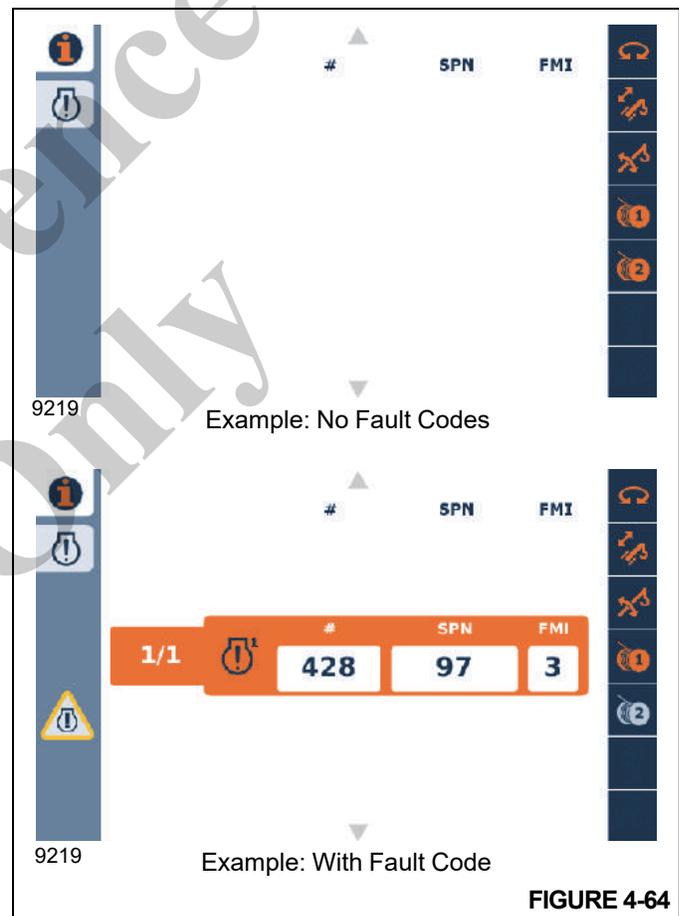


FIGURE 4-64

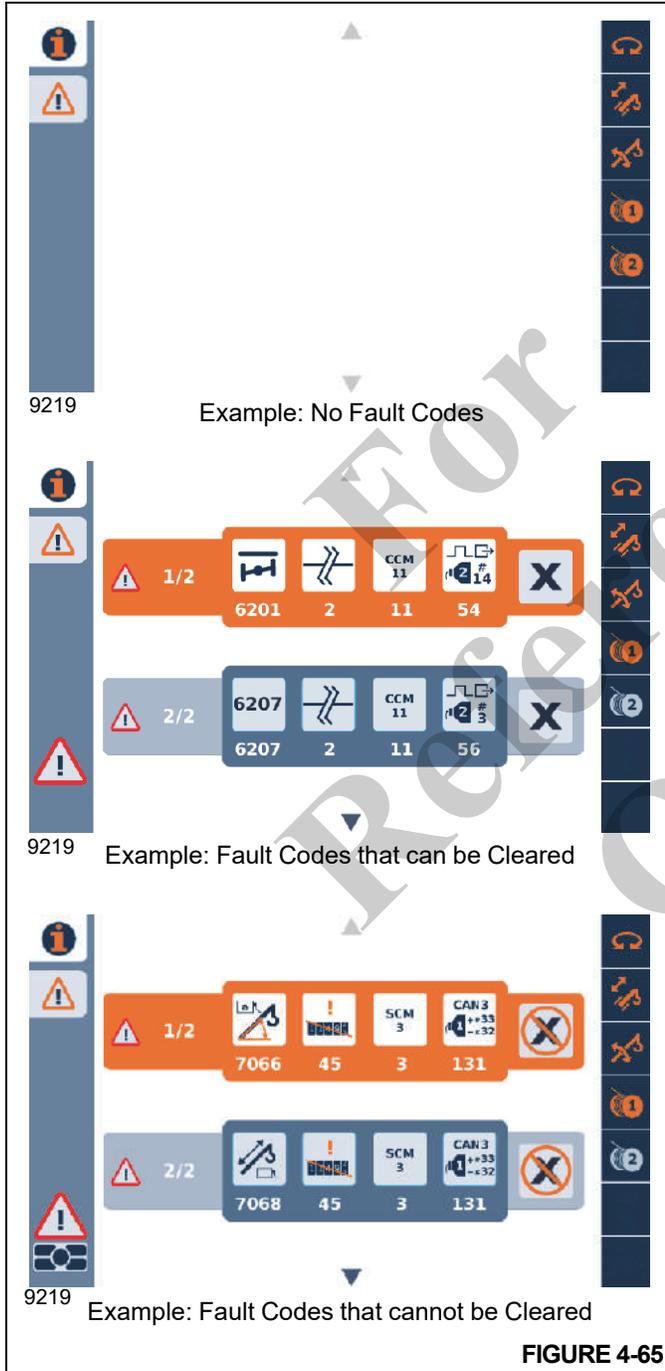
If several fault codes are active, use the Jog Dial or Arrow Buttons on the Navigation Control Pad to select the arrow at the top or bottom of the screen to scroll through the codes

Engine fault codes cannot be cleared by the operator without first correcting the malfunction, then cycling the ignition key to the Off position and back to the On position.

**Viewing the Crane Fault Codes**

The Crane Fault Code function screen (Figure 4-65) displays active crane fault codes.

If several fault codes are active, use the Jog Dial or Arrow Buttons on the Navigation Control Pad to select the arrow at the top or bottom of the screen to scroll through the codes

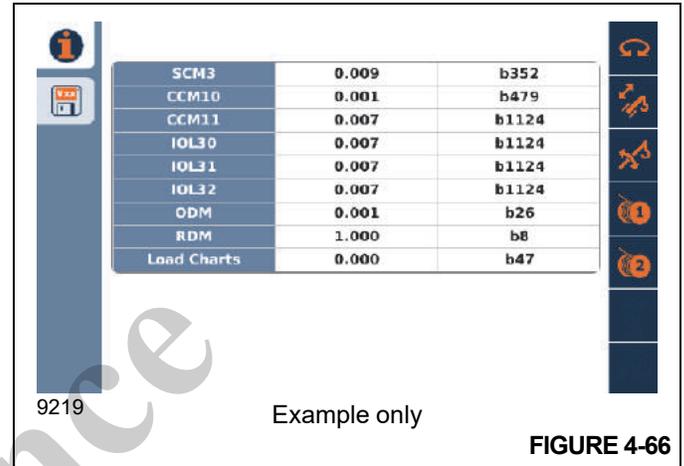


Crane fault codes with an “X” beside them can be cleared by the operator. Crane fault codes with an “X” surrounded by a red circle with strike-through cannot be cleared without first

correcting the malfunction, then cycling the ignition key to the Off position and back to the On position.

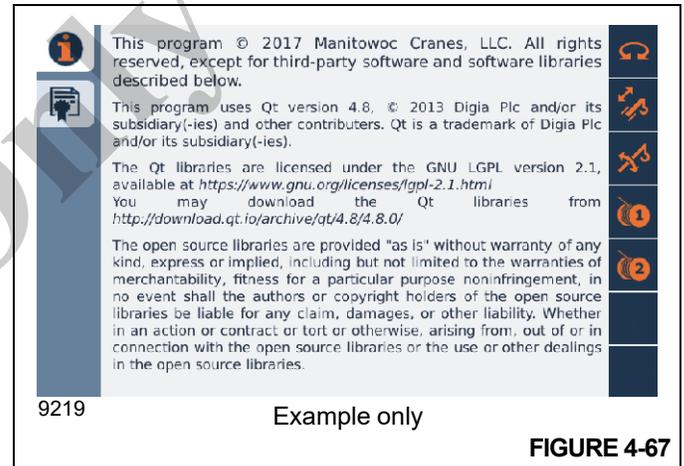
**Viewing the Software Revisions**

The Software Revision function screen (Figure 4-66) displays the current software revisions for all of the software installed on the crane.



**Viewing the Legal Notice**

The Legal Notice screen (Figure 4-67) displays the software licensing notice for the crane’s software.



**USING THE RATED CAPACITY LIMITER DISPLAY MODULE (RDM)**

**NOTE:** Refer to *Rated Capacity Limiter Display Module (RDM)*, page 3-8 for additional information.

The Rated Capacity Limiter (RCL) is an electro-mechanical sensing system designed to alert the crane operator of impending capacity when the system has been accurately programmed by the operator. When an overload condition is sensed, the system provides the operator with a visual and audible warning, and locks out the controller functions to

prevent raising and lowering the boom, extending the boom, or raising the main or auxiliary (optional) hoist ropes.

**! DANGER**

Electronic equipment on this crane is intended as an aid to the operator. Under no condition should it be relied on to replace the use of Load Charts and operating instructions.

Sole reliance on these electronic aids in place of good operating practices can cause an accident.

The RCL Setup Screen (Figure 4-68) appears on the RDM when the ignition key is set to the On position. The operator can either input a code number from the Load Chart or use the setup wizard.

Program the RCL by doing one of the following:

- *Entering a Code Number Manually*, page 4-96
- *Using the Setup Wizard*, page 4-98

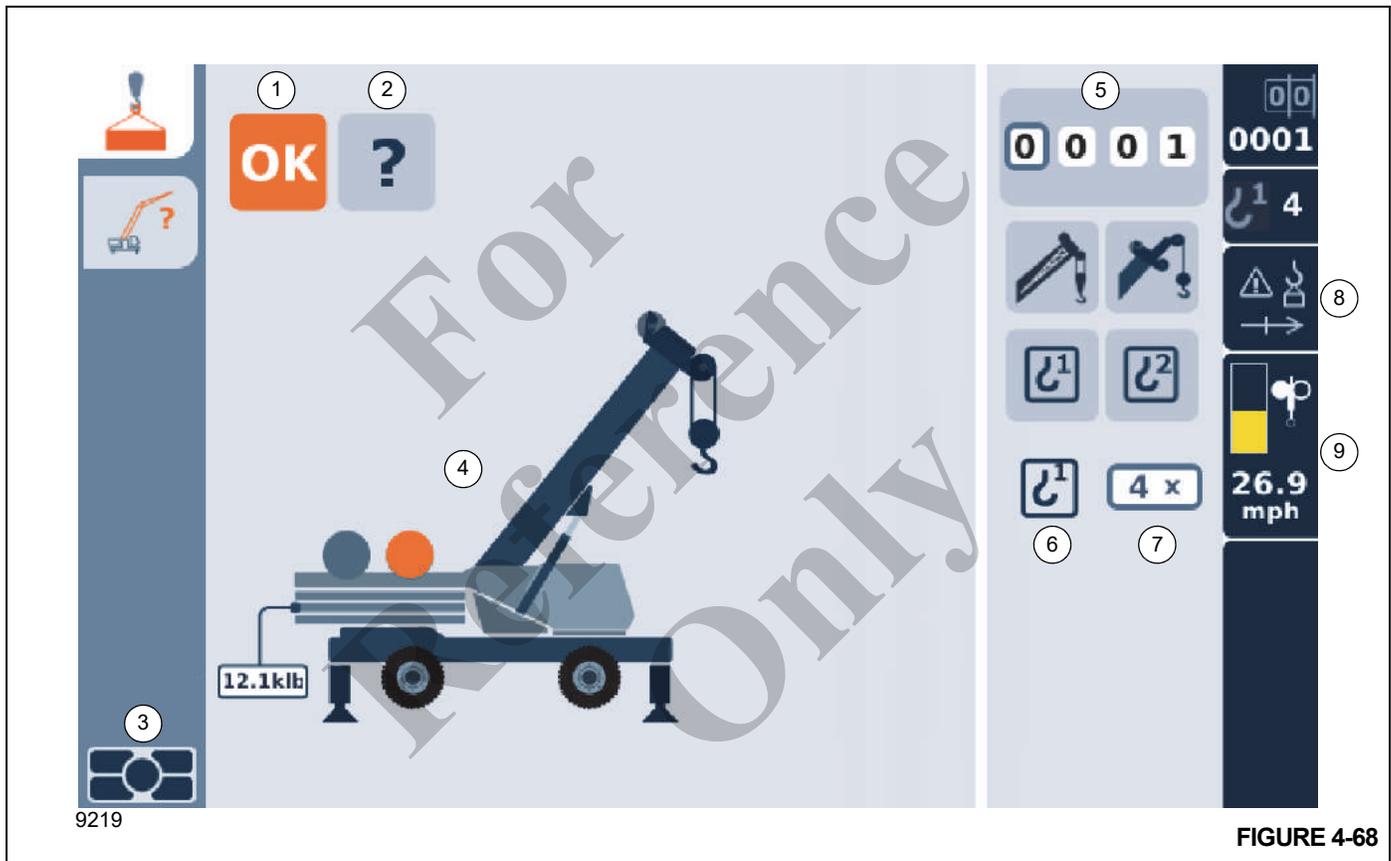


FIGURE 4-68

Item	Description	Graphic	Explanation
1	OK icon - not selected		Icon used to accept the current programmed RCL crane configuration or load chart code number.
	OK icon - selected		

Item	Description	Graphic	Explanation
2	RCL Setup Wizard icon - not selected		Icon used to select the RCL Setup Wizard.
	RCL Setup Wizard icon - selected		
3	Jog Dial Status Indicator		Indicates the RDM screen is being controlled by the Jog Dial. Refer to <i>Navigating the Operator Display Module and Rated Capacity Limiter Display Module</i> , page 4-34.
4	Crane Pictorial	–	Graphical representation of the programmed RCL crane configuration.
5	Load Chart Code Number		Load Chart Code Number for the programmed RCL crane configuration.
6	Active Hoist Programmed into RCL		Indicates the main hoist is programmed into the RCL as the active hoist.
			Indicates the auxiliary hoist is programmed into the RCL as the active hoist.
7	Parts of Line		Indicates the number of parts of line programmed into the RCL.
8	Limit Bypass Indicator		Indicates that none of the crane function limiters are bypassed.
	Limit Bypass Indicator (Amber - flashing)		Indicates the Limit Bypass Switch behind the operator's seat is in the bypassed position when the ignition switch is set to the On position. Make sure Limit Bypass Switch is in the non-bypassed position prior to turning the ignition switch to the On position.
	Limit Bypass Indicator (Red)		Indicates a Limit Bypass Switch is in the bypassed position.
9	Wind Speed Indicator (optional)	–	Indicates wind speed in kph or mph.

### Entering a Code Number Manually

**NOTE:** Each load chart in the *Load Chart Manual* is given a unique code number. The code number is found at the top of each load chart.

Manually program the RCL by entering the load chart code number into the RCL Setup Screen:

1.
  - Press the Screen Toggle Button (1, Figure 4-69) at the Jog Dial to select the RDM screen control.

Using the Jog Dial (2, Figure 4-69), select one of the code number fields (box around number will turn orange, Figure 4-70), then press the Jog Dial (2) (number will turn white with orange background).

- or -

- Using the Arrow Buttons (3, Figure 4-69) on the Navigation Control Pad at the RDM, select one of the code number fields (box around number will turn orange, Figure 4-70), then press the OK Button (4) (number will turn white with orange background).

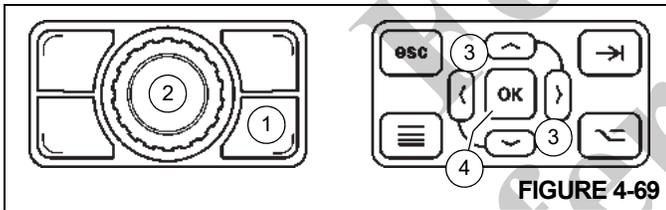


FIGURE 4-69

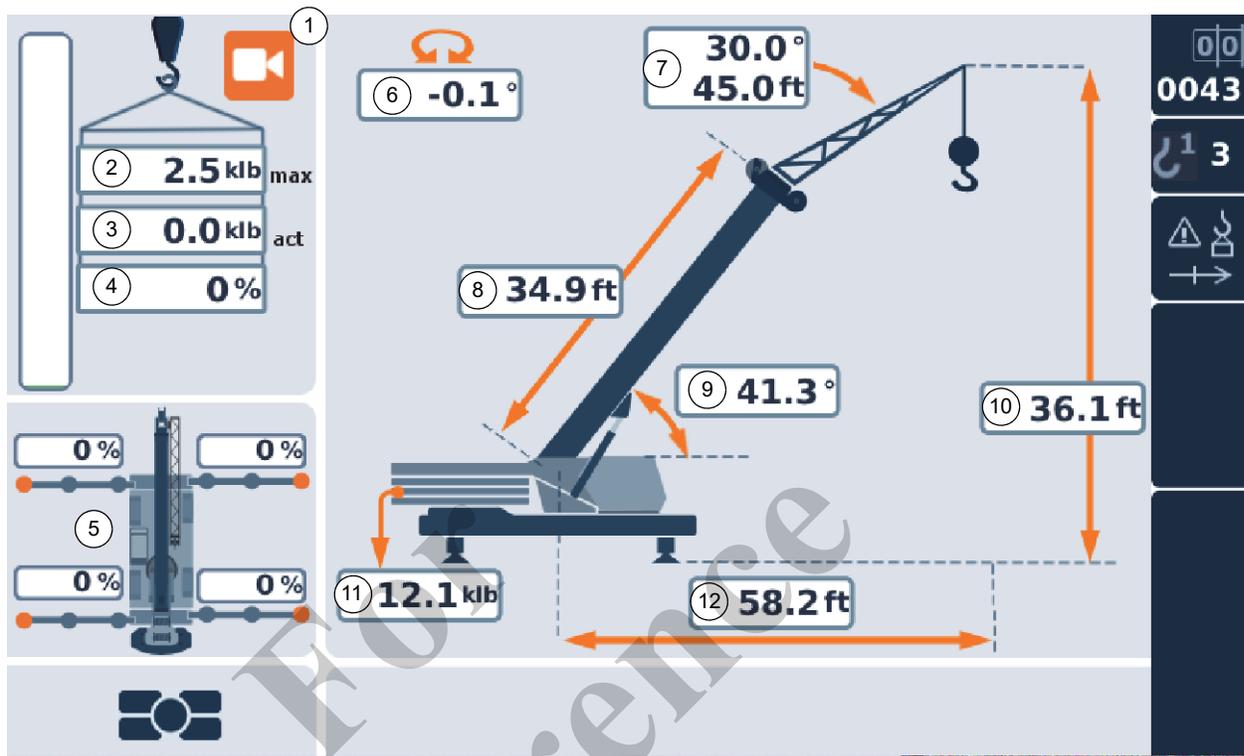


FIGURE 4-70

2. Using the Jog Dial or the Up/Down Arrow Buttons, select the correct code number.
3. Press the Jog Dial or OK Button on the Navigation Control Pad to accept the new number.
4. Repeat steps 1 through 3 until the complete code number is entered.
5. Using the Jog Dial or the Arrow Buttons, select the OK icon (icon will turn orange), then press the Jog Dial or the OK Button.

The RDM will display the RCL Main Screen.

The RCL Main Screen (Figure 4-71) shows specific information pertaining to the current crane configuration and the lift being performed.



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Item	Description	Item	Description
1	Backup Camera View On/Off Toggle icon	7	Boom Extension Offset and Length
2	Maximum Capacity (for the Current Crane Configuration/Load Chart Code Number)	8	Boom Length
3	Actual Load	9	Boom Angle
4	Actual Load as a Percentage of Maximum Capacity	10	Boom Tip Height
5	Outrigger Position as a Percentage (Fully Retracted = 0%, Mid-Extend = 50%, Fully Extended = 100%)	11	Counterweight
6	Swing Angle	12	Load Radius

FIGURE 4-71

### Using the Setup Wizard

**NOTE:** The crane can be setup in many different configurations. The RCL Setup Wizard uses 6 screens to define these crane configurations. Not all of the following RCL Setup Wizard's configuration screens may be needed when defining a given crane setup.

Program the RCL using the Setup Wizard:

- Press the Screen Toggle Button (1, Figure 4-72) at the Jog Dial to select the RDM screen control.

Using the Jog Dial (2, Figure 4-72), select the Setup Wizard icon (3, Figure 4-73) (icon will turn orange), then press the Jog Dial (2).

- or -

  - Using the Arrow Buttons (4, Figure 4-72) on the Navigation Control Pad at the RDM, select the Setup Wizard icon (3, Figure 4-73) (icon will turn orange), then press the OK Button (5).

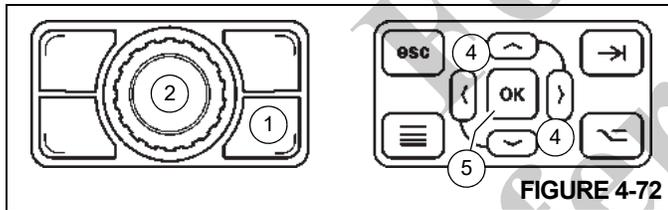


FIGURE 4-72

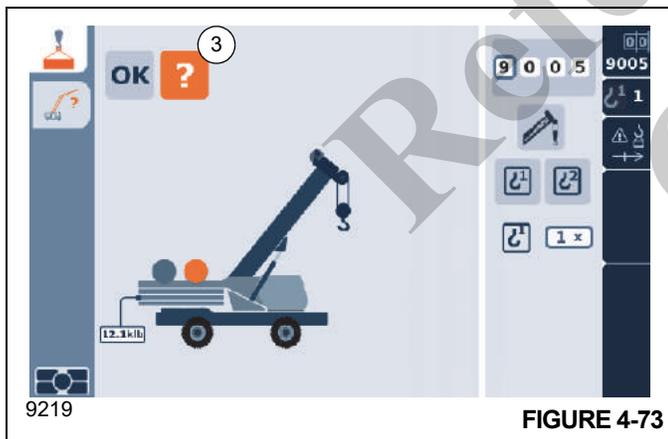


FIGURE 4-73

Icon	Description
	Setup Wizard - not selected
	Setup Wizard - selected

- Using the Jog Dial or Arrow Buttons, select one of the following tire or outrigger configurations (icon will turn orange) and press the Jog Dial or the OK Button to accept the selection.

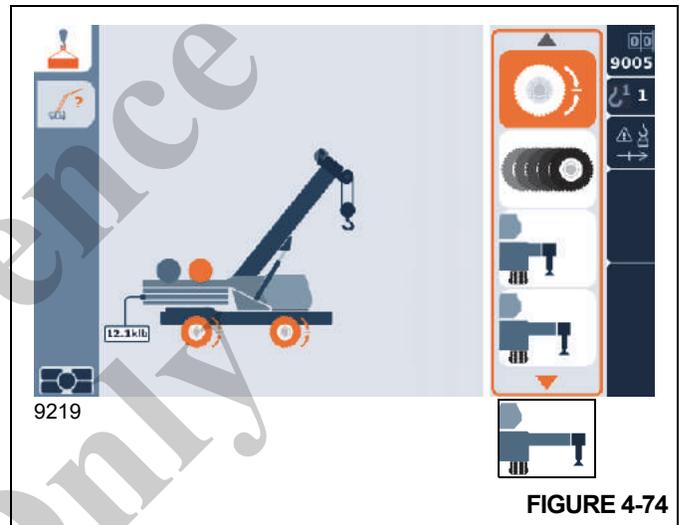
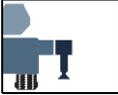
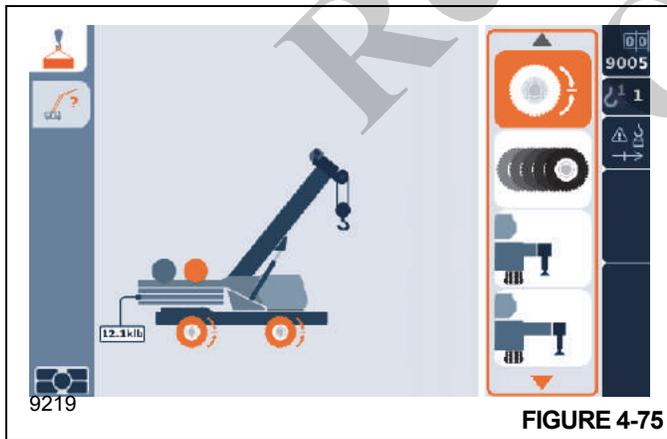


FIGURE 4-74

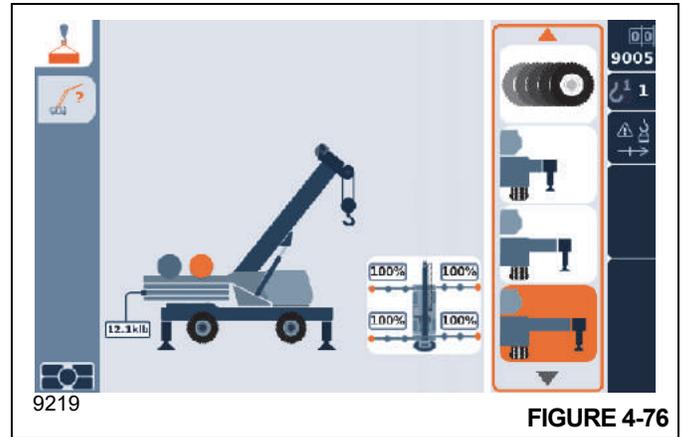
Icon	Description
	On Rubber/Stationary icon - not selected
	On Rubber/Stationary icon - selected
	On Rubber/Pick and Carry icon - not selected
	On Rubber/Pick and Carry icon - selected

Icon	Description
	On Outrigger/Fully Retracted icon - not selected
	On Outrigger/Fully Retracted icon - selected
	On Outrigger/Mid Extended icon - not selected
	On Outrigger/Mid Extended icon - selected
	On Outrigger/Fully Extended icon - not selected
	On Outrigger/Fully Extended icon - selected

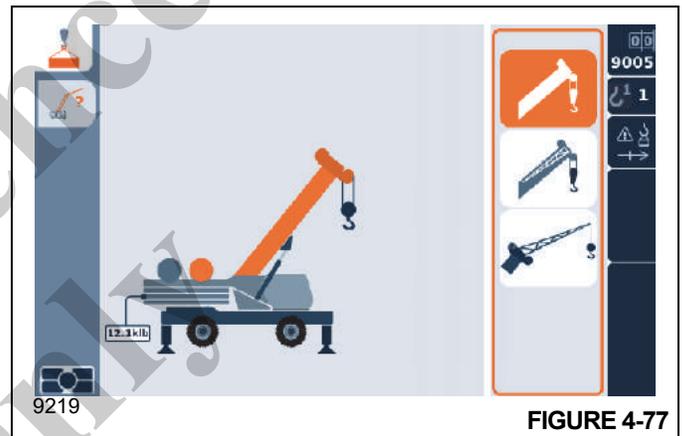
When an On Rubber configuration is chosen, the wheels of the crane will turn orange (Figure 4-75).



When choosing an On Outrigger configuration, a pictorial of the four outriggers will appear at the bottom right corner of the screen, which indicates where the outriggers are positioned as a percentage Figure 4-76).



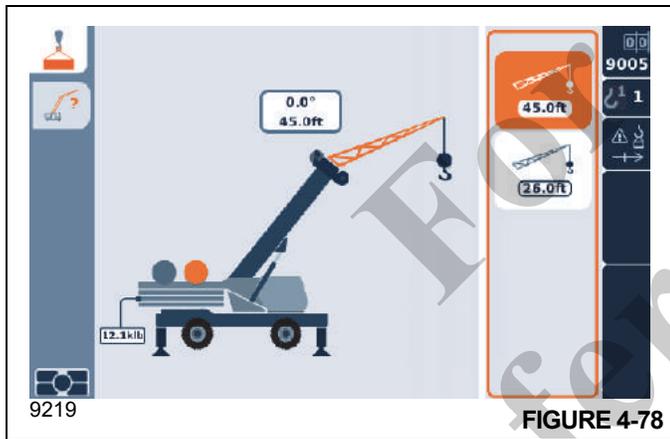
- If required, use the Jog Dial or Arrow Buttons to select one of the following Boom Extension configurations (icon will turn orange) (Figure 4-77) and then press the Jog Dial or the OK Button to accept the selection.

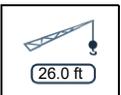


Icon	Description
	Boom Extension Removed icon - not selected
	Boom Extension Removed icon - selected
	Boom Extension Stowed icon - not selected
	Boom Extension Stowed icon - selected

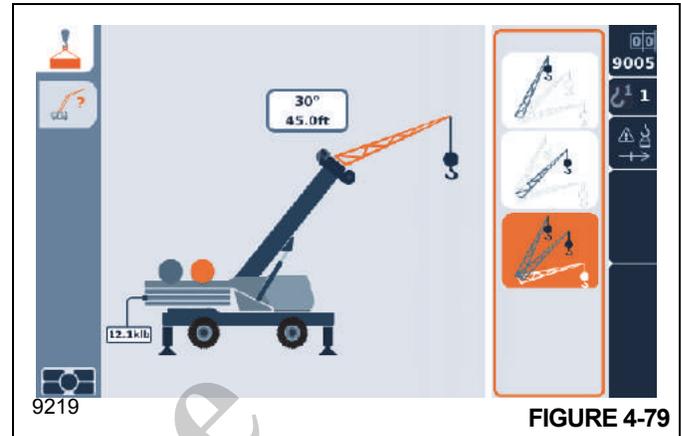
Icon	Description
	Boom Extension Erected icon - not selected
	Boom Extension Erected icon - selected

4. If required, use the Jog Dial or Arrow Buttons to select one of the following Boom Extension Length configurations (icon will turn orange) (Figure 4-78) and then press the Jog Dial or the OK Button to accept the selection.



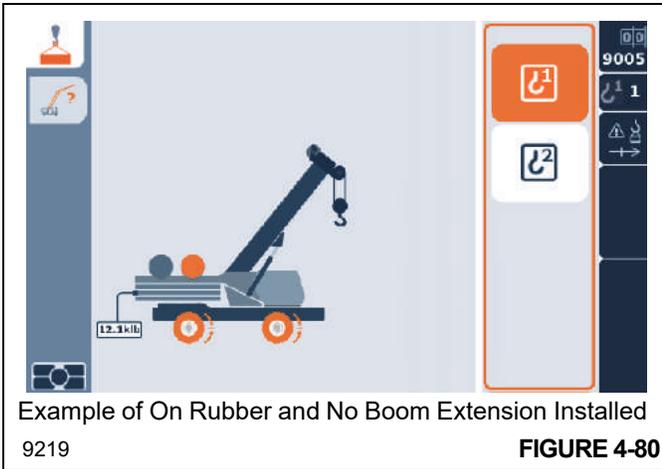
Icon	Description
	Boom Extension Length 13.7 m (45 ft) icon - not selected
	Boom Extension Length 13.7 m (45 ft) icon - selected
	Boom Extension Length 7.92 m (26 ft) icon - not selected
	Boom Extension Length 7.92 m (26 ft) icon - selected

5. If required, use the Jog Dial or Arrow Buttons to select one of the following Boom Extension Offset configurations (icon will turn orange) (Figure 4-79) and then press the Jog Dial or the OK Button to accept the selection.



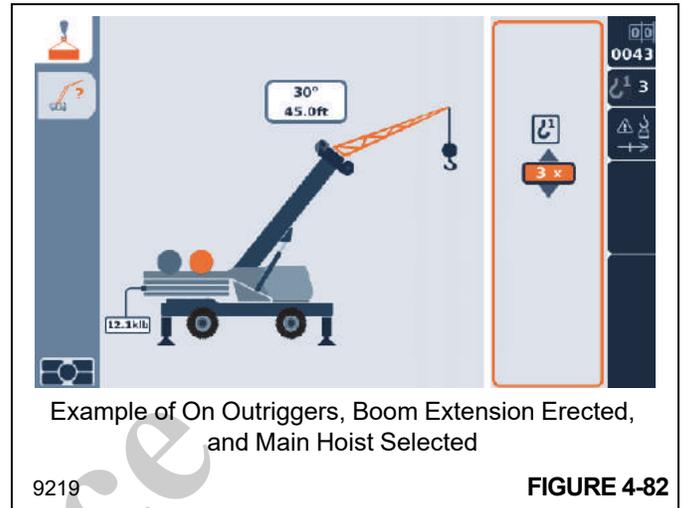
Icon	Description
	Boom Extension Offset 0° icon - not selected
	Boom Extension Offset 0° icon - selected
	Boom Extension Offset 15° icon - not selected
	Boom Extension Offset 15° icon - selected
	Boom Extension Offset 30° icon - not selected
	Boom Extension Offset 30° icon - selected

6. If the crane is equipped with the optional auxiliary hoist, use the Jog Dial or Arrow Buttons to select the main or auxiliary hoist (icon will turn orange) (Figure 4-80) and then press the Jog Dial or the OK Button to accept the selection.

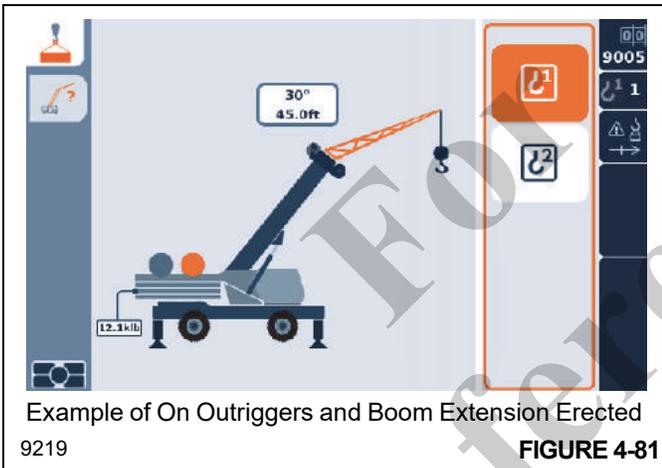


Example of On Rubber and No Boom Extension Installed  
9219 **FIGURE 4-80**

7. Press the Jog Dial or OK Button, select the number of Parts of Line (Figure 4-82) using the Jog Dial or Arrow Buttons, then press the Jog Dial or the OK Button to accept the selection.

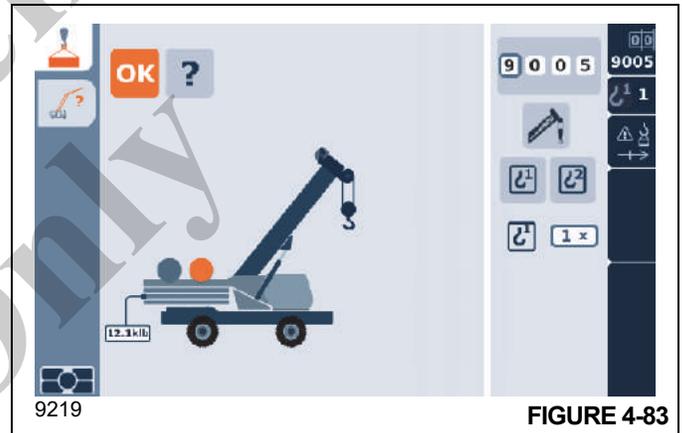


Example of On Outriggers, Boom Extension Erected,  
and Main Hoist Selected  
9219 **FIGURE 4-82**



Example of On Outriggers and Boom Extension Erected  
9219 **FIGURE 4-81**

8. Setup of the RCL is complete. The RDM display will return to the RCL Setup Screen (Figure 4-83).

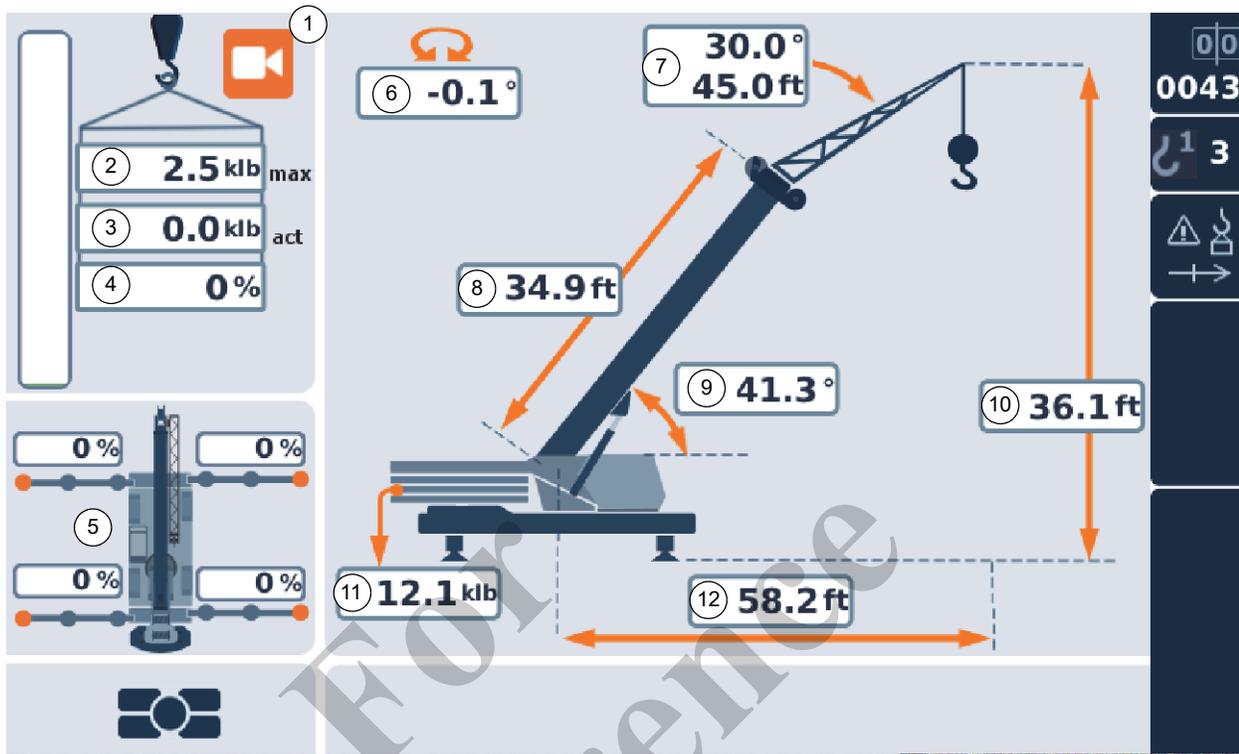


9219 **FIGURE 4-83**

Icon	Description
	Main Hoist - not selected
	Main Hoist - selected
	Auxiliary Hoist - not selected
	Auxiliary Hoist - selected

Click the OK icon to accept the programmed crane configuration.

The RDM will display the RCL Main Screen (Figure 4-84) which displays specific information pertaining to the current crane configuration and the lift being performed.



9219

Item	Description	Item	Description
1	Backup Camera View On/Off Toggle icon	7	Boom Extension Offset and Length
2	Maximum Capacity (for the Current Crane Configuration/Load Chart Code Number)	8	Boom Length
3	Actual Load	9	Boom Angle
4	Actual Load as a Percentage of Maximum Capacity	10	Boom Tip Height
5	Outrigger Position as a Percentage (Fully Retracted = 0%, Mid-Extend = 50%, Fully Extended = 100%)	11	Counterweight
6	Swing Angle	12	Load Radius

FIGURE 4-84

### Overriding the Outrigger Monitoring System (only for Cranes in North America and European Union Countries)

After programming the Rated Capacity Limiter (RCL) (by either manually entering a Load Chart code number or by completing the RCL Setup Wizard) and clicking on the OK icon (Figure 4-85), an outrigger beam over-ride warning screen (Figure 4-86) will appear if the outrigger beam configuration programmed by the operator does not match that which is detected by the Outrigger Monitoring System.

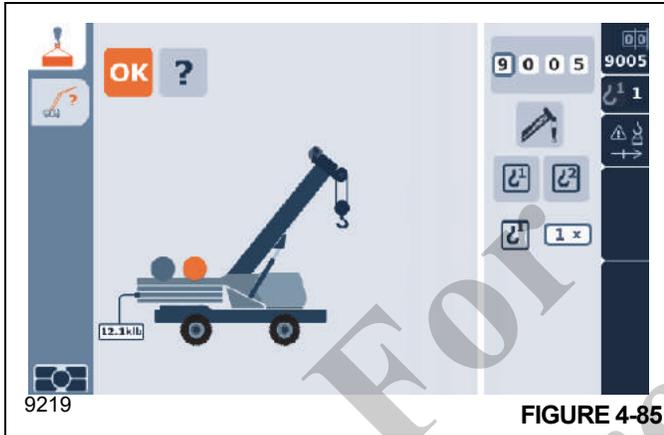
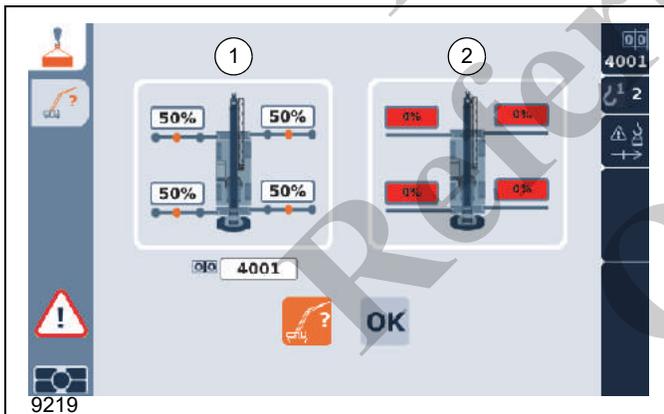


FIGURE 4-85



9219

Item	Description
1	Programmed Outrigger Beam Configuration
2	OMS Detected Outrigger Beam Configuration

FIGURE 4-86

Icon	Description
	Return to RCL Setup Screen icon - not selected
	Return to RCL Setup Screen - selected
	OK icon - not selected
	OK icon - selected

The operator must choose to either change the programmed outrigger beam configuration by selecting the Return to RCL Setup Screen icon (icon will turn orange) and then pressing the Jog Dial or the OK Button

— or —

override the OMS detected outrigger beam configuration by selecting the OK icon (icon will turn orange) and then pressing the Jog Dial or the OK Button.

### DANGER

When the OMS system is overridden, the RCL will not provide protection from overload. Death or serious injury will result if the crane tips overs.

The operator is responsible for ensuring that the crane is not overloaded or operated in excess of the allowable published capacities for the actual outrigger configuration.

A qualified person shall be consulted to determine if any capacity reductions, special operating procedures, or limitation are required.

If the outrigger beam position is overridden, the RCL Main Screen will appear as follows to indicate the override.

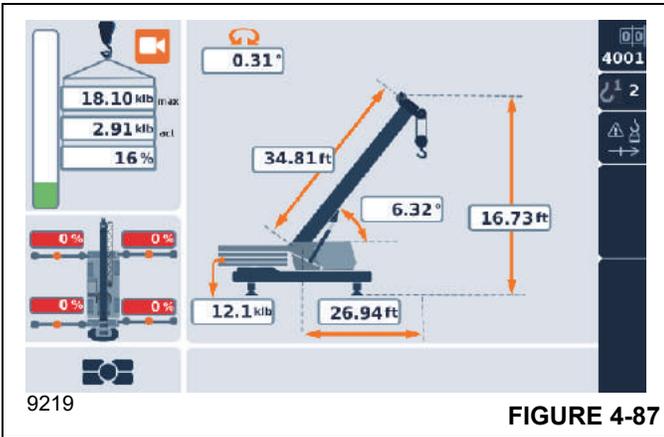


FIGURE 4-87

### Using the Tare Function

The tare function is not shown on the RDM at crane startup.

To show the tare function, do one of the following:

- Press the Screen Toggle Button (1, Figure 4-88) at the Jog Dial to select the RDM screen control.  
From the RCL Setup Screen, press the Tab Button (2).  
- or -
- Press the Tab Button (3, Figure 4-88) on the RDM Navigation Control Pad.

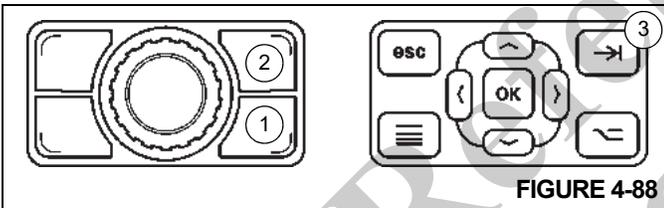


FIGURE 4-88

The tare weight (1, Figure 4-89) is shown below the percentage of the actual versus maximum percent load. The tare weight value equals the actual weight value until the tare weight is zeroed out. The operator sets the tare weight to zero by pressing the Tab Button on either the Jog Dial or the RDM Navigation Control Pad.

If the Operator changes the Load Chart Code Number, the tare weight will be reset to equal the current Actual Weight.

To disable the tare function, the operator must switch power off and back on using the Ignition Key Switch.

**NOTE:** The tare function does not change nor override the value of the Actual Load, and does not affect the RCL and its function lockouts.

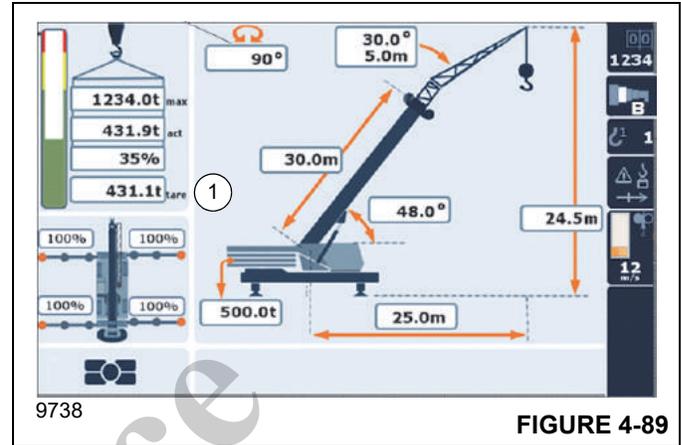


FIGURE 4-89

### Limit Bypass Indicators

In an emergency situation only, the Limit Bypass Switch located in the cab on the lower right console can be used to bypass the different limiter systems on the crane. Refer to the following pages for information regarding the switch's operation:

1. *Front Limit Bypass Switch (Non-CE Certified Cranes)*, page 3-14
2. *Limit Bypass Set-Up Switch (CE Certified Cranes)*, page 3-15

A Limit Bypass Switch is also located in the cab behind the operator's seat on non-CE certified cranes and on the outside rear of the cab on CE certified cranes:

3. *Rear Limit Bypass Switch (Non-CE Certified Cranes)*, page 3-19
4. *Bridging Switch and Indicator (CE Certified Cranes)*, page 3-20

When a Limit Bypass Switch is actuated, the following indicators on the Rated Capacity Limiter Display Module (RDM) come on to confirm that the limiters are bypassed (1 through 3, Figure 4-90).

Load Chart and Miscellaneous Indicators

Refer to Figure 4-90 for a list of indicators and their definitions that can appear at the bottom of the Main Screen of the RDM.

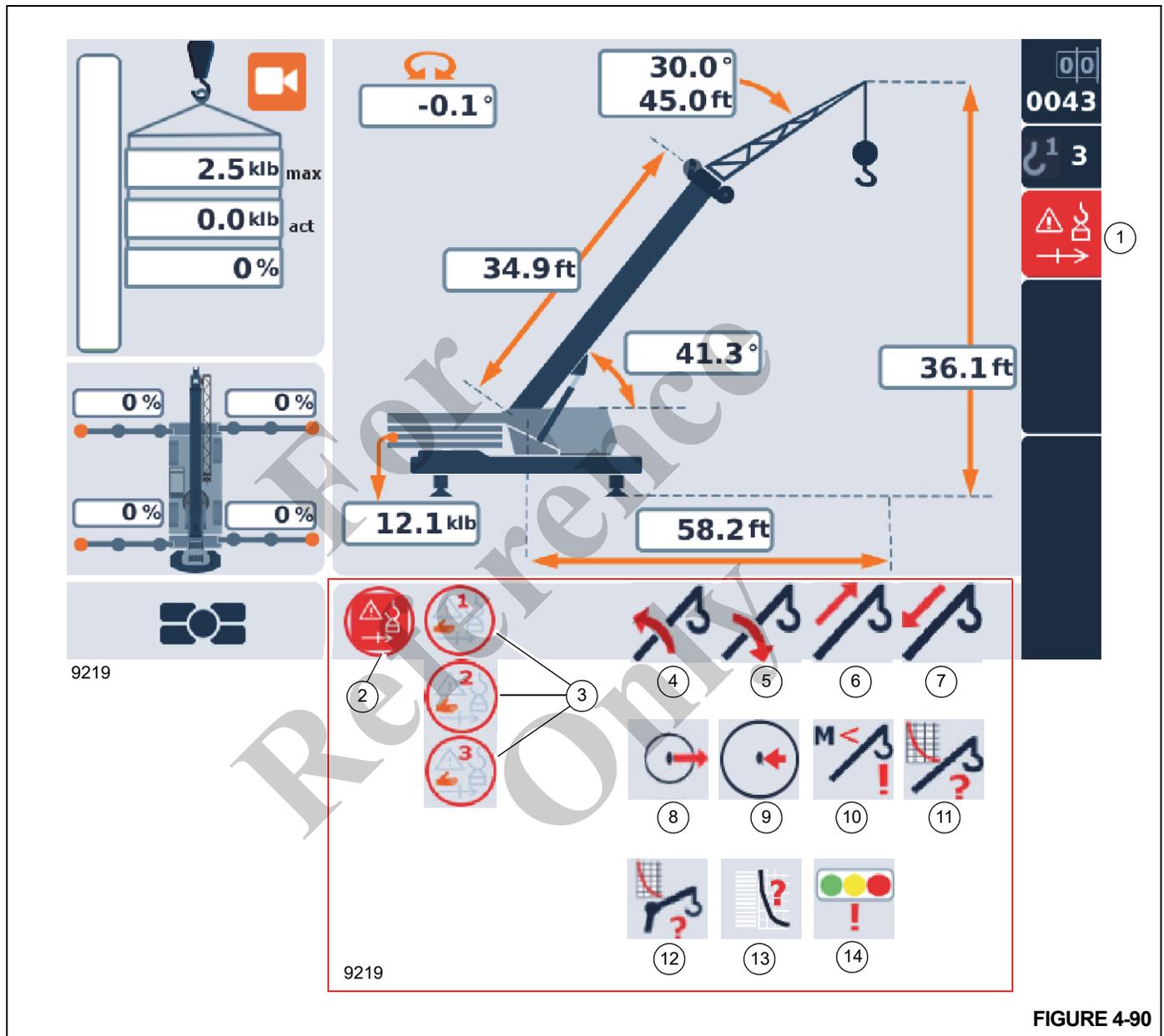


FIGURE 4-90

The following indicators can appear at the bottom of the Main Screen of the RDM (Figure 4-90)

Item	Description	Graphic	Explanation
1	<b>RCL Bypass Status Indicator (Red - Constant On)</b>		Indicates the RCL system is bypassed
2	<b>RCL Bypass Active Indicator (Red - Constant On)</b>		Indicates the RCL system is bypassed
3	<b>Bypass 1 Pressed Indicator (Constant On)</b>		Indicates that limiter systems have been bypassed by way of the Limit Bypass Switch located on the lower right console. Refer to <i>Front Limit Bypass Switch (Non-CE Certified Cranes)</i> , page 3-14 or <i>Limit Bypass Set-Up Switch (CE Certified Cranes)</i> , page 3-15 for more information on the switch's operation.
	<b>Bypass 2 Pressed Indicator (Constant On)</b>		Indicates that the limiter systems have been bypassed by way of the Boom Up Bypass Switch located on the right armrest. Refer to <i>Boom Up Bypass Switch</i> , page 3-12 for more information on the switch's operation.
	<b>Bypass 3 Pressed Indicator (Constant On)</b>		Indicates that limiter systems have been bypassed by way of the Limit Bypass Switch located behind the operator's seat on non-CE certified cranes or inside a key-locked single-door enclosure attached to the outside rear of the operator's cab on CE certified cranes. Refer to <i>Rear Limit Bypass Switch (Non-CE Certified Cranes)</i> , page 3-19 or <i>Bridging Switch and Indicator (CE Certified Cranes)</i> , page 3-20 for more information on the switch's operation.
4	<b>Boom Angle Too High Indicator</b>		Indicates the boom angle is greater than the maximum angle limit allowed by the selected load chart or the boom angle is greater than 78°.
5	<b>Boom Angle Too Low Indicator</b>		Indicates the boom angle is less than the minimum angle limit allowed by the selected load chart or the boom angle is less than -1°.
6	<b>Boom Length Too Long Indicator</b>		Indicates the boom length is longer than the last length of the selected load chart.
7	<b>Boom Length Too Short Indicator</b>		Indicates the boom length is shorter than the first length of the selected load chart.

Item	Description	Graphic	Explanation
8	<b>Radius Too Long Indicator</b>		Indicates the radius is greater than the maximum radius in the selected load chart.
9	<b>Radius Too Short Indicator</b>		Indicates the radius is smaller than the minimum radius in the selected load chart.
10	<b>Load Too Small Indicator</b>		Indicates the load is smaller than the minimum load in the selected load chart
11	<b>Boom - No Load Chart Indicator</b>		Indicates the main boom load chart is not available.
12	<b>Boom Extension - No Load Chart Indicator</b>		Indicates there is no load chart available for the boom extension, but the boom extension has been chosen in the RCL.
13	<b>Curve Chart Point Error Indicator</b>		Indicates there is no load chart found for the given crane configuration (off chart).
14	<b>Status Light Bar Indicator (CE cranes)</b>		Indicates the system setting for CE cranes is disabled but the system setting for the outside light bar is enabled. Accessing the system requires the CAN-link service software and connection cable, which are available through Crane Care to those service technicians who have attended the Drove New Technology training course.

**Enabling/Disabling the Rear View Camera**

The optional Rear View Camera On/Off Toggle icon (1, Figure 4-84 and Figure 4-92) allows the operator to toggle the rear view camera on and off.

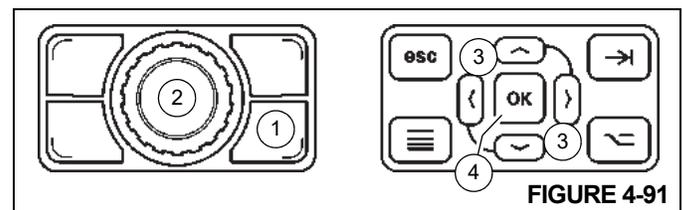
Turn the rear view camera on or off by doing one of the following:

- Press the Screen Toggle Button (1, Figure 4-91) at the Jog Dial to select the RDM screen control.

With the Rear View Camera icon selected (icon is orange), press the Jog Dial (2).

- or -

- With the Rear View Camera icon selected (icon is orange), press the OK Button (4, Figure 4-91).



**FIGURE 4-91**

When the rear view camera is turned on, an abbreviated version of the RCL Main Screen appears (Figure 4-92).



9219

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Item	Description	Item	Description
1	Backup Camera View On/Off Toggle icon	7	Boom Angle
2	Maximum Capacity (for the Current Crane Configuration/Load Chart Code Number)	8	Boom Tip Height
3	Actual Load	9	Counterweight
4	Actual Load as a Percentage of Maximum Capacity	10	Boom Length
5	Outrigger Position as a Percentage (Fully Retracted = 0%, Mid-Extend = 50%, Fully Extended = 100%)	11	Load Radius
6	Back Up Camera View	12	Swing Angle

FIGURE 4-92

### USING THE BIRDSEYE CAMERA (OPTIONAL)

Refer to *Birdseye Camera (Optional)*, page 3-23 for a description of the Birdseye Camera System and the different views that it offers.

The Birdseye Camera Display is factory set to come on and go off with the ignition keyswitch. Thus, there is no need to turn the display on and off by way of the Power Button on the display (Figure 4-93).

If the Power Button on the display is pressed, the display will go off and the Power Button will come on (red LED). To turn on the display, quickly press the Power Button two times.

The display must be set to the AV2 mode for it to show the different camera views. If the mode is set to any other mode, the display will show "NO SIGNAL". If the display is not set to the AV2 mode, it will go into a standby mode and the screen will go blank. If necessary, reset the display to the AV2 mode by first pressing the Power Button one time, then repeatedly pressing the Mode Button until the AV2 mode is selected.

The camera views automatically change based on operator inputs. The Birdseye View is the default view. When the operator actuates the swing controller, the Birdseye View with Swing Overlay will automatically appear. When the crane superstructure is centered over the front of the carrier and the operator presses the Outrigger Extend/Retract Switch, the Birdseye View with Outrigger Pad Target Overlay will automatically appear, and when the operator puts the Transmission Lever into the Reverse position, the Reverse View will automatically appear.

The Birdseye Camera Display has a Menu Screen where adjustments to the display's screen and operation can be made. Access the Menu screen by pressing the Menu Button (Figure 4-93).



Item	Description
1	MODE Button
2	MENU Button
3	DOWN Button
4	UP Button
5	PWR (Power) Button

9218-6

FIGURE 4-93

The contrast, brightness, color, and sharpness of the display can be adjusted by performing the following procedure:

1. Press the Menu Button to access the Menu screen.
2. Press the Up or Down Button until the Screen Icon is selected (Figure 4-93), then press the Mode Button.
3. Press the Mode Button to select the "Picture Mode - User" menu item (Figure 4-94).
4. Press the Up or Down Button to select the contrast, brightness, color, or sharpness menu item (Figure 4-95), then press the Mode Button.

5. Press the Up or Down Button to increase or decrease the menu item's value.
6. Press the Mode Button again to save the value.



9218-8

FIGURE 4-94



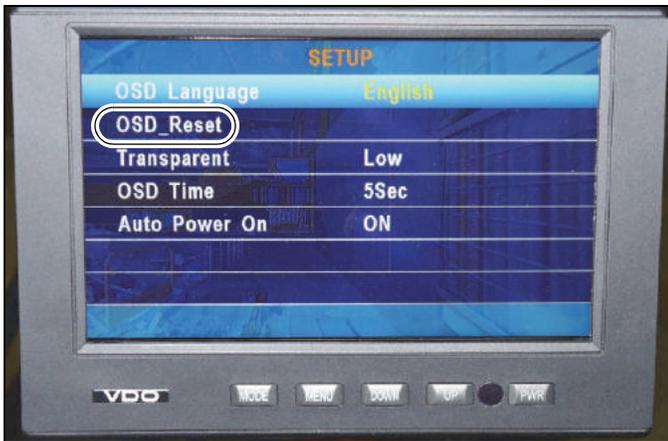
9218-7

FIGURE 4-95

For all menu item settings other than the display's contrast, brightness, color, and sharpness values, it is recommended to retain the factory default settings for proper operation of the camera system.

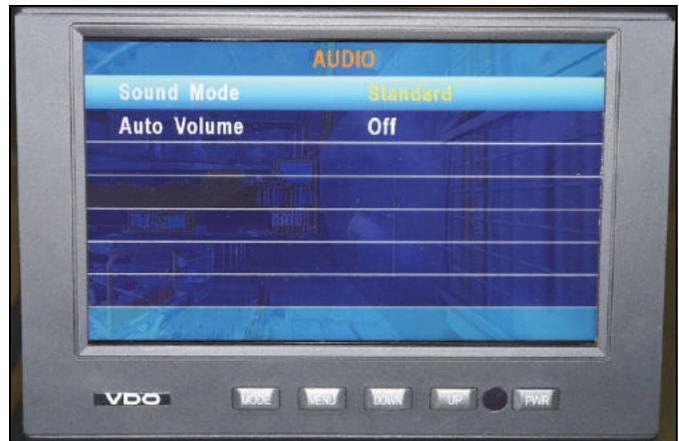
To reset all adjustments to the factory default settings, perform the following procedure:

1. Press the Menu Button to access the Menu screen.
2. Press the Up or Down Button until the Setup Icon is selected, then press the Mode Button.
3. Press the Down Button until the "OSD\_Reset" menu item is selected (Figure 4-96), then press the Mode Button.
4. Press the Down Button to indicate "Yes" you wish to reset all settings to the factory default settings.



9218-9

FIGURE 4-96



9218-4

FIGURE 4-98

The factory default settings are as follows:



9218-8

FIGURE 4-97



9218-5

FIGURE 4-99



9218-9

FIGURE 4-100

## SECTION 5 SET-UP AND INSTALLATION

### SECTION CONTENTS

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Reference Only

## SETUP OF CRANE BEFORE AND AFTER TRANSPORTING

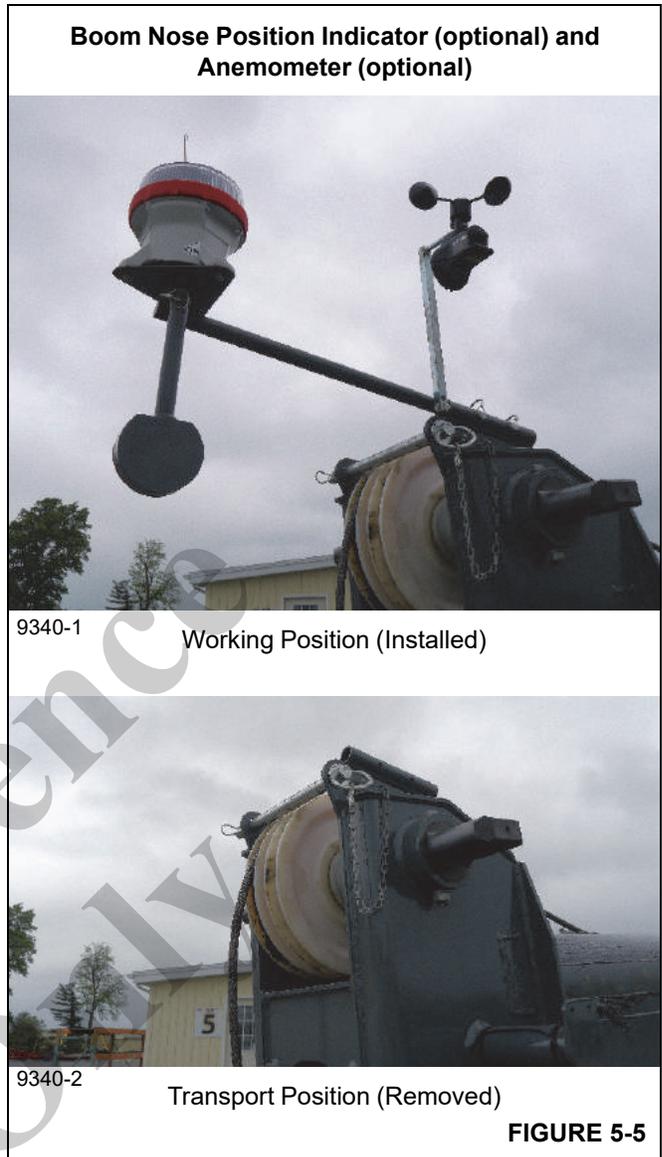
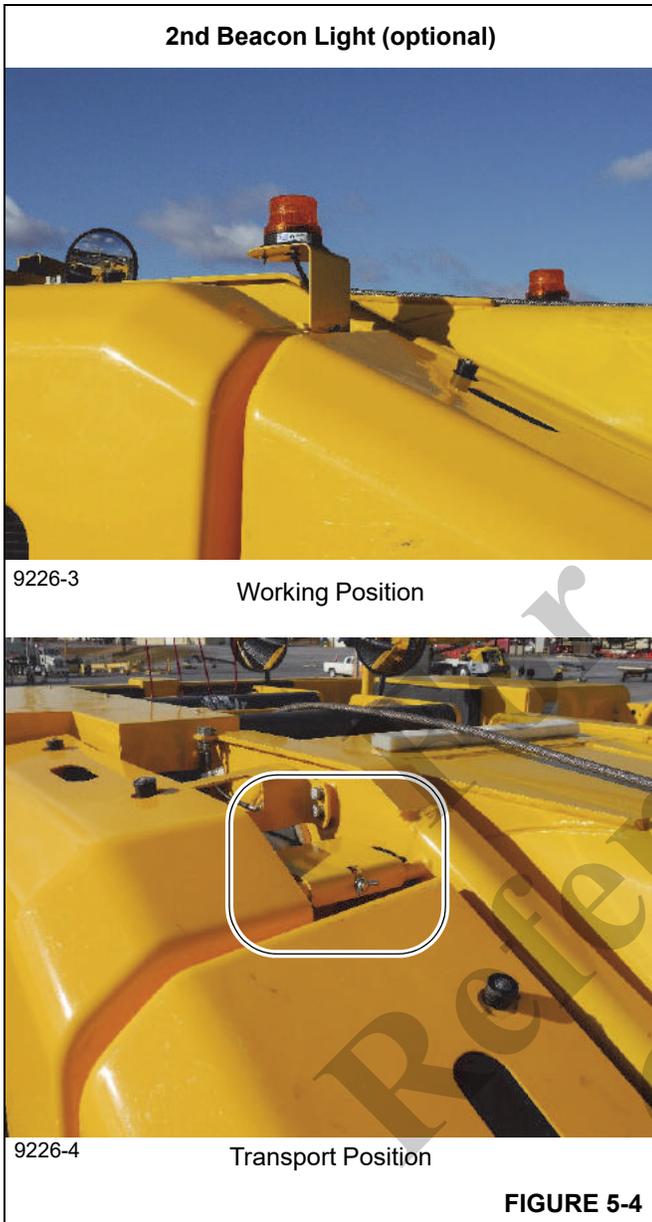
Before transporting the crane, place the following components into their transport positions. After transporting the crane, place these same components into their working positions:

- Hoist Mirrors (at hoists) (Figure 5-1)
- Hoist Camera (optional) (Figure 5-1)
- Hoist Mirror (at cab) (Figure 5-2)
- RCL Light Tower (optional) (Figure 5-2)
- Beacon Light (Figure 5-3)
- 2nd Beacon Light (optional) (Figure 5-4)
- Boom Nose Position Indicator (optional) and Anemometer (optional) (Figure 5-5)
- Front and Rear Access Ladders (Figure 5-6)

Securing all valve cover latches with tie-straps is recommended to prevent accidental opening during transportation.







Front and Rear Access Ladders



9225-1

Working Position



9225-2

Transport Position

FIGURE 5-6

**HOIST PLATFORM**

**⚠ DANGER**

Do not use platform for hauling passengers. Death or serious injury could occur.

No storage of components are allowed on the platform.

Only one person at a time is allowed on the platform.

**INSTALLING CABLE ON THE HOIST**

**CAUTION**

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

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

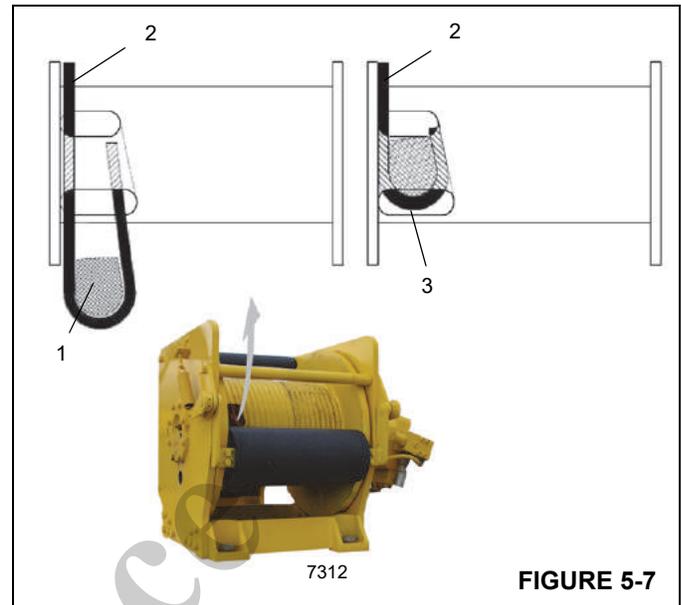
Install rope on the hoist drum in accordance with the following procedure.

1. Position the rope over the boom nose sheave and route to the hoist drum.
2. Position the hoist drum with the rope anchor slot on top.
3. Insert the rope through the slot and position around the anchor wedge (1, Figure 5-7).

**NOTE:** The end of the rope should be even with the bottom of the slot for the anchor wedge (1).

4. Position the anchor wedge in the drum slot. Pull firmly on the free end (2) of the rope to secure the wedge.

**NOTE:** If the wedge does not seat securely in the slot, carefully tap the top of the wedge (3) with a mallet.



**FIGURE 5-7**



5. Slowly rotate the hoist drum, ensuring the first layer of rope is evenly wound onto the drum.
6. Install the remainder of the rope.

**ANTI-TWO-BLOCK (A2B) SWITCH**

If a single hoist rope has been reeved and two A2B switches are installed, the unused A2B switch must be locked (disabled) to allow all crane operations.

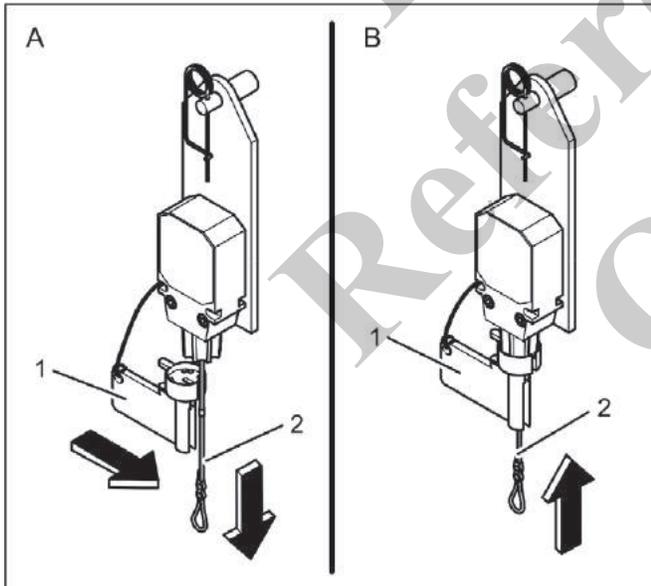
**Locking**

**! DANGER**  
**Two-Block Hazard!**

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

If the A2B switch is locked (disabled), the hook block could hit the main boom head or extension. Never lock an A2B switch when a hoist rope is installed to that attachment.

1. Remove A2B weight.
2. (A) Remove cap (1) from switch.
3. Pull lanyard (2) down.
4. (B) Secure lanyard (2) in this position using cap (1). A2B switch is locked (disabled).



8684-1

FIGURE 5-8

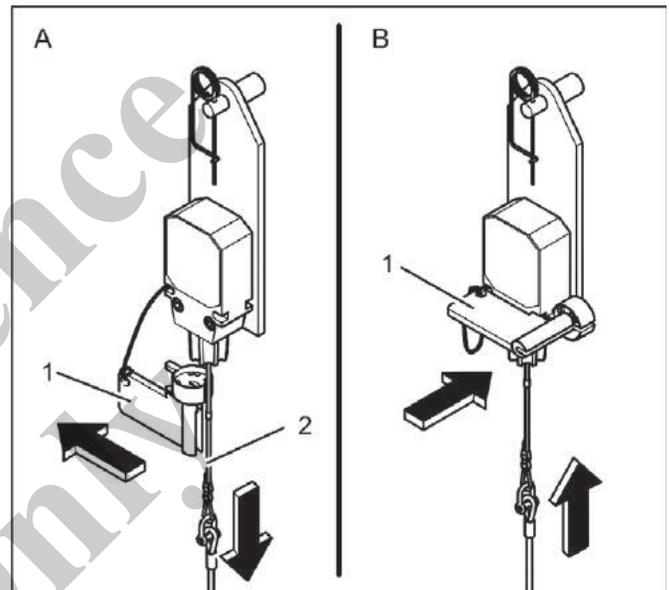
**Unlocking**

**! WARNING**

Failure to reposition the A2B weight will prevent the A2B system from functioning properly. No weight shall be mounted on the A2B switch of the main boom when working with the extension.

**NOTE:** Always remove the switch lock (enable) before installing an A2B weight around the hoist rope.

1. (A) Pull down lanyard (2) and remove cap (1). Switch is unlocked (enabled).
2. (B) Install cap (1) on A2B switch.



8684-2

FIGURE 5-9

## Checking Before Operation

Check the following electrical connections before operating the crane to make sure the Rated Capacity Limiter (RCL) system is properly connected for the crane configuration.

### *Cranes with Main Hoist Only*

If the crane is operated only with the boom and without boom extension, no additional connections are necessary. It must however be made sure that the A2B switch weight is correctly mounted on the main boom hoist rope. With even numbers of rope lines, the lifting limit switch weight shall be attached to the “dead end” of the hoist rope. With odd numbers of rope lines, the lifting limit switch weight shall be attached to the rope line with the lowest operating speed.

If the crane is operated with a main boom extension, the connecting cable must be mounted between the distributor socket on the extension, and the distributor socket on the main boom. The main boom A2B switch weight must be disconnected and mounted on the extension or fly section A2B switch.

### *Cranes with Main and Auxiliary Hoists*

If the main boom extension or fly section is not used, then the bridging plug must be plugged into the distributor socket on the main boom and the lifting limit switch weight must be mounted on the main boom.

If the crane is operated with a main boom extension and the main boom is equipped with a hoist rope, then the connecting cable must be mounted between the distributor socket on the extension or on the top section and the distributor socket on the main boom. In addition, weights must be fitted to both the A2B switch of the main boom and the extension or fly section.

If the boom extension is in working position and if the main boom is not equipped with a hoist rope, then the A2B switch on the main boom must be placed into its locked position.

After electrical connections have been checked to make sure the system is properly connected for the respective crane configuration, the following checks must be made:

1. Check electrical wiring connecting various parts of the system for physical damage.
2. Check A2B switches and weights for free movement.
3. Inspect RCL cable drum for smooth running, initial drum tension, and correct cable winding.



## WARNING

The following tests must be performed with care to prevent personnel injury or crane damage. Proper functioning of the Crane Control System (CCS) requires successful completion of these tests before starting work.

If the operator cannot see the hook block approaching the boom nose, this task must be assigned to an assistant.

The crane operator must be prepared to stop the crane immediately if the CCS is not working correctly, that is when the warning indicators do not display, the acoustic alarm does not sound, and the crane movements such as raising, extending and luffing are not disabled.

Check A2B switch warning light and acoustic alarm as follows:

1. Position boom over front of crane.
2. Manually raise weight fitted on the A2B switch. As soon as weight is raised, the acoustic alarm should sound and the A2B warning should display (refer to Figure 3-5).
3. Using the main hoist, pull hook block slowly against the A2B switch weight. As soon as the hook block raises the weight, the acoustic alarm should be triggered, the A2B warning should display, and the main hoist should switch off. Lower the hook block slightly to eliminate this condition.
4. Slowly lower the boom to bring about a potential two block situation. As soon as the hook block raises the weight, the acoustic alarm should sound, the A2B warning should display, and boom lower should switch off. Lower the hook block slightly to eliminate this condition.
5. Slowly extend (telescope out) the boom to bring about a potential two block situation. As soon as the hook block raises the weight, the acoustic alarm should sound, the A2B warning should display, and the telescoping function should switch off. Lower the hook block slightly to eliminate this condition.



## WARNING

If warning indicators and audible alarm do not function as described and crane movements are not switched off, the system is not working properly. The malfunction must be corrected before starting work.

6. If crane is equipped with a boom extension, the inspection procedure must be repeated for the A2B switch of the extension.

7. Verify display of main boom length agrees with actual boom length.
8. Verify display of main boom angle agrees with actual boom angles.
9. Verify display of the crane operating radius agrees with the actual radius.
10. Verify load display by lifting a load of known weight. Load display accuracy must be within the tolerance range.

**HOIST ROPE REEVING**

**NOTE:** 35 x 7 (rotation resistant) wire rope is used on this crane.

Within load and range chart limits 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 hoist rope reeving (part line) is possible with the boom nose and hook block (Figure 5-10 and Figure 5-15). Reeving should be done by a qualified rigger using standard rigging procedures.

To quick reeve the hook block without removing the wedge socket on end of hoist rope, remove the retaining clips from the two pins (1, Figure 5-10), then drop the two rope guards (2) to their lowered position.



**FIGURE 5-10**

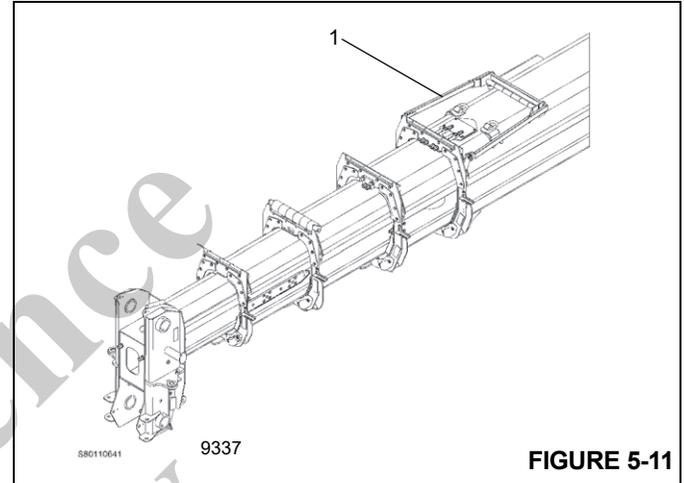
**Reeving Hoist Rope Over the Boom**

For cranes equipped with a rope guide, obey the following instruction.

**CAUTION**

Do not reeve auxiliary hoist rope through the rope guide.

Always reeve main hoist rope through rope guide (1, Figure 5-11). Always reeve auxiliary hoist rope *outside* rope guide.



**FIGURE 5-11**

**DEAD-END RIGGING/WEDGE SOCKETS**

Wedge socket assemblies are popular rigging accessories used for decades to terminate wire ropes on mobile cranes. A wedge socket assembly is easily installed and dismantled, but must be installed and used correctly. Use only a wedge and socket of the correct size for the rope fitted. Failure to do so may result in rope pulling through 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 Crane Care.

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

Grove specifies 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 it manufactures.

Other wire ropes and rigging accessories are available from various vendors. Different wire rope manufacturers have differing requirements for construction, handling, cutting, seizing, installation, termination, inspection, and

replacement of 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 boom to a working position with a load suspended to firmly seat wedge and rope in socket before crane is used operationally.

**CAUTION**

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

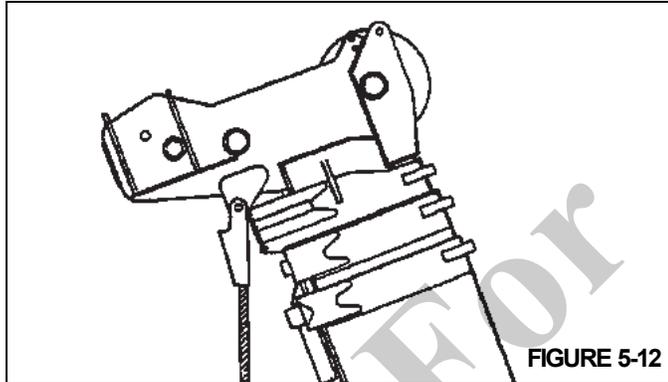


FIGURE 5-12

When anchoring socket to the boom, make sure flat face of socket is toward boom sections as shown in Figure 5-12.

**INSTALLING WEDGE AND SOCKET**

1. Inspect wedge and socket. Remove rough edges and burrs.
2. Seize wire rope end using soft or annealed wire or strand. If end of rope is welded, welded end should be cut off unless otherwise stated by the rope manufacturer. This allows distortion of the rope strands, caused by the bend around the wedge, to adjust themselves at the end of the line.
3. Make sure live end side (Figure 5-13) of rope is directly in line with ears of socket and direction of pull to which the rope will be subjected. If rope is loaded into socket incorrectly, under a load the rope will bend as it leaves the socket. The edge of the socket will wear into the rope causing damage and eventual failure.

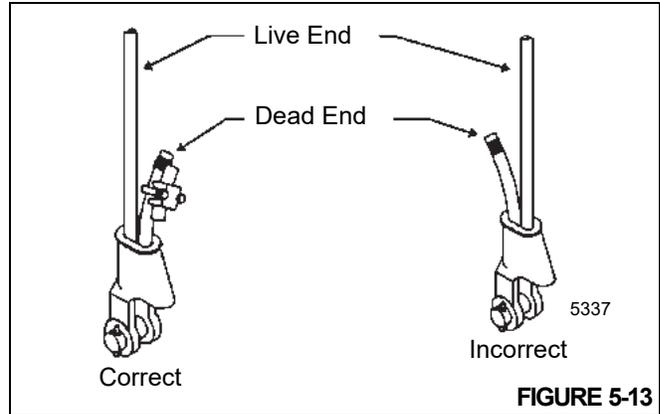


FIGURE 5-13

4. Insert wire rope end in socket, form a loop in the rope, and route rope back through socket allowing the “dead” end to protrude from the socket. Make sure dead end of the rope is long enough to apply end treatment after wedge is seated.
5. Insert wedge in loop. Pull live end of rope until wedge and rope are snug inside socket. It is recommended wedge be seated inside socket to properly secure the wire rope using the crane’s hoist to first apply a light load to the live line.
6. After final pin connections are made, increase loads gradually until wedge is properly seated.
7. Wire rope and wedge must be properly secured inside socket before placing crane into lifting service. It is the wedge that secures the wire rope inside the socket. The dead-end treatment is used to keep wedge from becoming dislodged from socket should the rope suddenly become unloaded from the overhaul ball or hook block striking the ground, etc.

Figure 5-14 shows methods for securing dead-ends of wire ropes in a wedge socket assembly. While the loop-back method (C, D, E) is acceptable, take care to prevent the loop becoming entangled with tree branches and other components during crane transport, or the anti two-block system and other components during crane operation.

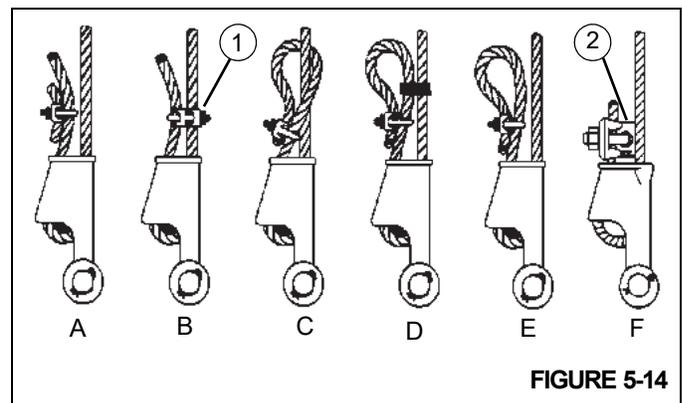


FIGURE 5-14

Of the methods shown, Grove prefers method A 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 (1) or wedge (2). It is recommended the dead-end tail length be a minimum of 6 rope diameters, but not less than 15.2 cm (6 in) for standard 6 to 8 strand ropes. For rotation resistant rope, the dead-end tail length must be a minimum of 20 rope diameters, but not less than 15.2 cm (6 in).

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 LIVE END. U-bolt should bear against the dead end. Clip saddle should bear against the short extra piece. Torque U-bolts to values listed in Table 5-1.

**NOTE:** Use of swivels is not allowed with non-rotation resistant wire ropes.

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 applies to cableways, cranes, derricks, hoists, hooks, jacks, and slings.

It states, in section 5-1.7.3, "(c) Swaged, compressed, or wedge socket fittings shall be applied as recommended by the rope, crane or fitting manufacturer." 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 *Wire Rope Users Manual*, latest revision.

Table 5-1. Wire Rope Clip Torque Values

Clip Size		Torque*	
mm	In	N-m	ft-lb
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

\*Torque values are based on threads being clean, dry, and free of lubrication.

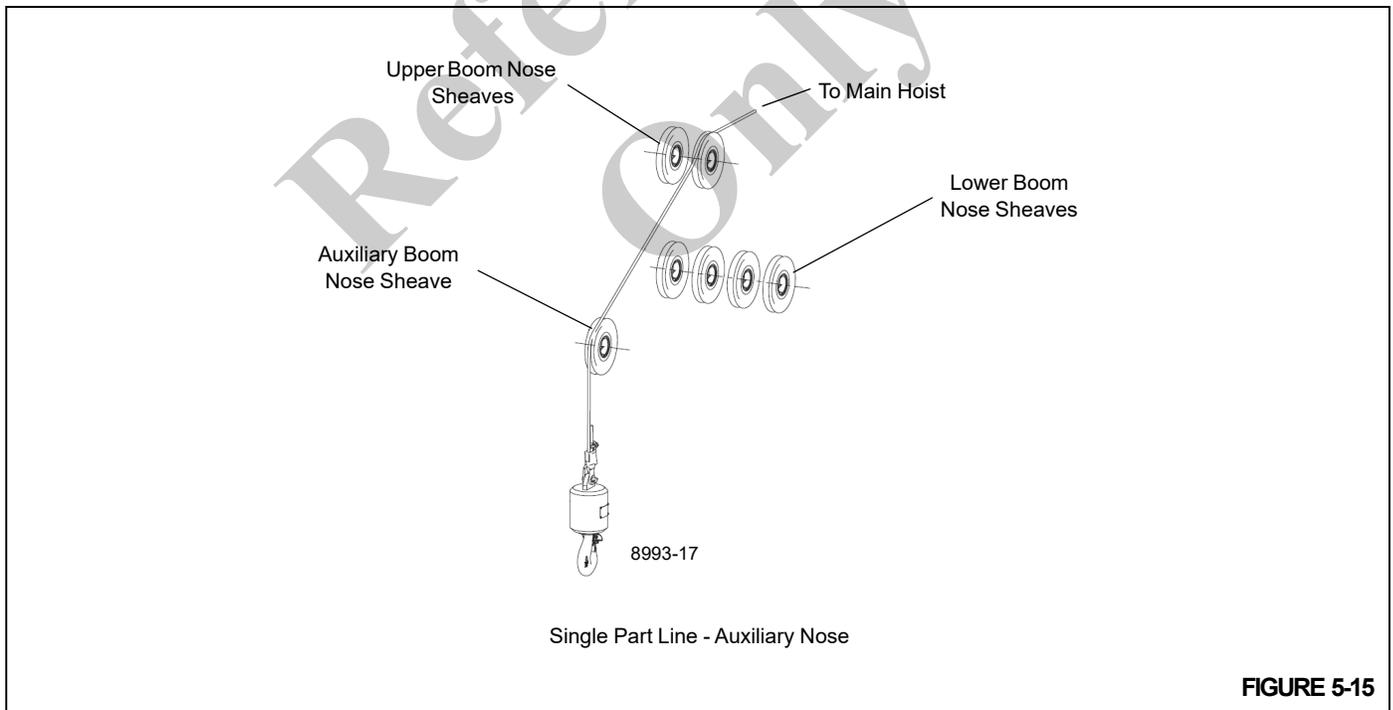


FIGURE 5-15

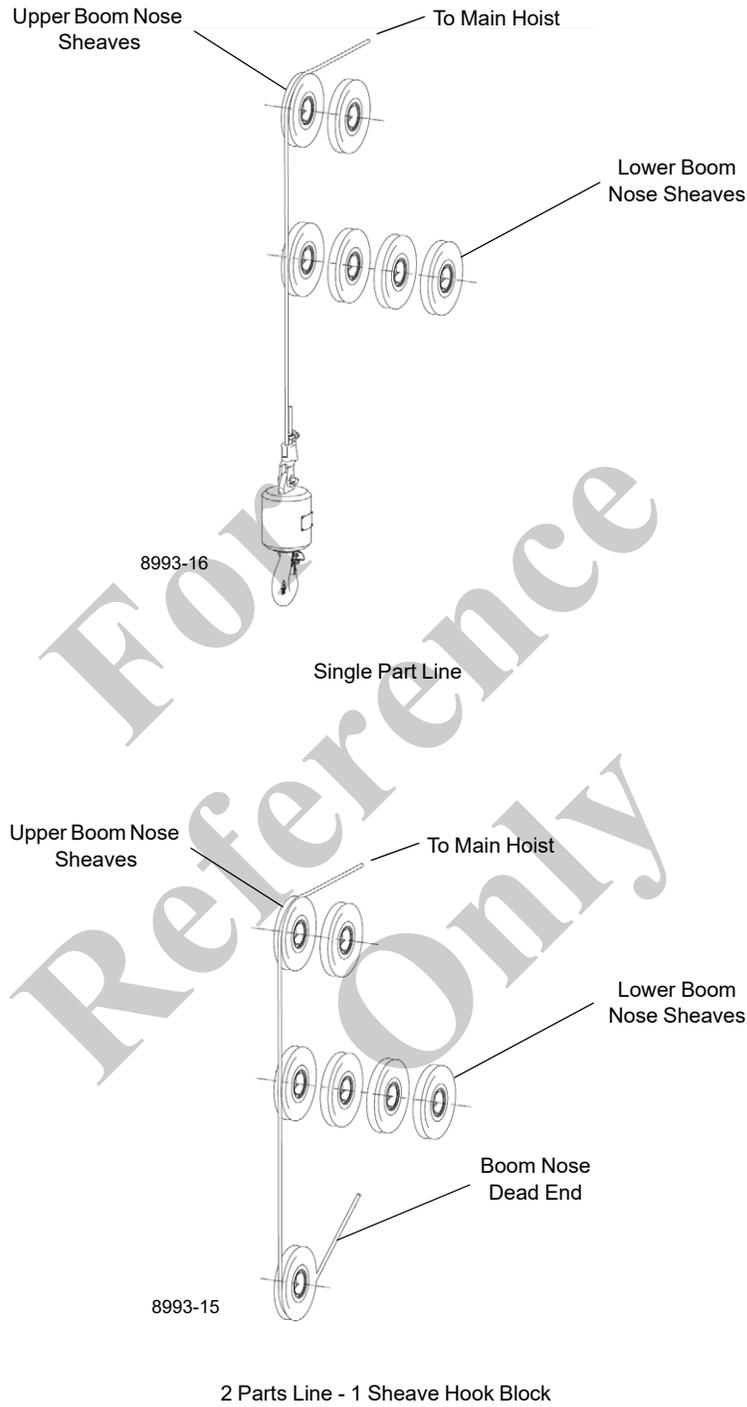
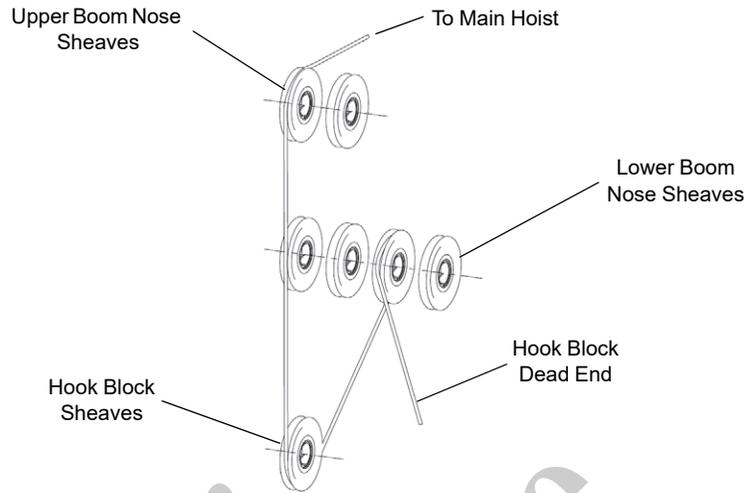
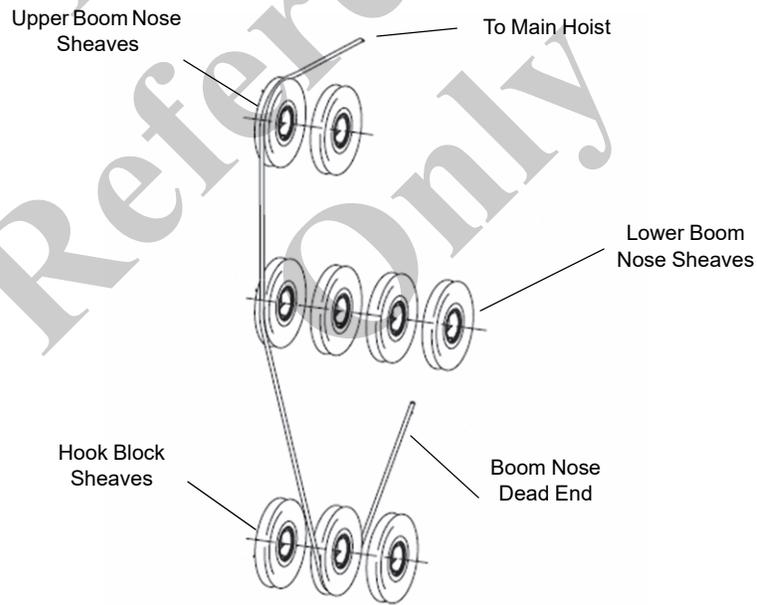


FIGURE 5-15 continued



8993-14

3 Parts Line - 1 Sheave Hook Block



8993-18

2 Parts Line - 3 Sheave Hook Block

Reference Only

FIGURE 5-15 continued

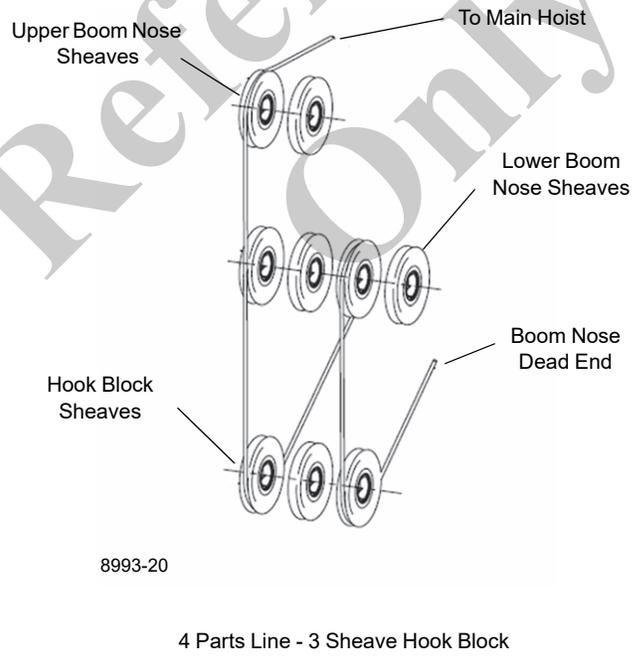
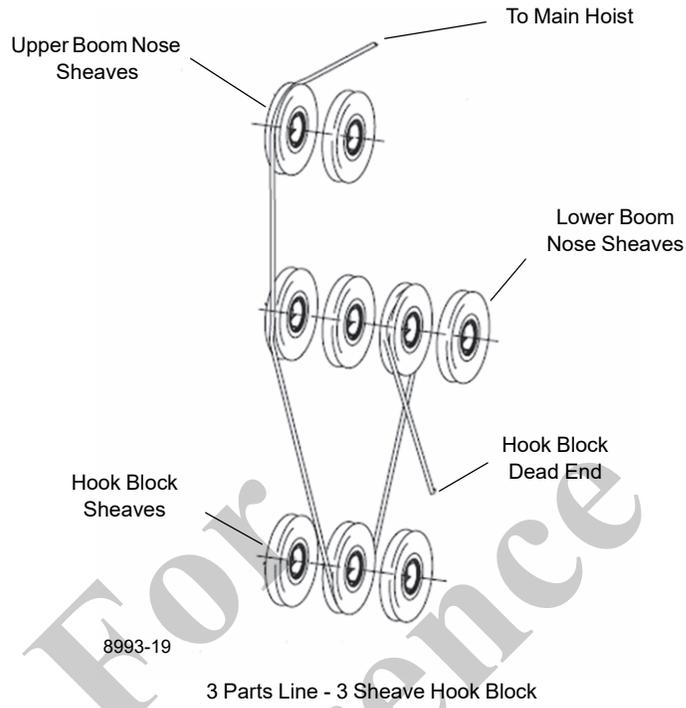


FIGURE 5-15 continued

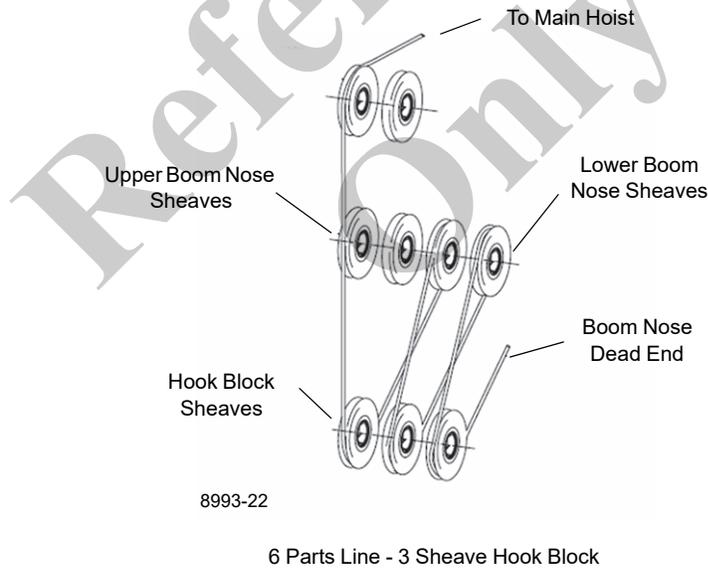
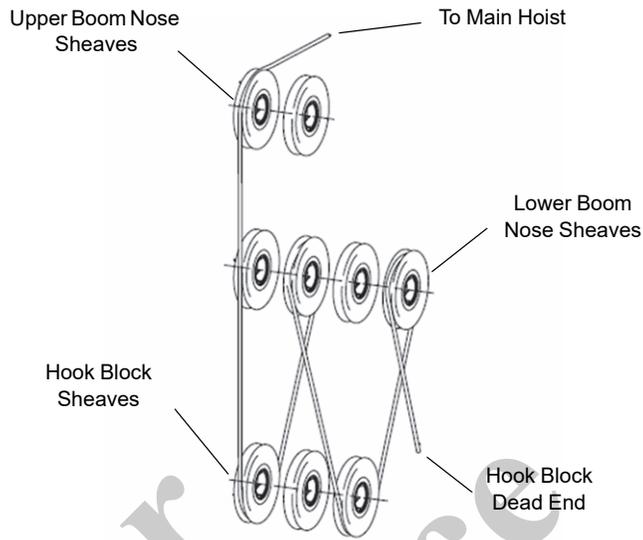


FIGURE 5-15 continued

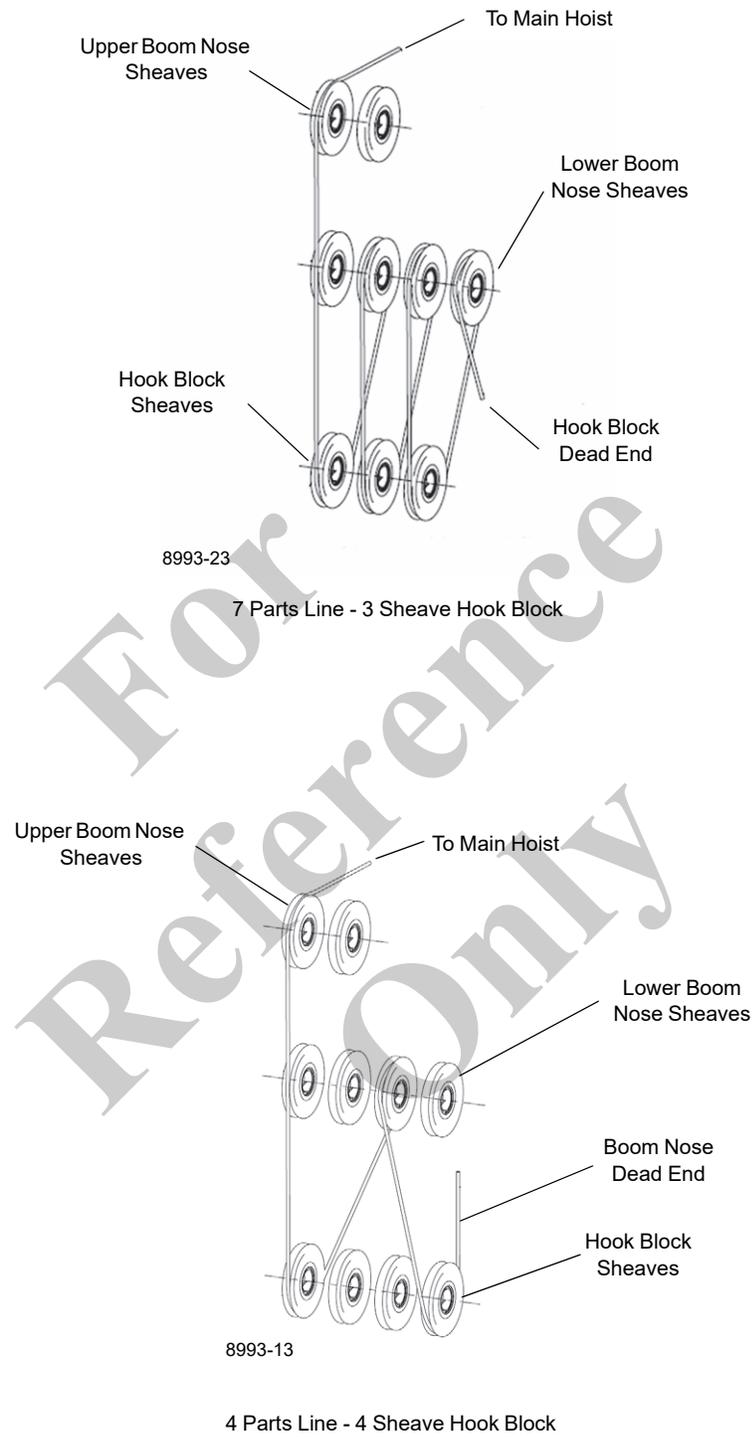
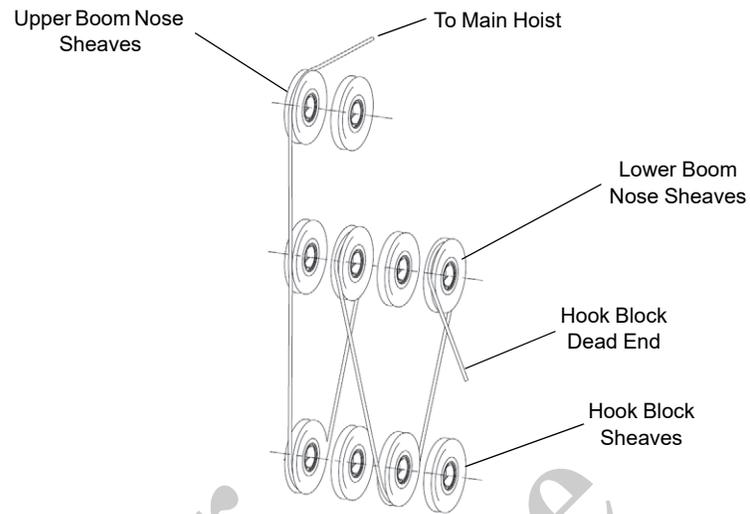
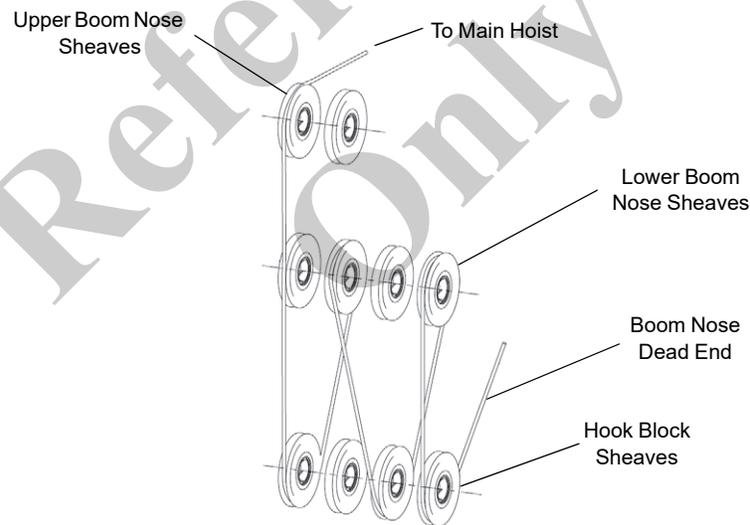


FIGURE 5-15 continued



8993-12

5 Parts Line - 4 Sheave Hook Block



8993-11

6 Parts Line - 4 Sheave Hook Block

For Reference Only

FIGURE 5-15 continued

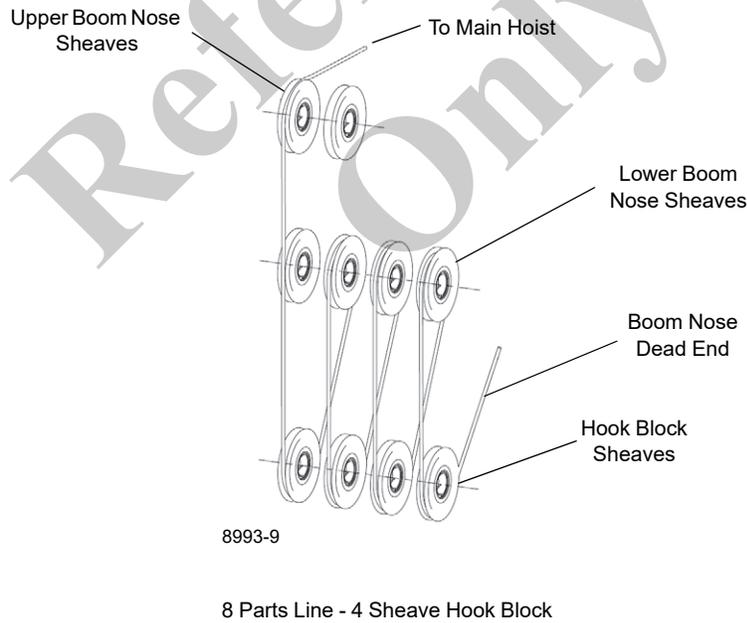
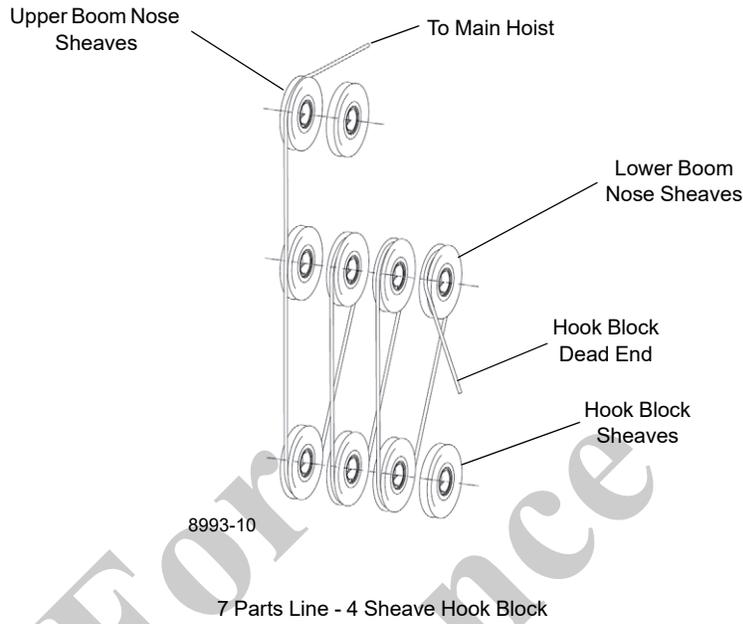


FIGURE 5-15 continued

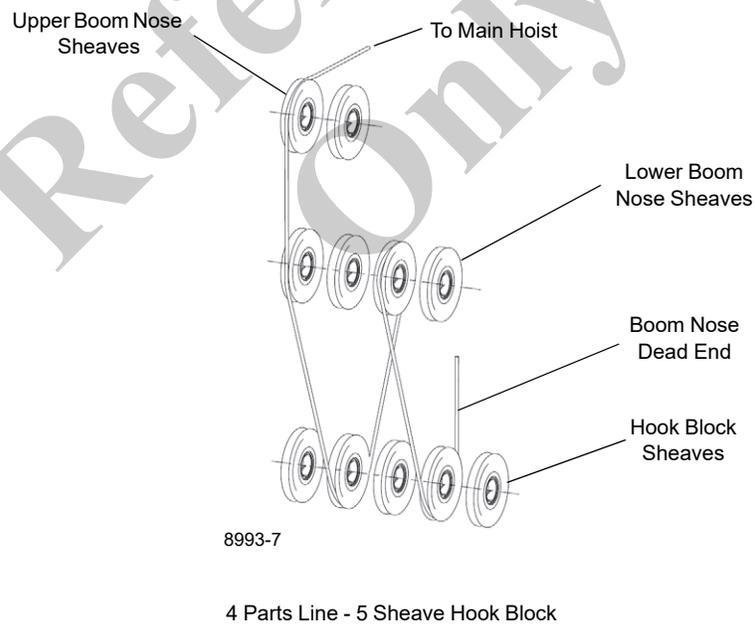
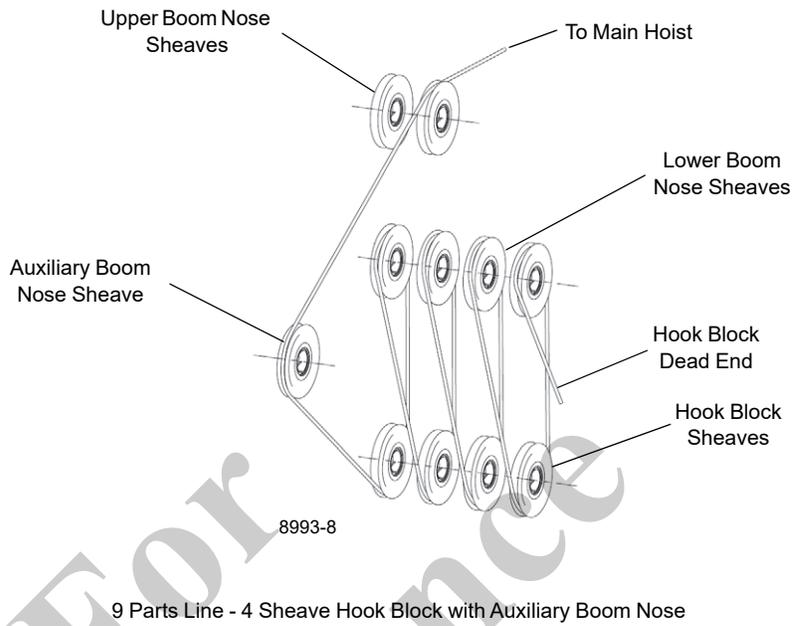


FIGURE 5-15 continued

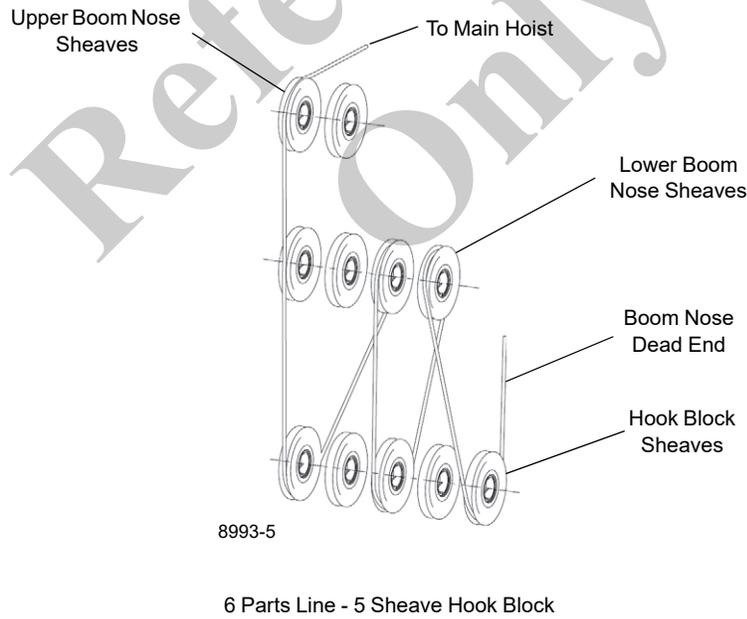
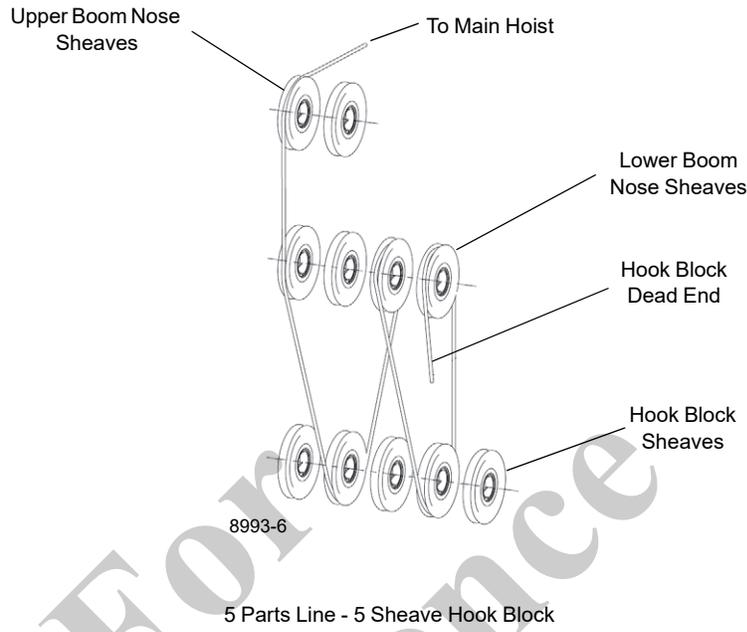
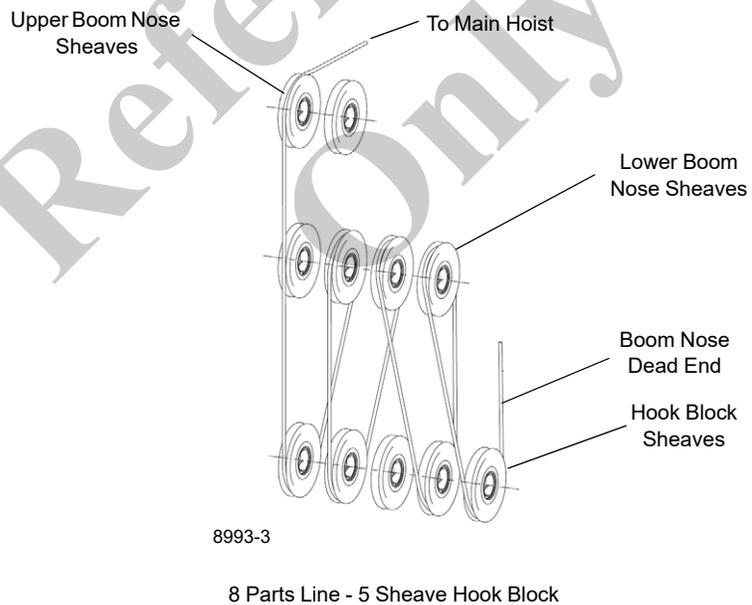
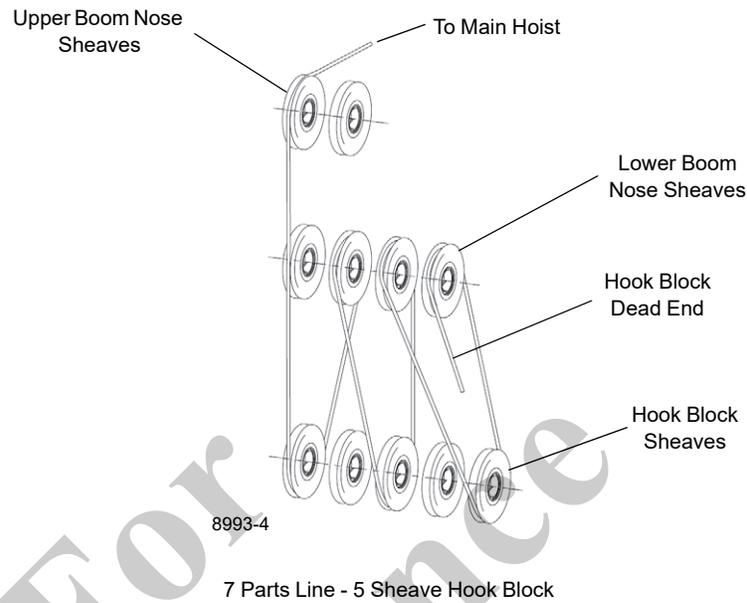


FIGURE 5-15 continued



For Reference Only

FIGURE 5-15 continued

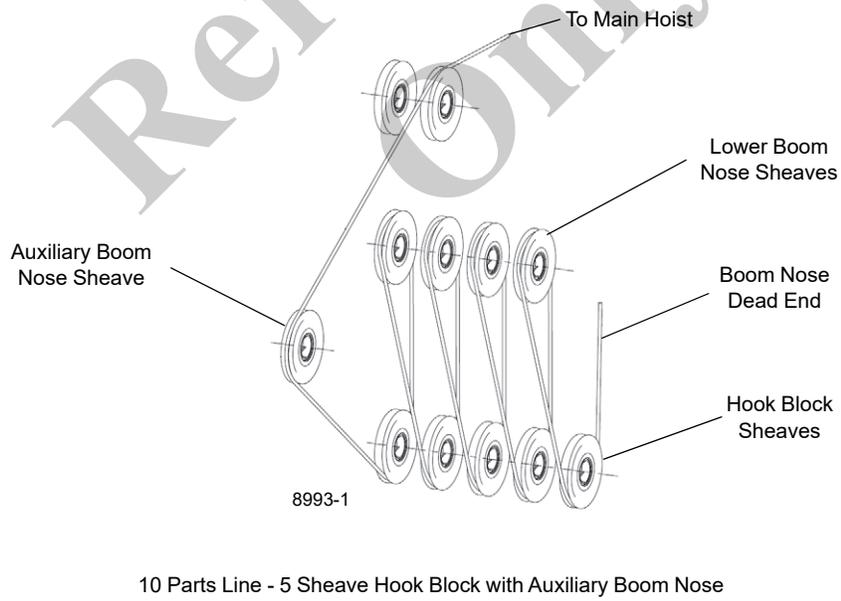
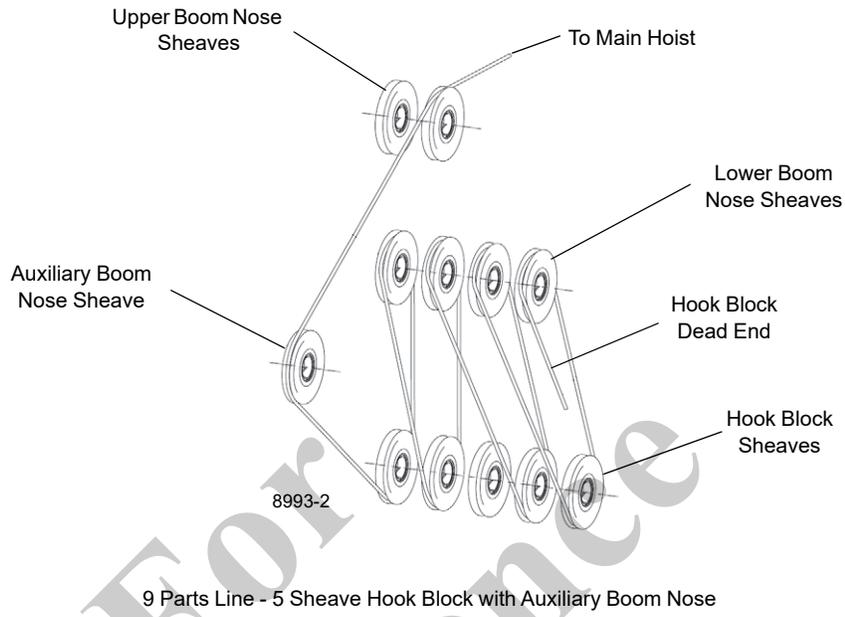


FIGURE 5-15 continued

## ERECTING AND STOWING THE BOOM EXTENSION

### Description

A 7.92 m to 13.7 m (26 ft to 45 ft) telescopic, manual off-settable boom extension provides additional boom reach. The boom extension weighs approximately 1678 kg (3700 lb).

Throughout the following instructions the lattice section portion of the boom extension is referred to as the boom extension base section and the solid steel boxed section portion is referred to as the boom extension fly section.



### DANGER

Make sure the boom is fully retracted during erection and stowage of the boom extension.

If the boom is extended during this process, the pins may not engage properly and/or the boom extension could move in an uncontrolled manner resulting in death or serious injury.

### General Warnings



### DANGER

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

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 to prevent serious injury or death.

Controlling the boom extension during erecting and stowing procedures is accomplished by raising or lowering the boom. Failure to control the boom extension could cause serious injury or death.

### Securing the Boom Extension with a Tag Line (Rope)

**NOTE:** A tag line attached to the tip of the boom extension is used to control the movement of the boom extension.



### DANGER

Always secure the boom extension with a tag line (rope) on the main boom before removing any connections. This will prevent the extension from swinging around contacting personnel in the vicinity of the boom extension or in the swing range.

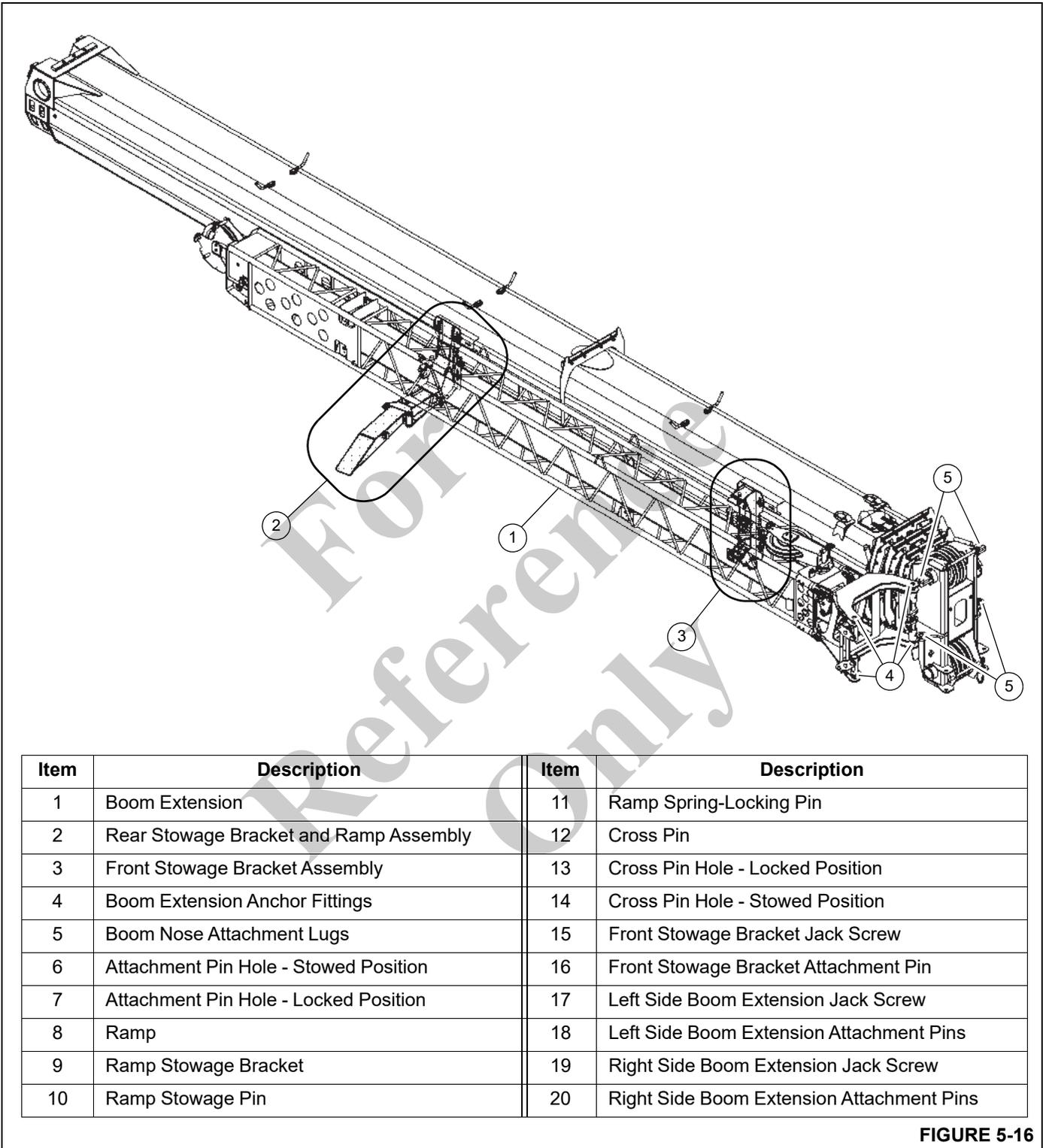
The boom extension may swing out on its own when you remove the last connection that holds the boom extension at the side of the main boom.

Always secure the boom extension before you begin the erection procedure.

Secure the boom extension as follows:

- Attached a tag line (rope) at the front of the boom extension.
- Have a helper hold the tag line (rope) tight while you are removing the rear stowage attachment pin.

**NOTE:** If you are alone, secure the other end of the tag line (rope) to the superstructure. Leave enough play in the tag line that it is tight only when you swing the boom extension towards the main boom nose later in the procedure.



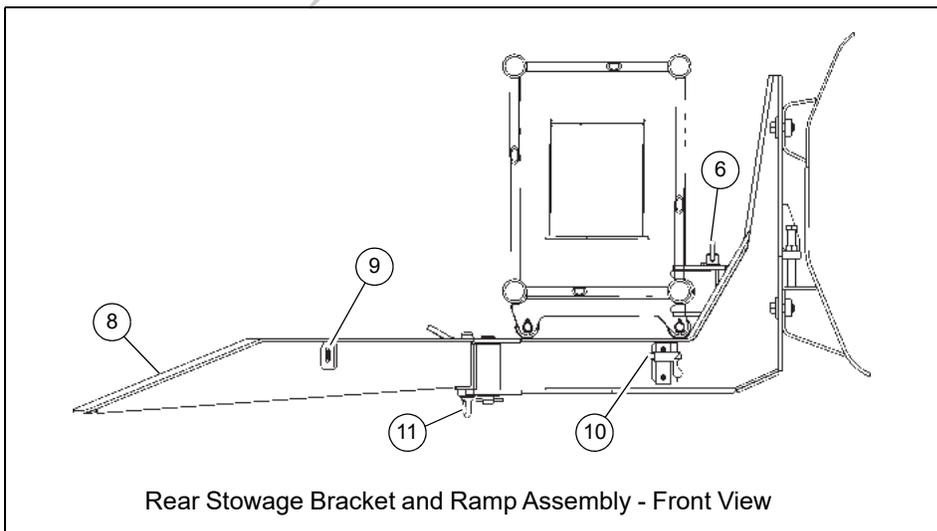
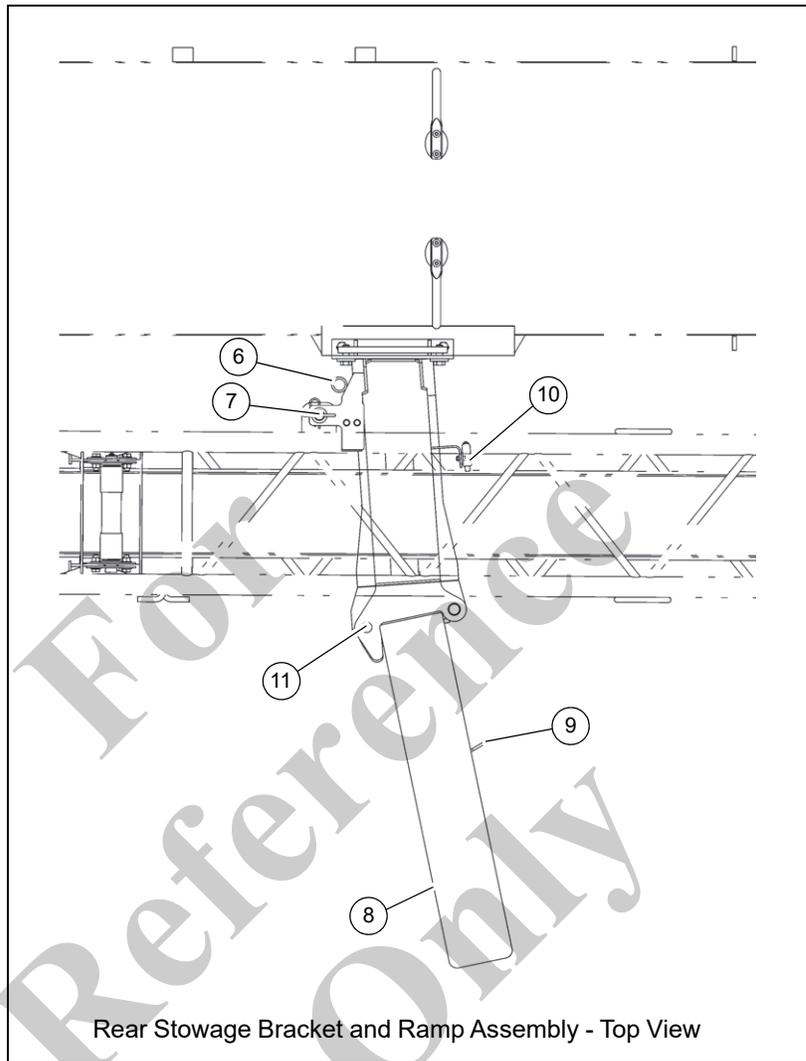


FIGURE 5-16 continued

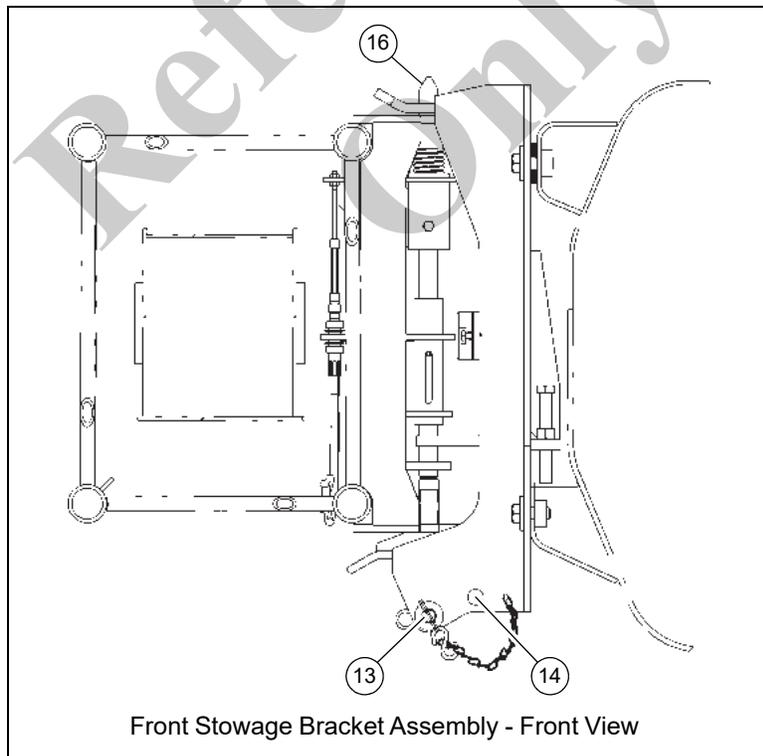
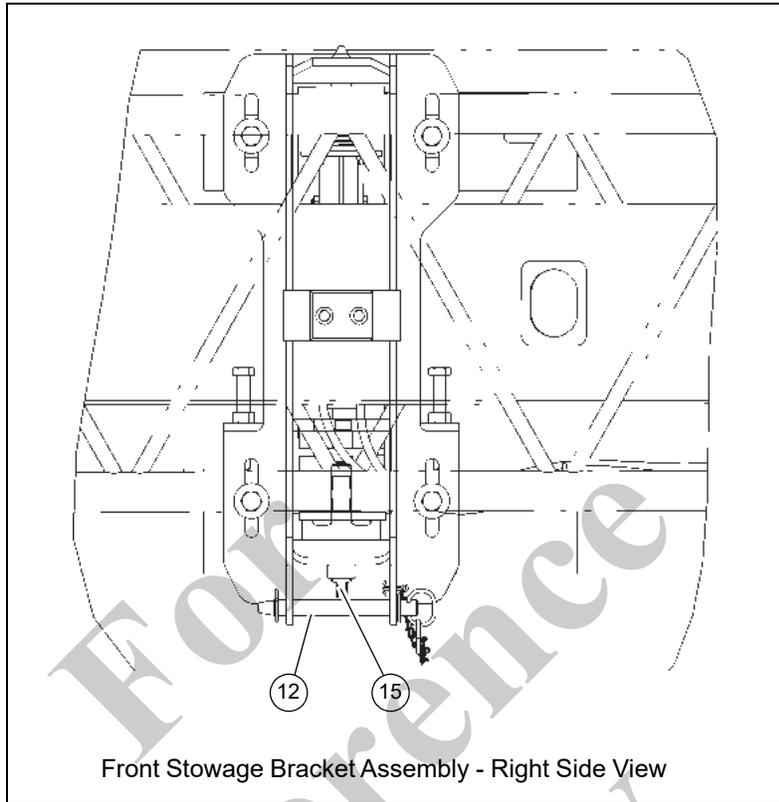


FIGURE 5-16 continued

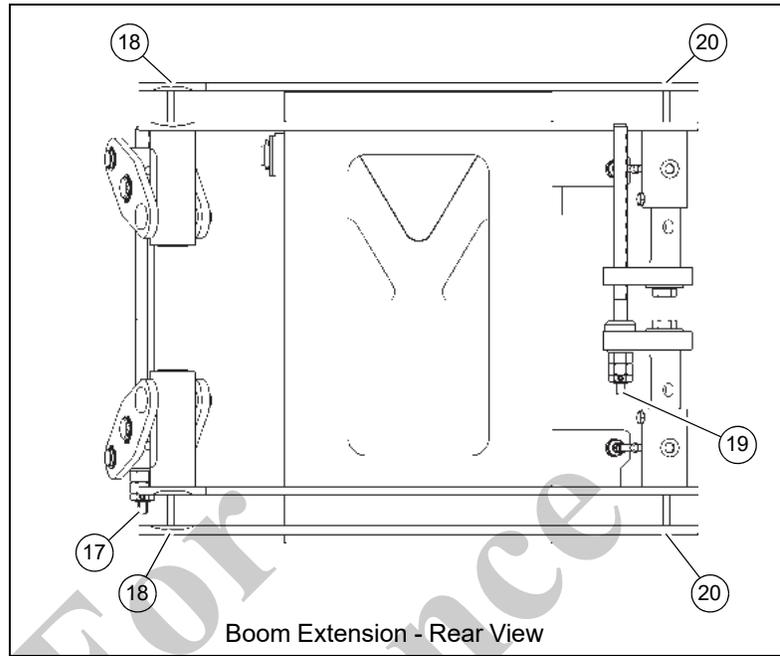


FIGURE 5-16 continued

For Reference Only

## Erecting



### DANGER

To prevent serious injury or death, do not stand on crane decking unless boom extension is secure.

Tools required:

- 1/2 in Impact Wrench
- 24 in - 1/2 in Drive Impact Extension (p/n 80104116)
- 1/2 in Square Drive Socket - 1/2 in Square Nut (80104383)

**NOTE:** Refer to Figure 5-16 for an illustration of the boom extension.

1. Fully extend and set the outriggers using normal setup procedures (refer to "Setting the Outriggers" on page 25).
2. If extended, fully retract all of the boom sections.
3. Set boom angle to 0° (zero degrees).

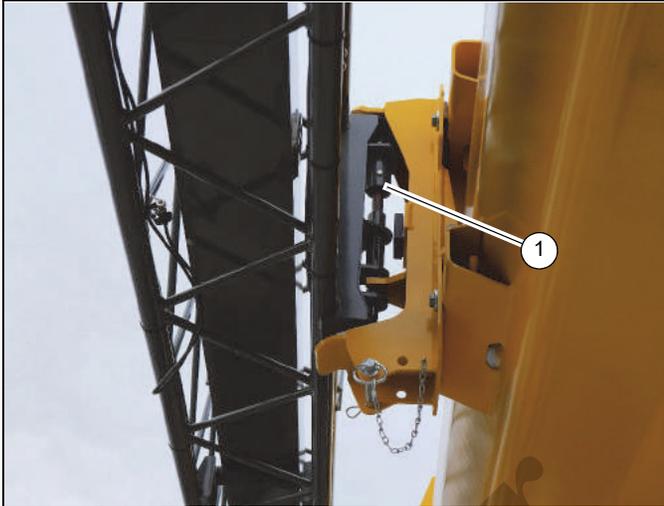
**NOTE:** The auxiliary boom nose (rooster sheave) does not have to be removed. However, if reeved, the hoist rope must be removed from the sheave.

4. Rig either the main hoist or optional auxiliary hoist rope for single part line with only the wedge socket on the end of the hoist rope.
5. Fold out the ramp (1, Figure 5-17) at the rear stowage bracket. Secure in place with spring-locking pin (2, Figure 5-17).



**FIGURE 5-17**

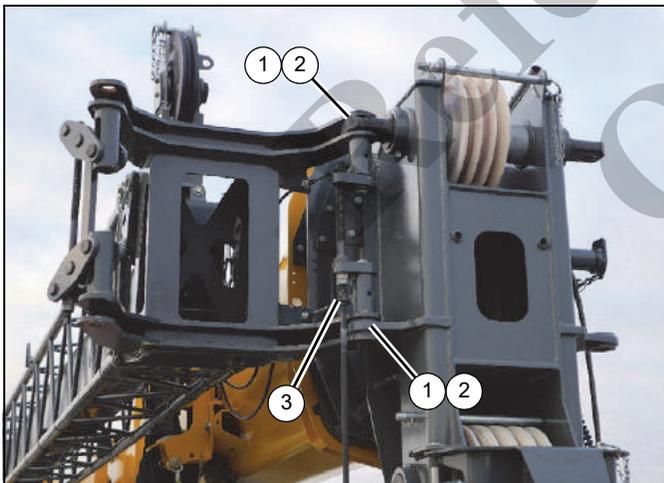
6. Make sure the attachment pin securing the boom extension to the front stowage bracket is engaged (1, Figure 5-18).



9216-9

FIGURE 5-18

7. Remove the attachment pin securing the boom extension to the rear stowage bracket. Place the attachment pin in the stowage hole and secure with retaining clip.
8. Using the tag line, swing the boom extension out to engage the boom extension anchor fittings (1, Figure 5-19) with the boom nose attachment lugs (2).



9216-2

FIGURE 5-19

9. Attach the boom extension base section to the boom nose by installing the right side attachment pins through the anchor fittings and attachment lugs.

Use an impact wrench and the provided extension (80104116) and socket (80104383) to turn the jack screw (3, Figure 5-19) counterclockwise to engage the attachment pins. Make sure the attachment pins are fully engaged.



**DANGER**

**Boom Extension Fall Hazard**

An unsecured boom extension may fall resulting in death or serious injury.

Do not remove the cross pin (1, Figure 5-20) unless the boom extension is securely attached to the boom nose.

10. Remove the cross pin (1, Figure 5-20) at the front stowage bracket. Place the cross pin in the stowage hole and secure with retaining clip.

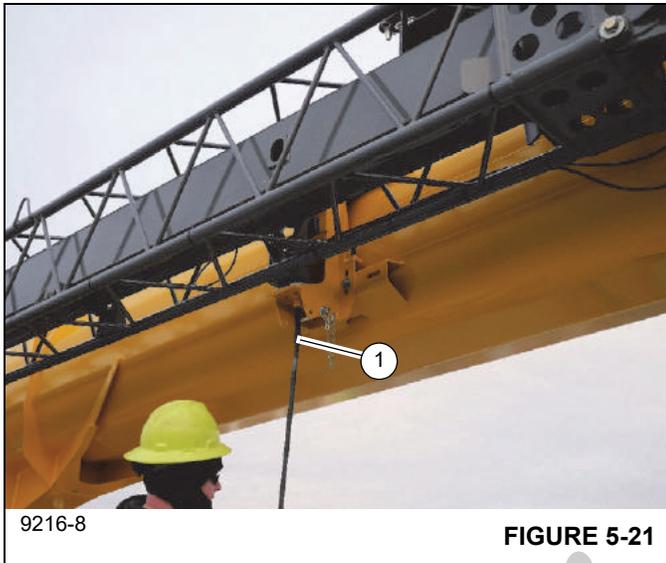


9216-9

FIGURE 5-20

11. Disconnect the boom extension from the front stowage bracket by using an impact wrench and the provided extension (80104116) and socket (80104383) to turn the jack screw counterclockwise (1, Figure 5-21).

Make sure the jack screw bottoms out and the top attachment pin is fully disengaged.



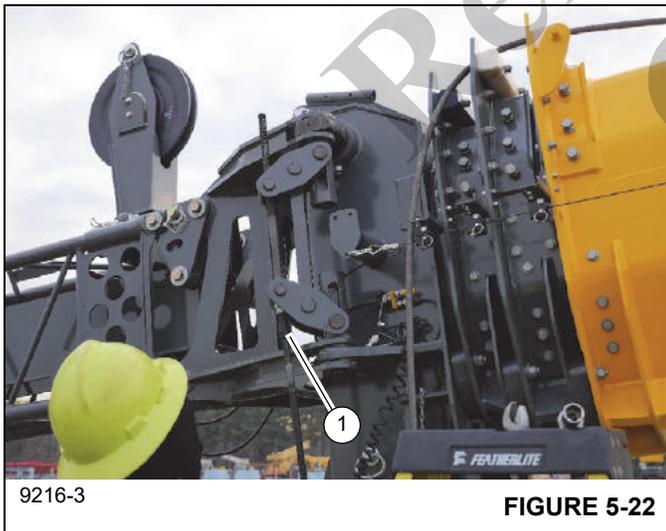
9216-8

FIGURE 5-21

### DANGER

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

12. Slightly raise and/or lower the boom to help control the boom extension. Using the tag line attached to the tip of the boom extension, manually swing the boom extension into place ahead of the boom nose, engaging the attachment lugs with the anchor fittings on the left side of the boom nose (Figure 5-22).



9216-3

FIGURE 5-22

### DANGER

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

### CAUTION

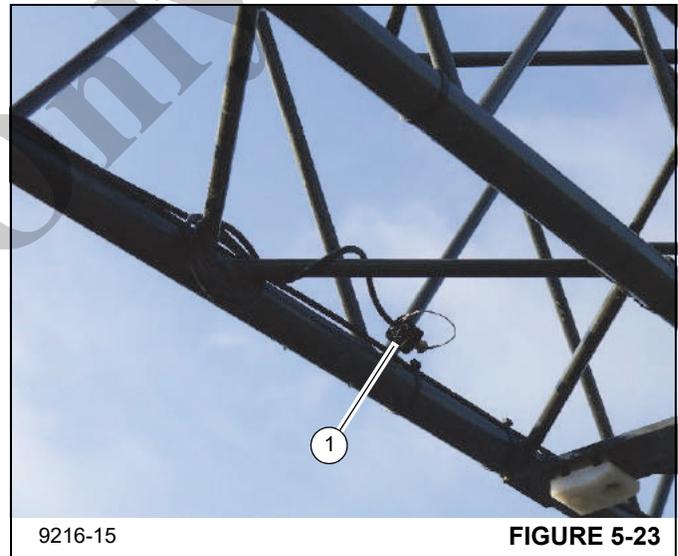
To prevent possible damage to the sheave wheel, do not place blocking under the boom extension sheave wheel.

13. Attach the boom extension base section to the boom nose by installing the left side attachment pins through the anchor fittings and attachment lugs.

Use an impact wrench and the provided extension (80104116) and socket (80104383) to turn the jack screw counterclockwise to engage the attachment pins (1, Figure 5-22). Make sure the attachment pins are fully engaged.

14. Connect Anti-Two-Block cables:

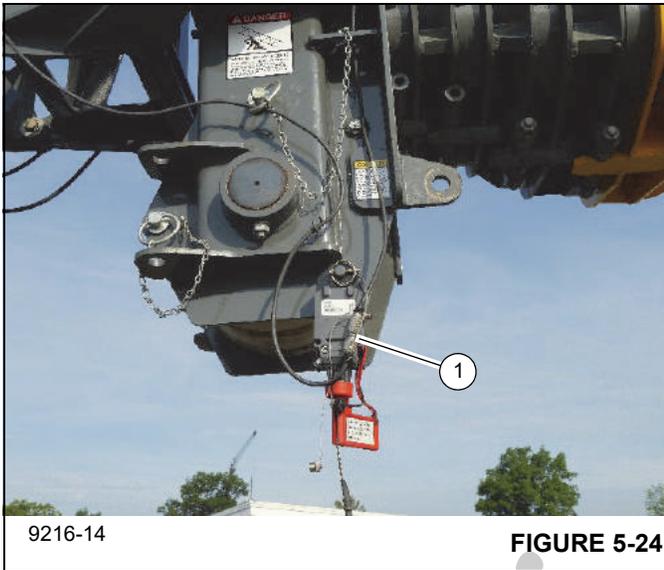
- a. Remove the Anti-Two-Block cable end connector (1, Figure 5-23) from the stowage clip on the boom extension. Route the cable through the boom extension and over to the Anti-Two-Block switch at the boom nose.



9216-15

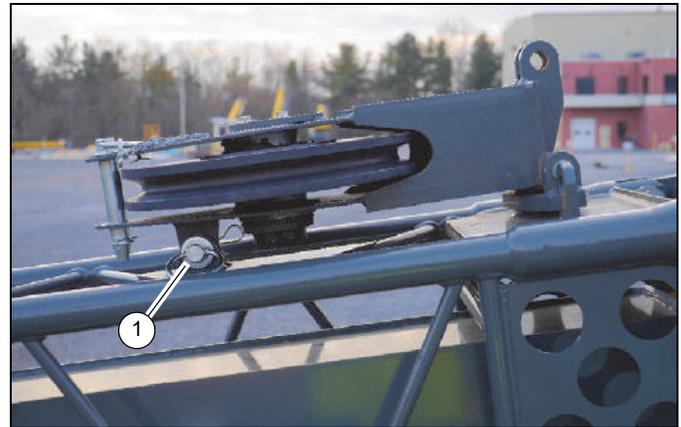
FIGURE 5-23

- b. Disconnect the boom anti-two-block switch cable end connector from the anti-two-block switch at the boom nose and connect it to the boom extension anti-two-block cable end connector (1, Figure 5-24).

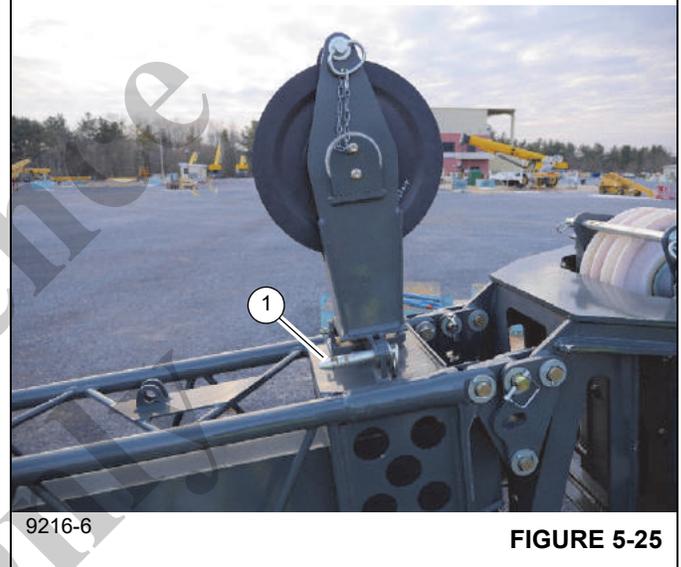


9216-14

FIGURE 5-24



9216-7



9216-6

FIGURE 5-25

c. If the boom extension stinger section is not to be erected, connect the boom extension base section anti-two-block cable end connector to the anti-two-block switch at the nose of the boom extension stinger section.

15. Lower the boom and remove the tag line from the tip of the boom extension.
16. If required, extend the boom extension fly section. Refer to “Extending and Stowing the Telescoping Boom Extension Fly Section” on page 36.
17. Lower the boom to minimum elevation and remove the hoist rope retaining pins from the tip of the boom extension.
18. Remove the upper boom nose hoist rope retaining pin to prevent the hoist rope from rubbing on the pin.
19. Raise the mast sheave assembly by doing the following:
  - a. Remove the attachment pin (1, Figure 5-25) securing the mast sheave in the stowed position.
  - b. Lift the mast sheave to its raised position and rotate it clockwise 90°.
  - c. Install the attachment pin (1) and secure with retaining clip.

20. Remove the hoist rope retaining pin and route the hoist rope over the mast sheave. Reinstall the hoist rope retaining pin and secure with retaining clip.
21. Remove the hoist rope retaining pins from the boom extension sheave and route the hoist rope over the sheave. Reinstall the hoist rope retaining pins and secure with retaining clips.
22. Rig the hoist rope.
23. In required, set the boom extension offset to 15° or 30°. Refer to “Setting the Offset” on page 35.

## Stowing

**NOTE:** The boom extension must be set at the minimum offset and, if used, the telescoping section must be fully retracted. Refer to “Setting the Offset” on page 35 and/or “Extending and Stowing the Telescoping Boom Extension Fly Section” on page 36.

Tools required:

- 1/2 in Impact Wrench
- 24 in - 1/2 in Drive Impact Extension (p/n 80104116)
- 1/2 in Square Drive Socket - 1/2 in Square Nut (80104383)

1. Fully retract the boom.
2. Lower the boom to minimum elevation.
3. Remove the hoist rope retaining pins from the boom extension sheave and the mast sheave. Remove the hoist rope from the two sheaves, then reinstall the boom extension and mast sheave hoist rope retaining pins and secure with retaining clips.
4. Lower the mast sheave assembly by doing the following:
  - a. Remove the attachment pin (1, Figure 5-25) securing the mast sheave in the working position.
  - b. Rotate the mast sheave clockwise 90° and then lower it to its stowed position.
  - c. Install the attachment pin (1) and secure with retaining clip.



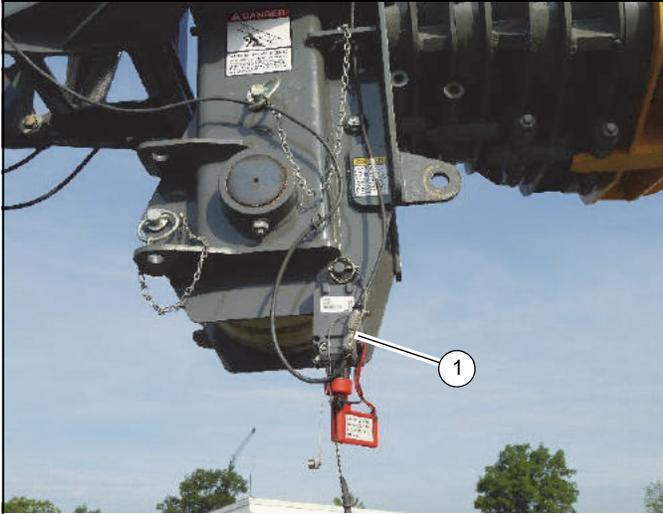
9216-6



9216-7

**FIGURE 5-26**

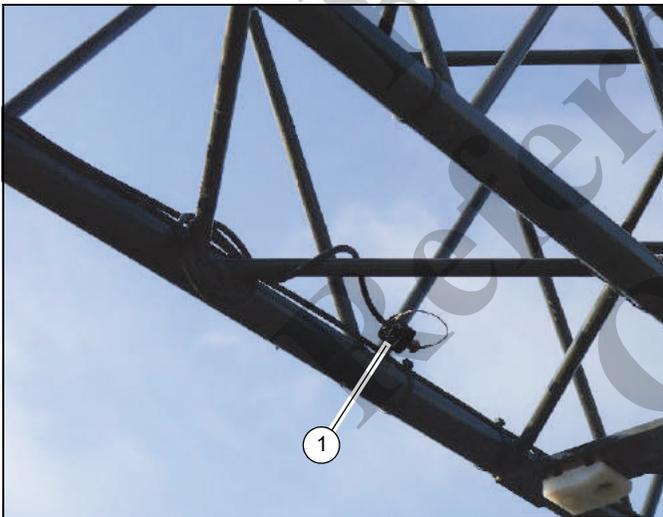
5. Disconnect Anti-Two-Block cable.
  - a. Disconnect the anti-two-block switch cable end connectors between the boom extension cable and boom cable (1, Figure 5-27). Connect the boom anti-two-block switch cable end connector to the anti-two-block switch at the boom nose.



9216-14

FIGURE 5-27

- b. Wrap the boom extension anti-two block cable around the boom extension lacing, then secure the anti-two block cable end connector in the stowage clip (1, Figure 5-28)



9216-15

FIGURE 5-28

- c. If the boom extension stinger section was not erected, disconnect the boom extension base section anti-two block cable end connector from the anti-two block switch at the nose of the boom extension stinger section. Stow the cable end connector in the stowage clip.

Connect the boom extension stinger section anti-two block cable end connector to the anti-two block switch.

- 6. Attach a tag line to the boom extension tip.
- 7. Raise the boom to horizontal.
- 8. Make sure the attachment pin (2, Figure 5-29) that secures the boom extension to the rear storage bracket is in the stowed position and that the rear storage ramp (1) is folded out and locked in position.

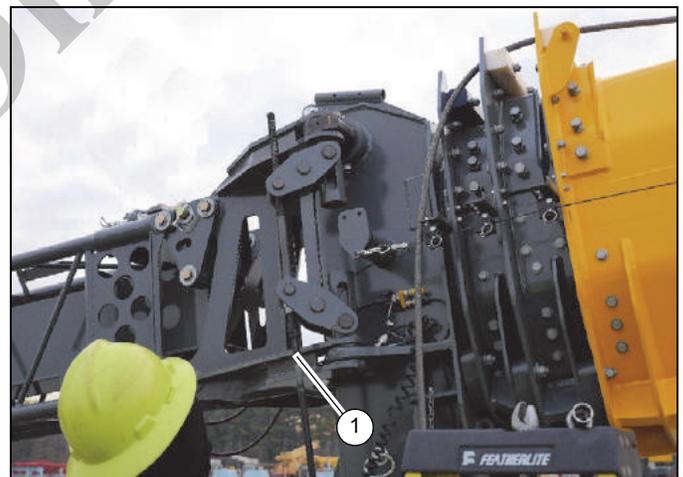


9216-13

FIGURE 5-29

- 9. Disengage the attachment pins securing the left side of the boom extension to the boom nose.

Use an impact wrench and the provided extension (80104116) and socket (80104383) to turn the jack screw (1, Figure 5-30) clockwise. Make sure the attachment pins are fully disengaged.



9216-3

FIGURE 5-30

**DANGER**

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

10. Sufficient momentum is needed to swing and engage the boom extension to the front stowage bracket. Using the tag line attached to the tip of the boom extension, manually swing the boom extension up the folded out ramp until the front stowage lugs engage the front stowage bracket (Figure 5-31). Raise and lower the boom as needed to help control the movement of the boom extension.



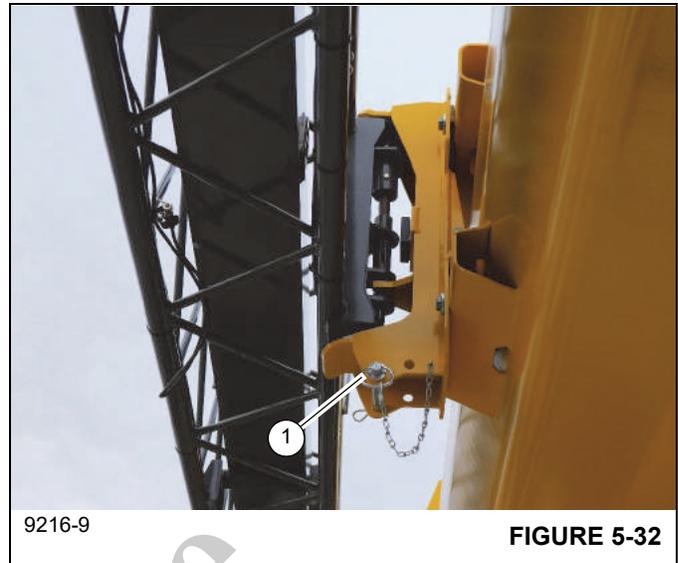
9216-8

**FIGURE 5-31**

11. Connect the boom extension to the front stowage bracket by using an impact wrench and the provided extension (80104116) and socket (80104383) to turn the jack screw (1, Figure 5-31) clockwise.

Make sure the jack screw bottoms out and the top attachment pin is fully engaged (spring will be compressed).

12. At the front stowage bracket, install the cross pin (1, Figure 5-32) in the holes underneath the jack screw. Secure the cross pin in position with retaining clip.



9216-9

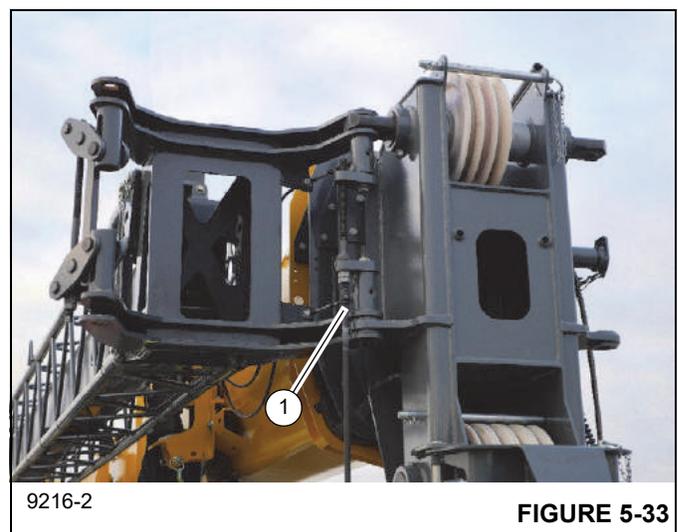
**FIGURE 5-32****DANGER****Boom Extension Fall Hazard**

An unsecured boom extension may fall resulting in death or serious injury.

Do not remove the boom nose attachment pins until the boom extension is supported on the rear stowage bracket ramp and securely attached to the front stowage bracket with the attachment pin.

13. Disengage the attachment pins securing the boom extension to the right side of the boom nose.

Use an impact wrench and the provided extension (80104116) and socket (80104383) to turn the jack screw (1, Figure 5-33) clockwise. Make sure the attachment pins are fully disengaged.



9216-2

**FIGURE 5-33**

14. Using the tag line, swing the boom extension towards the boom until the boom extension engages the rear stowage bracket. Raise the boom as necessary to help the boom extension engage the rear stowage bracket.
15. Remove the attachment pin (2, Figure 5-34) from its stowed position and secure the boom extension to the rear stowage bracket. Secure the attachment pin in position with retaining clip.



FIGURE 5-34

16. Fold in the ramp (1, Figure 5-34) at the rear stowage bracket.
17. Remove the tag line.

## Setting the Offset

Refer to Figure 5-35 through Figure 5-37.

1. Extend and set the outriggers. Swing the boom over the front of the crane.
2. Remove the hoist rope retaining pins from the boom extension sheave. Remove the hoist rope from the sheave, then reinstall the boom extension hoist rope retaining pin and secure with retaining clip.
3. To set the offset from a lesser degree to higher degree perform the following procedures.

### CAUTION

To prevent component damage, do not overload the boom extension anchor fittings or the boom extension base section when lowering the boom.

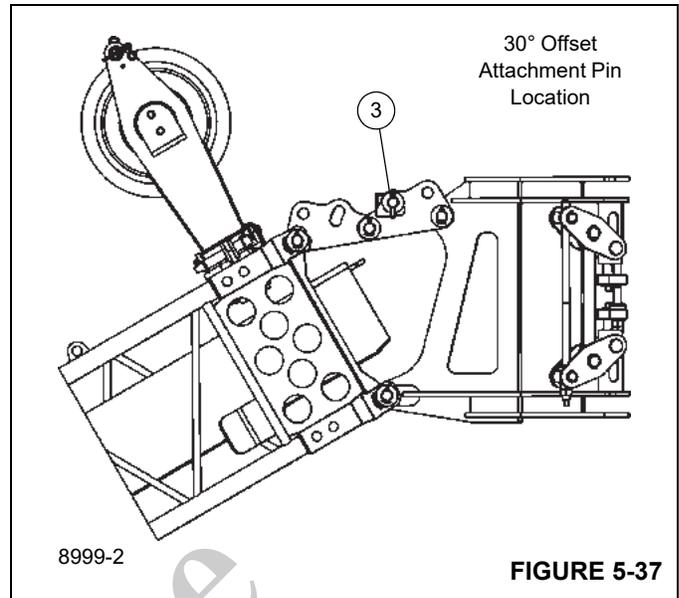
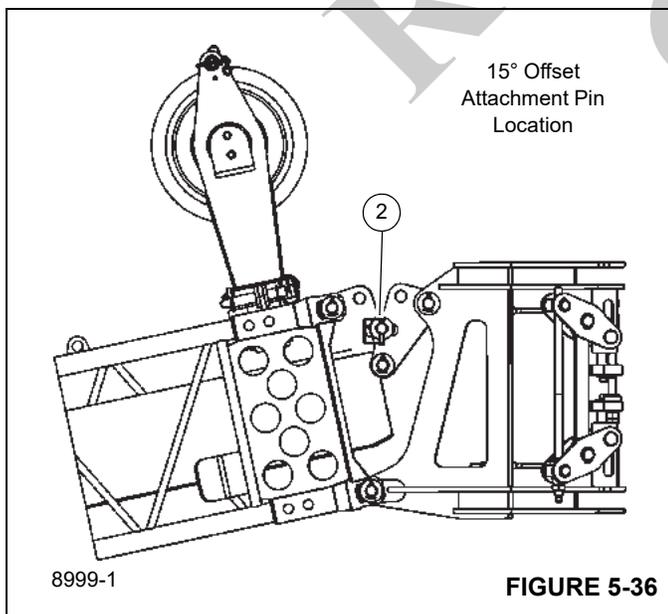
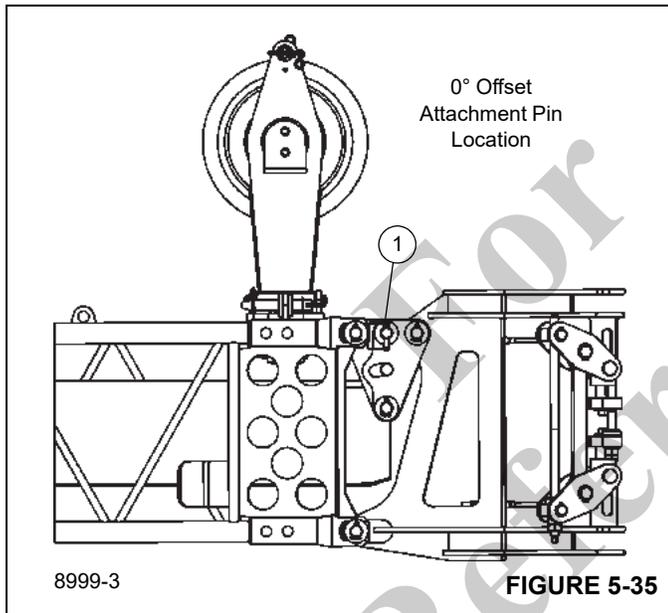
- a. Slowly lower the boom until the boom extension tip is resting on the ground and pressure is relieved on the offset link pins.
- b. Remove the offset link retaining clips and attachment pins securing the offset links in the lesser degree offset position. If going to maximum offset, stow them in the stowage lugs (3, Figure 5-37). If going to the intermediate (15 degree) offset, install them in the offset links for that degree of offset (2, Figure 5-36).
- c. Slowly elevate the boom until the offset links take the full weight of the boom extension.
- d. Reeve the hoist rope as described under normal erecting procedures.
4. To set the offset from a higher degree to lesser degree, perform the following procedures.

### CAUTION

To prevent component damage, do not overload the boom extension anchor fittings or the boom extension base section when lowering the boom

- a. Slowly lower the boom until the boom extension tip is near ground level.
- b. Remove the hoist rope retaining pins from the boom extension sheave. Remove the hoist rope from the sheave, then reinstall the boom extension hoist rope retaining pin and secure with retaining clip.

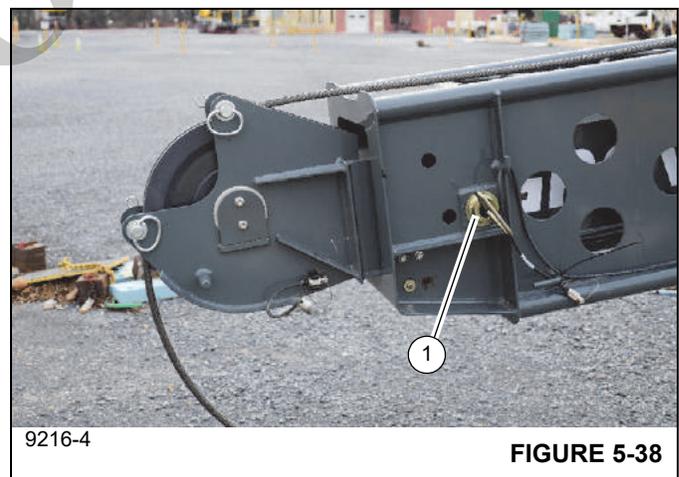
- c. Slowly lower the boom until the boom extension tip is resting on the ground and pressure is relieved from the offset links.
- d. Remove the offset link retaining clips and attachment pins and lower the boom until the holes for the lesser degree offset position align in the offset links. Install the offset attachment pins and retaining clips (Figure 5-35 through Figure 5-37).
- e. Slowly elevate the boom until the offset links take the full weight of the boom extension.
- f. Reeve the hoist rope as described under normal erecting procedures.



### Extending and Stowing the Telescoping Boom Extension Fly Section

#### Extending

1. Extend and set the outriggers and swing the boom to over the front.
2. Lower the boom to below horizontal.
3. Disconnect the stinger anti-two block cable end connector from the anti-two block switch and secure it in the stowage clip.
4. Remove the pin (1, Figure 5-38) securing the telescoping section to the base section.



5. Pull the telescoping section out of the base section until the holes in the rear of the telescoping section align with the holes in the tip of the base section.

- Reinstall the pin and retaining clip (Figure 5-39).



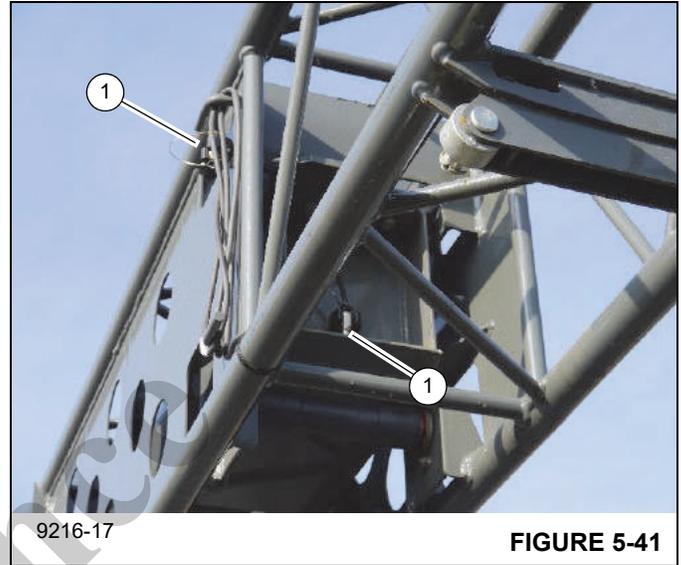
- Connect the boom extension base section anti-two-block cable end connector to the boom extension stinger section anti-two-block cable end connector (1, Figure 5-40).



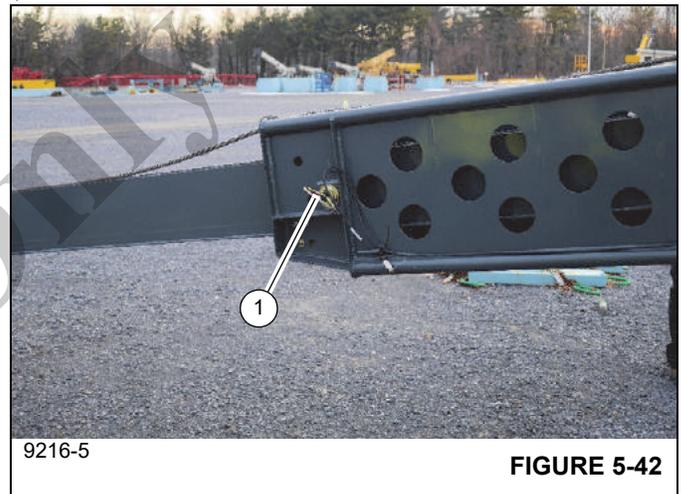
**Retracting**

- Extend and set the outriggers and swing the boom over the front of the crane.
- Lower the boom to below horizontal.

- Disconnect the boom extension base section anti-two-block cable end connector from the boom extension stinger section anti-two-block cable end connector. Stow the cable end connectors in their respective stowage clips (1, Figure 5-41).



- Remove the pin (1, Figure 5-42) securing the telescoping section to the base section.



- Using two people, slide the telescoping section into the base section until the holes in the front of the telescoping section align with the holes in the tip of the base section.

- Reinstall the pin and retaining clip (Figure 5-43).



9216-4

FIGURE 5-43

- Connect the boom extension stinger section anti-two-block cable end connector to the anti-two-block switch at the nose of the boom extension stinger section.

## REMOVING AND INSTALLING THE COUNTERWEIGHT – BOLT-ON VERSION

The counterweight is attached to the rear of the turntable and weighs 5580 kg (12,300 lb). For cranes without an auxiliary hoist, an additional 637 kg (1400 lb) counterweight is bolted to the hoist mounting area in lieu of the auxiliary hoist.

### Counterweight Removal



#### DANGER

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

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

Refer to Figure 5-44 for counterweight removal.

- Fully extend and set the outriggers.

**NOTE:** Turntable lock pin can only be engaged with boom over front.

- Rotate the superstructure so the counterweight is over the front of the carrier to gain additional clearance.

**NOTE:** The counterweight weighs approximately 5580 kg (12,300 lb).

- Lower and fully retract the boom
- Engage the 360° swing lock (if equipped).
- Shut down crane.

### CAUTION

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

- Attach an adequate lifting device to the four lifting lugs on the counterweight.
- Remove the four bolts and washers securing the counterweight to the superstructure. Slightly lift counterweight off of superstructure. Without raising or lowering the height of the counterweight, move the counterweight rearward until it clears the tail of the superstructure. Move counterweight far enough from crane to allow the superstructure to clear during repositioning.
- Rotate superstructure to the normal travel position.

### Counterweight Installation

- Fully extend and set the outriggers.
- Rotate the superstructure so the counterweight will be over the front of the carrier to gain additional clearance.
- Shut down crane.

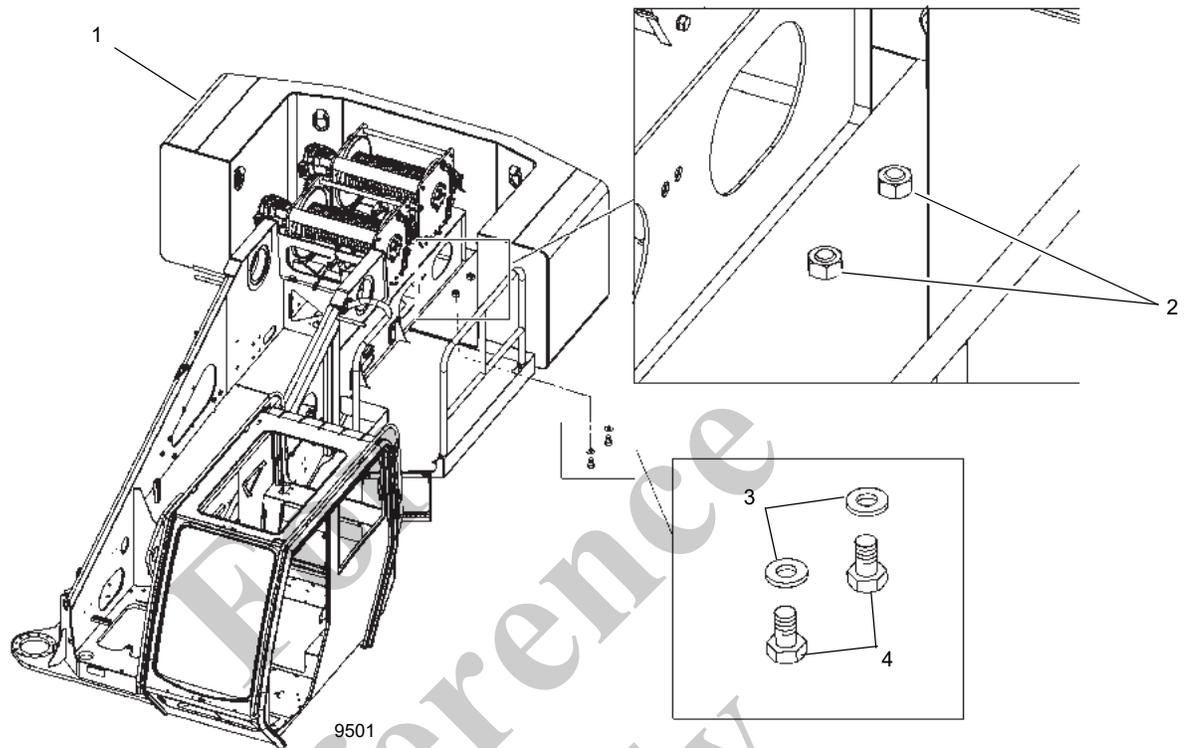
### CAUTION

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

**NOTE:** The counterweight weighs approximately 5580 kg (12,300 lb).

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

- Attach an adequate lifting device to the four lifting lugs on the counterweight. Lift the counterweight into place on the superstructure, aligning the securing nuts in the bottom of the counterweight with the holes in the superstructure.
- Secure the counterweight to the superstructure using four bolts and washers. Tighten bolts following torque specifications found in the *Fasteners and Torque Values* section of the *GRT655 Service Manual*.
- Remove the lifting device from the counterweight.



Item	Description
1	Counterweight
2	Nut
3	Washer
4	Bolt

FIGURE 5-44

## REMOVING AND INSTALLING THE COUNTERWEIGHT – PIN-ON VERSION

The counterweight is attached to the rear of the turntable and weighs 5580 kg (12,300 lb). For cranes without an auxiliary hoist, an additional 637 kg (1400 lb) counterweight is bolted to the hoist mounting area in lieu of the auxiliary hoist.

### Counterweight Removal



#### DANGER

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

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

Refer to Figure 5-45 for counterweight removal.

1. Fully extend and set the outriggers.

**NOTE:** Turntable lock pin can only be engaged with boom over front.

2. Rotate the superstructure so the counterweight is over the front of the carrier to gain additional clearance.

**NOTE:** The counterweight weighs approximately 5580 kg (12,300 lb).

3. Lower and fully retract the boom
4. Engage the 360° swing lock (if equipped).
5. Shut down crane.

#### CAUTION

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

6. Attach an adequate lifting device to the four lifting lugs on the counterweight.
7. Loosen the four jam nuts, then back off the jack bolts that center the counterweight on the superstructure.
8. Remove the two cotter pins that secure the large attachments pins in place. Remove the two attachment pins.

9. Slightly lift counterweight off of superstructure. Without raising or lowering the height of the counterweight, move the counterweight rearward until it clears the tail of the superstructure. Move counterweight far enough from crane to allow the superstructure to clear during repositioning.

10. Reinstall attachment pins in holes on superstructure, then secure with cotter pins.

11. Rotate superstructure to the normal travel position.

### 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.

#### CAUTION

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

**NOTE:** The counterweight weighs approximately 5580 kg (12,300 lb).

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

4. Remove the two large attachment pins from the superstructure.
5. Attach an adequate lifting device to the four lifting lugs on the counterweight. Lift the counterweight into place on the superstructure.
6. Secure the counterweight to the superstructure using the two attachment pins. Secure the attachment pins with cotter pins.

**NOTE:** If the attachment pin holes in the counterweight do not align with the holes in the superstructure, adjust the jack bolts until they align, then tighten the jam nuts.

7. Adjust the four jack bolts such that the counterweight is centered on the superstructure. Do not over-tighten the bolts. Tighten the jam nut at each bolt.

8. Remove the lifting device from the counterweight.

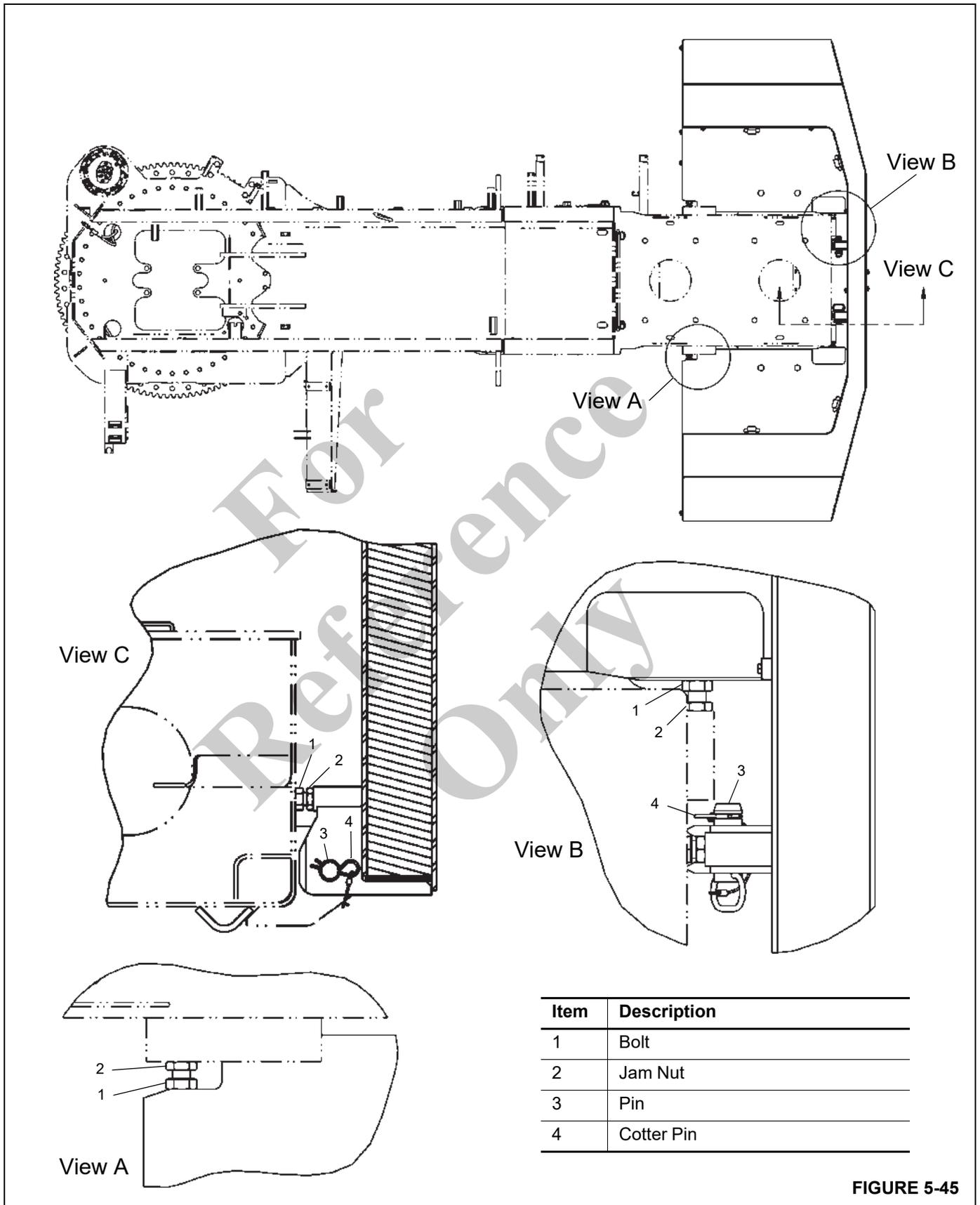


FIGURE 5-45

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## SECTION 6

### LUBRICATION AND MAINTENANCE

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#### GENERAL

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

#### ENVIRONMENTAL PROTECTION

**Dispose of waste properly!** Improperly disposing of waste can threaten the environment.

Potentially harmful waste used in Grove cranes includes—but is not limited to—oil, fuel, grease, coolant, air conditioning refrigerant, filters, batteries, and cloths which have come into contact with these environmentally harmful substances.

Handle and dispose of waste according to local, state, and federal environmental regulations.

When filling and draining crane components:

- Do not pour waste fluids onto the ground, down any drain, or into any source of water.
- Always drain waste fluids into leak proof container clearly marked with what they contain.

- Always fill or add fluids with a funnel or filling pump.
- Immediately clean up spills.

#### LUBRICANTS AND LUBRICATION INTERVALS

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 Crane Care.

**NOTE:** All fluids and lubricants may be purchased by contacting an authorized Grove distributor or Manitowoc Crane Care Parts Department.

#### CAUTION

##### Possible Equipment Damage!

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

The multipurpose grease applied during manufacturing is of a lithium base. Use of a non-compatible grease could result in damage to equipment.

## Standard Lubricants

Standard lubricants are used on all Grove cranes unless the crane is ordered with a cold weather package. These

standard lubricants are effective in temperatures down to -9°C (15°F). Refer to Table 6-1 for a list of the recommended standard lubricants.

**Table 6-1: Standard Lubricants [Down to -9°C (15°F)]**

Lubricant/Fluid	Grove Spec.	Recommended Lubricant		
		Type	Grade	Classification
Axle Gear Oil	6829012964	Century Unigear Semi-synthetic Texaco Multigear SS Chevron DELO Gear Lubricant	80W-90	
Engine Oil - Tier 3	6829003483	Exxon XD-3 Conoco Fleet Supreme	15W-40	CI-4
Engine Oil - Tier 4	6829104182	Conoco Fleet Supreme EC Mobil Delvac 1300 Super	15W-40	CJ-4
Hydraulic/Transmission Oil	6829006444	Phillip 66 PowerTran XP Exxon Mobil 424	ISO 46/68	Must meet John Deere Std. JDM J20c
Hoist Gear Oil Swing Drive Oil	6829100213	Mobil: Mobilegear 600XP 150 Texaco: Meropa 150 Phillips 66 Extra Duty Gear Oil, 150		AGMA No. 4 EP
Grease, Multipurpose	6829003477	Citgo Lithoplex MP# 2 Texaco Starplex Moly # 2 Phillips 66 Philube M Mobil Mobilgrese XHP 222 Special Chemtool Inc, Lube-A-Boom	NLGI 2	
Open Gear Lube	6829102971	Fuchs Ceplattyn 300 Spray	NLGI 1-2	
Antifreeze Coolant	6829101130	Old World Industries, Inc. Fleet Charge SCA Caterpillar DEAC Fleetguard Compleat EG	Mix 50/50	
Supplemental Coolant Additive (SCA)	6829012858	Fleetguard DCA4 Fleetguard DCA2 Penray Pencool 3000		

Table 6-1: Standard Lubricants [Down to -9°C (15°F)]

Lubricant/Fluid	Grove Spec.	Recommended Lubricant		
		Type	Grade	Classification
Diesel Exhaust Fluid (DEF)	80019225	Fleetguard StableGuard™ Urea 32 Premix AdBlue® TerraCair Ultrapure® DEF		
Extreme Pressure 3% Moly Grease	6829015304	Citgo Lithoplex CM2 Mobil Mobilgrease CM-P Ipiranga IPIFLEX LI-COMP Moly 2	NLGI 2	

For Reference Only

## Arctic Lubricants and Conditions

### *Temperatures Below -9°C (15°F)*

Regions with ambient temperatures below -9°C (15°F) are considered arctic. In general, petroleum based fluids developed especially for low temperature service may be used with satisfactory results in these temperatures. However, certain fluids, such as halogenated hydrocarbons, nitro hydrocarbons, and phosphate ester hydraulic fluids, may not be compatible with hydraulic system seals and wear bands. Therefore, always check with an authorized Grove distributor or Manitowoc Crane Care if in doubt of the suitability of a specific fluid or lubricant.

**NOTE:** Additional information regarding cold weather operation is available through your Cummins dealer/service center under Service Bulletin 3379009.

When operating in cold weather and regardless of the oil viscosity of the crane's lubricants, always follow the cold weather start-up and operating procedures described in *Section 4 - Operating Procedures* to ensure adequate lubrication during system warm-up and proper operation of all crane functions.

### *Cold Weather Package and Lubricants*

Grove Crane recommends the following cold weather lubricants for use with ambient temperatures down to -29°C (-20°F) (Table 6-2) and -40°C (-40°F) (Table 6-3). These cold weather lubricants alone are not sufficient to operate the crane in extreme low temperatures. Therefore, it is also recommended that the crane be equipped with the cold weather accessories given under the section titled *Cold Weather Operation*, page 4-9.

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Only

Table 6-2: Cold Weather Lubricants [Down to -29°C (-20°F)]

Lubricant/Fluid	Grove Spec.	Recommended Lubricant		
		Type	Grade	Classification
Axle Gear Oil	6829014058	Petro-Canada Traxon E Synthetic CITGO, Syntetic Gear Lube Eaton, Roadranger EP Mobil, Mobilube SCH Shell, Spirax S Sunoco Duragear EP	75W-90	
Engine Oil - Tier 3	6829101560	Mobil Delvac 1	5W-40	CI-4
Engine Oil - Tier 4	80056036	Shell Rotella® T6 Mobil Delvac 1 ESP Caterpillar Cat DE0-ULS Cold Weather	0W-40	CJ-4
Hydraulic/Transmission Oil	6829101559	Petro-Canada Duratran Synthetic THF Chevron All Weather THF Texaco TDH Oil SS		Must Meet John Deere Std. JDM J20c & J20d
Hoist Gear Oil Swing Drive Oil	6829103636	Petro-Canada ENDURATEX Synthetic EP 150 Mobil SHC629 Phillips 66 Syncon EP Plus	ISO 150	AGMA No. 4 EP
Grease, Multipurpose	6829104275	Petro-Canada Precision Synthetic EP1 Mobil, Mobilith SHC 220	NLGI 2	
Open Gear Lube	6829102971	Fuchs Ceplattyn 300 Spray	NLGI 1-2	
Antifreeze Coolant	6829101130	Old World Industries, Inc. Fleet Charge SCA Caterpillar DEAC Fleetguard Compleat EG	Mix 50/50	
Supplemental Coolant Additive (SCA)	6829012858	Fleetguard DCA4 Fleetguard DCA2 Penray Pencoool 3000		
Hydraulic Oil	6829006993	Exxon Mobil Univis HVI	26	
Diesel Exhaust Fluid (DEF)	80019225	Fleetguard StableGuard™ Urea 32 Premix AdBlue® TerraCair Ultrapure® DEF		
Windshield Washer fluid	90037773	Splash De-icer		

Table 6-2: Cold Weather Lubricants [Down to -29°C (-20°F)]

Lubricant/Fluid	Grove Spec.	Recommended Lubricant		
		Type	Grade	Classification
Diesel Fuel	80069407	NOCO Kerosene, 3, UN1223, III Product #1	#1	NLOCK08
Extreme Pressure 3% Moly Grease	6829104275	Mobil Mobilith SHC 220 Petro-Canada Precision Synthetic EP1	NLGI 2	

Table 6-3: Cold Weather Lubricants [Down to -40°C (-40°F)]

Lubricant/Fluid	Grove Spec.	Recommended Lubricant		
		Type	Grade	Classification
Axle Gear Oil Hoist Gear Oil	6829014058	Petro-Canada Traxon E Synthetic CITGO, Syntetic Gear Lube Eaton, Roadranger EP Mobil, Mobilube SCH Shell, Spirax S Sunoco Duragear EP	75W-90	
Tier 3/Tier 4 Engine Oil	80056036	Shell Rotella® T6 Mobil Delvac 1 ESP Caterpillar Cat DE0-ULS Cold Weather	0W-40	CJ-4
Transmission Oil	6829101559	Petro-Canada Duratran Synthetic THF Chevron All Weather THF Texaco TDH Oil SS		Must Meet John Deere Std. JDM J20c & J20d
Swing Drive Oil	6829103636	Petro-Canada ENDURATEX Synthetic EP 150 Mobil SHC629		AGMA No. 4 EP
Grease, Multipurpose	6829104275	Petro-Canada Precision Synthetic EP1 Mobil, Mobilith SHC 220	NLGI 2	
Open Gear Lube	6829102971	Fuchs Ceplattyn 300 Spray	NLGI 1-2	
Antifreeze Coolant	6829104212	Old World Industries, Inc. Fleet Charge SCA Pre-charged Fleetguard Compleat EG Petro-Canada	Mix 60/40	
Supplemental Coolant Additive (SCA)	6829012858	Fleetguard DCA4 Fleetguard DCA2 Penray Pencool 3000		
Hydraulic Oil	6829006993	Exxon Mobil Univis HVI	26	

Table 6-3: Cold Weather Lubricants [Down to -40°C (-40°F)]

Lubricant/Fluid	Grove Spec.	Recommended Lubricant		
		Type	Grade	Classification
Diesel Exhaust Fluid (DEF)	80019225	Fleetguard StableGuard™ Urea 32 Premix AdBlue® TerraCair Ultrapure® DEF		
Windshield Washer fluid	90037773	Splash De-icer		
Diesel Fuel	80069407	NOCO Kerosene, 3, UN1223, III	#1	NLOCK08
Extreme Pressure 3% Moly Grease	6829104275	Mobil Mobilith SHC 220 Petro-Canada Precision Synthetic EP1	NLGI 2	

For Reference Only

## CYLINDER ROD SURFACE PROTECTION

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 Crane Care has Boeshield® T-9 Premium Metal Protectant available in 12 oz. aerosol cans by ordering part number 9999101803 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 rods.

## 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. For more detailed information concerning the lubrication and inspection of wire rope, refer to *Wire Rope* in *Section 1 - Introduction* of the *Service Manual*.

## 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.

Check all oil levels with crane parked on a level surface in transport position, while oil is cold, unless otherwise specified.

On plug type check points, 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 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 1 lb (0.45 kg) grease gun.

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

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.

## CraneLUBE

Grove Crane highly recommends use of CraneLUBE lubricants to increase your crane's reliability and performance. Contact your Grove distributor for information about the Grove's CraneLUBE lubrication program.

## Cummins Oil Registration List

Cummins has a program that lists engine oils that it has tested to meet its engineering specifications. Listing of recommended oils is on QuickServe® Online. Log on to [quickserve.cummins.com](http://quickserve.cummins.com) and login with a current user name and password or create a new account by selecting "Create an Account" under information, choose Limited Owners Plan and register. Once logged in, click on the "Service" Tab in the top red bar, "Service Tools" mini-tab and "Oil Registration Lists" link within the Service Tools list. This will load a list of the different Cummins Engineering Specification numbers.

Select the one that applies to your engine to view the registered oils.

## Safety

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

---

 **WARNING**  
**Crushing Hazard!**

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.

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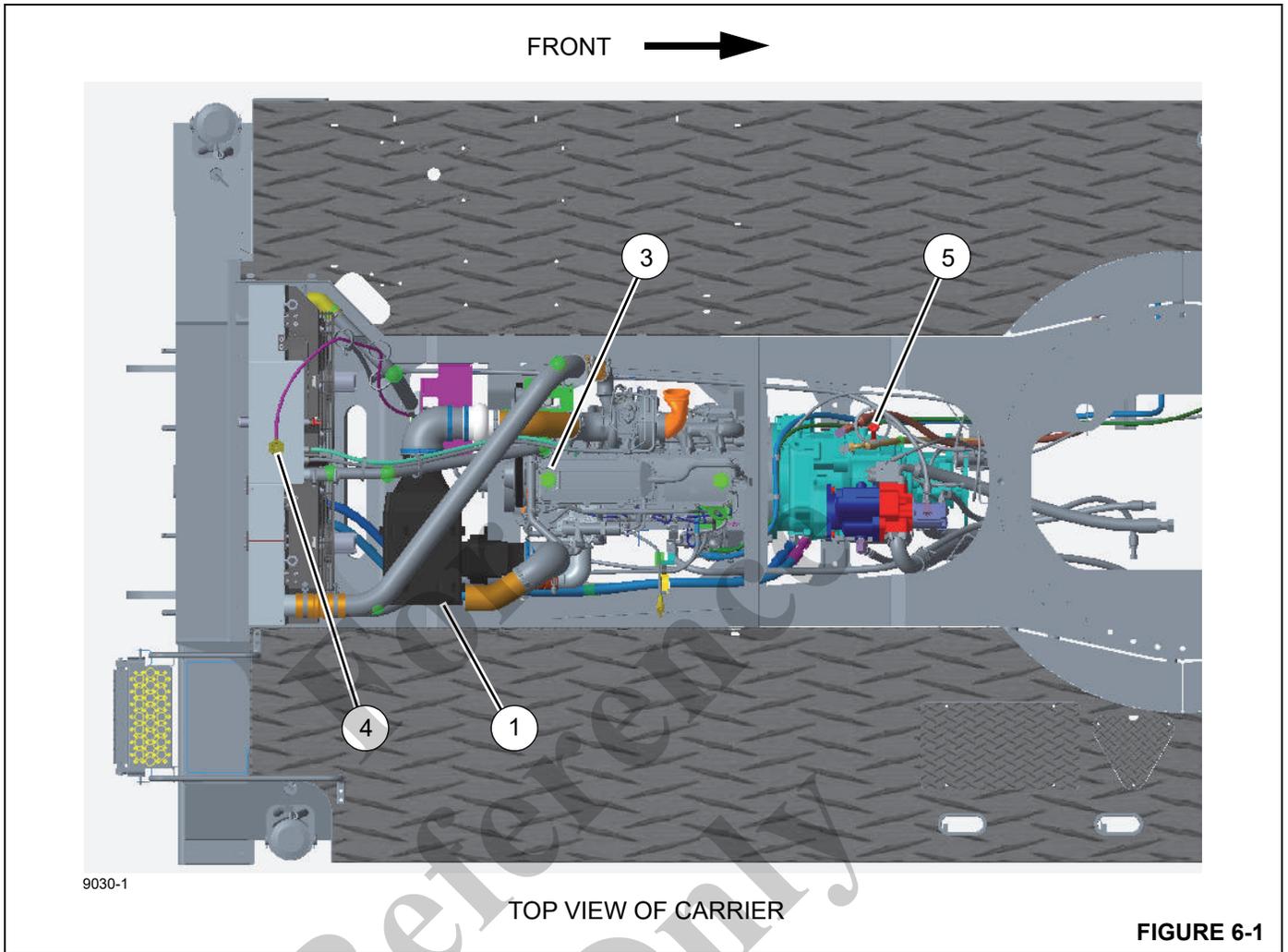
Table 6-4: Approved Lubricant Reference Table

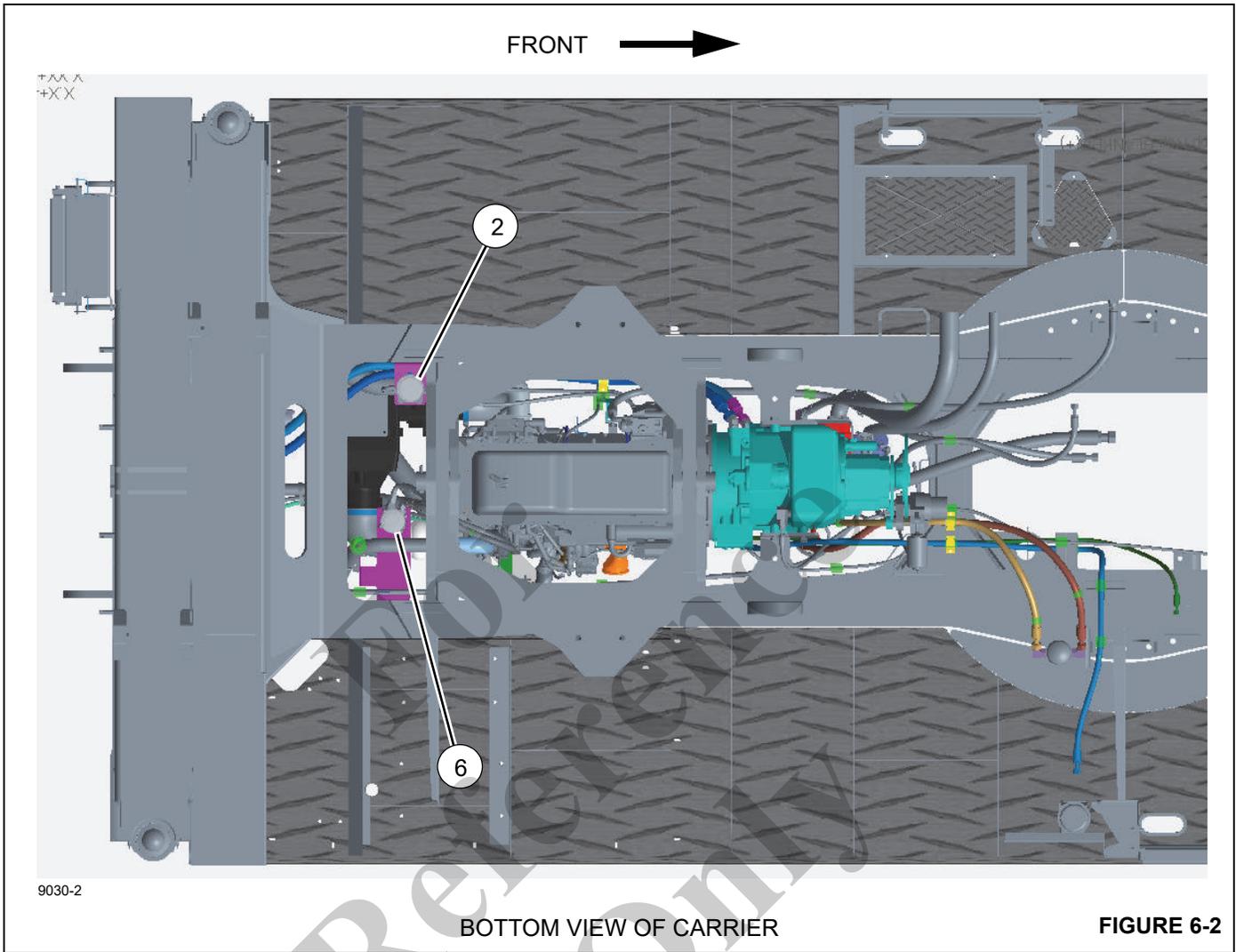
Ref.	Approved Lubricant	Lube Specification Down To -9°C (15°F)	Lube Specification Down To TO -29°C (-20°F)	Lube Specification Down To -40°C (-40°F)
A	Extreme Pressure Multipurpose Grease	6829003477	6829104275	6829104275
B	Gear Lube (GL-5)	6829014058	6829014058	6829014058
C	Fully Formulated Anti-Freeze Coolant	6829101130	6829101130	6829104212
D	Liquid Coolant Conditioner	6829012858	6829012858	6829012858
E	Tractor Hydraulic Fluid	6829006444	6829101559	6829101559
F	Engine Oil SAE (Tier 3)	6829003483	6829101560	80056036
	Engine Oil SAE (Tier 4)	6829104182	80056036	80056036
G	Open Gear Lube	6829102971	6829102971	6829102971
H	Extreme Pressure Gear Lube	6829100213	6829103636	6829103636
J	Hydraulic Oil	6829006444	6829006993	6829006993
K	Diesel Exhaust Fluid (DEF)	80019225	80019225	80019225
L	Extreme Pressure Multipurpose Grease	6829015304	6829104275	6829104275

For Reference Only

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
<b>Drive Train</b>						
1	Air Filter	Figure 6-1	---	---	Replace filter element when fault code 5576 or 3341 appears.	
	Air Filter - Tier 3	Figure 6-1	---	---	Replace filter element when air restriction indicator is in the red zone.	
2	Fuel Filter	Figure 6-2	---	---	Change filter every 500 hours or 6 months.	Fuel filter is located on inside right-hand side frame rail behind the engine.
3	Tier 4 Engine Crankcase	Figure 6-1	F	18 L (19 qt)	<ul style="list-style-type: none"> <li>Check level every 10 hours or daily.</li> <li>Drain, fill and replace filter every 500 hours.</li> </ul>	<ul style="list-style-type: none"> <li>Through fill cap to FULL mark on dipstick.</li> <li>Refer to Item 6.</li> </ul>
	Tier 3 Engine Crankcase	Figure 6-1	F	18 L (19 qt)	<ul style="list-style-type: none"> <li>Check level every 10 hours or daily.</li> <li>Drain, fill and replace filter every: 500 hours (0-500 ppm sulfur fuel); 400 hours (500-5000 ppm sulfur fuel); 250 hours (&gt;5000 ppm sulfur fuel).</li> </ul>	<ul style="list-style-type: none"> <li>Through fill cap to FULL mark on dipstick.</li> <li>Refer to Item 6.</li> </ul>
4	Engine Cooling System and SCA Levels	Figure 6-1	C, D	43 L 45.4 qt	<ul style="list-style-type: none"> <li>Check coolant level every 10 hours or daily.</li> <li>Check SCA levels every 500 hours.</li> <li>Check coolant for contamination every 1000 hours.</li> </ul>	Fill top tank to bottom of filler neck. Run engine through two (2) thermal cycles. Check level and refill as required.
<b>NOTE:</b> Refer to Service Manual for information regarding SCA levels and contamination limits.						

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
<b>Drive Train (Continued)</b>						
5	Transmission, Torque Converter	Figure 6-1	E	29.3 L (31 qt)	<ul style="list-style-type: none"> <li>Check level every 10 hours or daily.</li> <li>Drain, fill, and replace filter after first 50 and 100 hours of service, then every 1000 hours or 6 months thereafter.</li> </ul>	<ul style="list-style-type: none"> <li>Through fill pipe to FULL mark on dipstick.</li> <li>Refer to Item 7.</li> </ul>
<p><b>NOTE:</b></p> <ul style="list-style-type: none"> <li>Check transmission fluid level with engine running at 850 rpm idle and converter oil at 65°C to 93°C (150°F to 200°F). Do not attempt an oil level check with cold oil. To bring oil temperature to this range, it is necessary to work the crane or stall the converter. Converter stall should be accomplished by engaging shift lever in forward high range with brakes applied and then accelerating engine to half or three-quarter throttle. Hold stall until required converter temperature is reached and stabilized.</li> </ul> <p style="text-align: center;"><b>NOTICE</b></p> <p>Do not operate converter at stall condition for longer than 30 seconds at one time. Shift to neutral for 15 seconds and repeat procedure until desired temperature is reached. Excessive temperature [120°C (250°F) maximum] will damage transmission clutches, fluid, converter and seals.</p> <ul style="list-style-type: none"> <li>Drain oil at 65°C to 93°C (150°F to 200°F).</li> <li>Transmission filter is located on the outside left hand frame in the area of the fuel tank.</li> <li>To add fluid: <ul style="list-style-type: none"> <li>a. Fill to FULL mark on dipstick.</li> <li>b. Run engine at 850 rpm to prime torque converter and lines.</li> <li>c. Check oil level with engine running at 850 rpm and converter oil at 65°C to 93°C (150°F to 200°F). Add oil to bring oil level to FULL mark on dipstick.</li> </ul> </li> </ul>						
6	Engine Oil Filter	Figure 6-2	---	---	<ul style="list-style-type: none"> <li>Tier 4 engine, replace oil filter every 500 hours.</li> <li>Tier 3 engine, replace oil filter every: <ul style="list-style-type: none"> <li>• 500 hours (0-500 ppm sulfur fuel)</li> <li>• 400 hours (500-5000 ppm sulfur fuel)</li> <li>• 250 hours (&gt;5000 ppm sulfur fuel)</li> </ul> </li> </ul>	Refer to Item 3.





Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
<b>Drive Train (Continued)</b>						
7	Transmission Filter	Figure 6-3	---	---	Change transmission filter after first 50 and 100 hours of service, then every 500 hours thereafter.	<ul style="list-style-type: none"> <li>Refer to Item 5.</li> <li>Filter is located on the outside left hand frame in the area of the fuel tank.</li> </ul>
8	Coolant Strainer (Cab Heater)	Figure 6-3	---	---	Clean strainer screen after first 100 hours and every 2000 hours or 12 months intervals thereafter.	Close shutoff valves. Unscrew hex plug to clean filter.
9	Fuel/Water Separator	Figure 6-3	---	---	Drain water trap every 10 hours or daily.	
<b>NOTE:</b> During replacement of the water separator, note direction of the arrow. Arrow must point toward fuel filter						
10	Driveline - Slip Joints	Figure 6-3	A	Until grease extrudes	500 hours or 3 months	2 grease fittings

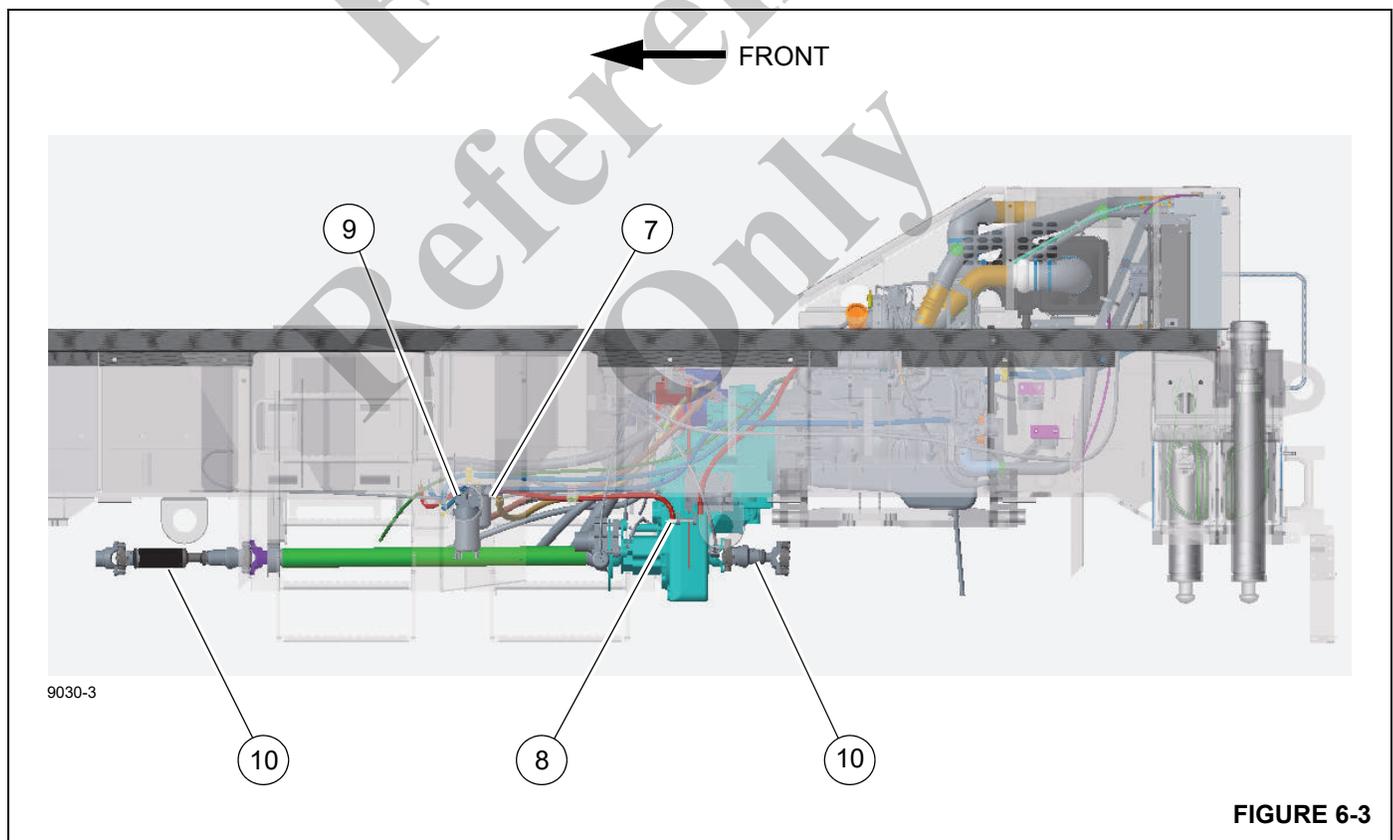


FIGURE 6-3

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
<b>Drive Train (Continued)</b>						
11	DEF Supply Module Filter (Tier 4)	Figure 6-4	---	---	Check filter every 4500 hours or 3 years	
12	DEF Tank (Tier 4)	Figure 6-4	K	18.9 L (20 qt)	Check and fill every 10 hours or daily	Indicator in cab comes on when fluid level is low.
13	DEF Tank Filter (Tier 4)	Figure 6-4	---	---	Check every 2000 hours or 1 year	

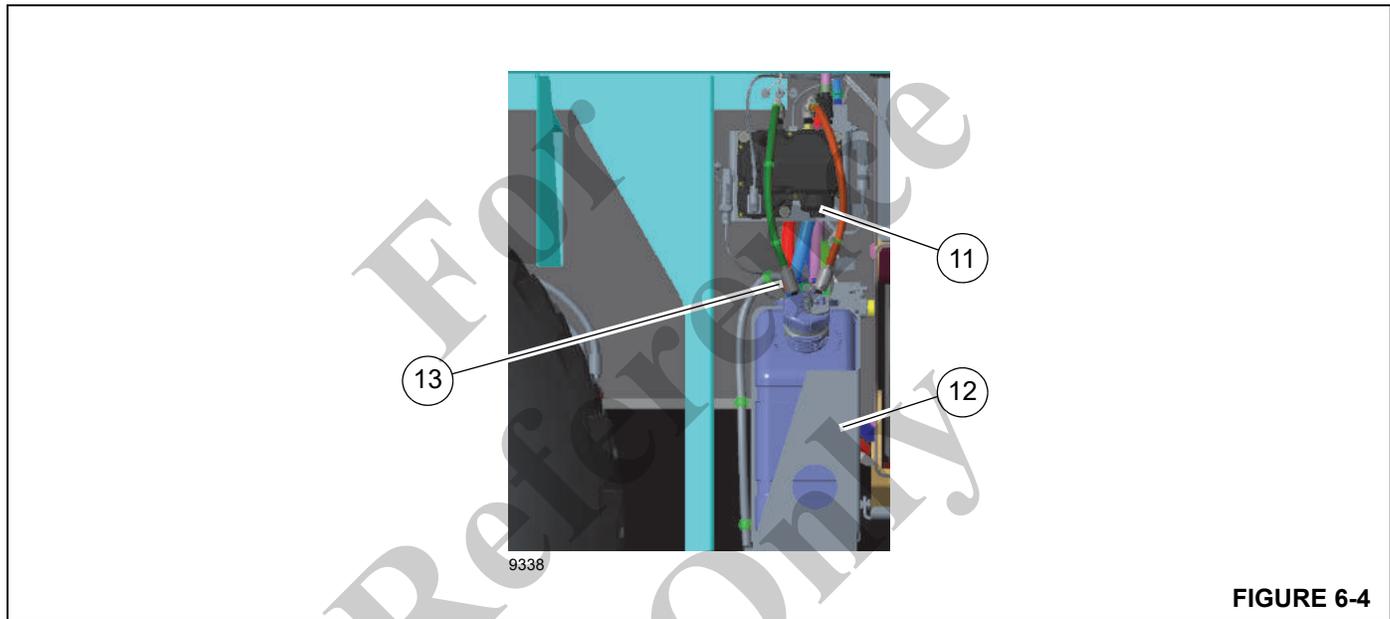


FIGURE 6-4

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
<b>Steering and Suspension</b>						
20	Steer Cylinder Pivot Pins	Figure 6-5	A	Until grease extrudes	500 hours or 3 months	8 grease fittings
21	Upper and Lower King Pins	Figure 6-5	A	Until grease extrudes	500 hours or 3 months	8 grease fittings
22	Tie Rod Pivot Pins	Figure 6-5	A	Until grease extrudes	500 hours or 3 months	4 grease fittings
23	Lockout Cylinder Pivot Pins	Figure 6-5	A	Until grease extrudes	500 hours or 3 months	4 grease fittings

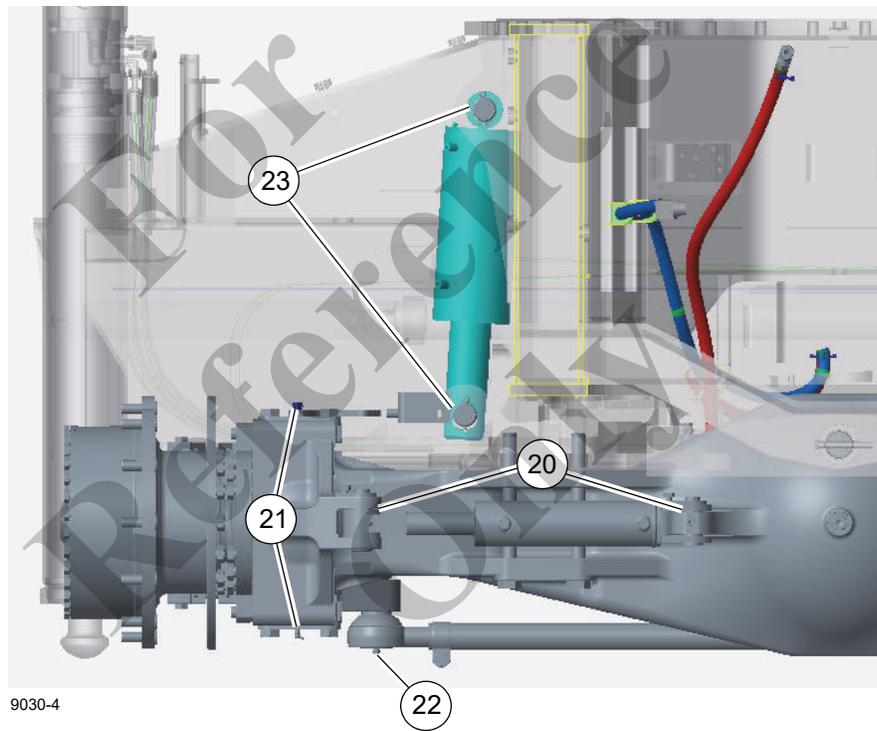
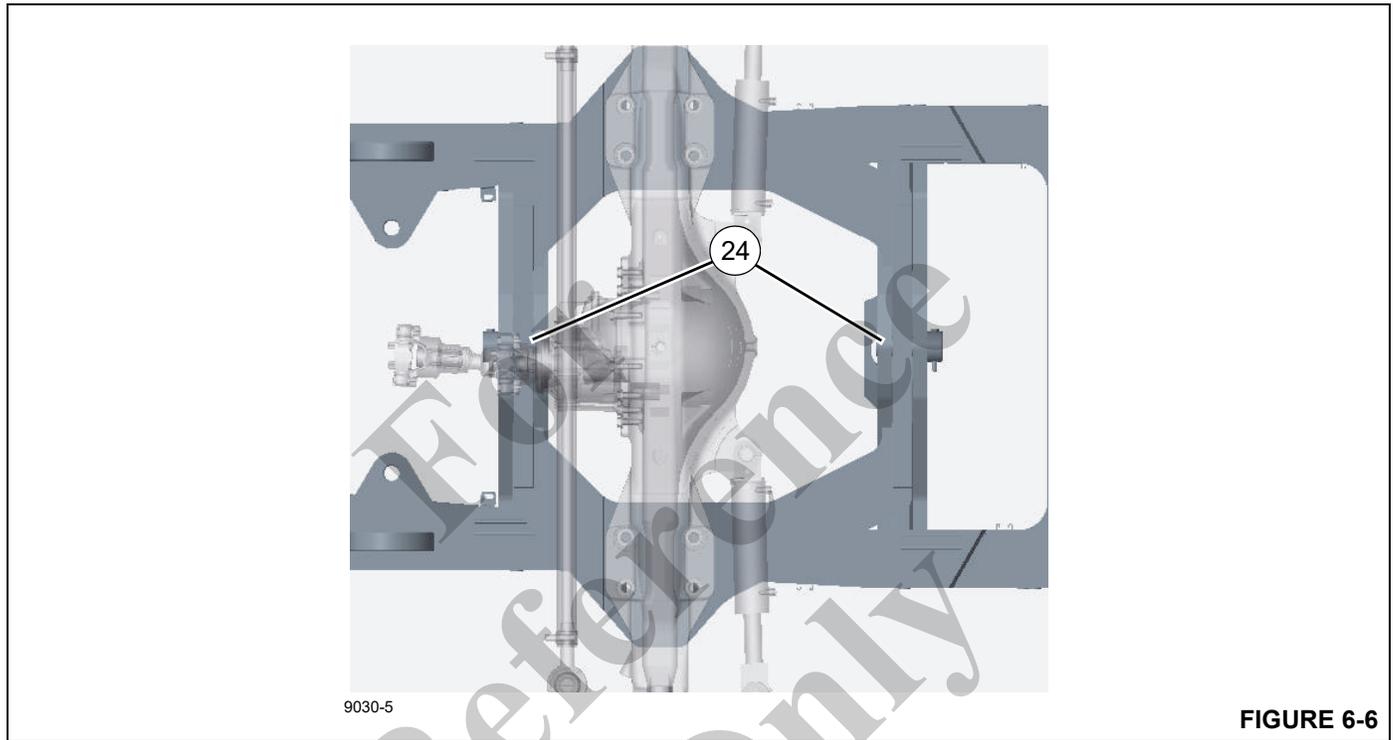


FIGURE 6-5

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
<b>Steering and Suspension (Continued)</b>						
24	Fifth Wheel Pivots	Figure 6-6	A	Until grease extrudes	500 hours or 3 months	2 grease fittings



Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
<b>Axles</b>						
30	Differentials	Figure 6-7	B	28.4 L (30 qt)	<ul style="list-style-type: none"> <li>• Check level every 500 hours or 3 months.</li> <li>• Drain and fill every 4000 hours or 2 years.</li> </ul>	
<p><b>NOTE:</b> 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.</p> <p><b>CAUTION:</b> Use of non-approved lubricant may damage components and/or invalidate published lubricant intervals.</p> <p><b>CAUTION:</b> If the makeup amount is substantially more than 0.23 L (0.5 pt), check for leaks.</p>						
31	Planetary Hubs and Wheel Bearings	Figure 6-7	B	2.5 L (5.3 pt)	<ul style="list-style-type: none"> <li>• Check level every 500 hours or 3 months.</li> <li>• Drain and fill every 4000 hours or 2 years.</li> </ul>	Fill to oil level indicated on axle hub.
<p><b>CAUTION:</b> Use of non-approved lubricant may damage components and/or invalidate published lubricant intervals.</p>						

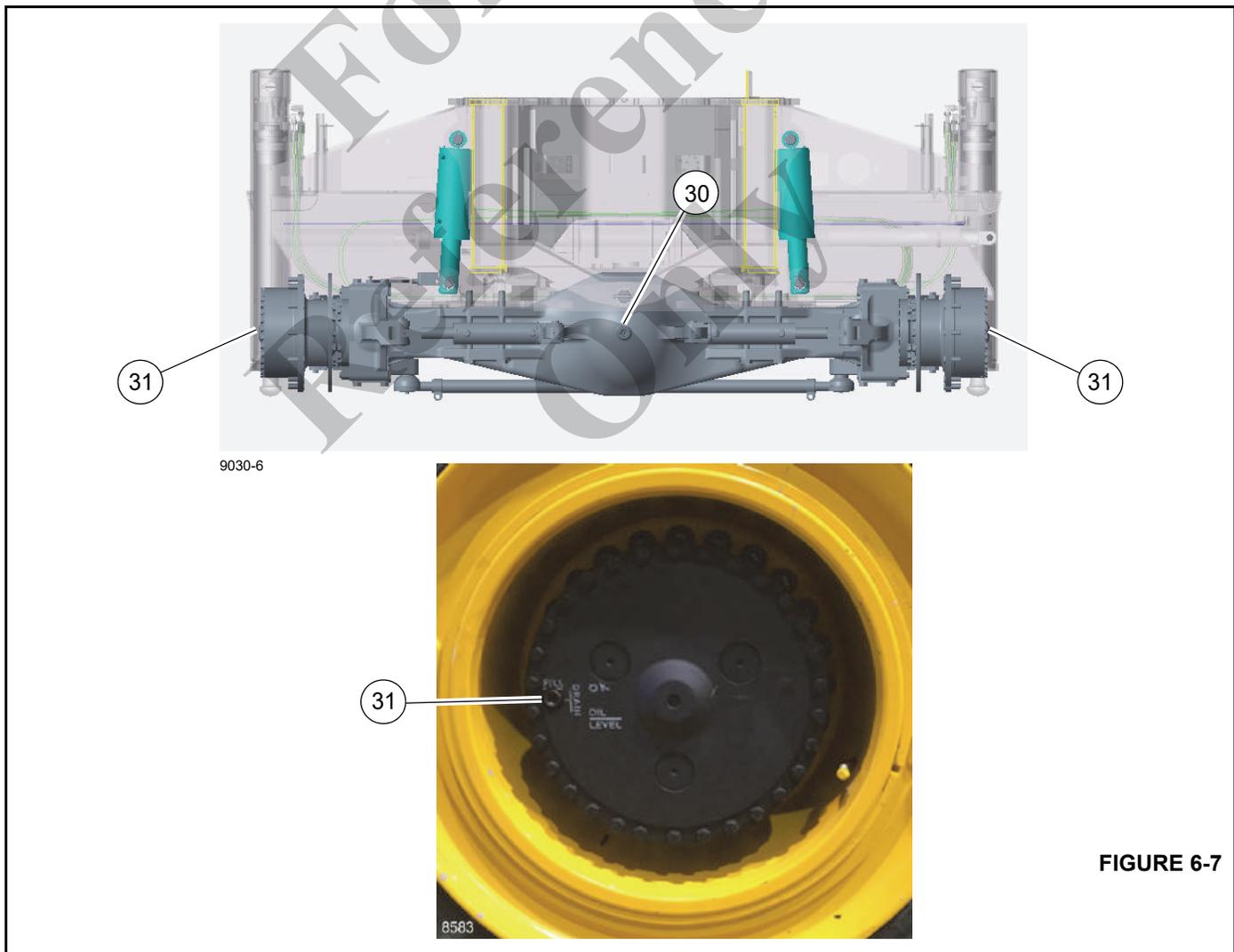
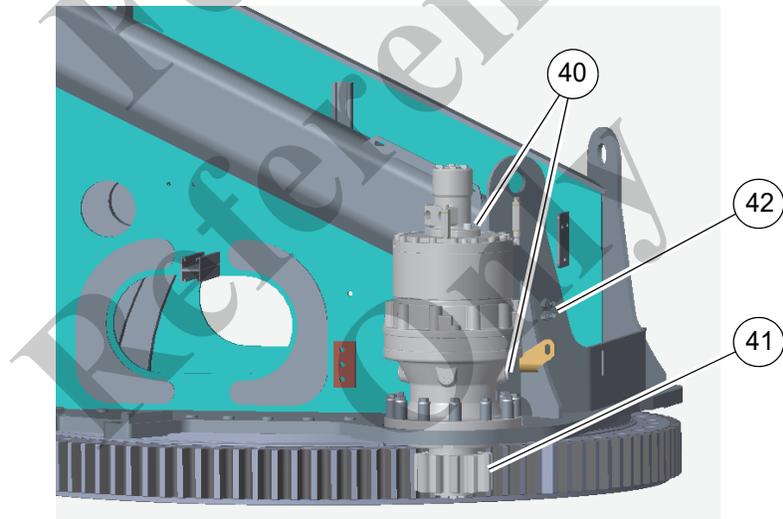
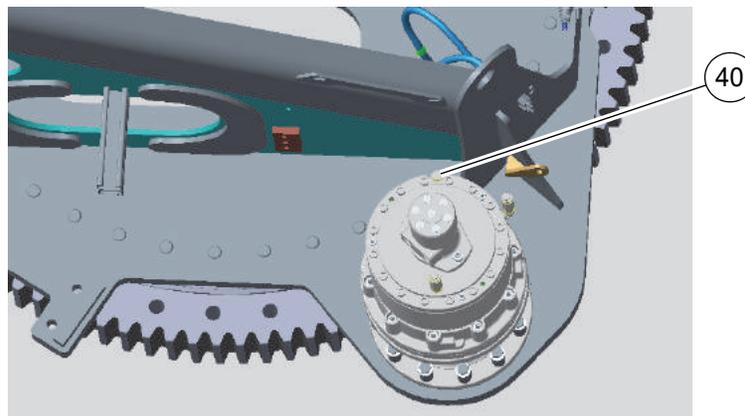


FIGURE 6-7

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
<b>Turntable</b>						
40	Turntable Gearbox	Figure 6-8	H	5.0 L (5.3 qt)	<ul style="list-style-type: none"> <li>Check and fill every 50 hours</li> <li>Drain and fill after first 250 hours and every 500 hours or 12 months thereafter.</li> </ul>	Fill gearbox to markings on dipstick.
41	Turntable Gear and Drive Pinion	Figure 6-8	G	Coat all teeth	500 hours or 6 months	Spray on
42	Turntable Bearing	Figure 6-8	A	Until grease extrudes from entire bearing circumference	500 hours or 6 months	2 grease fittings at front of turntable.
<b>NOTE:</b> Rotate turntable 90° and apply grease to fittings. Continue rotating in 90° increments and grease fittings until entire bearing is greased.						



9030-7



9030-8

FIGURE 6-8

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
<b>Turntable (Continued)</b>						
43	Turntable Lock Pin	Figure 6-9	G	Coat pin	500 hours or 6 months	Spray on
<b>Cab Tilt</b>						
50	Tilt Cylinder Pivot Pins	Figure 6-9	A	Until grease extrudes from entire bearing circumference	500 hours or 3 months	2 grease fittings
51	Pillow Block	Figure 6-9	A	Until grease extrudes from entire bearing circumference	500 hours or 3 months	4 grease fittings
<b>HVAC System</b>						
55	HVAC Filter	---	---	---	Replace HVAC filter yearly. If used in dirty conditions, check filter monthly or as needed and replace if necessary.	HVAC filter is located behind access panel on bottom side of cab.

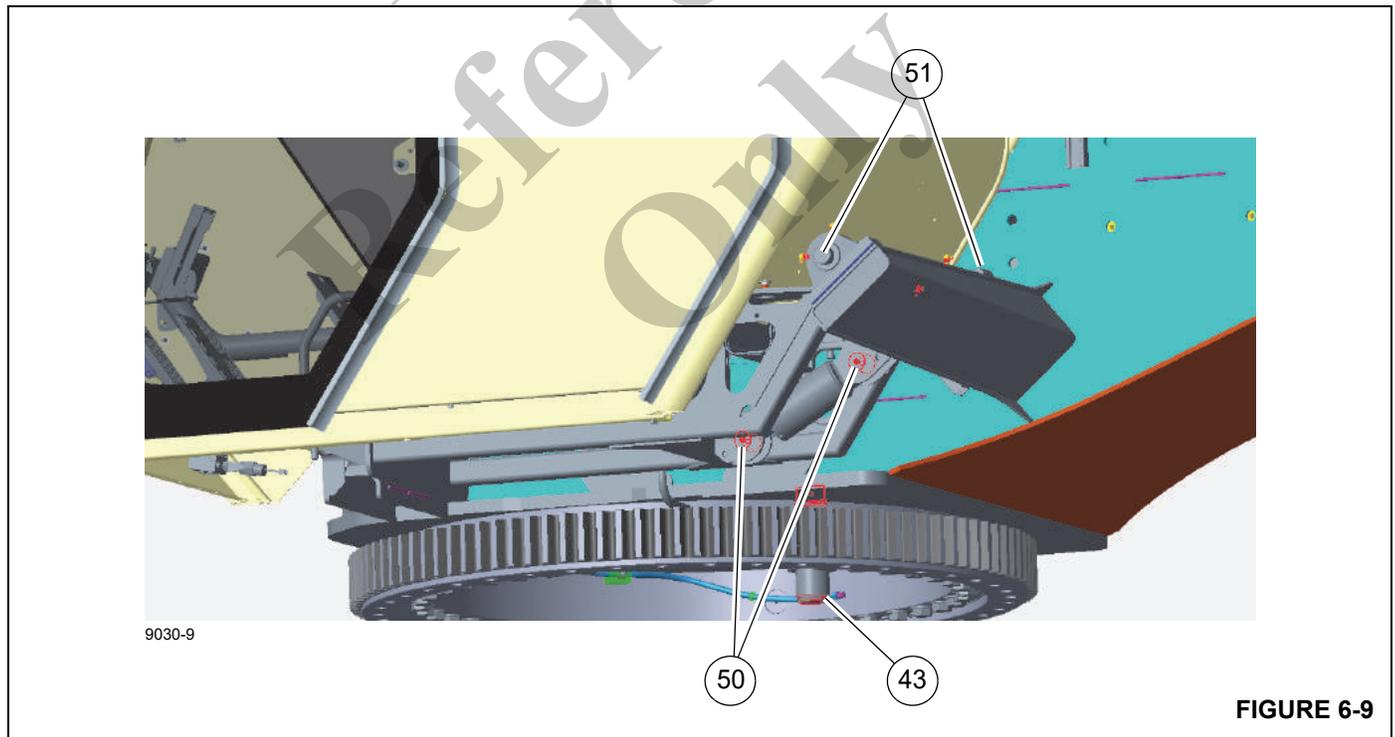
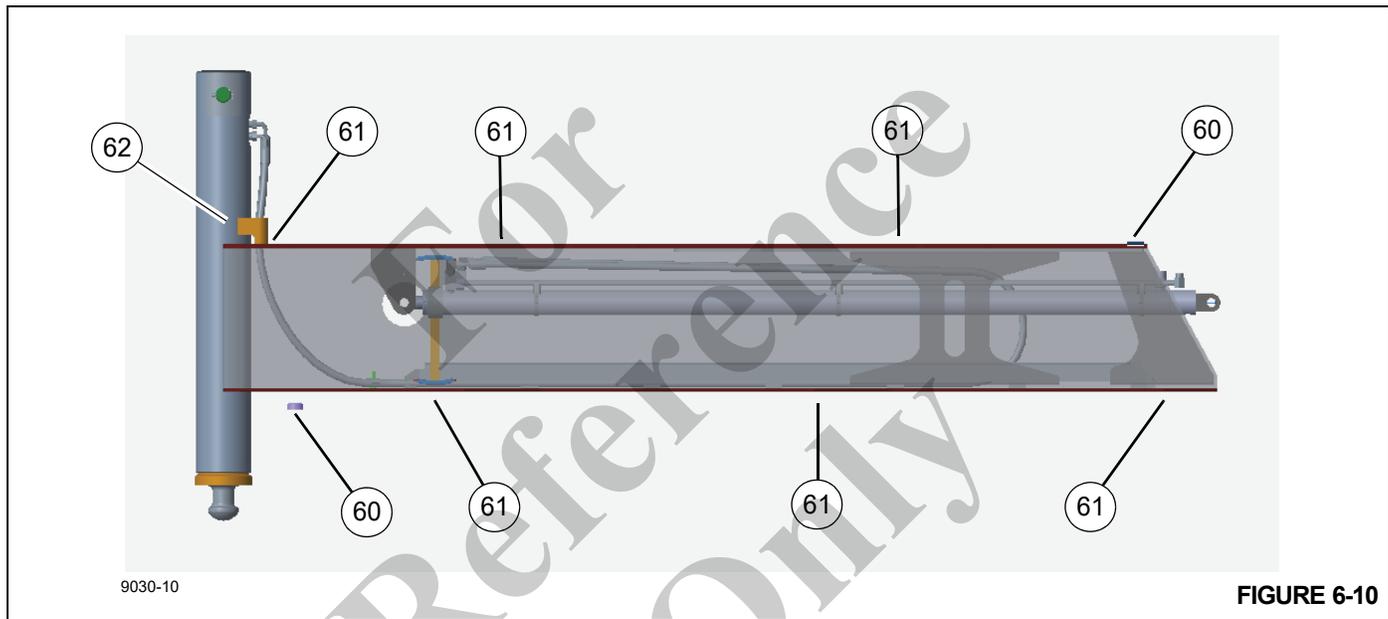


FIGURE 6-9

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
<b>Outriggers</b>						
60	Wear Pads	Figure 6-10	L	---	50 hours or 1 week	<ul style="list-style-type: none"> <li>• Brush on</li> <li>• 16 places</li> </ul>
61	Outrigger Beams	Figure 6-10	L	---	50 hours or 1 week	Brush on outrigger beam contact points
62	Jack Cylinder Support Tubes	Figure 6-10	L	---	Apply grease at tear-down.	4 places

**NOTE:** Brush lubricant on inside diameter of jack cylinder support tubes and wear bands before installing jack cylinders.



Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
<b>Boom</b>						
<p><b>NOTE:</b> Crane Setup: Machine shall be set up on firm level surface with fully extended outriggers and a 5579 kg (12,300 lb) counterweight installed. Ensure crane is level.</p> <ul style="list-style-type: none"> <li>• Boom must be directly over the front with house lock engaged.</li> <li>• Fully retract the boom and set boom angle to 0°. Remove the quick reeve pin on the boom nose, remove any reeved wire rope laying it off to the right side of the boom and place the rigging down on the ground in front of the crane. The boom should have no load on it.</li> <li>• At 0° boom angle, extend the boom to enable accessibility to the boom grease zerks. Do not exceed a boom length of 32.2 m (105.5 ft) for the GRT655 or a boom length of 29.5 m (96.8 ft) for the GRT655L. If stated boom length is exceeded, the RCL lockout function will activate.</li> <li>• After greasing is completed, fully retract the boom and then reinstall/reeve the rigging and wire rope that was temporarily removed.</li> </ul>						
80	Hook Block Swivel Bearing	Figure 6-11	A	Until grease extrudes	250 hours or 3 months	3 grease fittings
82	Overhaul Ball	Figure 6-11	A	Until grease extrudes	250 hours or 3 months	1 grease fitting

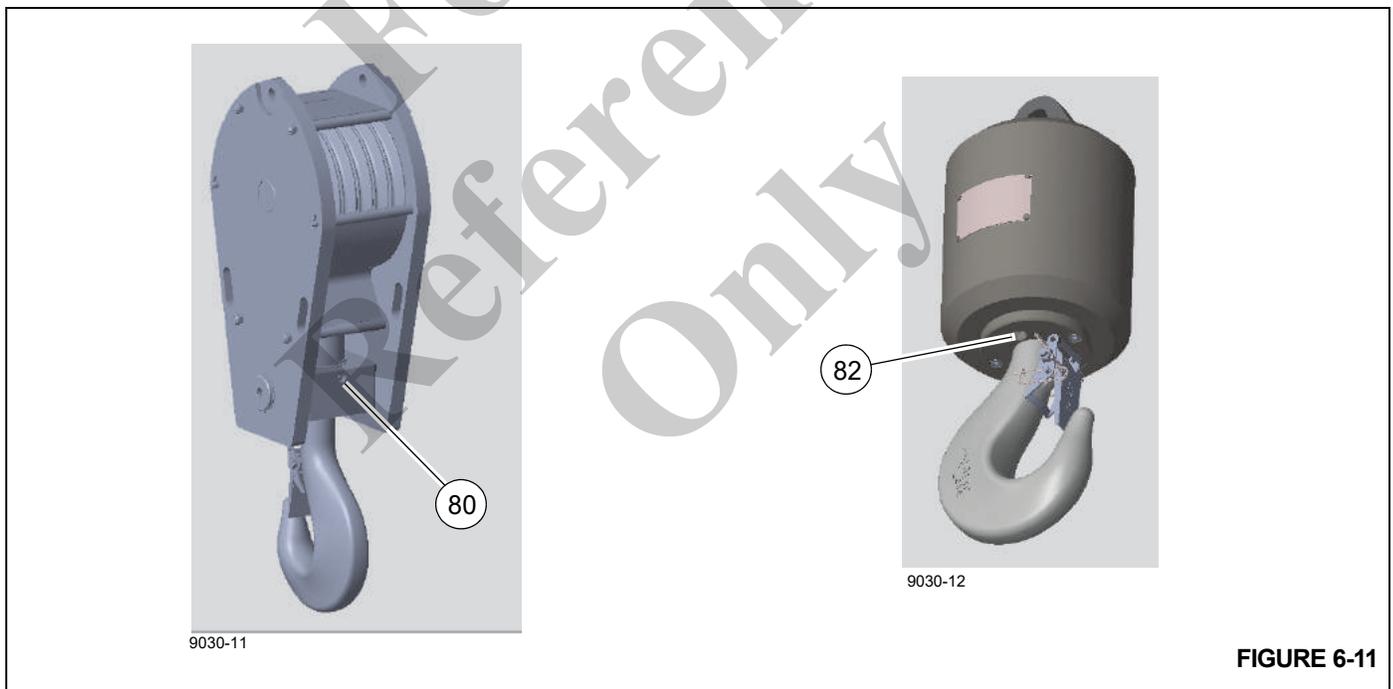
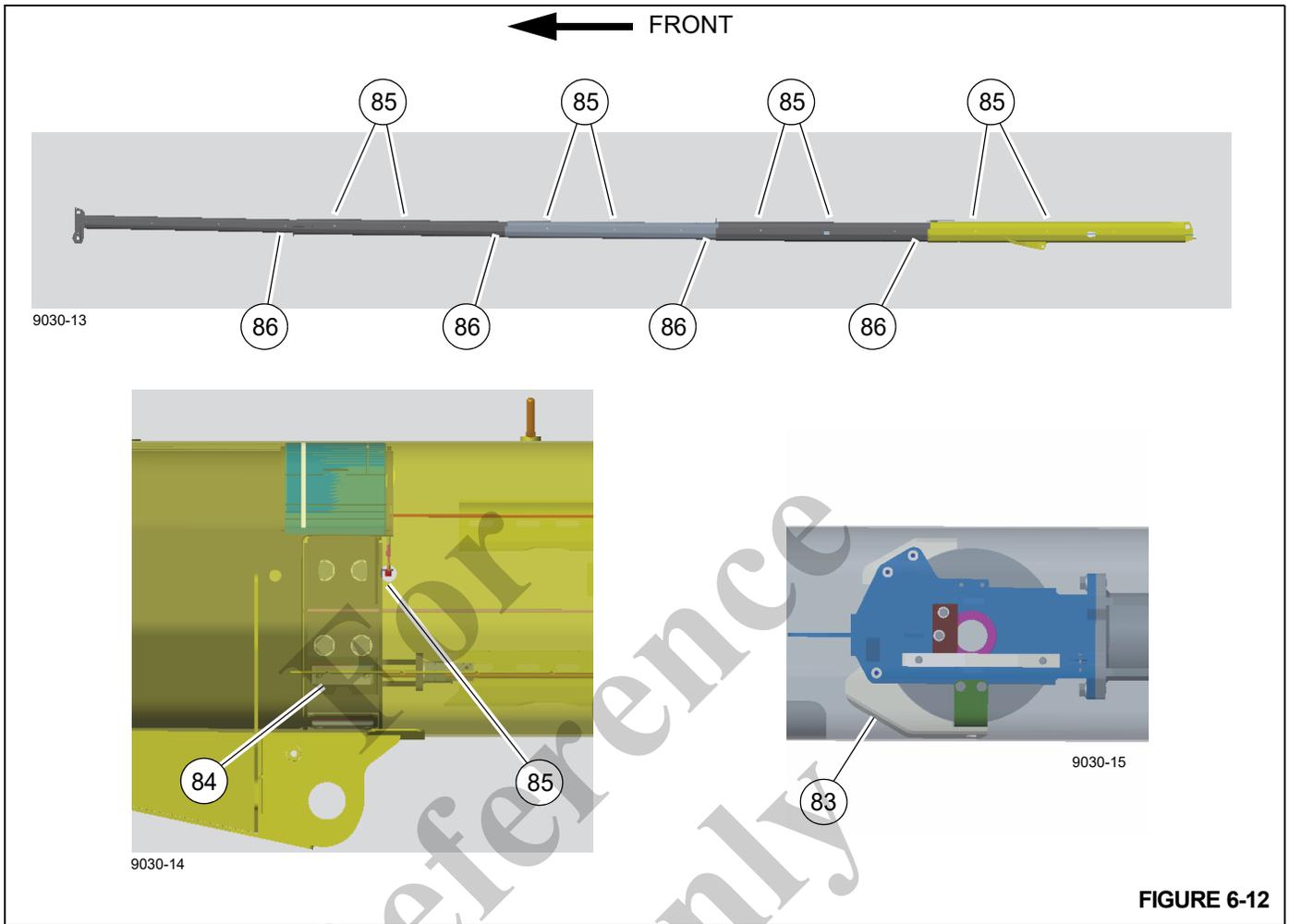
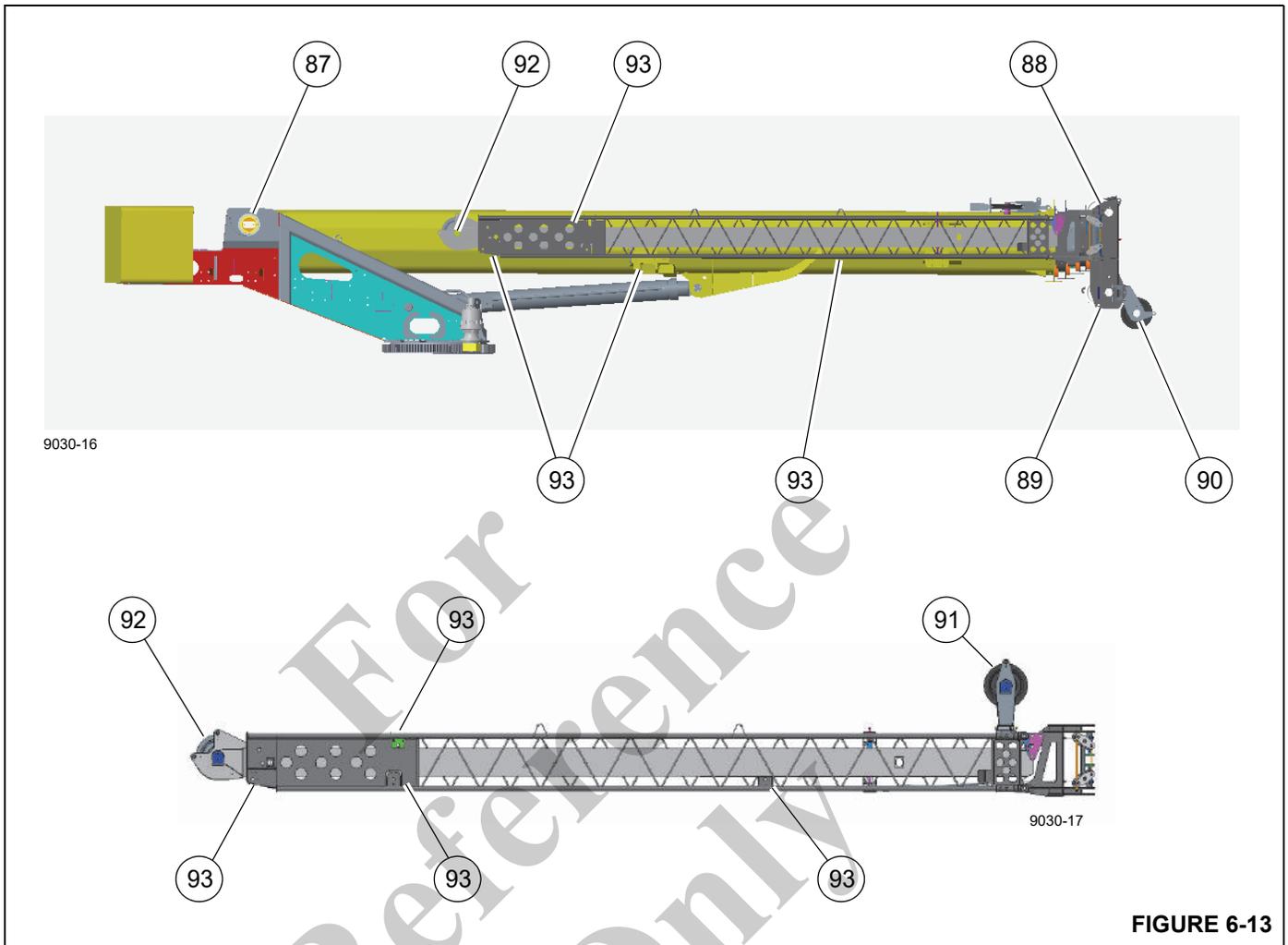


FIGURE 6-11

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
<b>Boom (Continued)</b>						
<p><b>NOTE:</b> Crane Setup: Machine shall be set up on firm level surface with fully extended outriggers and a 5579 kg (12,300 lb) counterweight installed. Ensure crane is level.</p> <ul style="list-style-type: none"> <li>• Boom must be directly over the front with house lock engaged.</li> <li>• Fully retract the boom and set boom angle to 0°. Remove the quick reeve pin on the boom nose, remove any reeved wire rope laying it off to the right side of the boom and place the rigging down on the ground in front of the crane. The boom should have no load on it.</li> <li>• At 0° boom angle, fully extend the boom to enable accessibility to the boom grease zerks. During boom extending, function the RCL bypass switch in order to enable the boom to proceed beyond the RCL limit to fully extended.</li> <li>• After greasing is completed, fully retract the boom and then reinstall/reeve the rigging and wire rope that was temporarily removed.</li> </ul>						
83	Telescope Cylinder Wear Pads	Figure 6-12	L	Thoroughly coat	Apply grease at tear-down.	<ul style="list-style-type: none"> <li>• 1 place on 4-section boom</li> <li>• 2 places on 5-section boom</li> </ul>
84	Internal Side and Bottom Wear Pads - Inner Sections	Figure 6-12	L	Thoroughly coat	Apply grease at tear-down.	<ul style="list-style-type: none"> <li>• Brush on</li> <li>• 12 places on 4-section boom</li> <li>• 16 places on 5-section boom</li> </ul>
85	Boom Section Rear Upper Wear Pads	Figure 6-12	L	---	50 hours or 1 week	<ul style="list-style-type: none"> <li>• 12 grease fittings on 4-section boom</li> <li>• 16 grease fittings on 5-section boom</li> <li>• See note below</li> </ul>
86	Boom Section Lower and Upper Wear Pads	Figure 6-12	L	Thoroughly coat all areas the wear pads move on	50 hours or 1 week	<ul style="list-style-type: none"> <li>• Brush on bottom, top, and side surfaces that wear pads move on</li> <li>• 12 places on 4-section boom</li> <li>• 9 places on 5-section boom</li> </ul>
<p><b>NOTE:</b> Lubricate items more frequently than interval in table if environmental conditions and/or operating conditions require.</p> <p><b>CAUTION:</b> Do not apply excessive pressure or force when greasing wear pads. This can cause grease fitting to separate from wear pad. Only apply grease until resistance is felt.</p>						



Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
<b>Boom (Continued)</b>						
<b>NOTE:</b> Crane Setup: Machine shall be set up on firm level surface with fully extended outriggers and 5579 kg (12,300 lb) counterweight installed. Ensure crane is level.						
<ul style="list-style-type: none"> <li>• Boom must be directly over the front with house lock engaged.</li> <li>• Fully retract the boom and set boom angle to 0°. Remove the quick reeve pin on the boom nose, remove any reeved wire rope laying it off to the right side of the boom and place the rigging down on the ground in front of the crane. The boom should have no load on it.</li> <li>• At 0° boom angle, fully extend the boom to enable accessibility to the boom grease zerks. During boom extending, function the RCL bypass switch in order to enable the boom to proceed beyond the RCL limit to fully extended.</li> <li>• After greasing is completed, fully retract the boom and then reinstall/reeve the rigging and wire rope that was temporarily removed.</li> </ul>						
87	Boom Pivot Shaft	Figure 6-13	L	---	<ul style="list-style-type: none"> <li>• 250 hours or 3 months</li> <li>• Apply grease at tear down</li> </ul>	2 grease fittings
88	Upper Boom Nose Sheave	Figure 6-13	A	Coat shaft and bushings	Apply grease at tear down.	
89	Lower Boom Nose Sheave	Figure 6-13	A	Coat shaft and bushings	Apply grease at tear down.	
90	Auxiliary Boom Nose Sheave	Figure 6-13	A	Until grease extrudes	<ul style="list-style-type: none"> <li>• 250 hours or 3 months</li> <li>• Apply grease at tear down</li> </ul>	1 grease fitting
91	Mast Sheave	Figure 6-13	A	Until grease extrudes	<ul style="list-style-type: none"> <li>• 500 hours or 12 months</li> <li>• Apply grease at tear down</li> </ul>	1 grease fitting
92	Boom Extension Sheaves	Figure 6-13	A	Until grease extrudes	<ul style="list-style-type: none"> <li>• 250 hours or 3 months</li> <li>• Apply grease at tear down</li> </ul>	1 grease fitting
93	Boom Extension Rollers	Figure 6-13	A	Until grease extrudes	<ul style="list-style-type: none"> <li>• 250 hours or 3 months</li> <li>• Apply grease at tear down</li> </ul>	4 grease fittings
<b>NOTE:</b> Lubricate items more frequently than interval in table if environmental conditions and/or operating conditions require.						



Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
<b>Hoist</b>						
100	Main Hoist	Figure 6-14	H	8.5 L (9.0 qt)	<ul style="list-style-type: none"> <li>• Check and fill every 50 hours or weekly</li> <li>• Drain and fill after first 300 hours, then every 1000 hours or 12 months thereafter</li> <li>• Check and clean breather needed</li> </ul>	Oil level must be visible in the sight glass.
101	Auxiliary Hoist	Figure 6-14	H	8.5 L (9.0 qt)	<ul style="list-style-type: none"> <li>• Check and fill every 50 hours or weekly</li> <li>• Drain and fill after first 300 hours, then every 1000 hours or 12 months thereafter</li> <li>• Check and clean breather as needed</li> </ul>	Oil level must be visible in the sight glass.
<p><b>NOTE:</b> Line up the Fill/Drain Plug with the top cutout hole (A). Verify hoist is level side to side. Place a level along the tie rod and confirm the bubble is centered. Let hoist sit idle for 20 minutes for an accurate reading. Oil should be visible in sight glass. Level of oil is acceptable if it is at least 1.6 mm (1/16 in) down from top or up 1.6 mm (1/16 in) from the bottom of the sight glass. Hoist and oil temperature should be in the 21°C ± 7°C (70°F ± 20°F) range. If oil temperature is outside this range, allow for a higher oil level reading if hotter or a lower oil level reading if colder. Oil escaping from vent plug is an indication the hoist may be overfilled. If hoist is over filled move the Fill/Drain Plug to the lower cutout hole (B) and drain until oil level falls within the sight glass.</p>						
102	Rope Follower (Arm)	Figure 6-14	G	Thoroughly coat	250 hours or 3 months	<ul style="list-style-type: none"> <li>• Spray on</li> <li>• 4 places per hoist</li> </ul>
103	Hoist Lower Limit Switch (Optional)	Figure 6-14	G	Thoroughly coat	250 hours or 3 months	<ul style="list-style-type: none"> <li>• Spray on</li> <li>• 1 place per hoist</li> </ul>
<p><b>NOTE:</b> Lubricate more frequently than interval indicated if environmental and/or operating conditions required.</p>						

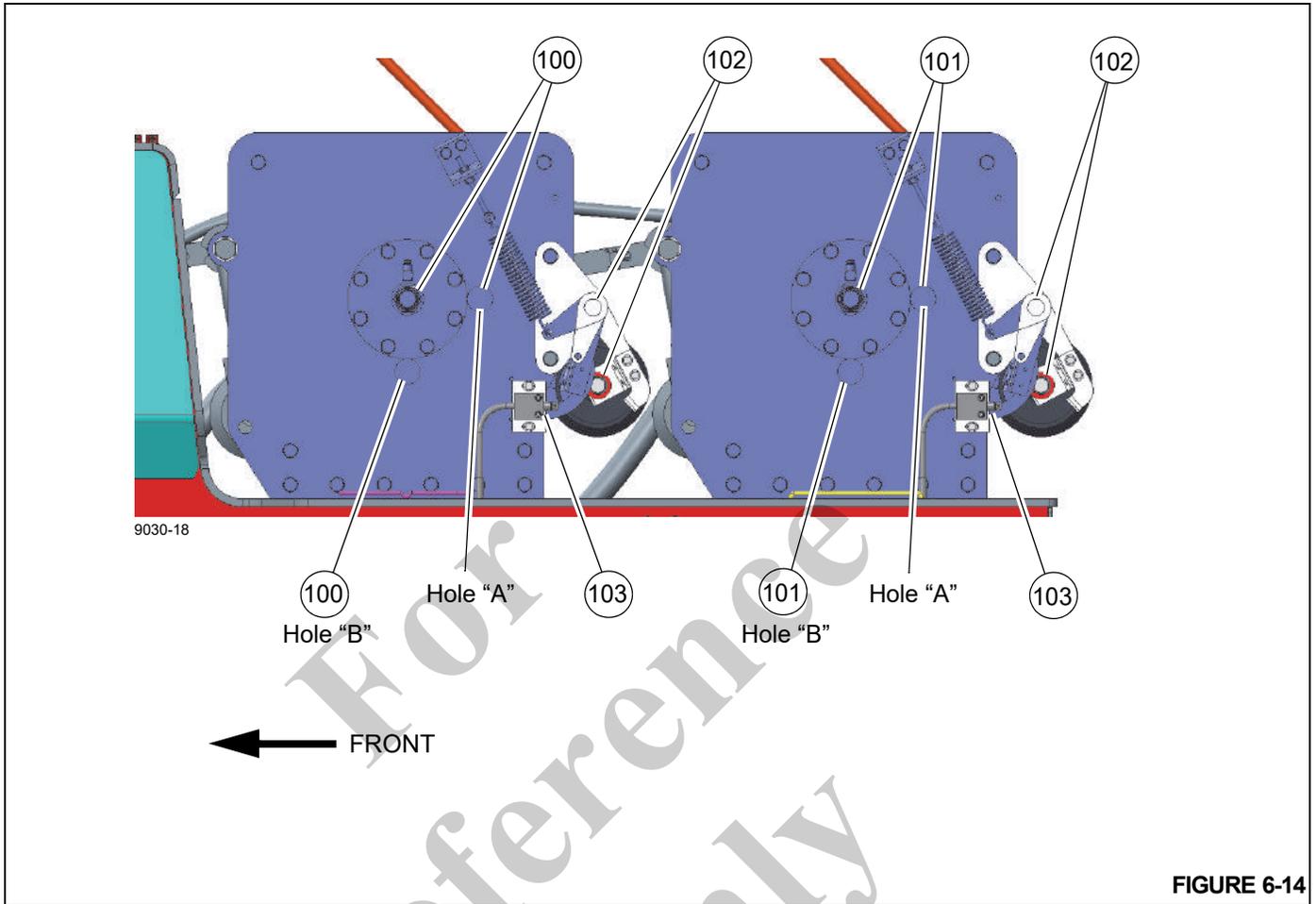


FIGURE 6-14

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
<b>Hydraulic</b>						
110	Hydraulic Tank (Tank Only)	Figure 6-15	J	469.7 L (124.1 gal)	Check fluid level every 10 hours or daily.	<ul style="list-style-type: none"> <li>Use sight gauge on side of tank, with boom fully lowered and all outrigger cylinders retracted.</li> <li>Drain and refill as necessary</li> </ul>
<b>NOTE:</b>						
<ul style="list-style-type: none"> <li>Environmental and other conditions can dramatically affect the condition of hydraulic oil and filters. Therefore, specific intervals for servicing/changing hydraulic oil, filters and hydraulic tank breathers cannot be set. However, it is imperative for the continued satisfactory performance of Grove cranes that inspections be performed on the basis of how and where each crane is used. Airborne and ingested contaminants can significantly reduce the life of oil and condition of hydraulic oil filters and tank breathers.</li> <li>Under normal operating conditions, it is recommended that hydraulic oil, filters and breathers be inspected and oils sampled at least every 3 to 6 months and more frequently for severe operating conditions. Inspections should be for airborne and/or ingested particles and water that deteriorate and contaminate the oil (e.g., oil appears "milky" or no longer has a transparent clear to amber color). The return filter by-pass indicator should be observed daily to determine if the contaminants content may be high. If indicator reaches red zone or indicates a by-pass condition, hydraulic oil must be sampled. The hydraulic tank breather should also be inspected to ensure it does not restrict air flow in and out of the reservoir.</li> <li>To inspect hydraulic oil, fill a small glass container with a sample of reservoir oil and another glass container with fresh oil. Let samples stand undisturbed for one to two hours, then compare the samples. If reservoir oil is heavily contaminated with water, the sample will appear "milky" with only a small layer of transparent oil on top. If the "milky" appearance was due to air foaming, it will dissipate and the oil should closely match the fresh oil. Should you have any questions, please contact your local authorized Grove distributor.</li> <li>Hydraulic oil shall meet or exceed ISO 4406 class 17/14 cleanliness level.</li> </ul>						
111	Hydraulic Filter	Figure 6-15	---	---	Change filter element when indicator is red. Replace breather when filter is replaced.	Oil must be at operating temperature.

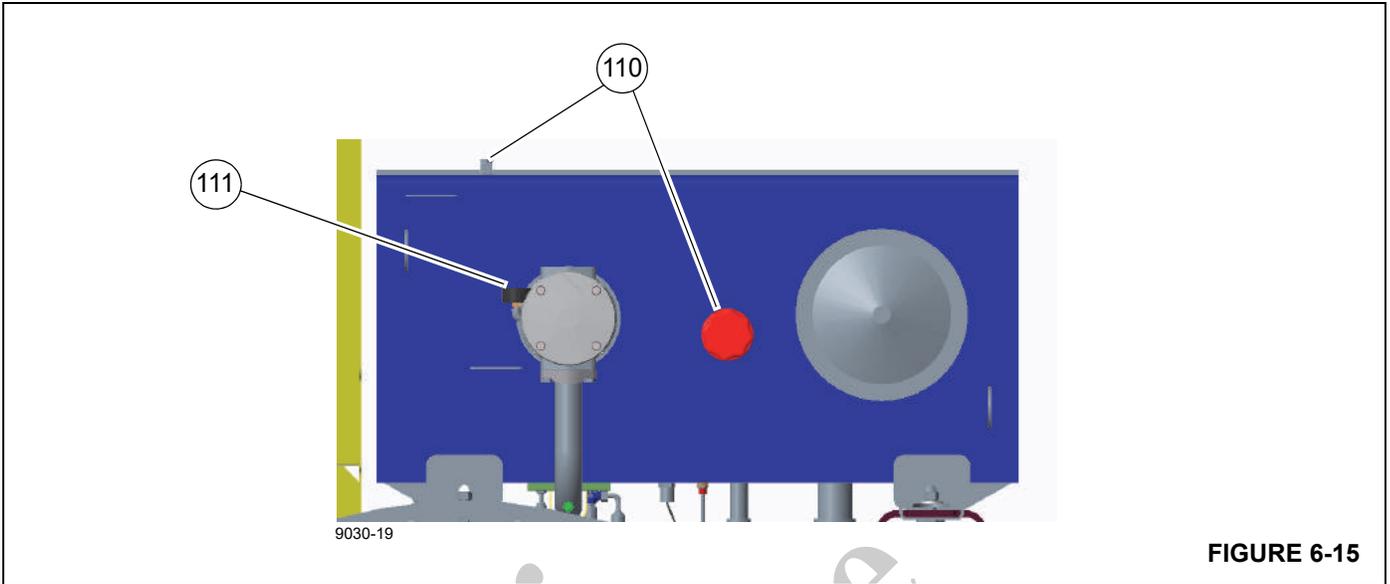


FIGURE 6-15

For Reference Only

## RUST PROTECTION

Grove cranes are manufactured to high quality standards, including the type of paint finish demanded by today's industry. In partnership with our paint supplier, we are also doing our part to help prevent premature corrosion of cranes.

Grove cranes are treated with Carwell<sup>®</sup> T32 (CP-90) rust inhibitor. While a rust inhibitor cannot guarantee that a machine will never rust, this product helps protect against corrosion on Grove cranes.

Carwell<sup>®</sup> is a treatment, not a coating. It contains no silicones, solvents, Chlorofluorocarbons (CFCs), or anything that would be classified as hazardous under OSHA Regulation 29CFR 1910.1200. The product is a liquid blend of petroleum derivatives, rust inhibitors, and water-repelling/water-displacing agents.

Special equipment is used to spray a light film on the entire undercarriage and various other areas of each new crane before shipment. When applied, the product has a red tint to allow applicators to view coverage. This red tint turns clear within approximately 24 hours after application.

Once applied, treatment can appear to leave a slightly "oily" residue on painted surfaces and until the red tinting fades, could be mistaken for a hydraulic oil leak. While the product is not harmful to painted surfaces, glass, plastic or rubber, it must be removed using standard steam-cleaning techniques.

This treatment works in various ways: (1) it eliminates the moisture containing salt, dirt and other pollutants by lifting and removing them from the metal surface; (2) the film creates a barrier to repel further moisture from coming in contact with the metal; and (3) it penetrates crevices.

In addition to the factory-applied treatment, Grove crane owners must provide proper maintenance and care to help ensure long-term protection of their crane against corrosion. This procedure provides information and guidelines to help maintain the paint finish on Grove cranes.

The most common causes of corrosion include the following:

- Road salts, chemicals, dirt, and moisture trapped in the hard-to-reach areas;
- Chipping or wear of paint, caused by minor incidents or moving components;
- Damage caused by personal abuse, such as using the decks to transport rigging gear, tools, or cribbing; and
- Exposure to harsh environmental hazards such as alkaline, acids, or other chemicals that can attack the crane's paint finish.

While crane surfaces that are easily seen have the biggest impact on appearance, particular attention should be given to the undercarriage to minimize harmful effects of corrosion.

Exercise special care and increase frequency of cleaning if crane is operated:

- on roads where large quantities of salt or calcium are applied to treat icy and snowy road surfaces;
- in areas that use dust control chemicals;
- anywhere there are increased levels of wetness - especially near salt water;
- during prolonged periods of exposure to damp conditions (e.g., moisture held in mud), where certain crane parts may become corroded even though other parts remain dry; or
- in high humidity, or when temperatures are just above the freezing point.

## Cleaning Procedures

To help protect against corrosion of cranes, Grove Crane recommends washing the crane at least monthly to remove all foreign matter. More frequent cleaning may be needed when operating in harsh environmental conditions. To clean the crane, follow these guidelines:

- High pressure water or steam is effective for cleaning the crane's undercarriage and wheel housings. Keeping these areas clean will not only help retard the effects of corrosion, but also improve the ability to identify potential issues before they grow into larger problems.

### CAUTION

High pressure water can be forced into spaces and infiltrate beyond seals. Avoid pressure washing near electrical controls, panels, wiring, sensors, hydraulic hoses and fittings, or anything that can be damaged by high pressure cleaning/spraying.

- Rinse dirt and dust off before washing the crane. Dirt can scratch the crane's finish during washing/cleaning.
- Hard to clean spots caused by road tar or bugs should be treated and cleaned after rinsing and before washing. Do not use solvents or gasoline.
- Wash using only soaps and detergents recommended for automotive paint finishes.
- Rinse all surfaces thoroughly to prevent streaking caused by soap residue.
- Allow crane to dry thoroughly. You can accelerate drying by using compressed air to remove excess water.

**NOTE:** Polishing and waxing (using automotive-type wax) is recommended to maintain original paint finish.

## Inspection and Repair

- Immediately following cleaning, Grove Crane recommends an inspection to detect areas that may have become damaged by stone chips or minor mishaps. A minor scratch (one that has not penetrated to the substrate surface) can be buffed with an automotive-type scratch remover. It is recommended that a good coat of automotive wax be applied to this area afterwards.
- Any area scratched through to bare metal should be touched up and repaired as soon as possible to prevent flash rusting. To repair a major scratch (down to bare metal) or minor damage, follow these procedures:

**NOTE:** Grove Crane recommends a qualified body repair technician prepare, prime, and paint any major scratch(es) or minor damage.



### CAUTION

To the extent any damage is structural in nature, Manitowoc Crane Care must be contacted and consulted as to what repairs may be required.

For scratches and marks in highly visible areas:

1. Sand to remove scratch. Feather outward from the mark to blend repair into the original surface. Apply body putty as necessary to hide the defect; then sand smooth.
2. Cover all bare metal with a primer compatible with the original paint finish and allow to dry thoroughly.
3. Prepare surface before applying finish coat of paint.
4. Apply a finish coat using accepted blending techniques. Use of original paint colors is recommended to ensure the best color match possible.

For scratches and marks in areas of low visibility:

- Consider touching up the spots with a brush technique to cover the bare metal. This will retard effects of corrosion and enable you to do the repair later during a normal maintenance interval.

Spots should be touched up with quality paint. Primers tend to be porous; using a single coat of primer only will allow air and water to penetrate the repair over time.

## Application

Depending on the environment in which a crane is used and/or stored, initial factory application of Carwell® T32 (CP-90) should help inhibit corrosion approximately 12 months.

It is recommended the treatment be periodically reapplied by the crane owner after that time to help continue to protect against corrosion of the crane and its components.

However, if a crane is used and/or stored in harsh environments (such as islands, coastal regions, industrial areas, areas where winter road salt is regularly used, etc.), reapplication of treatment is recommended sooner than 12 months, e.g., repeat treatment in 6-9 months.

- Do not apply to recently primed and painted areas for at least 48 hours after paint is properly dried and cured. For minor touch up areas a 24 hour period is needed for cure time before applying treatment.

**NOTE:** Unit must be completely dry before applying treatment.

- Do not allow product to puddle or build-up on weather stripping, rubber gaskets, etc. Unit should not have puddles or runs evident anywhere.
- To ensure proper coverage, product needs to be fogged on the unit.
- Use of pressure pots to apply treatment is recommended.
- Carwell® treatment is available in 16 ounce spray bottles from Manitowoc Crane Care (order part number 8898904099).
- After treatment application is complete, wash or clean film residue from lights, windshield, grab handles, ladders/steps and all access areas to crane, as necessary.

Contact Manitowoc Crane Care should you have any questions.

## Areas of Application

Refer to (Figure 6-16) and (Figure 6-17).

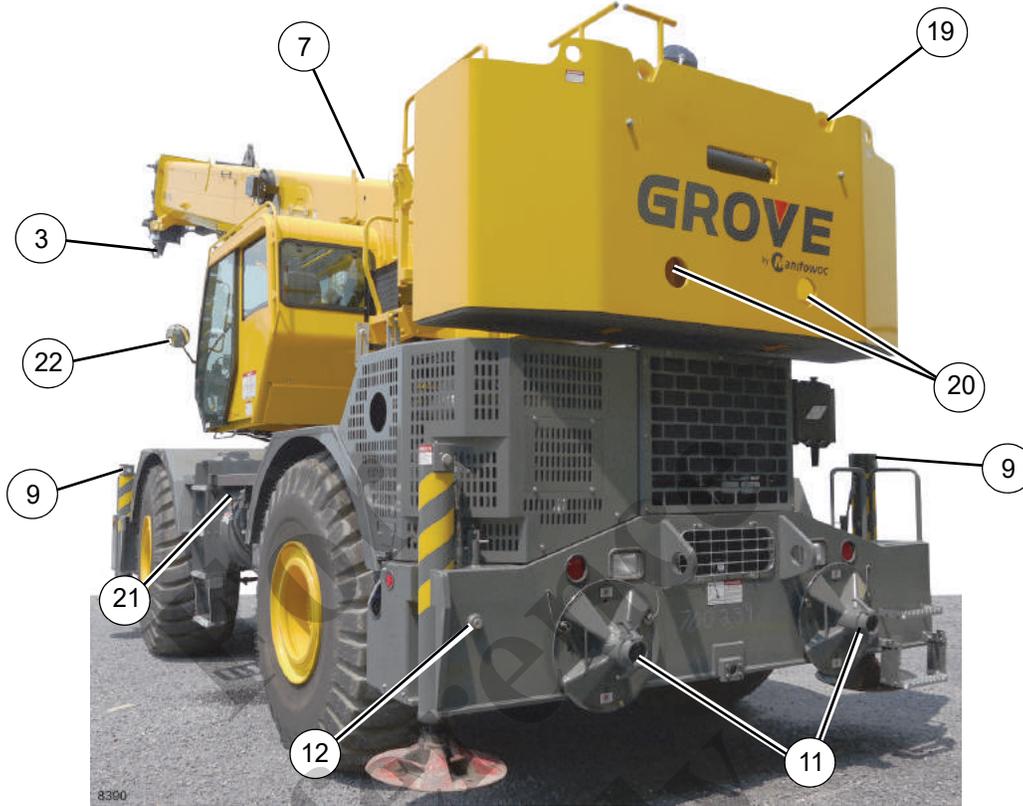
- Underside of unit will have full coverage of the rust inhibitor. These are the only areas that a full coat of rust inhibitor is acceptable on painted surfaces. Areas include; Valves, hose end and fittings, Swivel, pumps, axles, drive lines, transmission, slew ring fasteners and all interior surfaces of the frame.
- Frame application areas are; hose ends and fittings, all unpainted fasteners and hardware, all bare metal surfaces, outrigger pads, and back up alarm hardware.
- Superstructure applications are; hose end and fittings, wire rope on hoist roller tensioning springs on hoists, all unpainted fasteners and hardware, valves, slew ring fasteners and all bare metal surfaces.
- Boom applications areas are; pivot pins, hose end and fittings, jib pins and shafts, all bare metal surfaces, overhaul ball pins/ hook block pins and fasteners.
- All hardware, clips, pins, hose connections not painted will have treatment applied.



7650-75

Picture may not be same model as your machine, it is for reference only.

Figure 6-16



Picture may not be same model as your machine, it is for reference only.

Figure 6-17

TABLE 6-1. Rust Inhibitor Application Locations

1	Pivot Shaft	12	O/R Beam Wear Pad Adjustment Hardware
2	Boom Extension Pins, Clips	13	Entire underside of unit
3	Boom Nose Pins, Clips	14	Powertrain Hardware Inside Compartment
4	Hook Block/Overhaul Ball	15	Valve Bank
5	Boom Extension Hanger Hardware	16	Hoist Hose Connections
6	Hose Connections inside turntable	17	Tension Spring
7	All Hardware, Clips, Pins, Hose Connections not painted O/R Pins, Clips	18	Wire Rope
8	Turntable Bearing Fasteners	19	Counterweight Mounting Hardware
9	O/R Hose Connections	20	Counterweight Pins
10	Hook Block Tiedown Cable	21	Hose Connections
11	O/R Pins, Clips	22	Mirror Mounting Hardware

*For  
Reference  
Only*

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