

# Grove GRT8100

## Operator Manual



8848-1



## **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 -

## GRT8100

Crane Model Number

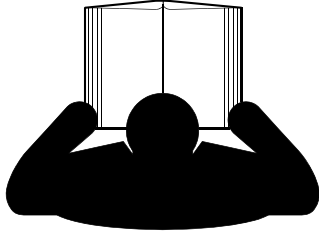
This Manual is divided into the following sections:

<b>SECTION 1</b>	<b>INTRODUCTION</b>
<b>SECTION 2</b>	<b>SAFETY INFORMATION</b>
<b>SECTION 3</b>	<b>OPERATING CONTROLS AND PROCEDURES</b>
<b>SECTION 4</b>	<b>SET-UP AND INSTALLATION</b>
<b>SECTION 5</b>	<b>MAINTENANCE AND LUBRICATION</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 style="text-align: center;">! DANGER</h2> <p><b>An untrained operator subjects himself and others to death or serious injury. Do not operate this crane unless:</b></p> <ul style="list-style-type: none"><li>• You are trained in the safe operation of this crane. Grove is not responsible for qualifying personnel.</li><li>• You read, understand, and follow safety and operating recommendations contained in the crane manufacturer's manuals and load charts, your employer's work rules, and applicable government regulations.</li><li>• You are sure all safety signs, guards, and other safety features are in place and in proper condition.</li><li>• Operator Manual and Load Chart are in the holder provided on crane.</li></ul>
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## SECTION 1 INTRODUCTION

### SECTION CONTENTS

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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 GRT8100 Grove Crane.

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

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

The superstructure is capable of 360° rotation in either direction. All crane functions are controlled from the fully-enclosed cab mounted on the superstructure. The crane is equipped with a five-section, full power, sequenced and synchronized boom. Additional reach is obtained by utilizing an optional swingaway boom extension. Lifting is provided by a main hoist and an 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 2000/14/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.

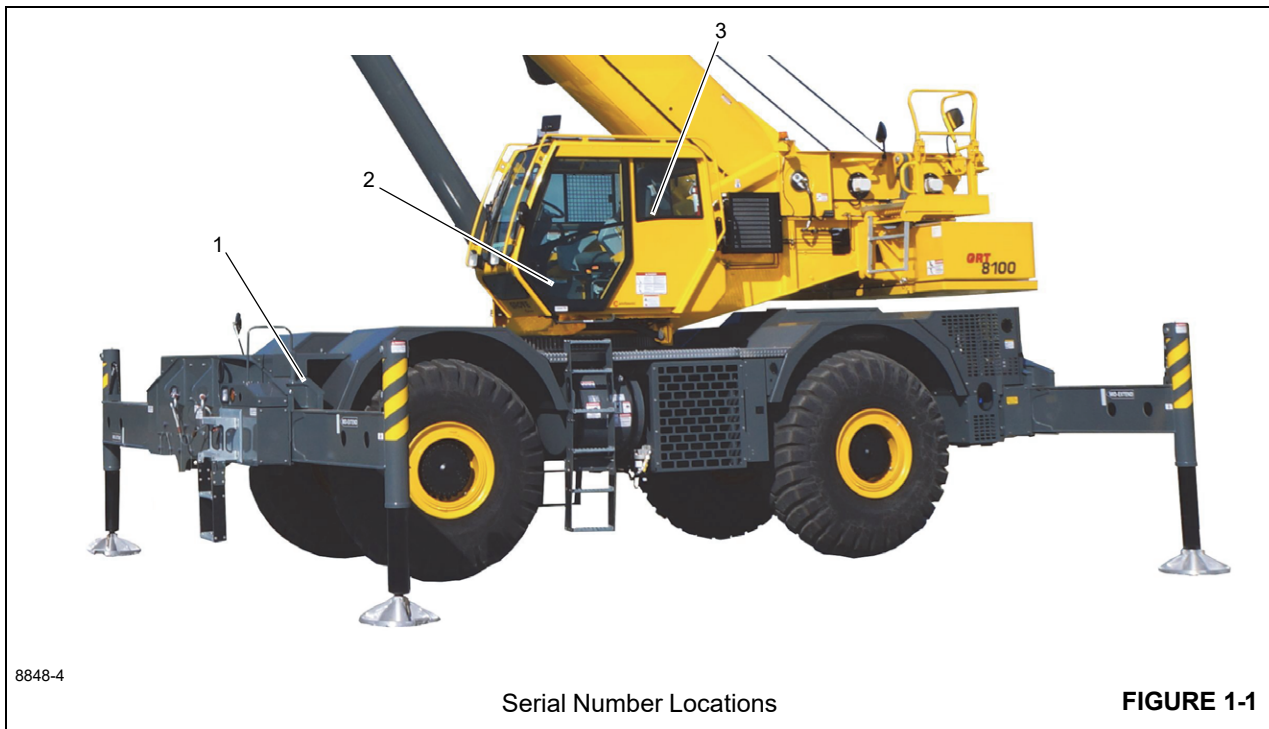
### SERIAL NUMBER LOCATION

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.



## LIST OF SPECIFICATIONS

### General

Model	GRT8100
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 with 29.5 x 25 tires.

Wheelbase	4215 mm (166 in)
Overall Crane Length	15,070 mm (593 in)
Overall Crane Width	3335 mm (131 in)
Overall Crane Height	3746 mm (147 in)
Outside Turning Radius	
2 Wheel Steer	12.5 m (41 ft-0 in)
4 Wheel Steer	7.3 m (23 ft-11 in)
Outside Curb Clearance	
2 Wheel Steer	12.9 m (42 ft-4 in)
4 Wheel Steer	7.7 m (25 ft-3 in)
Outrigger Spread	
Retracted	3150 mm (124 in)
Mid Extend	5233 mm (206 in)
Fully Extended	7316 mm (288 in)

### Capacities

Fuel Tank (total)	312 L (82 gal)
Coolant System	See Engine Specifications
Engine Lubrication System	See Engine Specifications
Hydraulic Tank (Reservoir Capacity)	
Total	1029.4 L (272 gal)
Full Level	926.5 L (245 gal)
Hoists	4.7 L (9.9 pt)
Swing Gearbox	5.4 L (11.4 pt)
Axle Planetary Hubs	6.5 L (14 pt)
Axle Differentials	24.6 L (51.9 pt)
Transmission (includes Torque Converter)	
	37.9 L (40 qt)
Diesel Exhaust Fluid (DEF) Tank	19 L (5 gal)

### Torque Converter

Stall Ratio	1.82:1
Charge Pump Capacity	106 L/min (28 gpm)
	@ 2000 rpm

### Transmission

Gear Ratios	
Forward and Reverse	
Low Range	
1st	12.59
2nd	6.06
3rd	2.22
High Range	
4th	4.33
5th	2.08
6th	0.76

### Engine

#### Cummins QSB 6.7 - Tier 4F

Type	4-cycle, Diesel, Turbocharged
Number of Cylinders	6
Horse Power Rating	205 kW (275 hp) @ 2500 rpm
Crank Case Capacity	20 L (21.1 qt)
Cooling System Capacity	52.7 L (55.7 qt)
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	205 kW (275 hp) @ 2500 rpm
Crank Case Capacity	20 L (21.1 qt)
Cooling System Capacity	52.7 L (55.7 qt)
Fuel	Maximum 5,000 ppm Sulfur Diesel

### Axles

Total Ratio	25.35:1
Carrier Ratio	4.875:1
Planetary Ratio	5.20:1

### Brakes

Type	4-Wheel Hydraulic Disc
------	------------------------

### Wheels and Tires

Lugs	24
Torque	407 to 475 Nm (300 to 350 lb-ft)
Tire Size	
Standard	29.5 x 25, 34 ply rating

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

### Swing Gearbox

Reduction Ratio	33.6:1
Output Torque	8160 Nm (72,222 lb-in)

### Boom

Length	11.8 to 46.9 m (39 to 154 ft)
Power	5 Tele Section, Full Power
Elevation	-3 to +80 degrees
Extensions (Optional)	
Manual Bi-Fold	10 to 17 m (33 to 56 ft)
Offset 0°, 20°, or 40°	
Hydraulic Bi-Fold	10 to 17 m (33 to 56 ft)
Offset 0° - 40°	
Lattice Insert	6.0 m (20 ft)
	(Installs between boom nose and extension)

### Swivel Assembly

Electrical	20 Slip Rings
Hydraulic	12 ports
Water	2 ports

**Hydraulic Pumps**

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

**Pump #1**

Type ..... Piston  
 Sections ..... 1  
 Output - @ loaded engine speed  
 Section 1 ..... 204.4 L/min (54 gpm)

**Pump #2**

Type ..... Piston  
 Sections ..... 1  
 Output - @ loaded engine speed  
 Section 1 ..... 204.4 L/min (54 gpm)

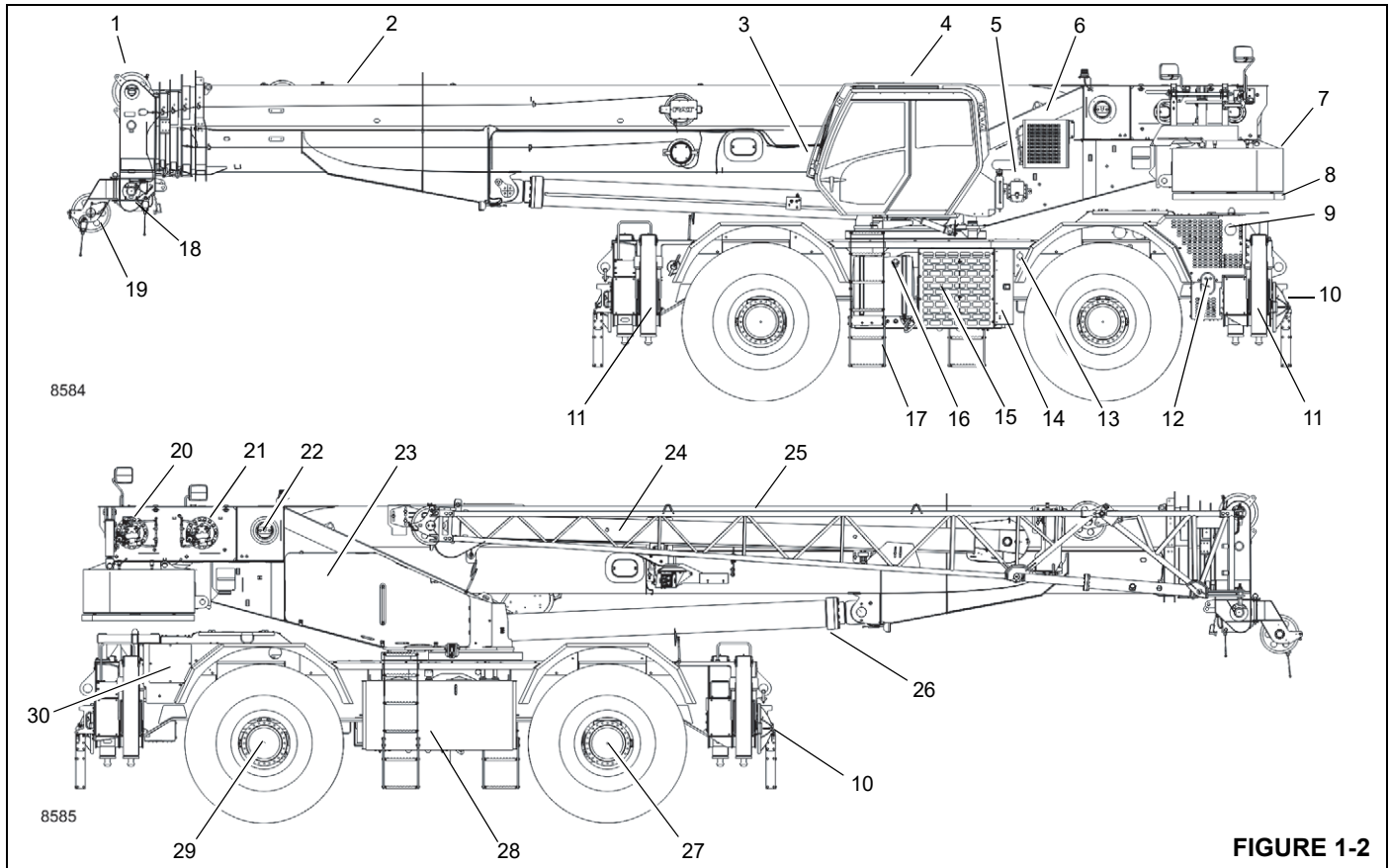
**Pump #3**

Type ..... Gear  
 Sections ..... 1  
 Output - @ loaded engine speed  
 Section 1 ..... 86.7 L/min (22.9 gpm)

**Hoists**

Drum Dimensions  
 Diameter ..... 471 mm (18.5 in)  
 Length (Standard) ..... 559 mm (22.0 in)  
 Cable, Steel  
 Diameter ..... 19 mm (0.75 in)  
 Length ..... 215 m (705 ft)  
 Max. Permissible Line Pull (35x7)  
 ..... 7765 kg (17,120 lb)  
 Max. Single Line Speed ..... 148 m/min (487 fpm)  
 Motor Displacement  
 High ..... 85 cc (5.19 cu-in)  
 Low ..... 48 cc (2.93 cu-in)

**Crane Nomenclature**



**FIGURE 1-2**

Item	Description	Item	Description
1	Boom Nose Sheaves	16	Fuel Tank
2	Boom	17	Crane Steps
3	Work Lights	18	Hydraulic Valves and Swing Motor Cover
4	Tilt Cab	19	Auxiliary Boom Nose

Item	Description	Item	Description
5	Windshield Washer Fluid Container	20	Auxiliary Hoist
6	Air Conditioning Condenser	21	Main Hoist
7	Counterweight	22	Boom Pivot Pin
8	Optional Pinned Slab	23	Hydraulic Valves and Swing Motor Cover
9	Muffler	24	Boom Extension
10	Outrigger Floats	25	Swingaway Extension
11	Outrigger Jack Cylinder	26	Lift Cylinder
12	Diesel Exhaust Fluid (DEF) Tank (Tier 4 only)	27	Front Axle
13	Battery Disconnect Switch	28	Hydraulic Fluid Tank
14	Battery and CANbus Compartment	29	Rear Axle
15	Hydraulic Oil Cooler	30	Air Intake Cleaner
*Tier 4 engines use Ultra Low Sulfur Fuel (Max 15 ppm) and Diesel Exhaust Fluid (DEF).			

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## SECTION 2

### SAFETY INFORMATION

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## SAFETY MESSAGES

### General

The importance of safe operation jib 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

**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.

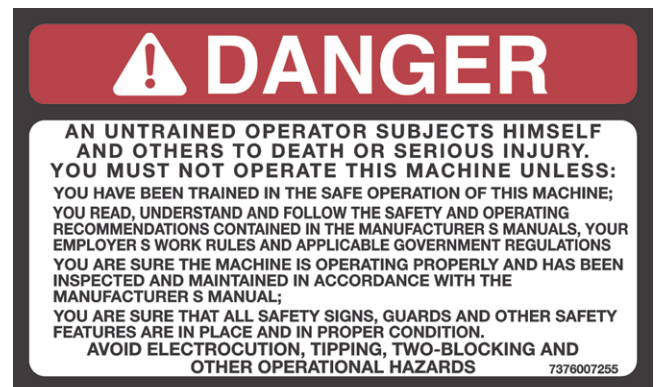
**OPERATOR QUALIFICATIONS**

**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.



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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.

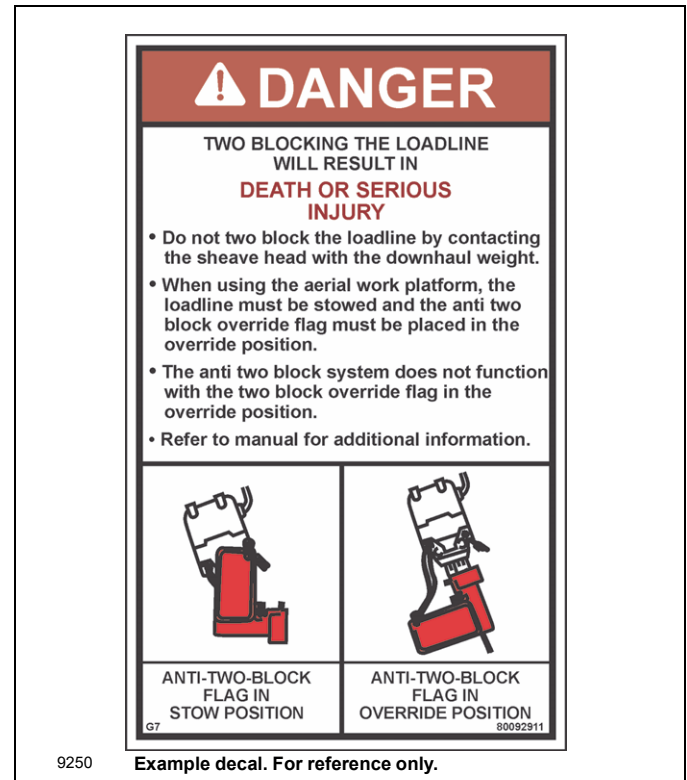
Two-blocking occurs when the load block (hook block, overhaul ball, rigging, etc.) comes into physical contact with the boom (boom nose, sheaves, boom extension, etc.). Two-blocking can cause hoist rope (wire rope or synthetic rope), rigging, reeving, and other components to become highly stressed and 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.



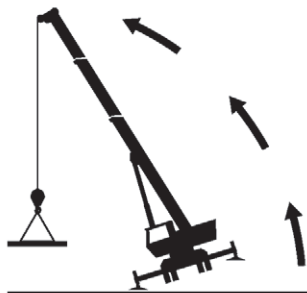
Example decal. For reference only.

### 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



## TIPPING HAZARD

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.

This crane should have a functional load moment indicator and control lock-out system. Test daily for proper operation.

POSITION CRANE ON FIRM SURFACE. EXTEND OUTRIGGERS AND LEVEL CRANE.

## TO AVOID DEATH OR SERIOUS INJURY:

**NEVER** handle personnel with this machine unless the requirements of the applicable national, state and local regulations and safety codes are met.

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

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

**NEVER** get on or off a moving crane.

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



## TWO-BLOCKING HAZARD

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

This crane should have a functional anti-two-block and control lock-out system. Test daily for proper operation.

DO NOT PASS LOADS OR BOOM OVER GROUND PERSONNEL.

**ELECTRONIC EQUIPMENT** on this crane is intended as an aid to the operator.

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

Do not remove any decal, the load chart, or the Operator's and Safety Handbook from this crane.

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FOLLOW INSTRUCTIONS IN OPERATOR'S AND SAFETY HANDBOOK.

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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 **Ap** and by the wind drag coefficient **Cd**: 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.



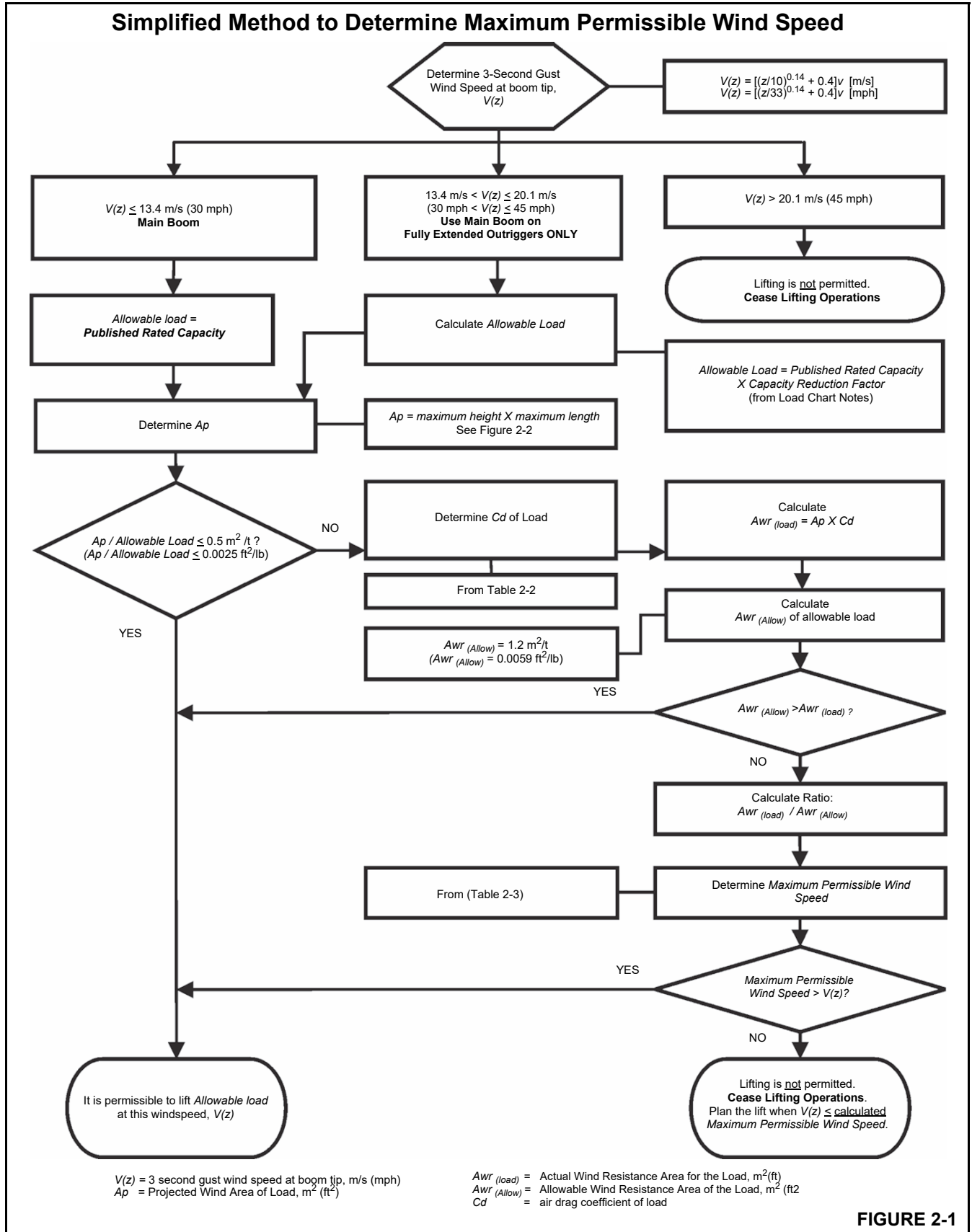


FIGURE 2-1

**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  $Z = 30 \text{ m (100 ft)}$

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  $\leq 13.4 \text{ m/s (30 mph)}$ , 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 2-3).

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

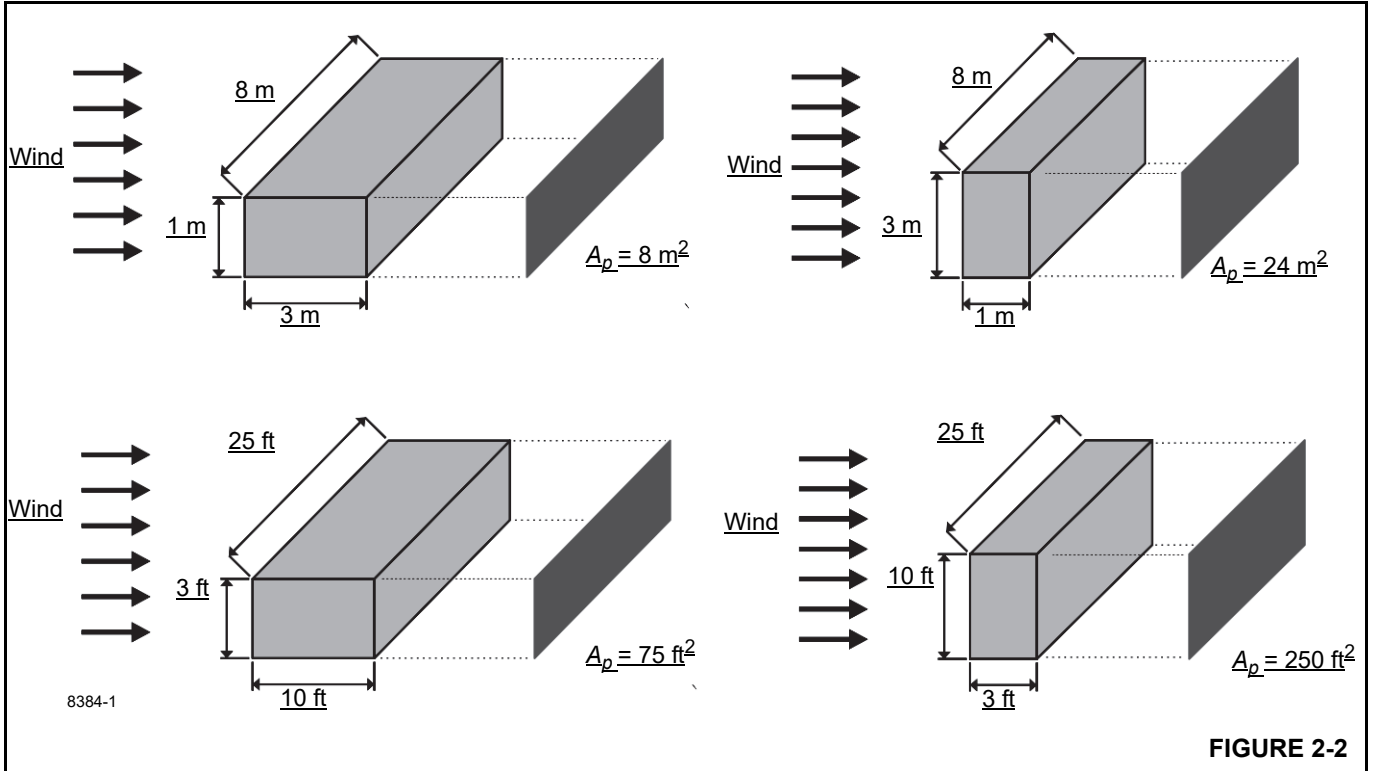
$$Awr_{(allow)} = 0.0012 \times m_{(load)} \quad (2.4)$$

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 ( $A_p$ ):



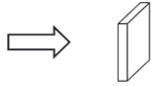
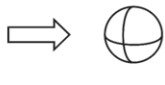
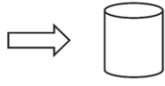
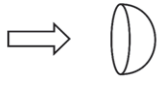
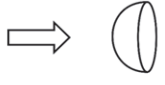


**Determining Wind Drag Coefficient ( $C_d$ )**

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	Turbine Blade or Complete Rotor
	Approximately 1.6	

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**Maximum Permissible Wind Speed**

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

Table 2-3  $Awr$  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)	15,145 (64)	13,725 (67.5)	12,700 (70.5)	11,400 (72.5)
12			14,025 (35)	12,575 (45.5)	12,575 (53.5)	11,600 (59)	11,600 (63)	10,725 (66.5)	10,050 (69)
14				9,000 (35)	9,360 (36)	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 (27)	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,  $Awr_{(allow)} = 0.0012 \times \text{calculated reduced capacity in kg}$ .  
 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  $\leq 20.1$  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  $\leq$  12,040 kg YES
- Is  $Awr_{(load)}$  less than  $Awr_{(allow)}$ ?  
19.83 m<sup>2</sup>  $\leq$  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:

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

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.



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 (36.5)	56,600 (45)	56,350 (56)	53,650 (63)	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)	33,550 (66)	26,400 (69)	24,700 (71.5)
40			25,800 (28)	26,150 (44.5)	26,300 (52.5)	27,300 (53.5)	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				17,550 (35)	17,400 (41)	18,250 (49.5)	19,100 (55)	18,550 (59.5)	17,350 (62.5)
55					14,300 (33.5)	15,150 (44)	16,000 (51)	16,400 (56)	15,600 (60)
60					11,050 (23.5)	12,700 (38.5)	13,550 (46.5)	13,950 (52.5)	14,100 (56.5)
65						11,000 (31.5)	11,550 (41.5)	11,950 (48.5)	12,300 (53.5)
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, **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 2-21 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.**



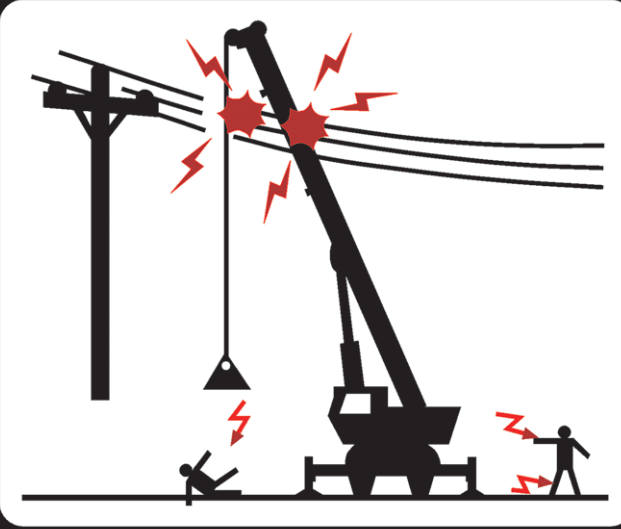
**DANGER**

#### 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.

**THIS CRANE IS NOT INSULATED.**

7937 80037260

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.



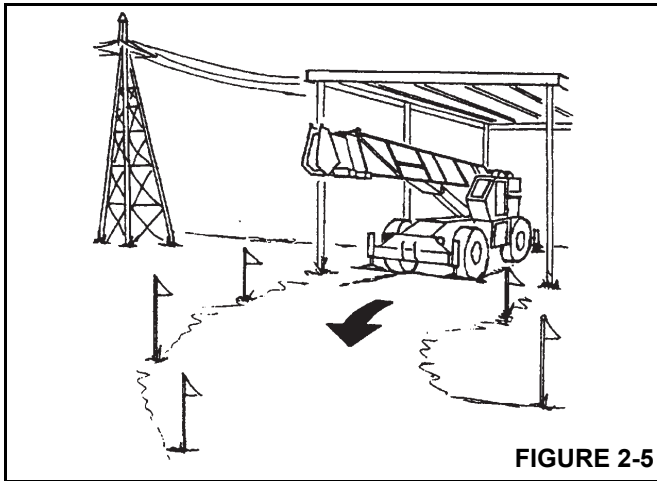


FIGURE 2-5

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 dealer 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

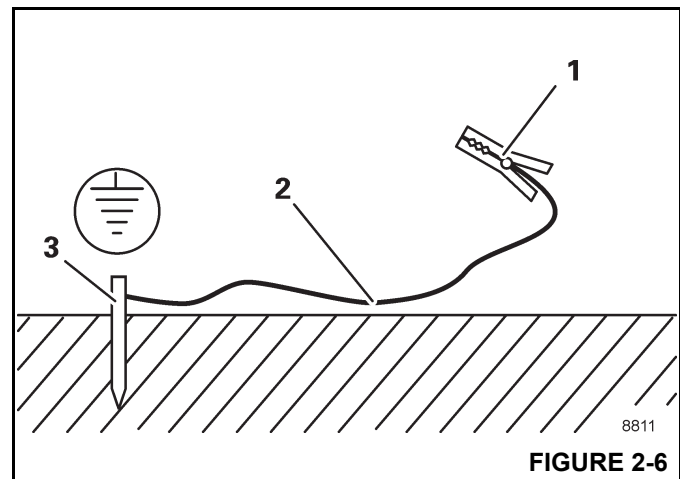
##### Risk of accidents due to electric shock!

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.



#### 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*.

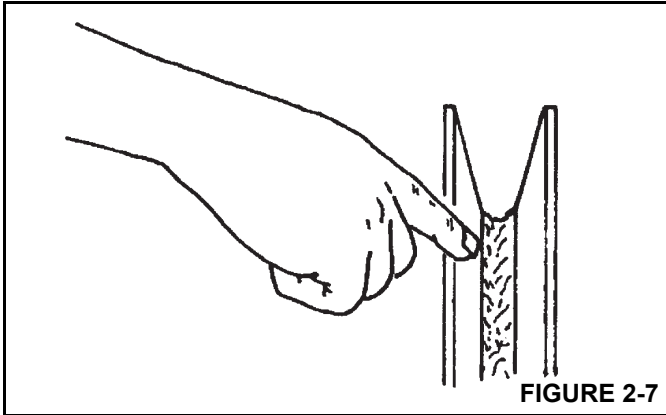
- ***When a rope has been removed from service because it is no longer suitable for use, it must not be reused on another application.***

#### 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**

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

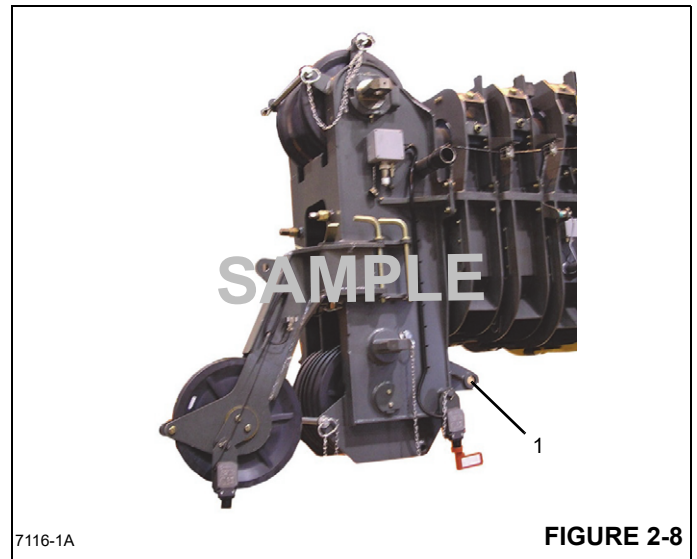
Before transporting the crane, check the suitability of the proposed route with regard to the crane height, width, length, and weight.

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.



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.

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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.

## 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.

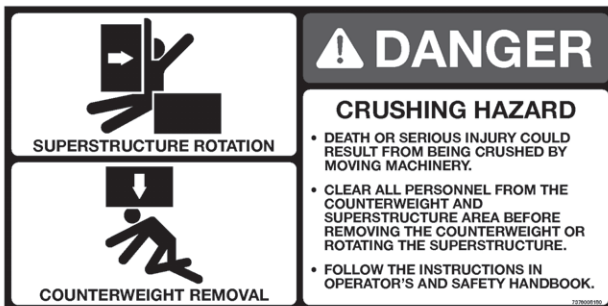
Carbon monoxide fumes from the engine exhaust can cause suffocation in an enclosed area. Good ventilation is very important when operating the crane.

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.

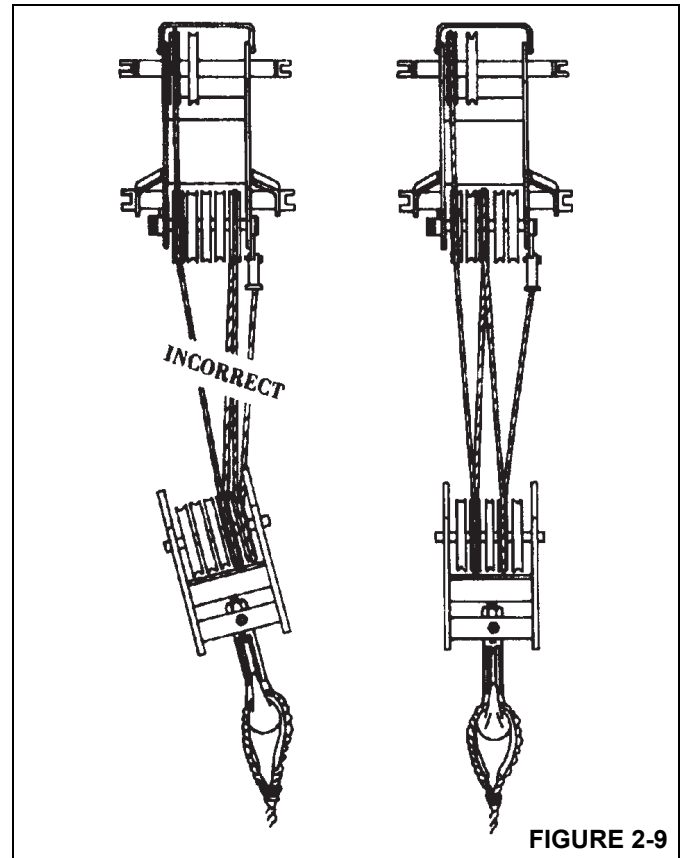
You must always be aware of everything around the crane while lifting or traveling. If you are unable to clearly see in the direction of motion, you must post a look out or signal person before moving the crane or making a lift. Sound the horn to warn personnel

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 2-20.

**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.

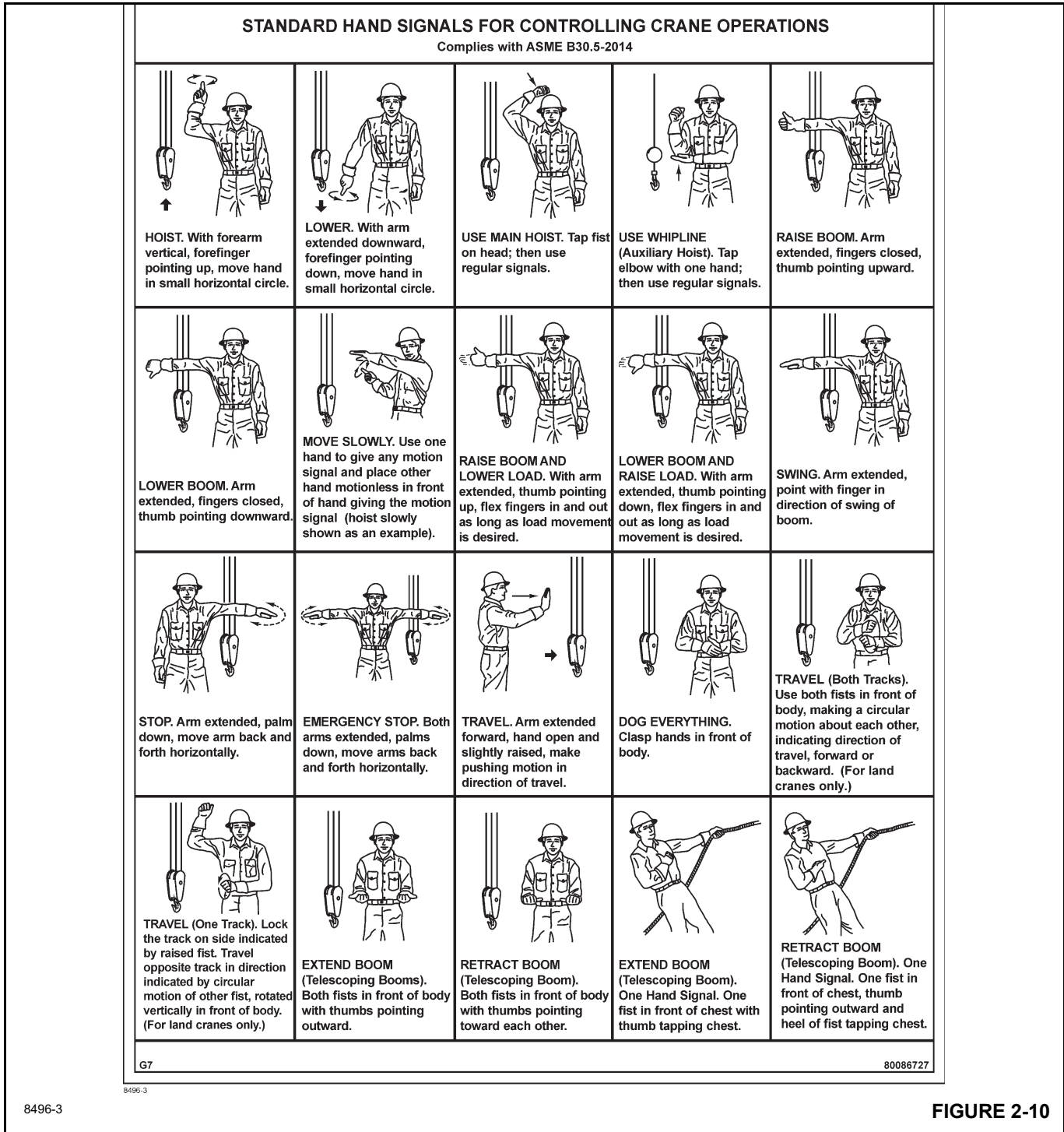


FIGURE 2-10

## 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).
- Place crane function power switch to OFF (if equipped).
- Place controls in neutral position.
- Shut down the engine and remove the ignition key.
- Wait a minimum of two 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).

## 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.



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

## MODEL SPECIFIC INFORMATION

### Crane Stability

The GRT8100 rubber 360° load chart has a minimum radius of 6 m (19.7 ft) with a load. Without a load, a radius of 4.0 m (13.1 ft) is safe for 360° on rubber. A radius of less than 4.0 m (13.1 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.

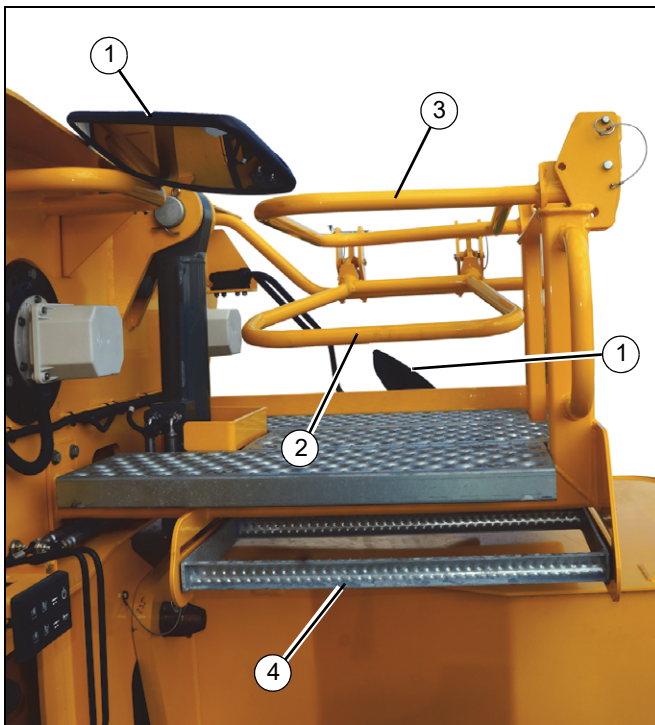
No storage of components are allowed on the platform.

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

### Travel Position

Hoist platform must be in the travel position when moving the crane. Refer to Figure 2-11.

1. Lower two hoist mirrors (1).
2. Remove two pins and lower rear rail (2). Reinsert pins.
3. Remove two pins and lower side rail (3). Reinsert pins.
4. Lift and slide steps (4) into retaining bracket. Pull out on steps to ensure notch is engaged in bracket.



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FIGURE 2-11

## OVERLOAD INSPECTION

When the 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!

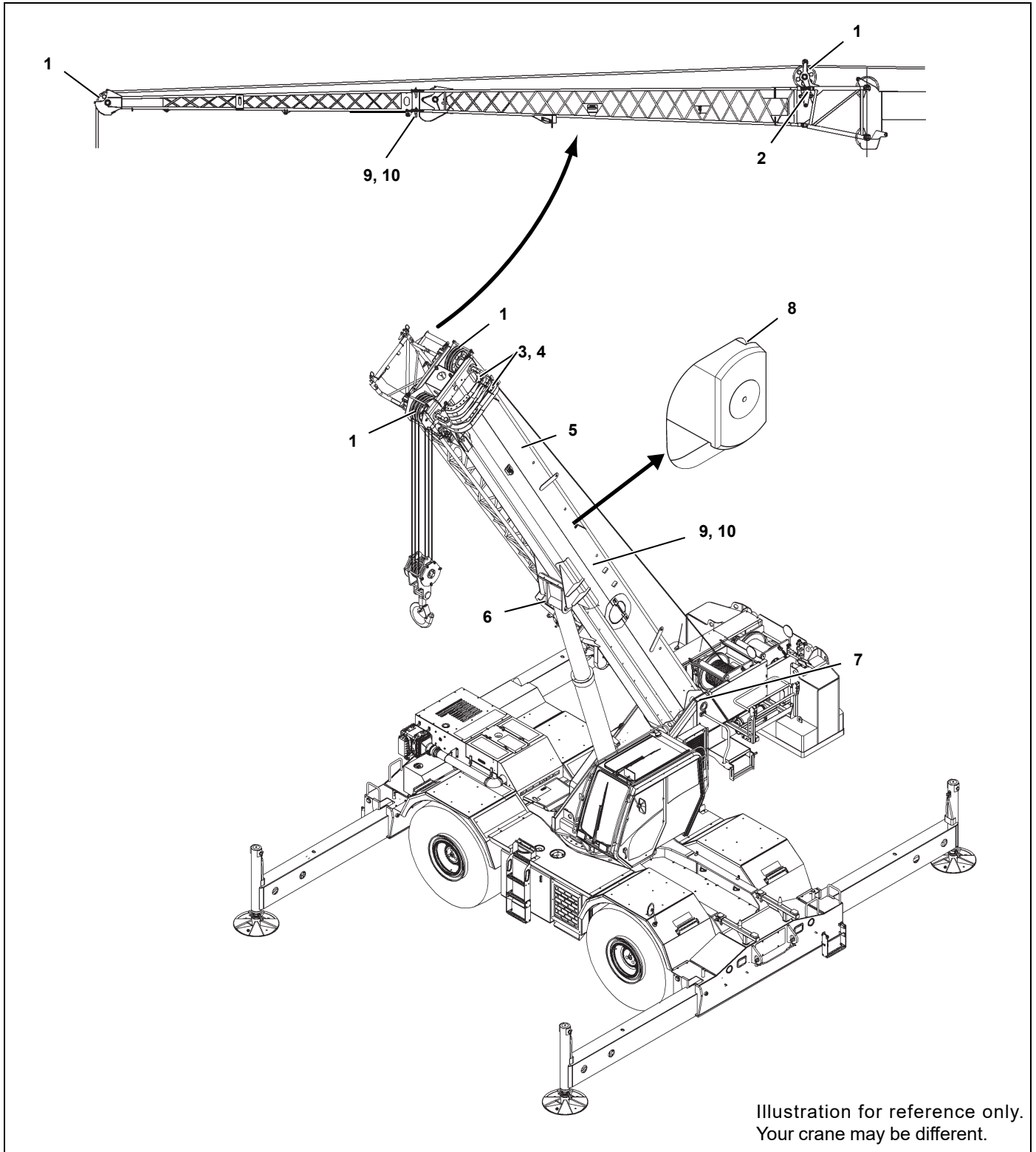
To avoid an accident caused by overload damage to your crane:

- Perform the inspections outlined in this publication for overloads up to 50%.
- Stop operating the crane and contact Manitowoc Crane Care 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.

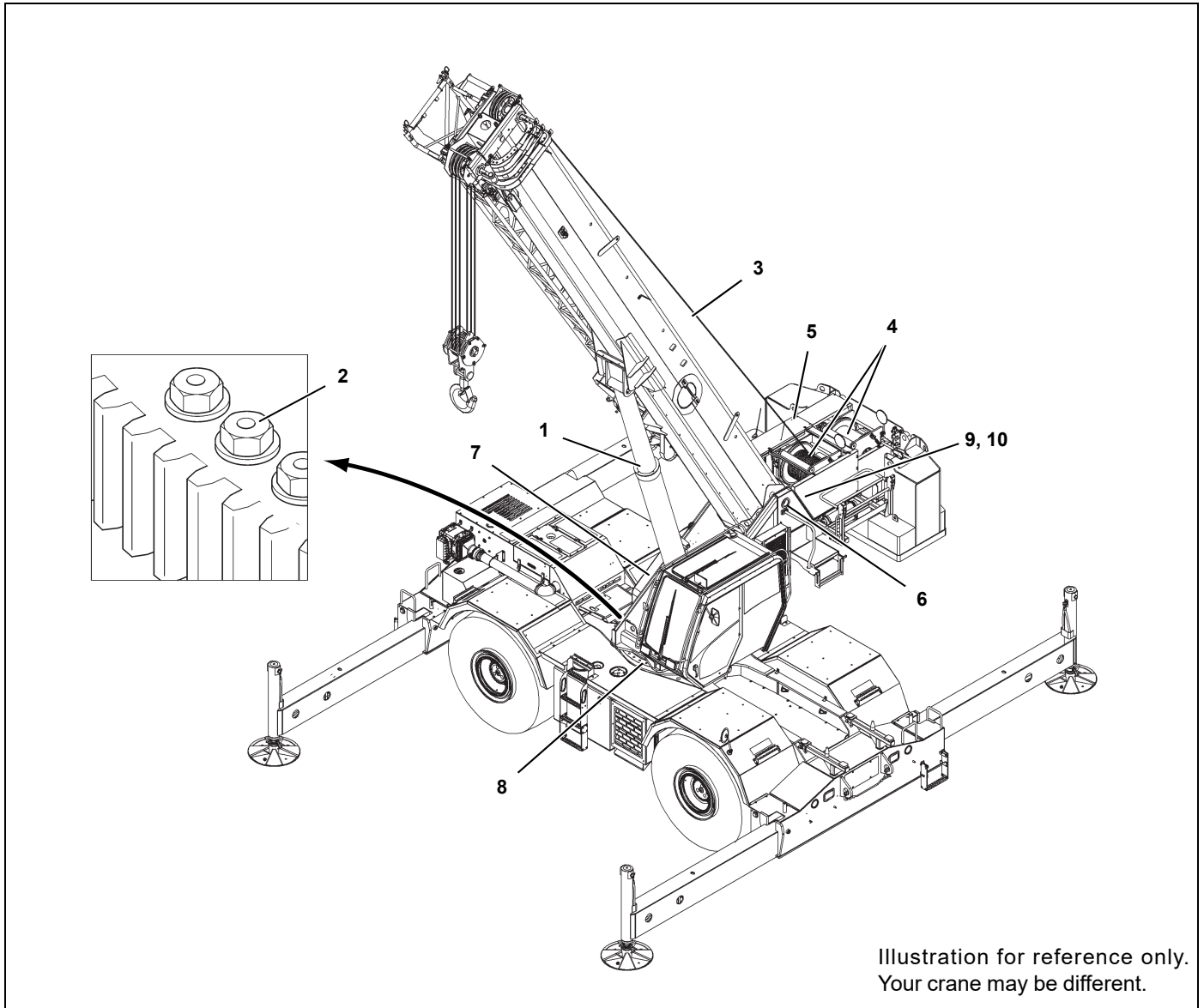
Boom Inspection



**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	Luffing 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	Turret-Base Section	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.	

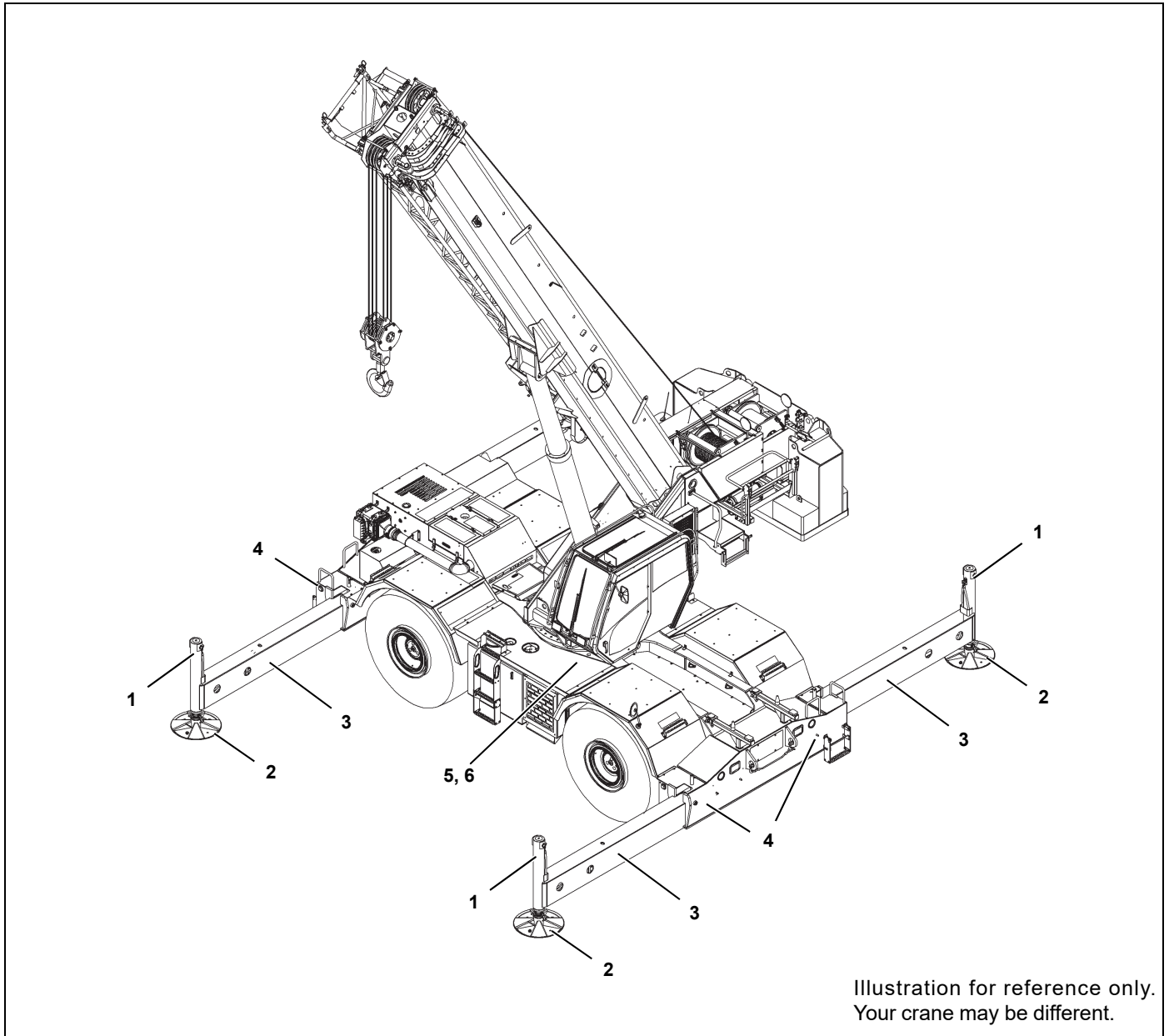
Superstructure Inspection



**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



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



## SECTION 3 OPERATING CONTROLS AND PROCEDURES

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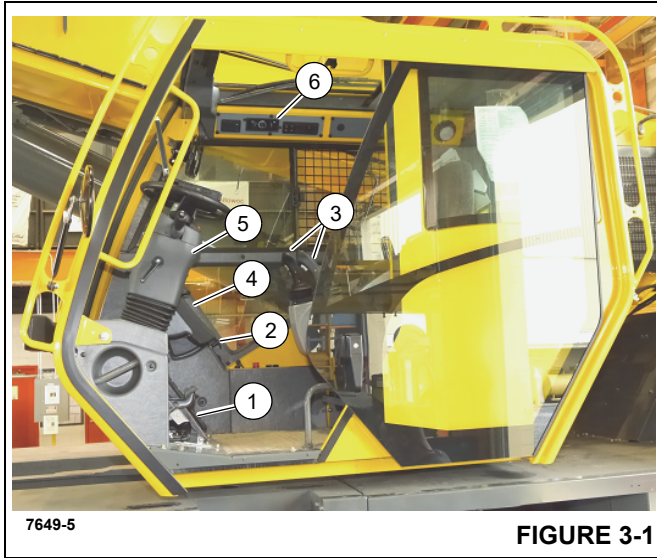


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**CONTROLS AND INDICATORS**

The engine is electronically controlled by the Electronic Control Module (ECM); it is the control center of the entire engine system. The ECM processes all inputs and sends commands to the fuel systems, vehicle, and engine control devices. This Operator Manual does not include engine ECM information. ECM information is in a separate manual by the engine manufacturer shipped with the crane from the factory.

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

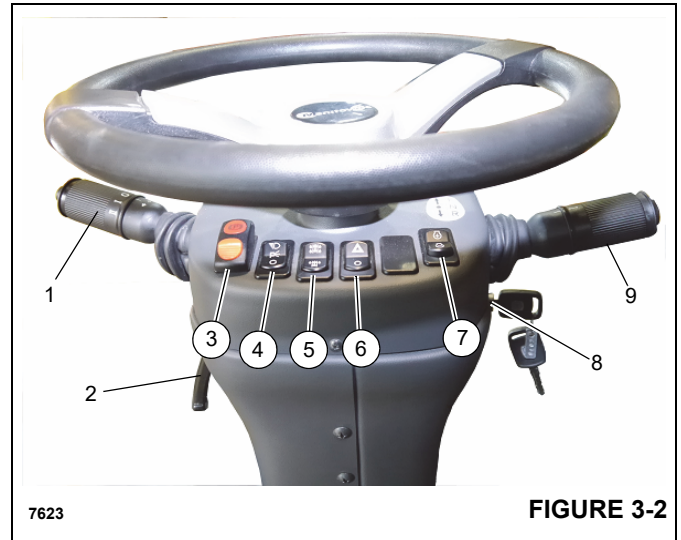


**FIGURE 3-1**

Item	Description
1	Foot Pedals
2	Turntable Swing Pin Lock Control
3	Seat Joystick and Armrest Controls
4	CCS and RCL Display Panels
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 Lever
3	Park Brake Control Switch
4	Headlights Switch
5	Drive Axle Selector Switch
6	Hazard Lights Switch
7	Engine Speed (RPM) Increase/Decrease 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 left side of steering column. Pushing turn signal lever down causes left front and left rear turn signals to flash. Pushing turn signal lever up causes 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: O, I, II and interval wiping. Pushing button in end of knob energizes the windshield washer pump to spray washer fluid on the windshield. Positioning knob to I operates wiper at low speed. Positioning knob to II operates wiper at high speed. Positioning knob to O turns wiper motor off and automatically returns wiper to parked position.

Push small button on end of lever to sound horn.

## Steering Column Tilt Lever

The steering control column can be rotated rearward approximately 30° and raised approximately 60 mm (2.3 in). Rotate control lever (2) Figure 3-2 down to lock steering column in place. Rotating lever up 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 Park Brake Indicator light on the display is illuminated when pressure switch in the brake release system is activated and 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, rear, and side 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 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 icon background on the CCS operating display turns yellow when crane is in four-wheel drive mode. This icon will flash if switch position is changed when engine is running, transmission is not in Neutral, and brake pedal is not pressed.

## 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 turn signal indicator lights on steering column flash at the same time.

## Increment/Decrement Switch

The 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 (RPM). Press top or bottom of the Increment/Decrement Switch to increase or decrease low engine idle.

Quickly press top of switch once to go to full engine RPM. Quickly press bottom of switch once 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: OFF [0], RUN [1], and START [2].

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 1, 2, or 3.

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 3-67 and *Traveling — Reverse*, page 3-68 for more detailed information on shifting the transmission.

**CAB OVERHEAD CONTROLS**

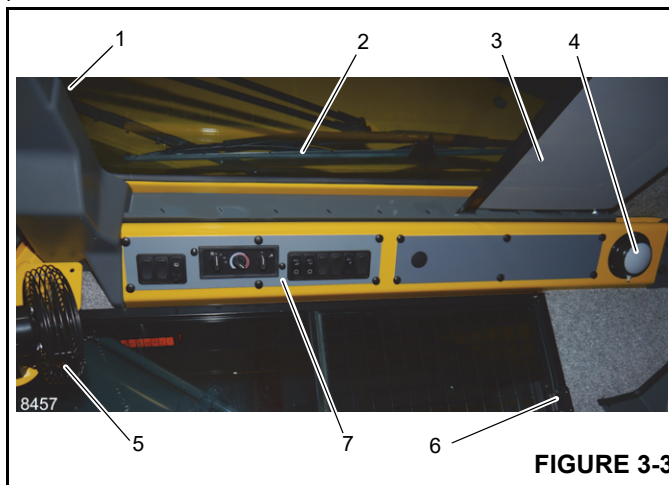


FIGURE 3-3

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

**Skylight Window Latch**

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, (4) (Figure 3-4), and operated by the Wiper Motor.

**Skylight Sunscreen**

The Skylight Sunscreen (3) (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.

**Dome Light**

The cab Dome Light (4) (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.

**Cab Circulating Fan**

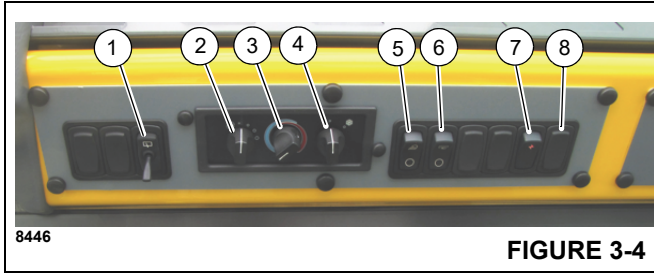
The Cab Circulating Fan (5) (Figure 3-3) is located on left front side of cab above the window frame. A swivel allows the fan to be rotated and a switch on the fan base controls the fan. The switch has a high, low and off position.

**Right Side Window Latch**

Window on the right side of the cab can be opened. Squeeze latch (6) (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 Control Switch
4	Air Conditioning Switch
5	Work Lights Switch
6	Flood Lights Switch (Optional)
7	Crane Function Power Switch
8	Exhaust System Cleaning Switch (Tier 4 engine only)

**Skylight Wiper Switch**

The electrically-operated Skyline Wiper is installed to remove moisture from the skylight. The Skyline Wiper is controlled by the Skyline Wiper Switch (1) Figure 3-4. This switch has 6 positions, including intermittent setting.

**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 Control Switch**

The Heater 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.

**Air Conditioner Switch**

The Air Conditioning Switch (4) Figure 3-4 controls the optional air conditioning system. Settings are Off (O) and On (I).

**Work Lights Switch**

The Work Lights Switch (5) Figure 3-4 controls work lights mounted on bottom front of the superstructure cab. Press top of switch to turn work lights on. Press bottom of switch to turn work lights off.

**Crane Function Power Switch**

The Crane Function Power Switch (7) Figure 3-4 is located on the overhead control panel. This spring return switch permits the operator to activate all crane functions at once or disconnect power from crane functions controlled by the remote controllers on the armrests. Pressing it turns ON all crane functions. Pressing a second time turns OFF all crane functions. Turn off all crane functions to prevent inadvertent operation of functions due to bumping controllers while roading or any other operation.

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



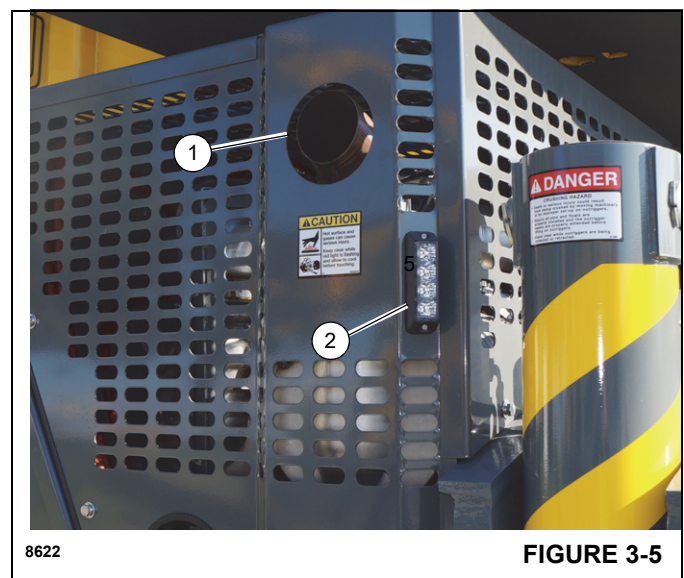
**WARNING**  
**Extreme Heat Hazard!**

During cleaning process exhaust becomes very hot. Do not park vehicle near flammable objects.

Use caution near the exhaust tailpipe as it will also become very hot.

The Engine DPF (Diesel Particulate Filter) Switch (8) Figure 3-4 is located on the right side of the overhead control panel. This is a three position switch: Inhibit Cleaning/Permit Active Cleaning/Initiate Manual Cleaning. Center position enables clean to occur when required, or press this switch to force manual cleaning to begin immediately or to disable cleaning indefinitely:

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



**FIGURE 3-5**

To manually clean, set the crane parking brake, the crane transmission must be in neutral and have the brake and throttle pedals released. Refer to “Exhaust System Cleaning (Tier 4 Engines Only)” on page 7 for cleaning mode definitions and a description of when manual cleaning is needed.

Set up a safe area around the crane’s exhaust; remove tools, rags, grease, or any debris from engine exhaust area.

With engine idling, push Cleaning Switch (8) to start manual cleaning.

Within 5 seconds engine revolutions increase to 1000 -1400 rpm. The engine will continue to run at this speed for up to 45 minutes.

As a warning, strobe light (2, (Figure 3-5)) near exhaust pipe (1, (Figure 3-5)) will flash during exhaust system cleaning.

Pressing brake or throttle pedal during cleaning or activating the Inhibit Cleaning Switch will interrupt the manual cleaning process.

Make sure crane and surrounding area are monitored during manual cleaning. If any unsafe condition occurs, shut off engine immediately.

Engine returns to normal idle speed when manual cleaning is complete.

### Exhaust System Cleaning (Tier 4 Engines Only)

The Exhaust System Cleaning Required Indicator (24) is located in the CCS display Figure 3-14. This indicator illuminates amber when exhaust system requires cleaning.

When the DPF indicator illuminates or flashes, start the manual cleaning process at the next opportune time.

The indicator will be illuminated continuously during the early stages of required cleaning. If this condition continues, the lamp will begin to flash and a slight engine derate will occur.

If this condition continues further, the Engine Warning light (17) will illuminate in addition to the cleaning indicator (24) and severe engine derate will occur.



#### WARNING

##### Extreme Heat Hazard!

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

The only way in either of these conditions can occur is if cleaning has been inhibited or a manual cleaning was interrupted.

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 not sufficient heat in the exhaust 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.

### Inhibit Exhaust System Cleaning

The Inhibit Exhaust System Cleaning Indicator (25) is located in the CCS display Figure 3-14. When the Cleaning Switch (8) Figure 3-4 is in the exhaust system cleaning position, this amber indicator is illuminated and active and manual exhaust system cleaning is prevented.

### Diesel Exhaust Fluid (Tier 4 Engines Only)

The Diesel Exhaust Fluid (DEF) Indicator (6) Figure 3-14 is located in the CCS display. The indicator has four different stages which will be triggered by the fluid level sensor in the DEF tank:

**Low Tank** - First warning reducing agent in the tank is low. DEF Indicator (6) is lit continuously.

**Derate** - DEF Indicator (6) starts to flash as a warning that a derate will be activated if reducing agent in the DEF tank is not refilled.

**Low Level Inducement** - DEF Indicator (6) flashes and the Engine Warning Indicator (17) is lit continuously. Derate is activated.

**Severe Inducement** - Once the DEF tank is empty, the crane operation will be restricted. The DEF Indicator (6) will flash and the Stop Engine Indicator (16) is solid red.

#### CAUTION

##### Engine Damage Hazard!

Ultra low sulfur diesel fuel is required in Tier 4 engines.

If “Ultra Low Sulfur” fuel is not used in engines that require it, the Cummins warranty will be void. Engine performance will quickly deteriorate and may stop running.

### High Exhaust System Temperature

The High Exhaust System Temperature (HEST) Indicator (26) Figure 3-14 is located on the CCS Main Screen display.

During exhaust system cleaning it is possible for engine exhaust to reach temperatures exceeding 650° C (1200° F). The HEST indicator will illuminate red to warn when

temperatures reach 675° C (1247° F) and will stay on until temperatures fall below 625° C (1157° F).

A warning light near the tailpipe will flash during exhaust system cleaning when high exhaust temperatures exist.

For more information on the exhaust system cleaning process, refer to *Exhaust System Cleaning (Tier 4 Engines Only)*, page 3-7.

### CONTROL SEAT ASSEMBLY

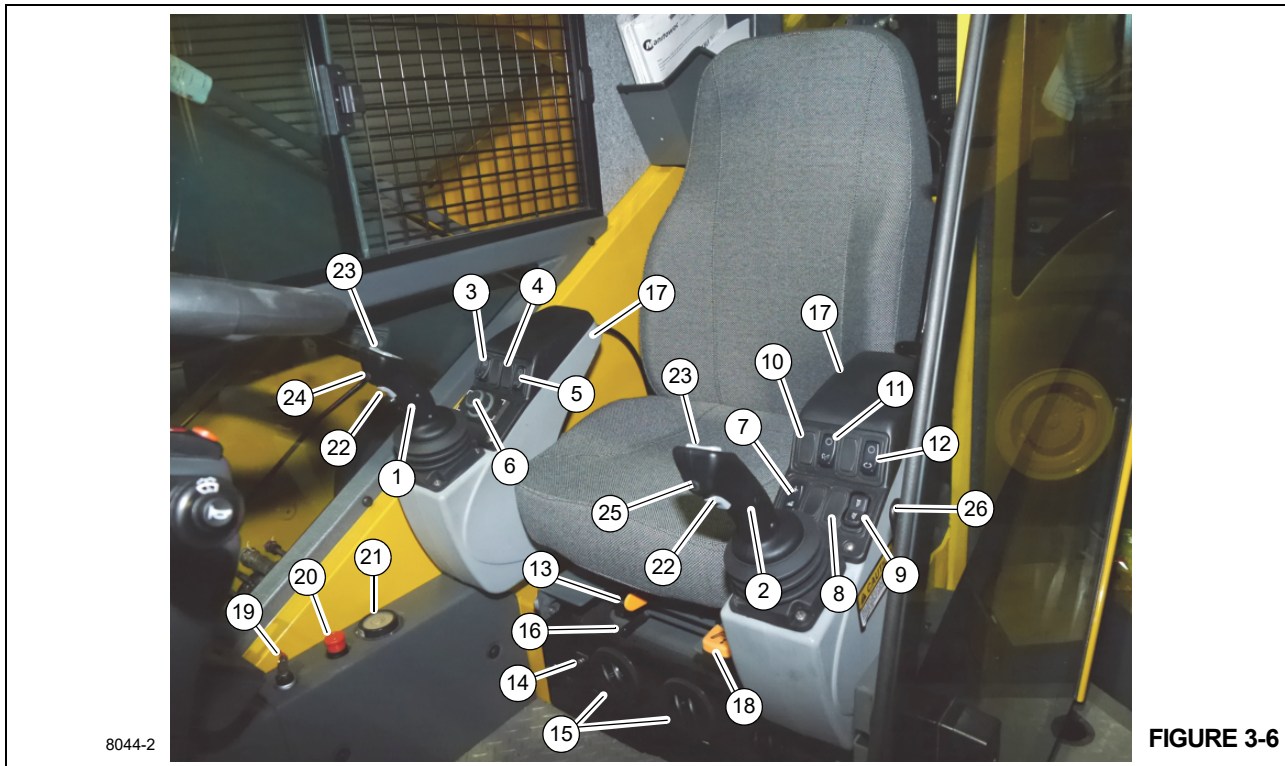


FIGURE 3-6

Item	Description	Item	Description
1	Boom Lift/Main Hoist Control Lever	15	AC/Heater Vents
2	Swing/Telescope or Swing/Auxiliary Hoist Control Lever	16	Seat Frame Slide Lever
3	Main Hoist Enable Switch	17	Armrest Adjustment Button(s) (Underside)
4	Boom Up Bypass	18	Seat Height Adjustment Lever
5	Boom Lift Function Enable Switch	19	Limit Bypass Switch - Keyed
6	Jog Dial	20	Emergency Stop Switch
7	Outrigger Function Enable Switch	21	Level Indicator
8	Differential Lock On/Off (Optional)	22	Deadman Switches (Optional) (Dual Axis Control Levers only)
9	Rear Steer Switch	23	Hoist Speed Toggle Switches
10	Auxiliary Hoist Enable Switch (Optional)	24	Horn
11	Boom Telescope Enable Switch	25	Free Swing Button



Item	Description	Item	Description
12	Swing Enable Switch	26	Cab Door Release Lever
13	Seat Slide Lever	27	Hoist Rotation Indicators (Not Shown)
14	AC/Heater Climate Unit	28	Seat Switch (Not Shown)

**Boom Lift/Main Hoist Control Lever (Dual Axis)**

The Boom Lift/Main Hoist Control Lever (1) Figure 3-6 is located on the right armrest. The controller, when pushed to the right lowers the boom, or pushed left raises the boom.

When used for main hoist, the controller, when pushed forward lowers the cable, or pulled back raises the cable.

**Swing/Telescope or Swing/Auxiliary Hoist Control Lever (Dual Axis)**



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

Before actuating swing or other functions, sound horn and verify all personnel are clear of rotating and moving parts.

The Swing/Telescope or Swing/Auxiliary Hoist (Swing/Tele or Swing/Aux) Control Lever (2) Figure 3-6 is located on the end of the left armrest. The lever controls swing and telescope functions when crane is not equipped with an auxiliary hoist.

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

If not equipped with an auxiliary hoist, positioning the lever to the left or right actuates a control valve through hydraulic pilot pressure to provide 360 degree continuous rotation in the desired direction. Positioning the lever forward actuates the control valve to telescope the boom out and pulling the lever back actuates the boom to telescope in.

If equipped with an auxiliary hoist, positioning the lever forward actuates the control valve to let out hoist cable and pulling the lever back reels the cable in. Moving the lever in a diagonal direction actuates the two functions simultaneously.

**Main Hoist Enable Switch**

The Main Hoist Enable Switch (3) Figure 3-6 is a momentary switch that is located on the right armrest. Press once to enable hoist; press again to disable hoist. Pressing the switch twice rapidly enables hoist at high speed. Pressing once and holding the switch for about 2 seconds also enables high speed.

**Boom Up Bypass Switch**

The Boom Up Bypass Switch (4) Figure 3-6 is a momentary two-position rocker switch that is located on the right armrest. While lift function is enabled and in a RCL lockout condition, pressing and releasing the Boom Up Bypass Switch will enable boom lift up.

The following indicators illuminate to indicate the limiter is bypassed:

- Bypass 2 Pressed indicator is on constant (only when switch is pressed)
- Bypass 2 Active indicator is on constant
- RCL Lockout LED 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 lockout is bypassed until one of the following occurs:

- Boom Up Bypass switch is again pressed and released while joysticks are in neutral position
- Boom up joystick 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

**Lift Function Enable Switch**

The Lift Function Enable switch (5) Figure 3-6 is a momentary switch that enables boom up and boom down.



## Jog Dial

The Jog Dial Control (6) (Figure 3-6) is located on the right arm rest. It selects and chooses functions on the screen(s) to navigate the Crane Control System.

## Outrigger Function Enable Switch

The Outrigger Function Enable Switch (7) Figure 3-6 allows the operator to switch between extension/retraction of outriggers and raising/lowering of the jacks. Press and hold switch to force the lower screen display to change to the outrigger page.

## Differential Lock On/Off Switch (Optional)

The Differential Lock Switch (8) (Figure 3-6) is located on the left arm rest. 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 crane is in 4WD mode.

## Rear Steer Switch

The Rear Steer Control Switch (9) (Figure 3-6) is a three-position, spring centered to off, rocker switch, located on the left armrest. Press bottom of switch to actuate a control valve to turn rear wheels to the left, causing crane to turn to the right. Pressing top of switch actuates a control valve to turn rear wheels to the right, causing crane to turn to the left. When wheels are not centered, the Wheels Not Centered icon on the CCS Operating Display illuminates. Releasing the switch causes it to return to the center off position.

To straighten rear wheels, press switch until Rear Wheels Not Centered icon indicator light goes off.

## Auxiliary Hoist Enable Switch

The Auxiliary Hoist Enable Switch (10) (Figure 3-6) is located on the left arm rest. It enables the Auxiliary Hoist and sets the high speed the same as the Main Hoist Enable Switch does for the Main Hoist.

## Boom Telescope Enable Switch

The Boom Telescope Enable Switch (11) (Figure 3-6) is located on the left arm rest. It enables the boom telescoping function for the optional Telescope Control Foot Pedal, or for the Control Lever (joystick) if there is no auxiliary hoist.

## Swing Enable Switch

The Swing Enable Switch (12) (Figure 3-6) is located on the left arm rest. This two-position rocker switch (On/Off) is used to control a hydraulic valve that directs a regulated flow of pressure to and from the swing brake. When the joystick

moves to swing the crane the brake releases. When the crane stops swinging the swing brake re-engages.

## Seat Slide Lever

Moving the Seat Slide Lever (13) (Figure 3-6) slides only the seat forward or backward.

## Air Conditioner/Heater Climate Unit

The crane cab Air Conditioner/Heater Climate Unit (14) Figure 3-6 is located in the cab under the driver's seat. The vents (15) are part of the climate unit and can be adjusted to direct the flow of air.

## Seat Frame Slide Lever

Moving the Seat Frame Slide Lever (16) (Figure 3-6) slides the seat and armrests forward or backward.

## Armrest Adjustment Knobs

Left and right armrest and armrest controls can be adjusted using the adjustment buttons (17) (Figure 3-6) found under the rear of the armrest. Press the button to rotate the entire armrest; release button at the desired position.

## Seat Height Adjustment Lever

To adjust seat height, lift height adjustment lever (18) Figure 3-6 and adjust seat as needed.

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



### WARNING

#### Loss of RCL Monitoring Hazard!

The Limit Bypass Switch is to be used to override the RCL system in emergency situations only.

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

The Rated Capacity Limiter (RCL) system, when programmed accurately, will lockout 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 Switch (19) (Figure 3-6) is a three-position, momentary type key switch. In an emergency situation only, turn switch clockwise or counterclockwise and hold to bypass the different limiter systems on the crane.

Turn key switch clockwise and hold to bypass the following limiter systems and their craning function lockouts:

- Anti-two block system (boom up/down, telescope extend, hoist up)
- Third wrap limiter system (hoist down)

The following indicators illuminate to indicate the limiters are bypassed:

- Third wrap indicator is flashing
- Anti-2-Block indicator is flashing

Turn key switch counterclockwise and hold to bypass the following limiter systems and their craning function lockouts:

- 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 illuminate to indicate the limiters are bypassed:

- Bypass 1 Pressed indicator is on
- RCL Bypass Active indicator is on
- RCL Bypass Status indicator is on
- RCL Lockout LED is flashing
- Third wrap indicator is flashing
- Working range limiter (WRL) indicator is flashing
- Carrier avoidance indicator is flashing
- -29°C temperature limiter indicator is flashing

All craning functions locked out are bypassed while the Limit Bypass switch is held in the actuated position.

### Limit Bypass Switch (CE Certified Cranes)



#### WARNING

##### Loss of RCL Monitoring Hazard!

The Limit Bypass Switch is to be used to override the RCL system in emergency situations only.

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

The Rated Capacity Limiter (RCL) system, when programmed accurately, will lockout 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 Switch (19) (Figure 3-6) is a three-position, momentary type key switch. In an emergency situation only, turn switch clockwise or counterclockwise to bypass the different limiter systems on the crane.

Turn key switch clockwise and release to bypass the following limiter systems and their craning function lockouts:

- Anti-two block system (boom up/down, telescope extend, hoist up)
- Third wrap limiter system (hoist down)

The following indicators illuminate to indicate the limiters are bypassed:

- Third wrap indicator is flashing
- Anti-2-Block indicator is flashing

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

Turn key switch counterclockwise and release to bypass the following limiter systems and their craning function lockouts:

- RCL system (boom up/down, telescope extend, hoist up)
- Working range limiter (WRL) system
- Carrier avoidance system
- -29°C temperature limiter system (optional)

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

- Bypass 1 Pressed indicator is on (only when in the counterclockwise position)
- Bypass 1 Active indicator is on
- RCL Bypass Active indicator is on
- RCL Bypass Status indicator is on

- RCL Lockout LED is flashing
- Working range limiter (WRL) indicator is on
- Carrier avoidance indicator is on
- -29°C temperature limiter indicator is on

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 illuminate to indicate the limiters are bypassed:

- Bypass 1 Pressed indicator is on (only when in the counterclockwise position)
- Bypass 1 Active indicator is on
- RCL Bypass Status indicator is on
- RCL Lockout LED is flashing
- Working range limiter (WRL) indicator is on
- Carrier avoidance indicator is on
- -29°C temperature limiter indicator is on

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 joysticks are in the neutral position
- Joysticks are in neutral position for 10 seconds

## Emergency Stop Switch

The crane Emergency Stop Switch (20) Figure 3-6 is located on the cab right console and is used to shut down the crane's engine. Push the red button in to shut down the engine, which illuminates the Emergency Stop icon on the CCS operator display. Rotate and pull out knob to resume normal operation.

## Level Indicator

The Level Indicator (21) Figure 3-6 is located on the right side of the cab by 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 Control Levers only)

Deadman Switches (22) Figure 3-6 are located on the front of both control levers. Either of these switches can be used instead of the seat switch to keep crane functions active.

## Hoist High Speed Toggle Switches

The Hoist High Speed Toggle Switches (23) (Figure 3-6) are thumb operated two-position center spring return switches. Pressing the right side maintains high speed until it is deactivated; pressing the left is momentary speed increase.

## Horn Button

The Horn Button (24) (Figure 3-6) is located on the upper front of the right control lever. The button sounds the horn during crane operations.

## Free Swing Button

The Free Swing Button (25) (Figure 3-6) is located on the upper front of the left control lever. 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 (26) (Figure 3-6) to open and close the cab door from inside the cab.

## Hoist Rotation Indicators (Not Shown)

Hoist Rotation Indicators (27) (Figure 3-6) for auxiliary and main hoists are located on top of each hoist control lever (1, 2) (Figure 3-6). 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 control lever (1, 2) pulses when its hoist is running so the operator's thumb can sense it.

## Seat Switch (Not Shown)

This switch (28) (Figure 3-6) is located within the seat. An operator must be sitting in the seat, enabling the switch, before any crane functions can be activated.

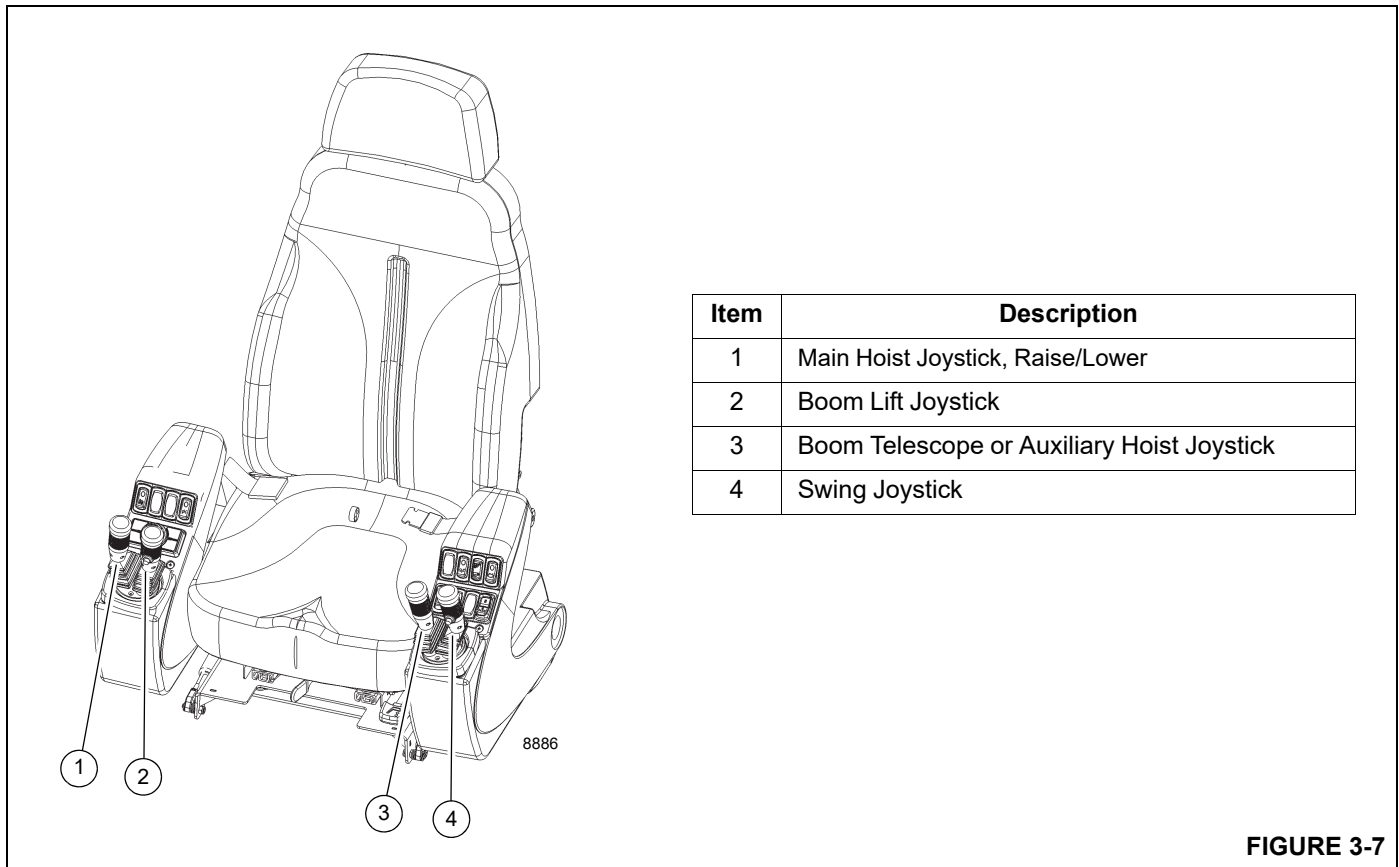


FIGURE 3-7

### Main Hoist Control (Single Axis Option)

The Main Hoist Control (1, Figure 3-7) is located on the right armrest. The joystick, when pushed forward, lowers the cable. When pulled back, it raises the cable.

### Boom Lift Control (Single Axis Option)

The Boom Lift Control (2, Figure 3-7) is located on the right armrest. The joystick, when pushed forward (lowers the boom) or pulled back (raises the boom).

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

The Telescope or Auxiliary Hoist (Tele or Aux) Control (3, Figure 3-7) is located on the left armrest. The joystick controls the telescope functions when the crane is not equipped with an auxiliary hoist. Push the joystick forward to telescope the boom out, or pull the joystick back to telescope boom in.

When equipped with an auxiliary hoist, the joystick controls auxiliary hoist functions and telescope functions are

controlled through a foot pedal. Push the joystick forward to let out the hoist cable or pull the lever back to reel the cable in.

### Swing Control (Single Axis Option)



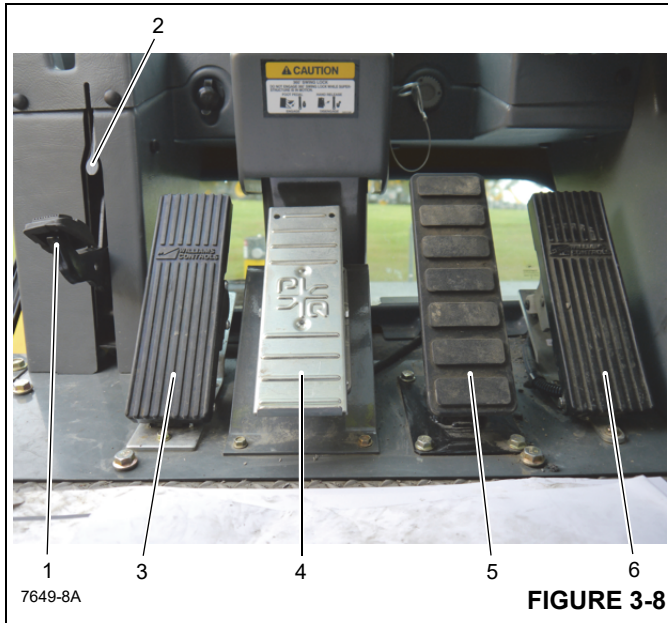
#### **DANGER** Crushing Hazard!

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

Before actuating swing or other functions, sound horn and verify all personnel are clear of rotating and moving parts.

The Swing Control joystick (4, Figure 3-7) located on the right armrest, controls the swing function. The joystick, when positioned forward (rotates the turntable clockwise) or back (rotates the turntable counterclockwise), actuates a control valve through hydraulic pilot pressure to provide 360 degree continuous rotation in the desired direction.

**FOOT PEDAL CONTROLS**



7649-8A

**FIGURE 3-8**

Item	Description
1	360° Swing Lock Pedal
2	360° Swing Lock Release Lever
3	Swing Brake Pedal
4	Telescope Control Foot Pedal
5	Service Brake Pedal
6	Foot Throttle Pedal

**360° Swing Lock Pedal**

The 360° Swing Lock Pedal (1) (Figure 3-8) is located on the left side of the cab floor. The pedal activates the swing lock to prevent superstructure from turning. To release the swing lock, pull up the 360° Swing Lock Release Lever (2).

**Swing Brake Pedal**

The Swing Brake Pedal (3) (Figure 3-8) 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 3-8) is located in the middle of the cab floor. Pushing top of pedal extends the boom. Pushing bottom of pedal retracts the boom.

**Service Brake Pedal**

The Service Brake Pedal (5) (Figure 3-8) is the second pedal from the right on the cab floor. Pressing the pedal controls application of the service brakes.

**Foot Throttle Pedal**

The Foot Throttle Pedal (6) (Figure 3-8) is located on the right side of the floor. It controls engine RPM which increases or decreases proportionately with the amount of foot pressure applied to the pedal. The pedal is electrically connected to the superstructure control module which sends the signal to the engine ECM via the J1939 data link.

**MISCELLANEOUS CONTROLS AND INDICATORS**

**Fuse and Relay Panels**

The fuse panel (1) Figure 3-9 is located behind the cab seat on the cab fuse and relay panel assembly. It contains up to 20 fuses that protect various electrical components.

**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 (for CE units)
- Hoist third wrap condition (for CE units)
- Anti-Two-Block alarm

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



### WARNING

#### Loss of RCL Monitoring Hazard!

The Limit Bypass Switch is to be used to override the RCL system in emergency situations only.

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

The Rated Capacity Limiter (RCL) system, when programmed accurately, will lockout 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 Limit Bypass Switch (1) (Figure 3-9) is a two-position, maintained type key switch. In an emergency situation only, turn switch clockwise to bypass the following limiter systems and their craning function lockouts:

- 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 illuminate to indicate the limiters are bypassed:

- Bypass 3 Pressed indicator is on
- RCL Bypass Active indicator is on
- RCL Bypass Status indicator is on
- RCL Lockout LED is flashing
- Anti-two-block indicator is flashing
- Third wrap indicator is flashing
- Working range limiter (WRL) indicator is flashing
- Carrier avoidance indicator is flashing
- -29°C temperature limiter indicator is flashing

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 in an emergency.

**NOTE:** Before powering up crane, ensure Limit Bypass Switch is in the Normal (not Override) position to avoid an error code.



FIGURE 3-9

## Limit Bypass Switch and Indicator (CE Certified Cranes)



### WARNING

#### Loss of RCL Monitoring Hazard!

The Limit Bypass Switch is to be used to override the RCL system in emergency situations only.

Do not operate crane with RCL overridden during normal operations.

The Rated Capacity Limiter (RCL) system, when programmed accurately, will lockout 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 Limit Bypass Switch is located inside a key-locked single-door enclosure (1) (Figure 3-10) attached to the outside rear of the operator's cab. The switch is a two-position momentary rocker switch. In an emergency situation only, press and release the switch to bypass the following limiter systems and their craning function lockouts:

- RCL system (boom up/down, telescope extend, hoist up)
- Working range limiter (WRL) system
- Carrier avoidance system
- -29°C temperature limiter system (optional)

The following indicators illuminate to indicate the limiters are bypassed:

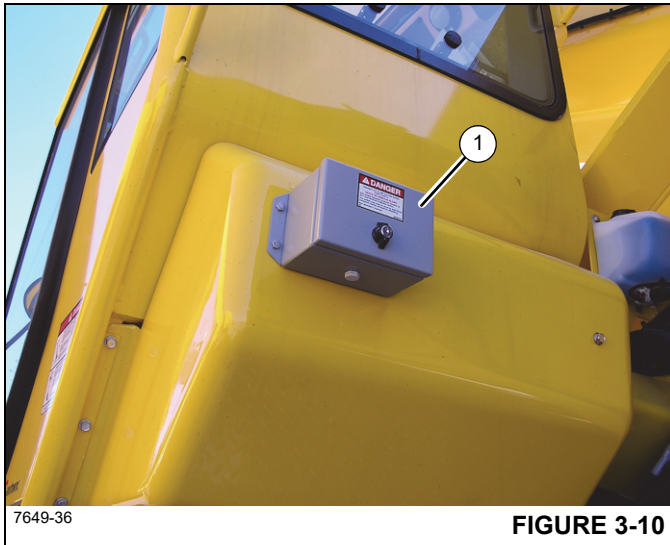
- Bypass 3 Pressed indicator is on (only when pressed and held)
- Bypass 3 Active indicator is on
- Working range limiter (WRL) indicator is on
- Carrier avoidance indicator is on
- -29°C temperature limiter indicator is on

Upon pressing the limit bypass switch, the swing left/right function speed is reduced to 25% and the boom down, hoist up, and telescope extend function speeds are reduced to 15% of rated function speed when actuated.

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

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

- Limit Bypass Switch is again pressed and released.
- 30 minutes has passed since the Bypass Limit switch was initially pressed and the joysticks are in the neutral position.
- Engine is turned off.

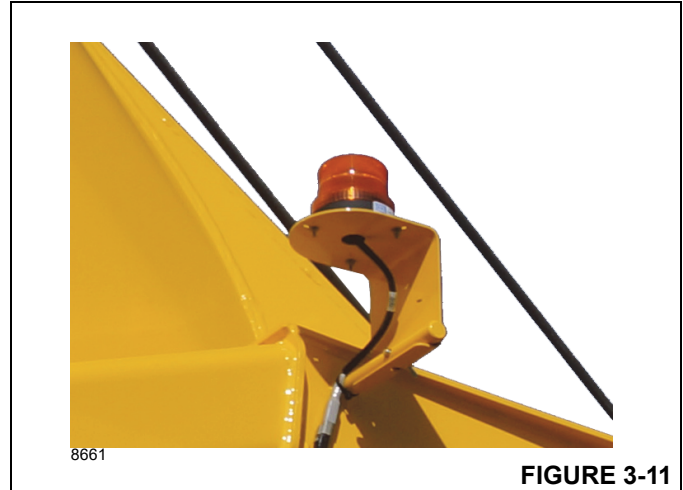


### RCL Internal Light Bar (Optional)

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

### Strobe Light or Beacon (Optional)

The strobe light or beacon 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. The alarm is connected to electrical wiring for the transmission reverse solenoids. It is activated when the transmission is in the reverse. The backup alarm is installed in the right side of the rear outrigger box.

### Emergency Exit

The windshield is the Emergency Exit. In an emergency, push out windshield and escape through opening.



**CRANE CONTROL SYSTEM (CCS)**

CCS consists of a cab electronic control unit and several other electronic control units located on the superstructure and carrier.

**CCS Display**

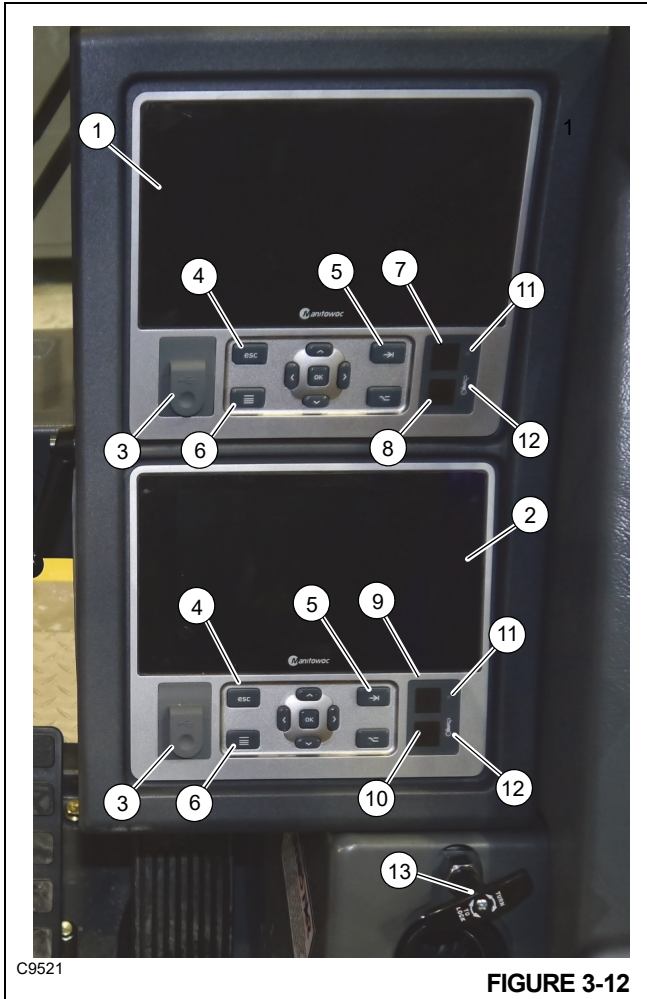


FIGURE 3-12

Item	Description
1	Rated Capacity Limiter (RCL) Display
2	CCS Operation Display
3	USB Diagnostic Connector
4	Escape Button
5	Tab Button
6	Menu Button
7	RCL Shutdown Warning Indicator
8	RCL Early Warning Indicator
9	Anti Two-Block Indicator
10	Swing Brake Engaged Indicator
11	Brightness Sensor

Item	Description
12	Internal Temperature Warning Indicator
13	Turntable Swing Lock Pin Control

**Turntable Swing Lock Pin Control**

The Turntable Swing Lock Pin Control Handle (13) (Figure 3-12) is located beside the front console on the right side of the cab. When control handle is pushed down and superstructure is directly over front of carrier, the swing lock pin drops into the socket on the carrier frame, locking superstructure in place. When control handle is pulled up, the pin is pulled out of the socket, unlocking superstructure.

**Menu Control**

The Jog Dial operates the CCS identically to buttons on the display console, providing easier access for the operator. Rotating the jog dial performs the same function as navigation arrow buttons on the display console. The icon in the lower left corner of the display screen reminds the operator which display is being controlled by the jog dial at that time. The Screen Toggle Button (4) (Figure 3-13) is used to switch screens. The tab button can also be used to temporarily silence audible alarms. Other buttons operate differently depending on area, screen, and menu.

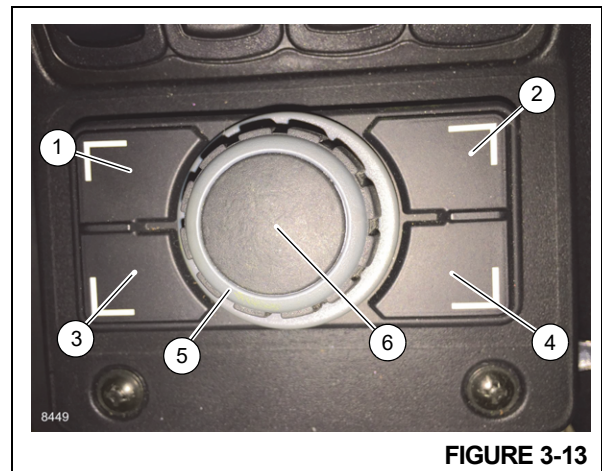


FIGURE 3-13

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

3

CCS Main Screen Symbols and Icons

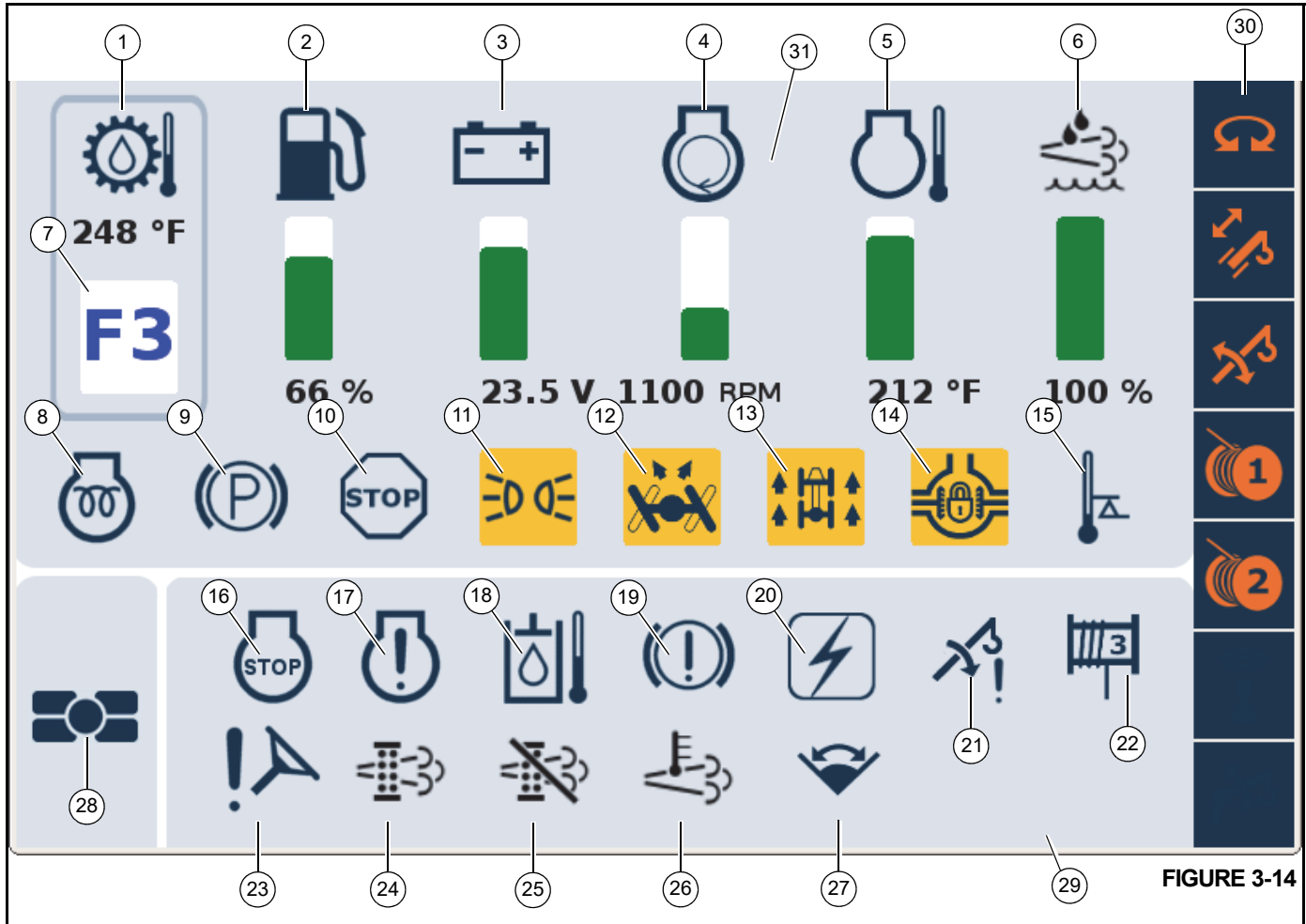


FIGURE 3-14

Item	Description	Item	Description
1	Transmission Temperature	17	Engine Warning Indicator
2	Fuel Level	18	High Hydraulic Oil Temperature
3	Battery Voltage	19	Low Brake Pressure
4	Engine Speed (Tachometer)	20	System Fault
5	Engine Coolant Temperature	21	Boom Angle Too Low (Optional)
6	Diesel Exhaust Fluid (Optional)	22	3rd Wrap Indicator (Optional)
7	Direction/Gear Number	23	Low Steering Pressure (Optional)
8	Engine Warm-up Indicator (Wait-to-start)	24	Exhaust System Cleaning Needed (Optional)
9	Park Brake	25	Exhaust System Cleaning Inhibited (Optional)
10	Emergency Stop	26	High Exhaust Temperature (Optional)
11	Marker/Position/Side Light	27	Work Range Limiter Indicator (Optional)
12	Rear Wheels Not Centered	28	Active Screen Indicator
13	Four-Wheel Drive Indicator	29	Alerts Area
14	Differential Lock Indicator (Optional)	30	Status Bar
15	Cold Temperature Warning (Optional)	31	Status Area
16	Engine Stop		

CCS Menu Screen

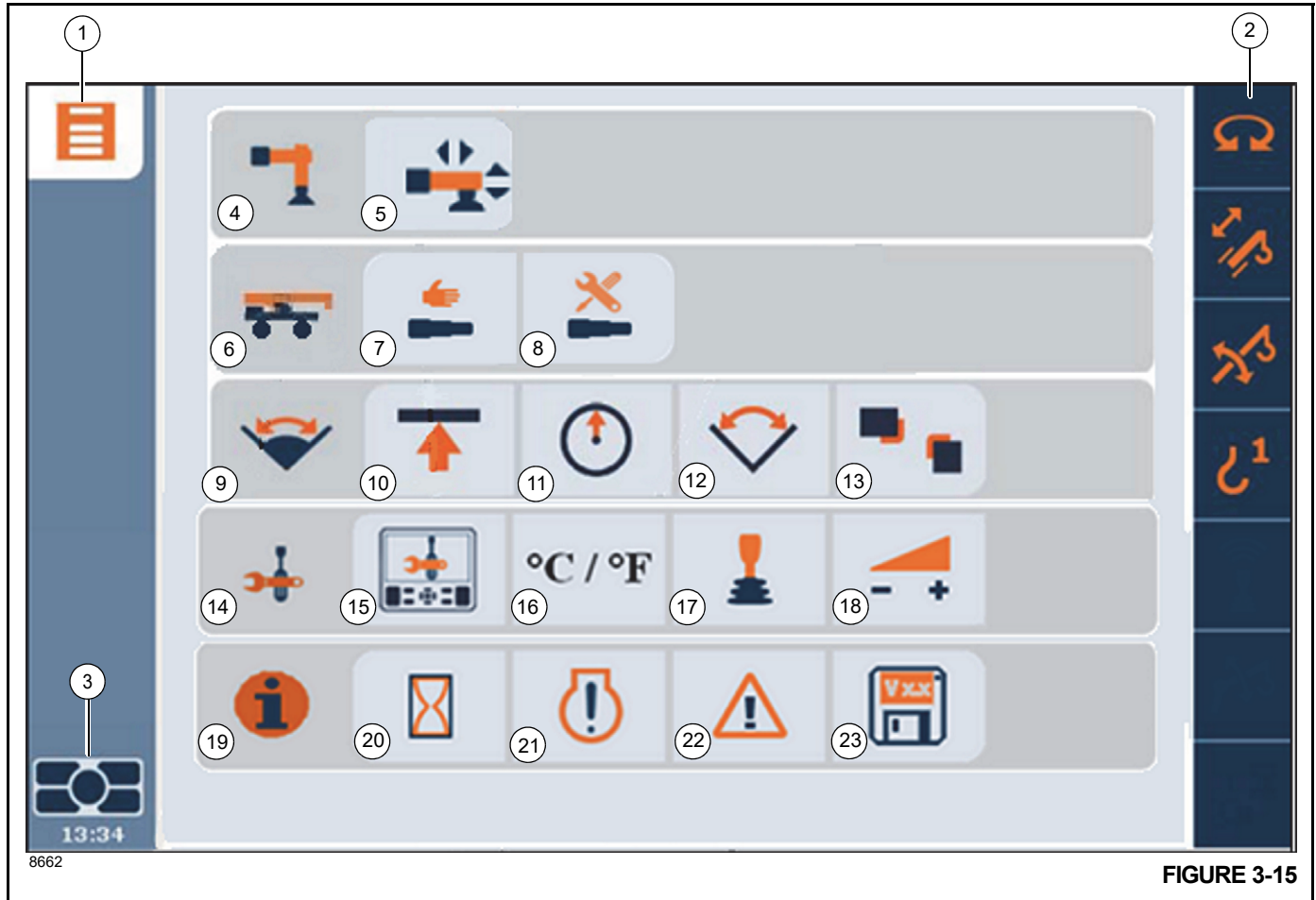


FIGURE 3-15

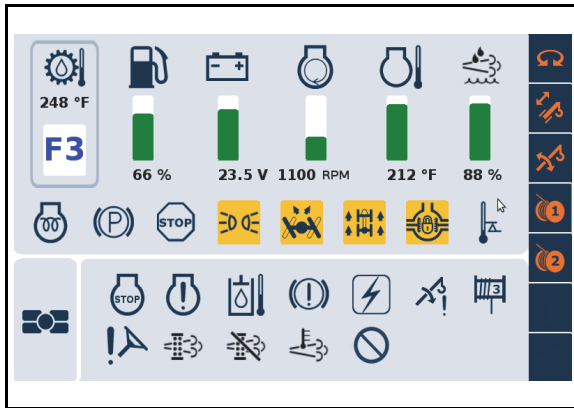
Item	Description	Item	Description
1	Menu Screen Indicator	13	WRL Virtual Wall Limit
2	Status Indicator Bar	14	Tools Group
3	Active Screen Indicator	15	Display Brightness Settings
4	Outrigger Group	16	Imperial/Metric Measurement Selection
5	Outrigger Button	17	Control Lever Settings
6	Telescoping Menu	18	Function Speed Setting
7	Manual Telescope	19	Information Group
8	Telescoping Configuration	20	Operating Hours
9	WRL Limit Group	21	Engine System Faults
10	WRL Height Limit	22	Crane Faults
11	WRL Radius Limit	23	Software Revision
12	WRL Swing Angle Limit		

### CCS Operation Display

There are three different levels:

1. Main Screen
2. Menu Screen
3. Sub Level menus

The main screen (below) appears on the operating display (lower screen) when the key is turned on. The main screen displays the crane system status. The amber lit icons are enabled. It also displays data from codes on other screens. The operator can choose and activate areas from this screen. The Escape Button (1) (Figure 3-13) defaults back to the main screen.



When an icon on the right side vertical bar is flashing, it indicates the joystick was not at a zero position when the Function Enable button or All Crane Functions button was pressed. Move the joystick to the center/no motion position and then enable the function.

For example, if the Swing Enable icon is flashing, it is NOT enabled. Move the Swing Joystick to the center/no motion position and then enable the Swing Enable Switch.

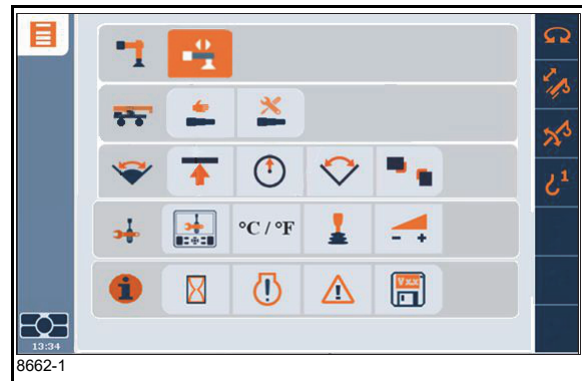
### Menu Screen

When menu button on the jog dial (3) (Figure 3-13) or control panel of the CCS is pressed, an overview of menu groups displays.

Menu buttons are categorized by groups on each row. The group icon is displayed at the beginning of each group bar followed by related member buttons.

A menu button is selected using the jog dial or arrow keys. The menu button is now active and highlighted orange. Open the active menu by pressing the jog dial or OK button on the control panel.

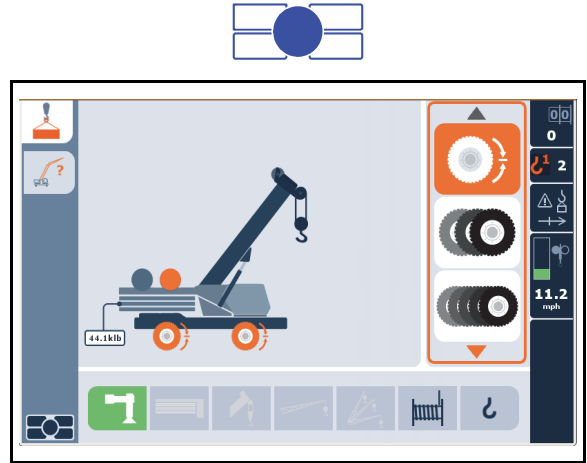
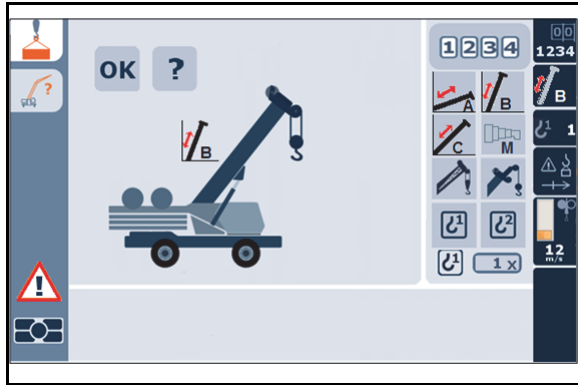
**NOTE:** One menu button is always active.



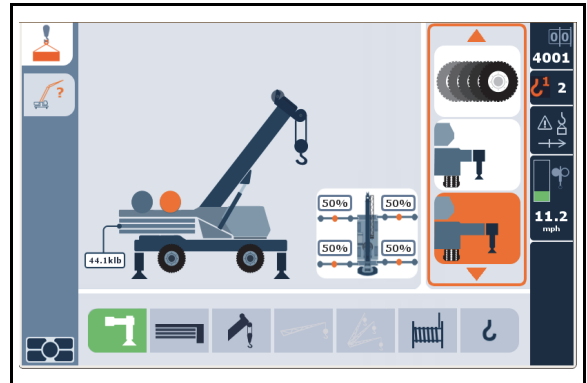
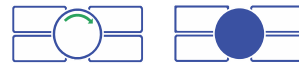
### RATED CAPACITY LIMITER (RCL) SYSTEM

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 properly preset by the operator. The control panel is mounted in the front console of the operator cab. When an overload condition is sensed, the system provides the operator with a visual and audible warning, and locks out the control levers to prevent lowering the boom, extending the boom, or raising the main or auxiliary hoist cables.

The RCL Setup Screen appears on the RCL Display (upper screen) when the key is turned on. The operator can select rigging first, or go directly to the setup wizard.



To choose one of the outriggers' proper positions, fully retracted, mid-extend or fully extended.



### DANGER

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

### Mode of Operation

Rigging options on this screen select static rubber, pick and carry, or outrigger configuration. The Outrigger Operation Menu is navigated on the lower CCS Screen.

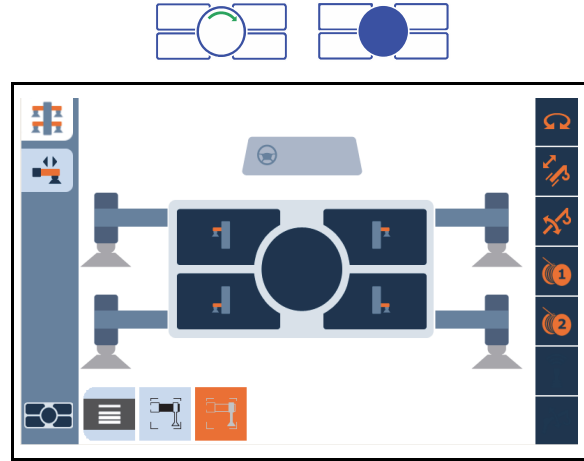
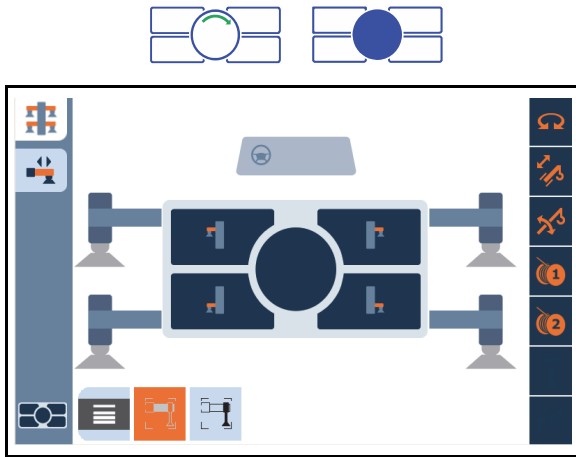
3

### Outrigger Operation Menu

For choosing options during rigging. This is the only function where the menu button (3) (Figure 3-13) will not automatically navigate directly to the menu screen. It must be selected and chosen with the menu icon on the lower left of this screen.

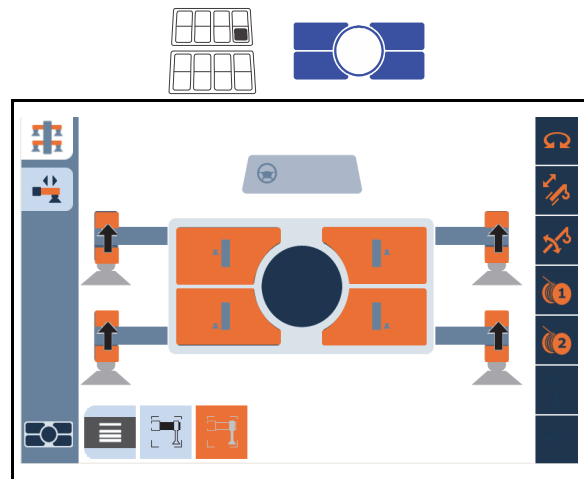
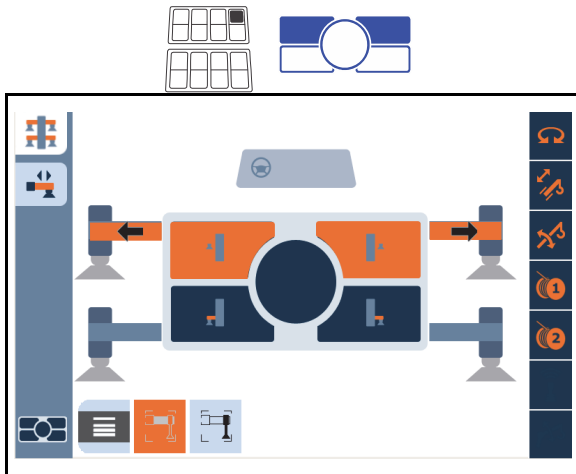
#### Set Outriggers

Function Enable Switch on the left armrest to enable jack operation.



The operator can now choose which jack, or combination of jacks, to raise or lower.

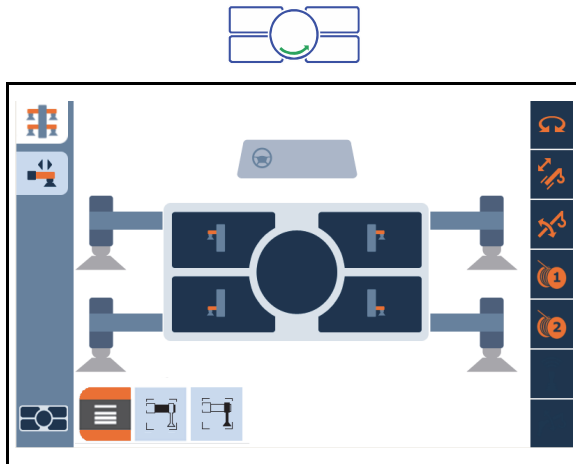
The operator can choose which beam, or combination of beams, to extend or retract. Press top of Outrigger Function Enable Switch on left armrest to select outrigger extension.



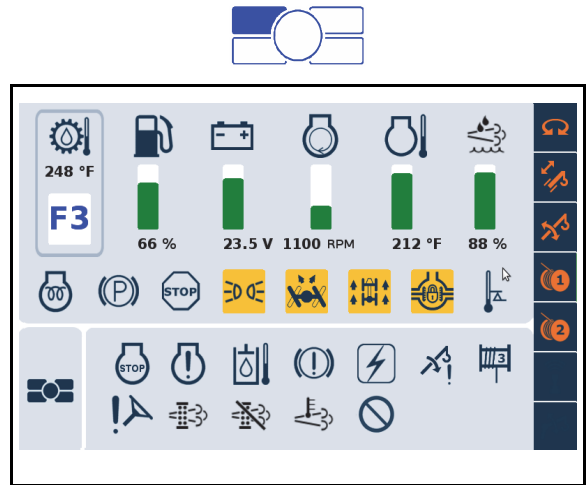
#### Raise Jacks

Spin jog dial clockwise and press OK button to select and choose jack operation. Press lower side of Outrigger

Toggle counterclockwise and select Menu icon to exit this group



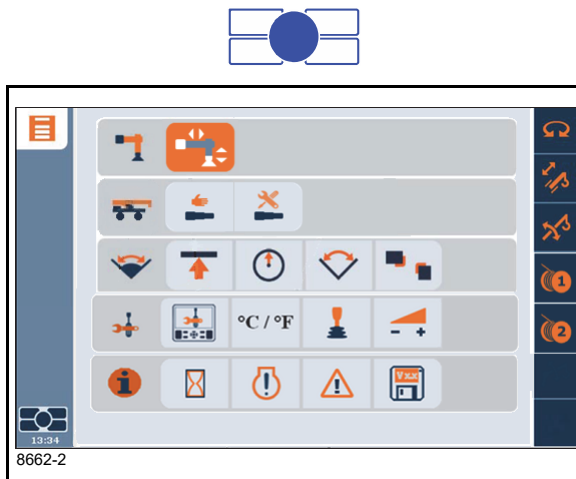
Press Escape button (1) (Figure 3-13) to leave menu and return to CCS main screen. The operator can now navigate to the RCL screen.



**CAUTION**

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

Press OK/Enter button on display or jog dial (6) (Figure 3-13) to exit outrigger screen.

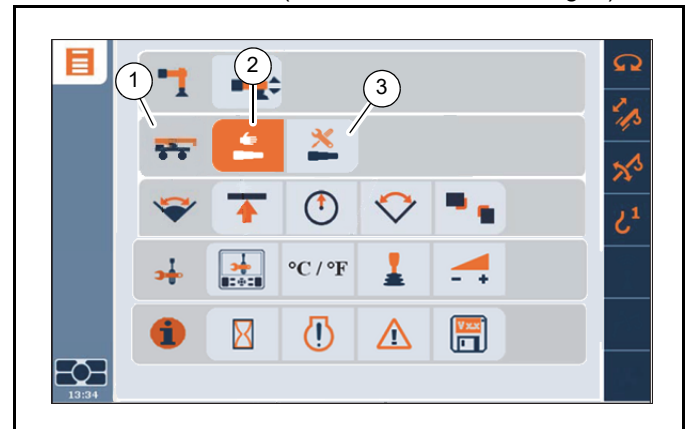


**Telescope Operation Menus**

Telescoping Menu (1) displays telescope operating display for modes A, B, and X.

Manual Telescoping (2) displays telescope operating display for Manual Mode only.

Telescoping Configuration (3) displays screen to enable or disable Mode A, B, or X (Mode M can not be changed).

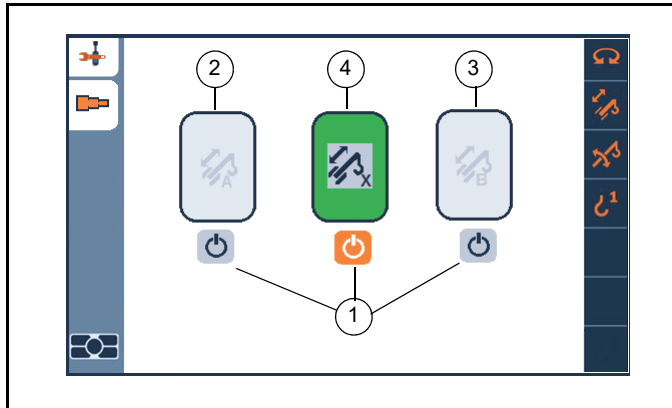


**Telescoping Configuration Screen**

Select On/Off buttons (1) to enable or disable A, X, or B modes. Mode M can not be disabled.

Disabled modes are not shown on the RCL setup screen (Quick Select or Wizard).

In the following example, Modes A (2) and B (3) are disabled and grayed out. Mode X (4) is active. Any automatic mode combination allowed.

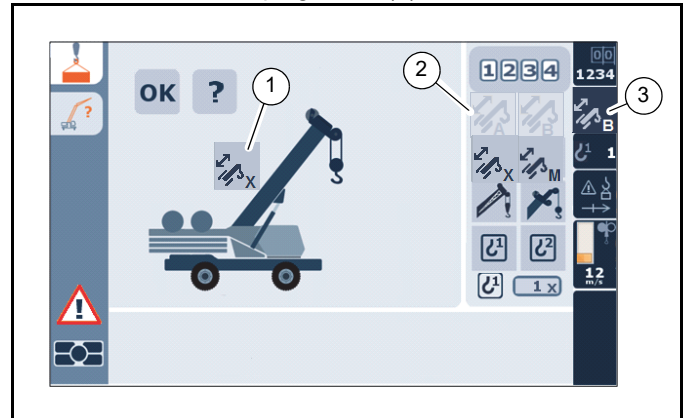


**All Modes Enabled - A & B Out of Sequence**

Select Telescoping Mode (load chart) on RCL. Selected mode displays in status bar (1).

Mode selection is grayed out (2) and not available if out of sequence or load chart not available.

Last confirmed telescoping mode (3) shown in status bar.



**RCL Display Setup Screens**

Telescoping Mode change requires rigging code confirmation. 4-digit rigging code is the same for all telescoping modes.

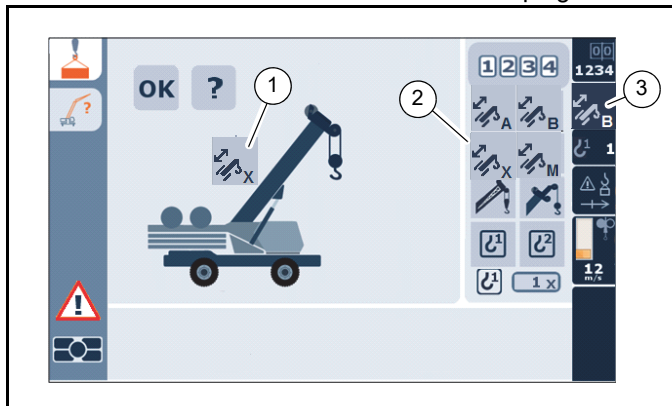
**All Modes Available and in Sequence**

Select Telescoping Mode (load chart) on RCL. Selected mode (1) displays on screen.

Telescope Mode/Load Chart (2) shows all modes enabled and in sequence.

Last confirmed telescoping mode (3) shown in status bar.

**NOTE:** RCL override does not effect Telescoping Mode.

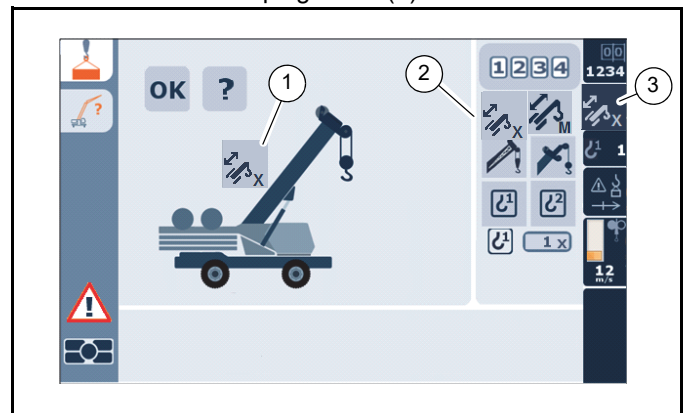


**A & B Modes Disabled - X Mode In Sequence**

Select Telescoping Mode (load chart) on RCL. Selected mode displays on screen(1).

A and B modes disabled. Telescope Mode/Load Chart (2) does not display disabled modes.

Last confirmed telescoping mode (3) shown in status bar.



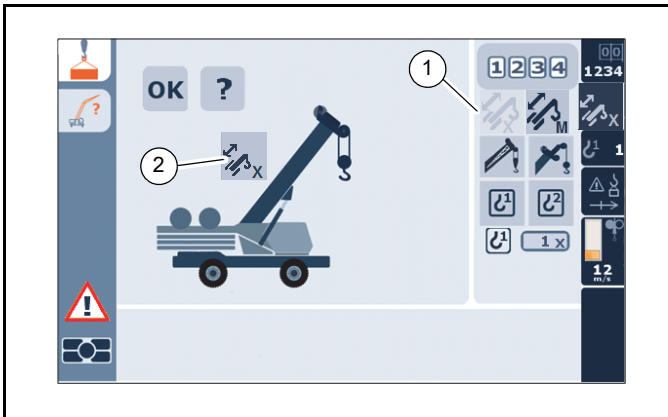


**A&B Modes Disabled - No Load Chart For Selected Rigging Code**

Example: Operator manually selects a rigging code for “On Rubber” using numeric spin boxes. The code is for Mode A, which is disabled.

Any enabled mode not available for selection is grayed out (1).

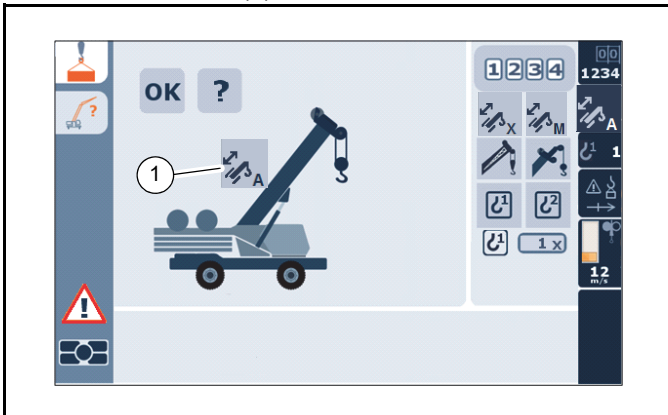
The selected mode (2) not available for the entered rigging code flashes.



**A & B Modes Disabled When “A” Mode Confirmed**

Example: Operator disables an automatic mode on the Telescoping Configuration Screen when mode is currently active on the Operating Screen.

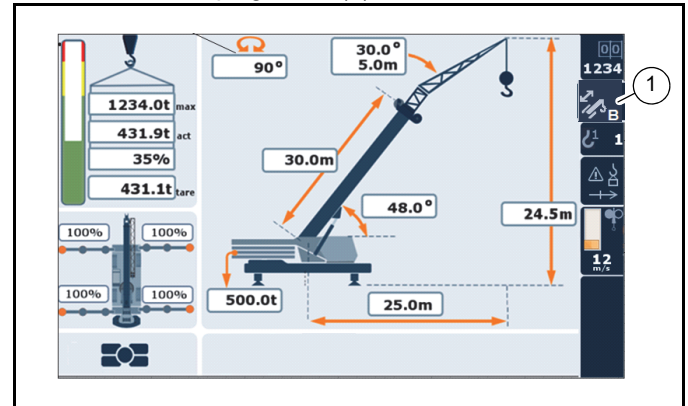
Flash selected mode (1), which was disabled.



**RCL Display Operating Screen**

**Confirmed Telescoping Mode**

Confirmed telescoping mode (1) shown in status bar.

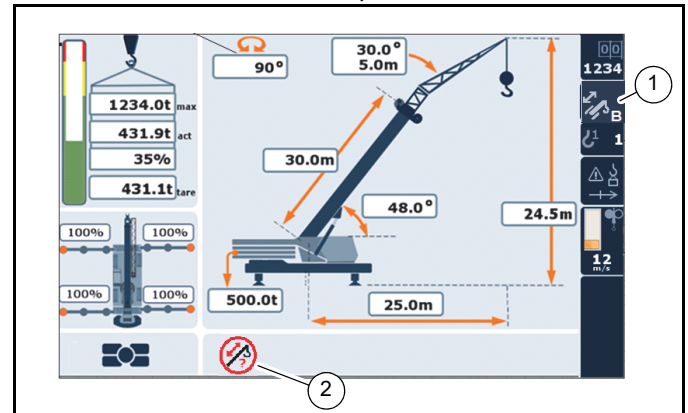


**Out of Sequence**

Confirmed telescoping mode (1) shown in status bar.

Out of sequence symbol (2) displayed. RCL is locked out with audible and visual indications.

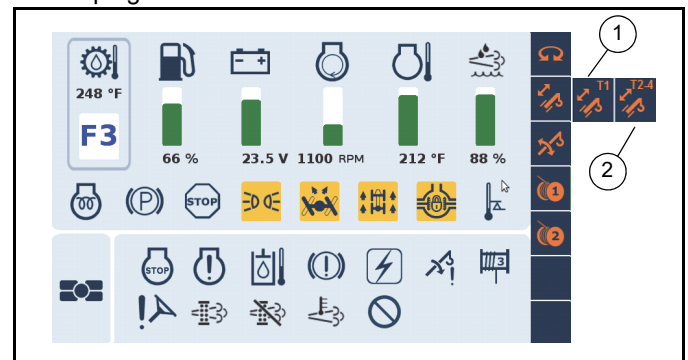
Select mode M in the RCL setup screen to recover.



**Operating Screen**

Mode M: active telescoping section T1 (1) or T2-4 (2) always shown in the status bar

Mode A, X, B: T1 (1) or T2-4 (2) only shown when telescoping is active.

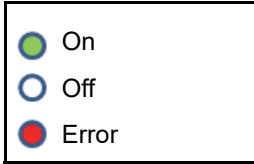


**Telescoping Menu Screens**

Display T1 (1) and overall lengths (2).

Display all section percentages (3). Percentage values flash in out of sequence sections.

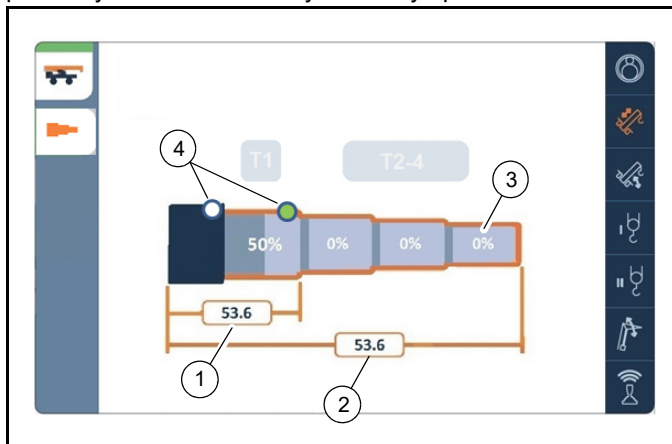
Display status of both proximity switches (4).



Proximity switch status will flash if cause of “out of sequence”.

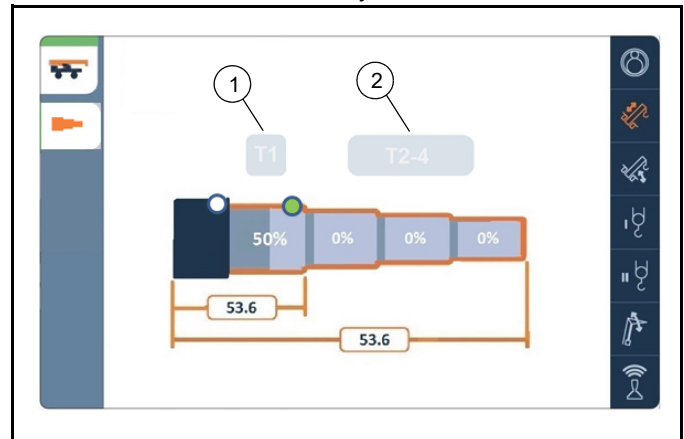
Boom representation graphic is static.

Section percentage values, section fill, boom lengths and proximity switches status dynamically update.



**Operating Display In Sequence. All except Mode M.**

T1 (1) and T2-4 (2) buttons are grayed out in all automatic modes A, X, and B. Buttons only selectable in mode M.

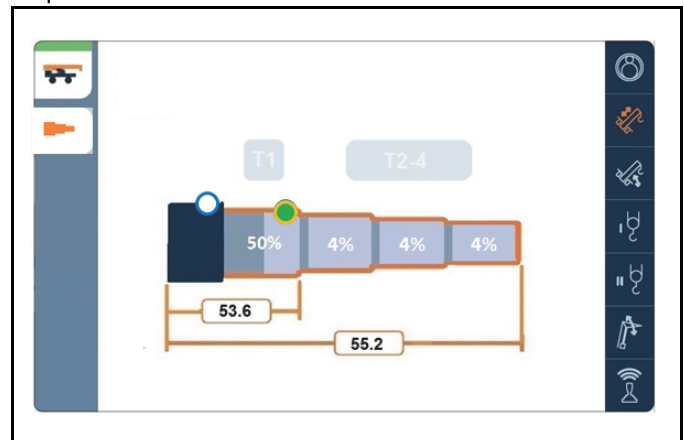


**Operating Display Out Of Sequence. All modes except M.**

When “out of sequence” jump (toggle) to this screen (one time only).

Percentage values flash in out of sequence sections.

Proximity switch status will flash if cause of “out of sequence”.

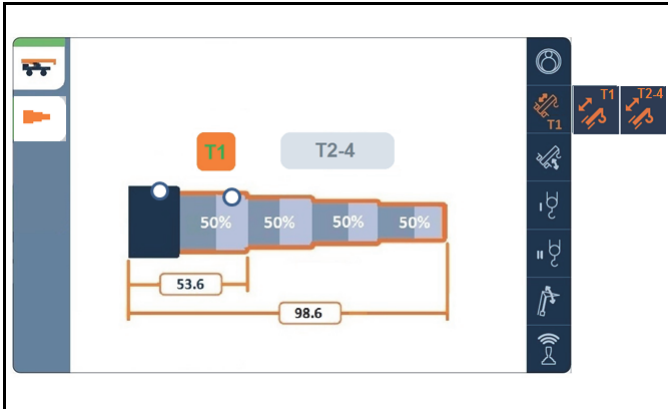


**Telescope Mode M**

When mode M is active and telescoping is enabled, jump (toggle) to this screen and force jog dial to operating display module (ODM).

Focus on desired telescoping section and activate it by pressing the enter button. Last active telescoping section displays in the status bar.

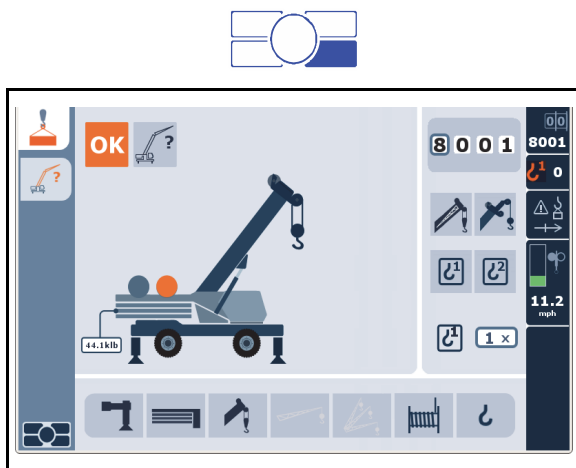
Operator may switch between T1 or T2-4.



**RCL Setup Wizard**

**NOTE:** When lifting with the optional 3.05 m (10 ft) heavy duty boom extension installed on the boom nose, operator must manually input the load chart rigging code into the RCL. The RCL Setup Wizard cannot be used to configure the RCL for this crane configuration. The rigging code is located at the top of each load chart.

The RCL can be set graphically, or by direct number input or rigging code. The rigging code is determined using the load chart. This screen always appears with some rigging code displayed, even if it does not match actual crane configuration.

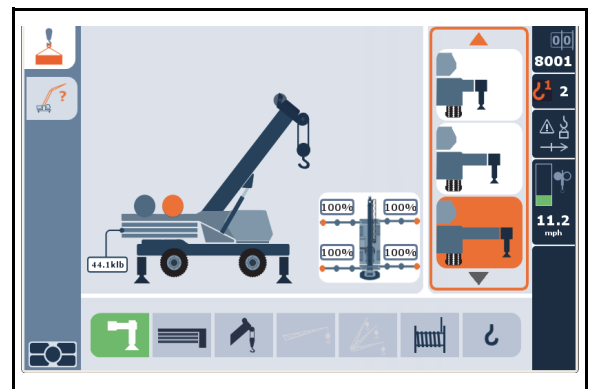
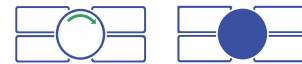


The RCL is working correctly if no error message displays. If any fault codes are present, the fault indicator on the main CCS screen will be illuminated in red.

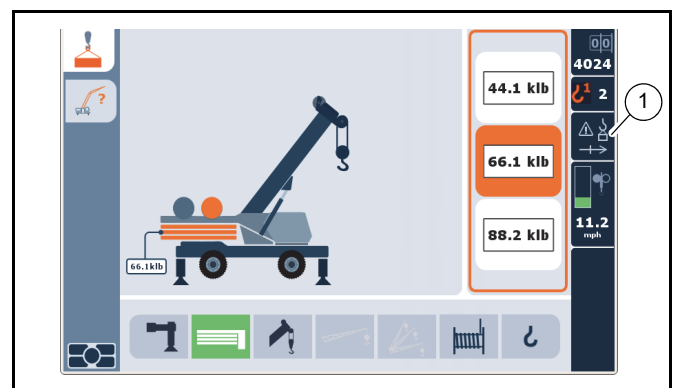
**NOTE:** If the RCL is not working correctly, do not start work with the crane but notify Manitowoc Crane Care.

**Set Counterweight**

When rigging is complete, toggle clockwise to exit the outrigger position and move on to setting the counterweight.



Toggle clockwise and select the counterweight icon. Available choices display on the right of the screen.



**NOTE:** When the RCL override icon (1) is flashing, it means the override switch was active at crane startup. In this case override is NOT active. To

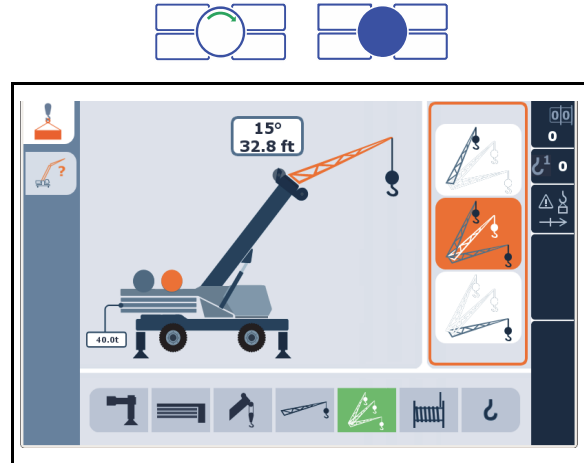
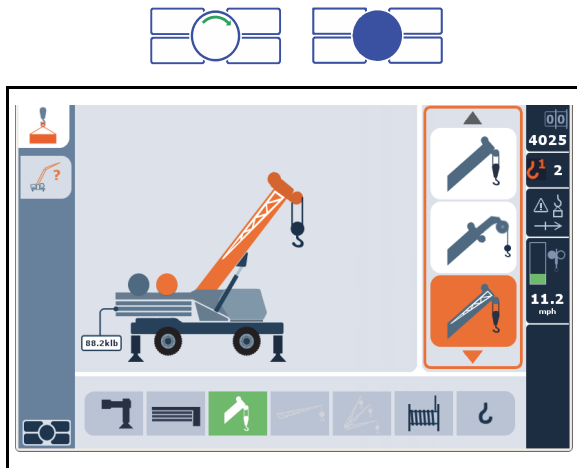
override the RCL, turn switch OFF for 1 second then ON again. The RCL will be bypassed.

**Set Jib Angle (if installed)**

Turn jog dial clockwise to program the jib angle after length is selected.

**Set Boom**

Turn jog dial clockwise to set boom, including aux nose and reeving options.



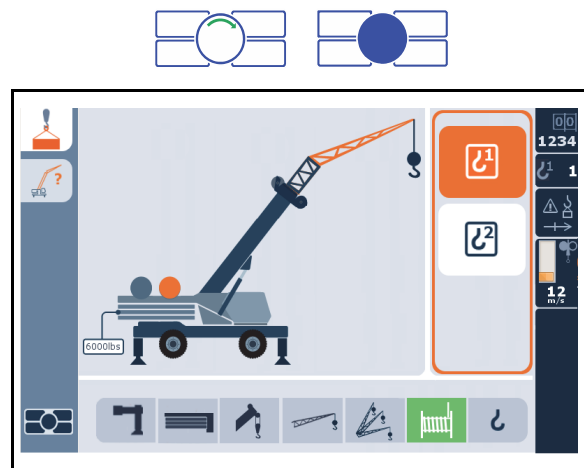
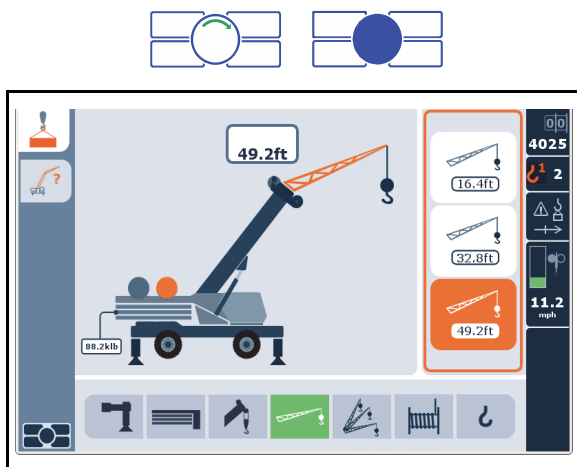
**NOTE:** If no jib configuration is chosen for the boom, the following selection will be for reeving.

**Hoist Selection**

Turn jog dial clockwise to select between main and auxiliary hoists.

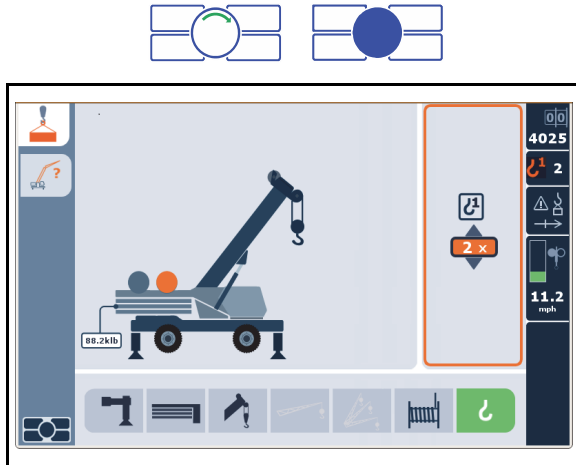
**Set Jib Length (if installed)**

Turn jog dial clockwise and select to determine and choose the length of the jib, including inserts.



### Reeving Selection

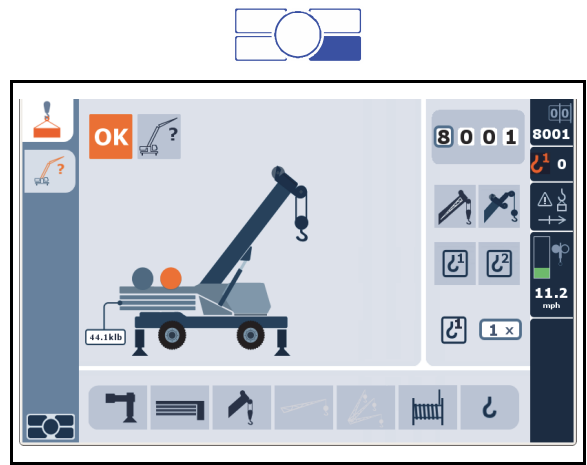
Turn jog dial clockwise to select the icon for reeving options. Press ENTER a second time and turn dial to change reeving number options.



Press ENTER button on Jog Dial to choose and set desired reeving option and move on to the next screen.

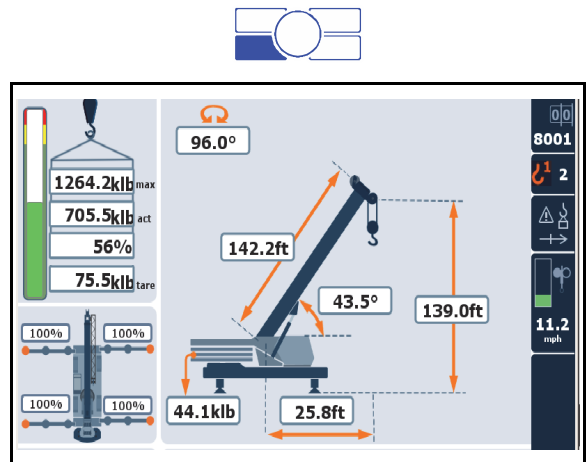
### Switch to RCL Home Screen Display

Press Screen Toggle button (4) (Figure 3-13) on the Jog Dial menu control to switch to the RCL main menu screen.



Press ENTER on Jog Dial or Menu button to access RCL Main Screen. This screen displays after key is turned on, but the operator must press the tab button to display tare value.

3



### 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 3-16) 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 3-16) on the RDM Navigation Control Pad.

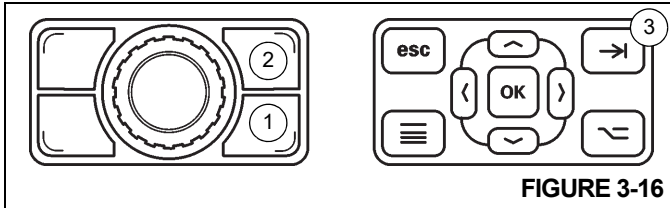


FIGURE 3-16

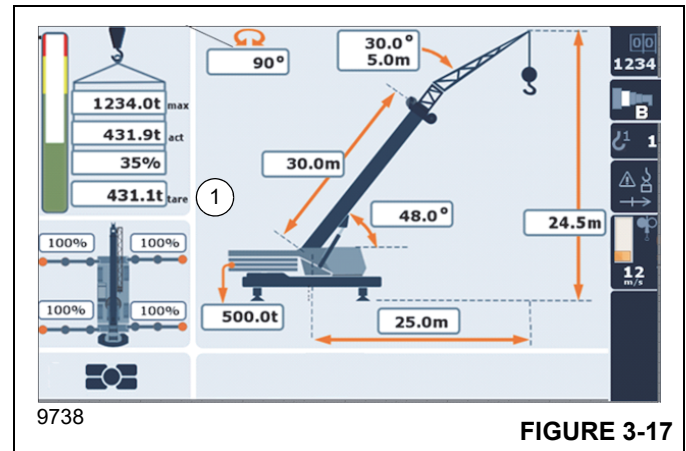
The tare weight (1, Figure 3-17) is shown below the percentage of the actual versus maximum percent load. The tare weight value equals the actual weight value until the tare weight is zeroed out. The operator sets the tare weight to

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.



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FIGURE 3-17

## CCS WORKING RANGE LIMITER (WRL)

### Introduction

The Working Range Limiter (WRL) is a feature of the crane control system that allows for the definition of obstacles or limits for crane operation. This definition can then be used by the crane control system to assist the operator with identifying the motion of crane with respect to these obstacles and limits.

In addition, if the WRL is configured to do so, the crane functions can be affected to slow and stop with respect to limitations; this behavior is referred to as lockout.

The following limitations are available for the WRL:

- Height Limitation: boom height limit can be defined for a maximum boom elevation.
- Boom Up/Down Limitation: boom up/down 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 aide, 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 lockout capability is utilized, crane functions are expected to be used with the same caution as if the lockout capability was not

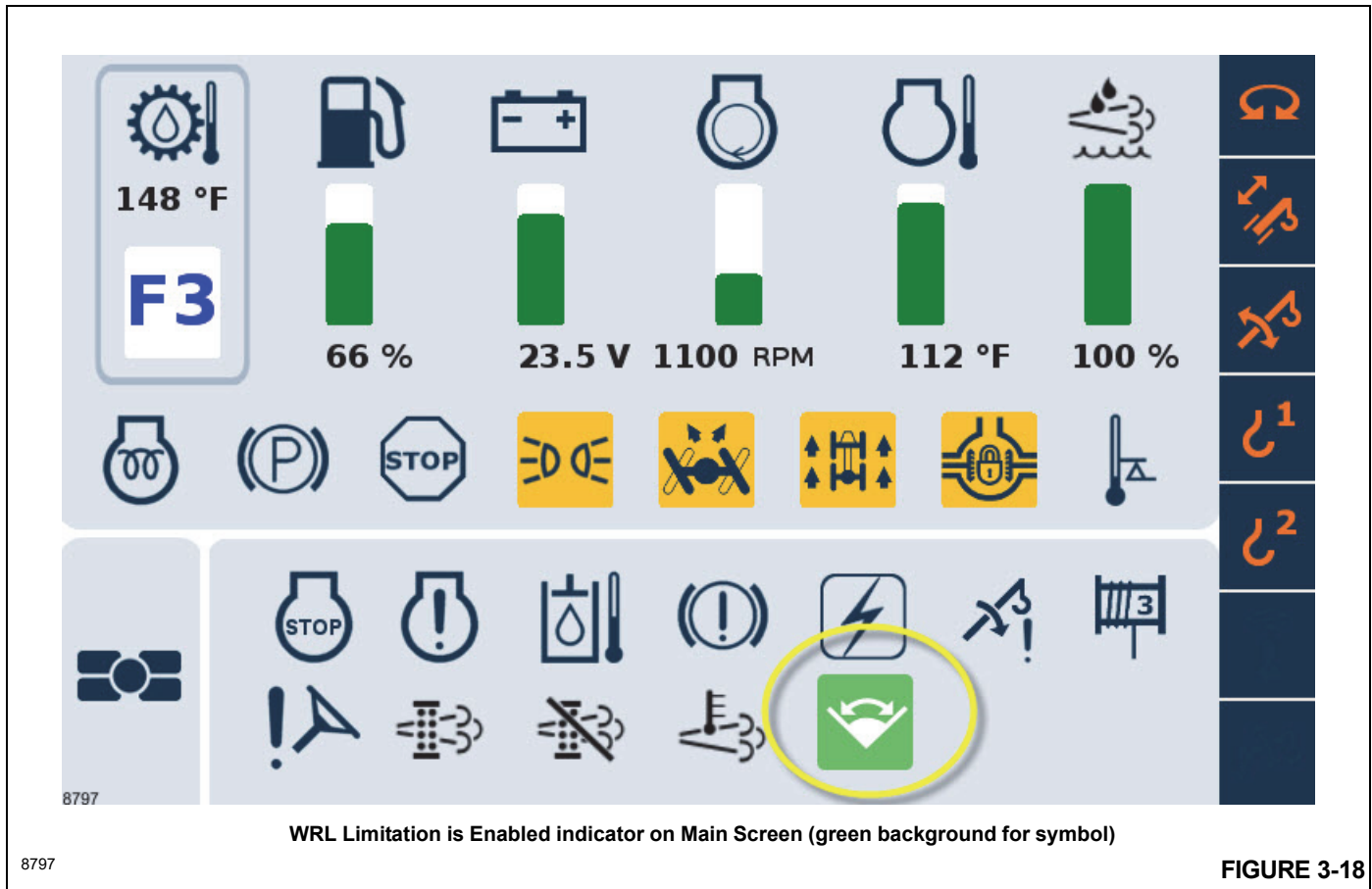
present. In particular, it must be noted that the swing function has a coasting or free-swing characteristic that will not be affected by the slow-down and lockout of the swing function. As such, swing speeds are to be no more than 1 degree of swing per second.

Turning off the power to the control system disables any WRL limitations.

### WRL Limitations

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. 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, 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, then, the use of the WRL involves steps to enable the limitation, define the limitation, and then limitations can become active once warnings are generated for the operator (based on the crane position).

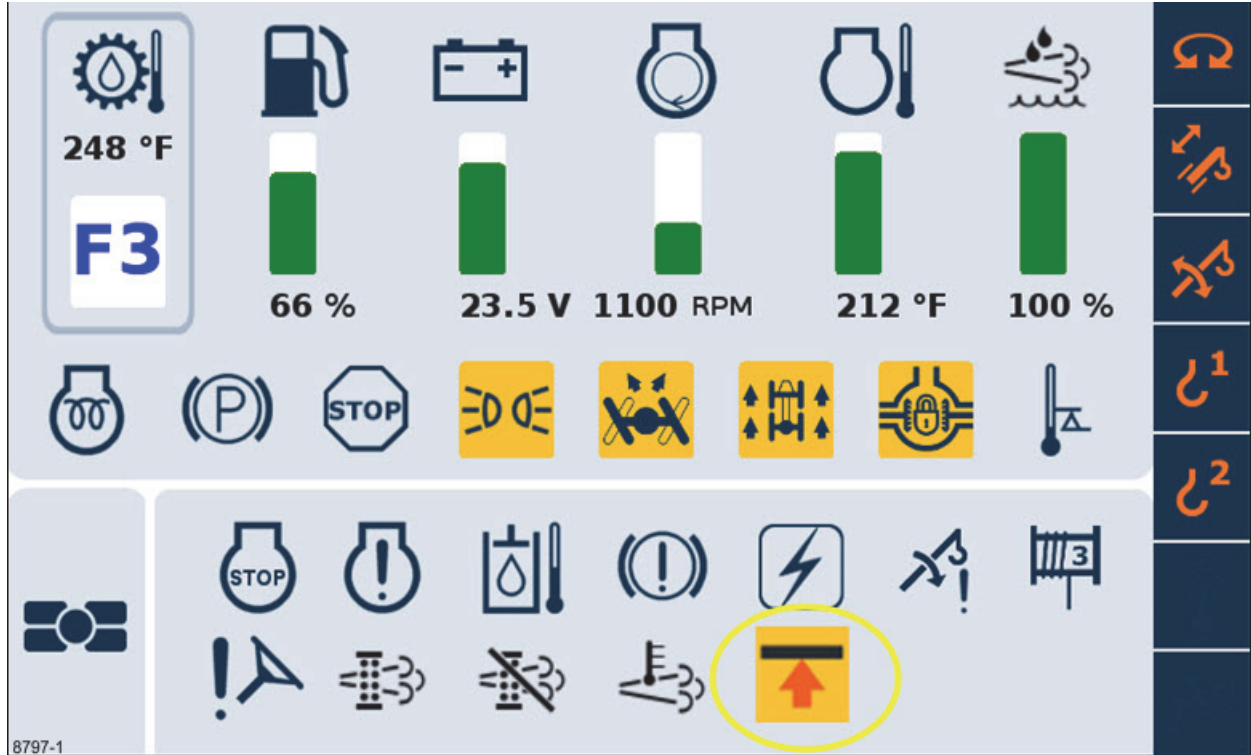
When any limitation is enabled (but none are active), the Main Screen shows an indicator. Figure 3-18 shows the Main Screen with the indicating symbol, which has a green-colored background, and the symbol is highlighted with a circle. If no limitations are enabled, then this same symbol is shown, but 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 3-19 shows the Main Screen example; the height limitation is active. There are similar symbols for the other limitations; Table 3-1: shows the boom up/down (boom angle) limitation active

symbol; the radius limitation active symbol; the swing limitation active symbol; the 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.










Height Limitation is Active indicator on Main Screen (amber-colored background for symbol)

8797-1

FIGURE 3-19

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Table 3-1: Active Indicator Symbols

Symbol	Description
	Height Limitation is Active indicator symbol (amber color)
	Boom Up/Down Limitation is Active indicator symbol (amber color)
	Radius Limitation is Active indicator symbol (amber color)
	Swing Limitation is Active indicator symbol (amber color)
	Wall Limitation is Active indicator symbol (amber color)

When a limitation is active, audible alarms are generated. Table 3-2: indicates the behavior of the audible alarm for the various limitations when the WRL is configured to only have an alarm (not lockout). When the WRL is configured for the lockout option, the alarm is generated based on when crane functions are being affected.

The operator should notice that all the audible alarm triggers use the values of 10 and 5. This may be 10 or 5 degrees, or it

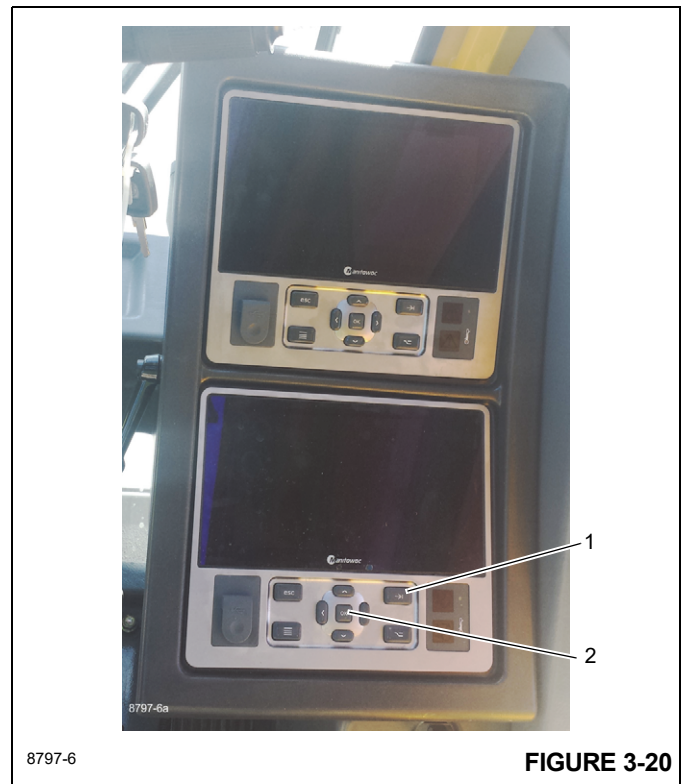
may be 10 or 5 ft distance. This is intentional so that the operator can continue to watch the crane operation and not have to look at the display (assuming the 10 and 5 values are remembered). Whenever slow beeping is heard, this will be a 10 threshold. Whenever fast beeping is heard, this will be a 5 threshold. Whenever there is a solid sound, this will signify being at the limitation.

Table 3-2: Alarm Characteristics

LIMITATION	POSITION	ALARM
Height Limitation	10 ft before limit	Slow beeping
	5 ft before limit	Fast beeping
	At limit	Solid sound
Boom Up/Down	10 deg before limit	Slow beeping
	5 deg before limit	Fast beeping
	At limit	Solid sound
Radius	10 ft before limit	Slow beeping
	5 ft before limit	Fast beeping
	At limit	Solid sound
Swing	10 deg before limit	Slow beeping
	5 deg before limit	Fast beeping
	At limit	Solid sound
Virtual wall	10 ft before limit	Slow beeping
	5 ft before limit	Fast beeping
	At limit	Solid sound

Note that the audible alarm can be canceled. It is the Tab button on the display. Refer to item 1 in Figure 3-20. It can be canceled once the boom is no longer being moved. When boom motion again becomes apparent in the control system, the audible alarm will be restored.

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 3-21 shows the Main Screen example; the swing limit has been reached. There are similar symbols for the other limitations; Table 3-3: shows the boom up/down (boom angle) limitation active symbol; the radius limitation active symbol; the height limitation active symbol; and the 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.



Item	Description
1	Tab Button
2	OK Button

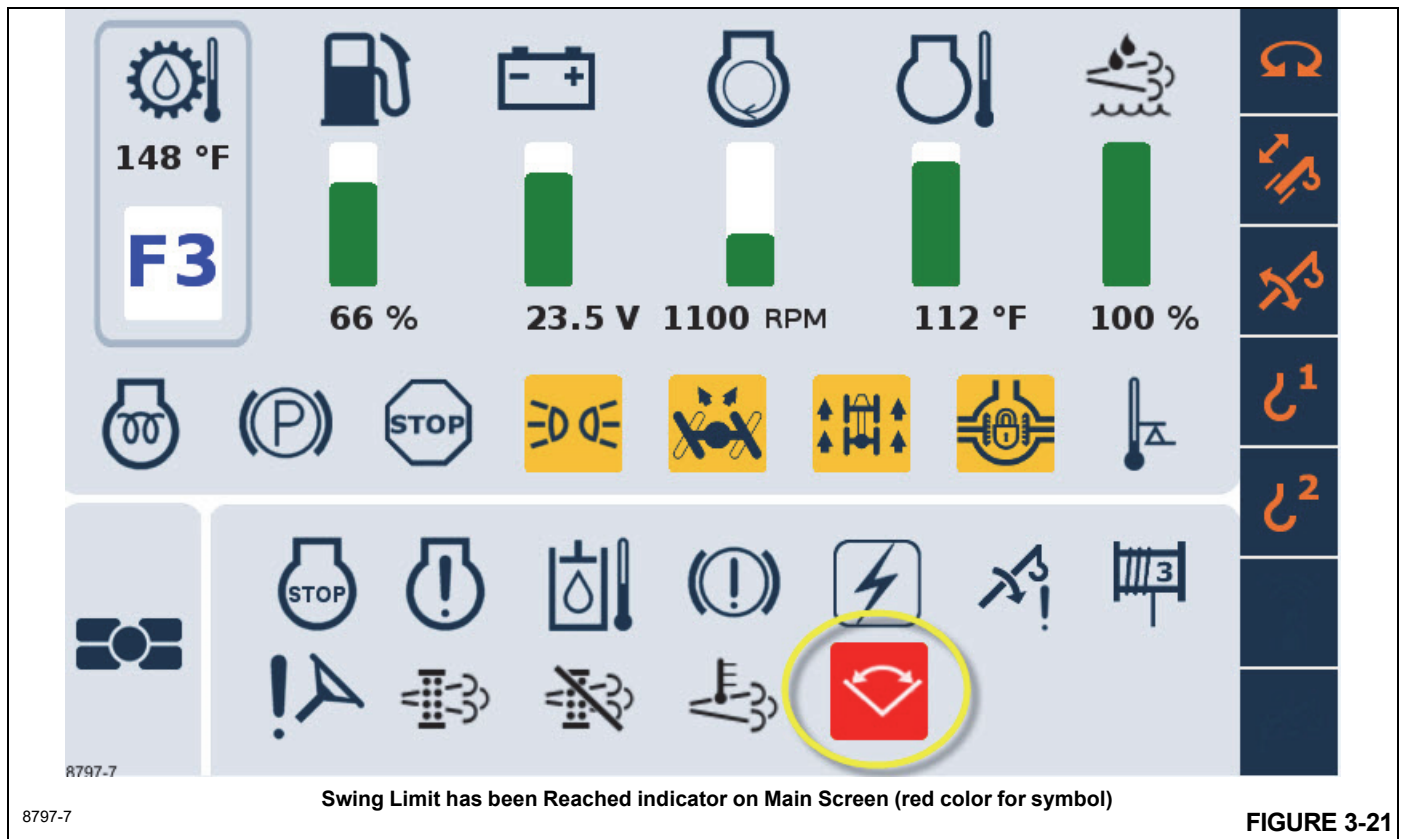


Table 3-3: Limit Reached Indicator Symbols

Symbol	Description
	Swing Limit has been reached indicator symbol (red).
	Boom Up/Down Limit has been reached indicator symbol (red).
	Radius Limit has been reached indicator symbol (red).
	Height Limit has been reached indicator symbol (red).
	Wall Limit has been reached indicator symbol (red).

### Accessing Limitation Screens

Each of the limitations for the WRL has a screen on the display for the enabling and definition of the limitation. To access these screens, the Menu function is used with the display. Once the main menu screen is shown, the WRL

limitations are shown as a group, and one of the limitations can then be selected to work with that limitation screen. This WRL sub-menu is highlighted in Figure 3-22 with an ellipse outline.



### Height Limitation

If the Height Limitation is selected from the menu of WRL limitations, then the Height Limitation Screen will be shown (Figure 3-23).

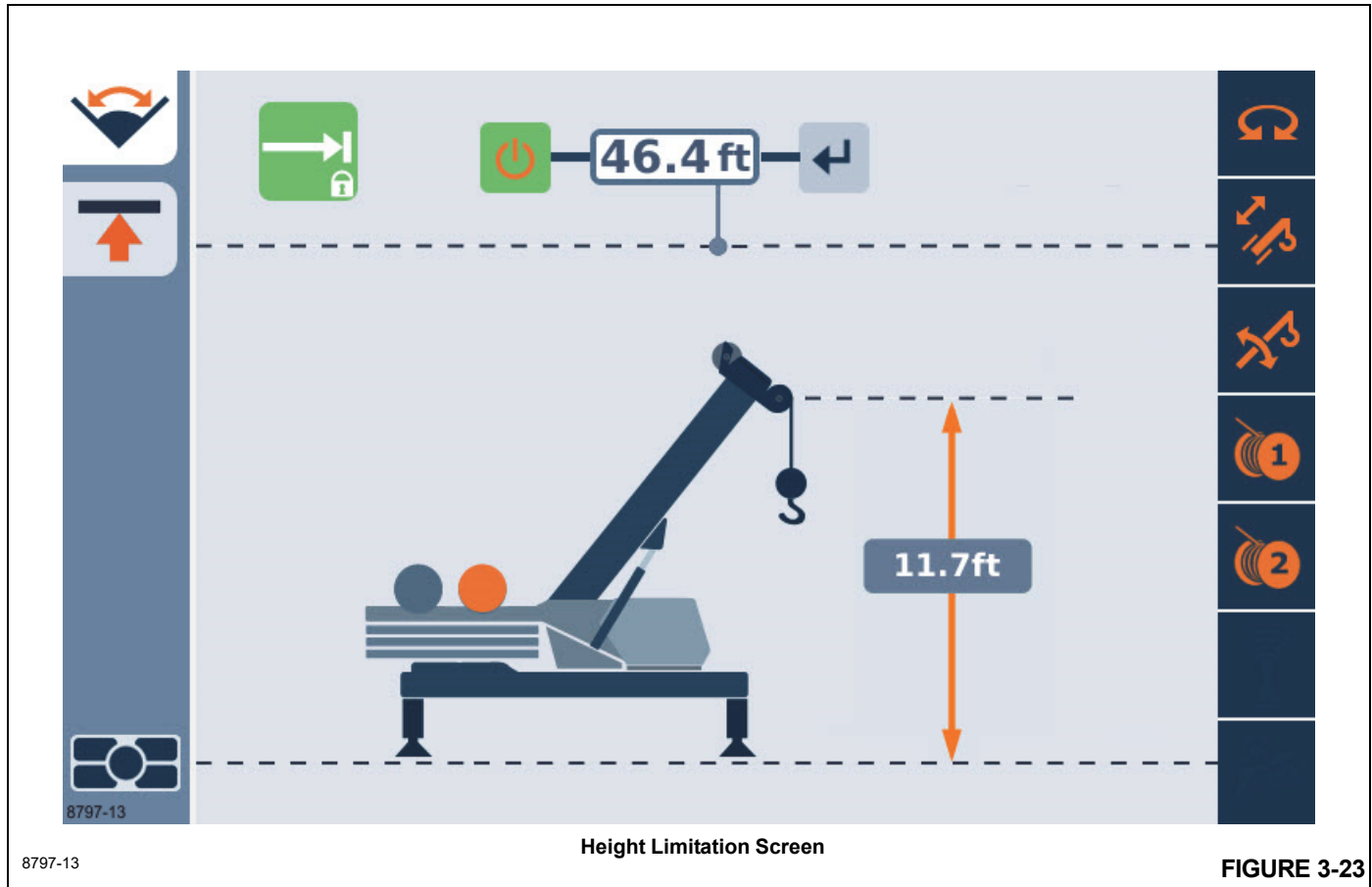



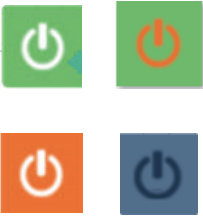


FIGURE 3-23

Using the Left Arrow and Right Arrow function on the display 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 3-23, one can see that the




symbol is selected since it has the orange color highlighting. Table 3-4: shows the objects available on the Height Limitation Screen.

Table 3-4: Screen Symbols

Symbol	Description
	<p>Lockout symbol - this symbol indicates the selection for affecting crane functions (lockout) or just alarm/warning. This symbol will not appear if the WRL is not configured for the lockout option. Furthermore, in some countries, regulations may require the use of the lockout configuration, and lockout will always be enabled (so it may not be able to change from lockout to alarm/warning). The selection for this option is toggled with an OK button, item 2, Figure 3-20. The top symbol indicates that the crane functions will be affected (lockout). The bottom symbol indicates that the crane functions will not be affected (but warnings will still be indicated).</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, item 2, Figure 3-20. 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 (item 2, Figure 3-20) 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>

### ***Height Limitation Procedure by Crane Position***

To define and enable the 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 3-23) is to be shown on the display.
3. Use the Left Arrow and/or Right Arrow function to highlight the Lockout symbol (the green symbol, refer to Table 3-4:, will turn orange). If this symbol is not shown, then this can be ignored (WRL configured to not enable the lockout option).
4. Use an OK button (item 2, Figure 3-20) to change the lockout option to either affect controls (including lockout), if desired, or to just get warning indicators from the display.
5. Use the Right Arrow function to highlight the Enable symbol.
6. 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).
7. Use the Right Arrow function twice to skip the Limitation Value and then highlight the Accept Crane Position symbol (refer to Table 3-4:). Use an OK button (item 2, Figure 3-20) to accept the current crane position (such as the 11.7 ft value shown in Figure 3-23) 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 cease the alarm. Refer to Table 3-2: for how the alarm performs. Refer to Figure 3-20 for the button to cancel an audible alarm (once boom motion has stopped).
8. The Height Limitation is now defined and enabled. Crane operations can be resumed with the WRL working with this specified limitation.

### ***Height Limitation Procedure by Value***

To define and enable the Height Limitation using a "typed in" value of tip height as the limitation, the following steps can be used:

1. The Height Limitation Screen (Figure 3-23) is to be shown on the display.
2. Use the Right Arrow function once to highlight the Enable symbol (refer to Table 3-4:).
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 3-20) 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 cease the alarm, if needed. Refer to Table 3-2: for how the alarm performs when the lockout option is not used. Refer to item 1, Figure 3-20 for the button to cancel an audible alarm (once boom motion has ceased).
5. The Height Limitation is now defined and enabled. Crane operations can be resumed with the WRL working with this specified limitation.

### ***Height Limitation Disable Procedure***

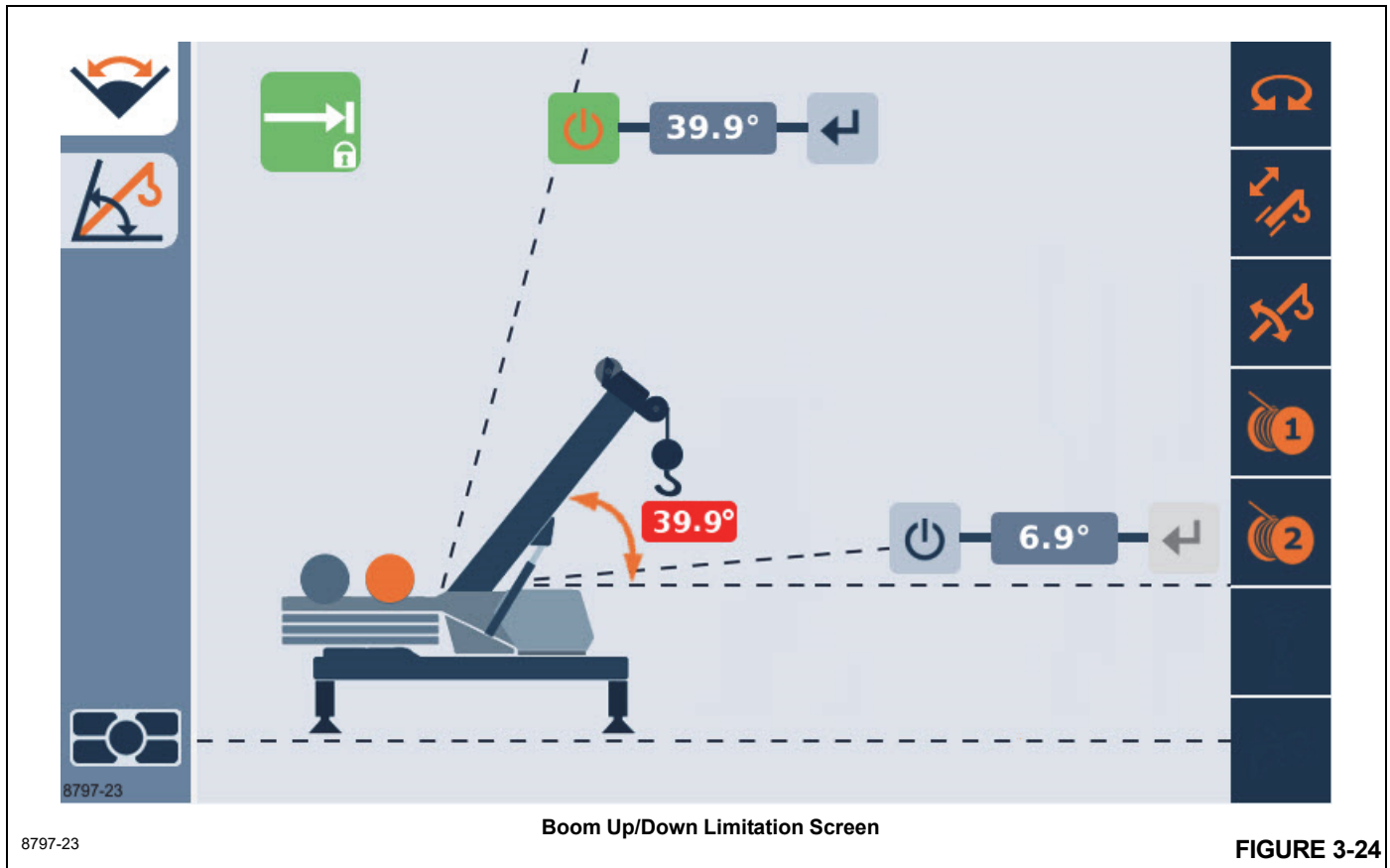
To disable an active Height Limitation, the following steps can be used (note that turning off the power to the control system also disables the WRL limitations):

1. The Height Limitation Screen (Figure 3-23) 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 3-4:).
3. Use an OK button (item 2, Figure 3-20) to set the symbol to the limitation being disabled - it will not have the green color when it is disabled.

### ***Boom Up/Down Limitation***

If the Boom Up/Down Limitation is selected from the menu of WRL limitations, then the Boom Up/Down Limitation Screen will be shown (Figure 3-24).






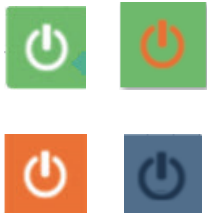

3

Using the Left Arrow and Right Arrow function on the display 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 3-24, one can see that the


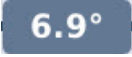



symbol for the maximum boom angle is selected since it has the orange color highlighting. Table 3-4: shows the objects available on the Boom Up/Down Limitation Screen. Note that the boom angle cannot be typed in (as is possible with the Height Limitation).

Table 3-5: Screen Symbols

Symbol	Description
	<p>Lockout symbol - this symbol indicates the selection for affecting crane functions (lockout) or just alarm/warning. This symbol will not appear if the WRL is not configured for the lockout option. Furthermore, in some countries, regulations may require the use of the lockout configuration, and lockout will always be enabled (so it may not be able to change from lockout to alarm/warning). The selection for this option is toggled with an OK button (item 2, Figure 3-20). The top symbol indicates that the crane functions will be affected (lockout). The bottom symbol indicates that the crane functions will not be affected (but warnings will still be indicated).</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. 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 (item 2, Figure 3-20), 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 Up/Down Limitation Screen (Figure 3-24) is to be shown on the display.
3. Use the Left Arrow and/or Right Arrow function to highlight the Lockout symbol (orange color; refer to Table 3-5:). If this symbol is not shown, then only alarm/warning option is available).
4. Use an OK button (item 2, Figure 3-20) to change the lockout option to either affect controls (including lockout), if desired, or to just get warning indicators from the display. Again, this step can be ignored if this symbol is not shown.
5. Use the Right Arrow function to highlight the Enable symbol (refer to Table 3-5:).
6. 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).
7. Use the Right Arrow function once to highlight the upper boom angle Accept Crane Position symbol (refer to Table 3-5:). Use an OK button (item 2, Figure 3-20) to accept the current crane position (such as the 39.9 deg value shown in Figure 3-24) 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 cease the alarm. Refer to Table 3-2: for how the alarm performs when the lockout option is not used. Refer to Figure 3-20 for the button to cancel an audible alarm (once boom motion has stopped).
8. 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 Up/Down Limitation Screen (Figure 3-24) is to be shown on the display.

3. Use the Left Arrow and/or Right Arrow function to highlight the Lockout symbol (orange color; refer to Table 3-5:). If this symbol is not shown, then only alarm/warning option is available).
4. Use an OK button to change the lockout option to either affect controls (including lockout), if desired, or to just get warning indicators from the display. Again, this step can be ignored if this symbol is not shown.
5. Use the Right Arrow function to skip the Boom Up Limitation symbols and then highlight the Boom Down Enable symbol (refer to Table 3-5:).
6. Use an OK button (item 2, Figure 3-20) 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).
7. Use the Right Arrow function once to highlight the lower boom angle Accept Crane Position symbol (refer to Table 3-5:). Use an OK button to accept the current crane position (such as the 6.9 degree value shown in Figure 3-24) 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 cease the alarm. Refer to Table 3-2: for how the alarm performs when the lockout option is not used. Refer to Figure 3-20 for the button to cancel an audible alarm (once boom motion has stopped).
8. The Boom Down Limitation is now defined and enabled. Crane operations can be resumed with the WRL working with this specified limitation.

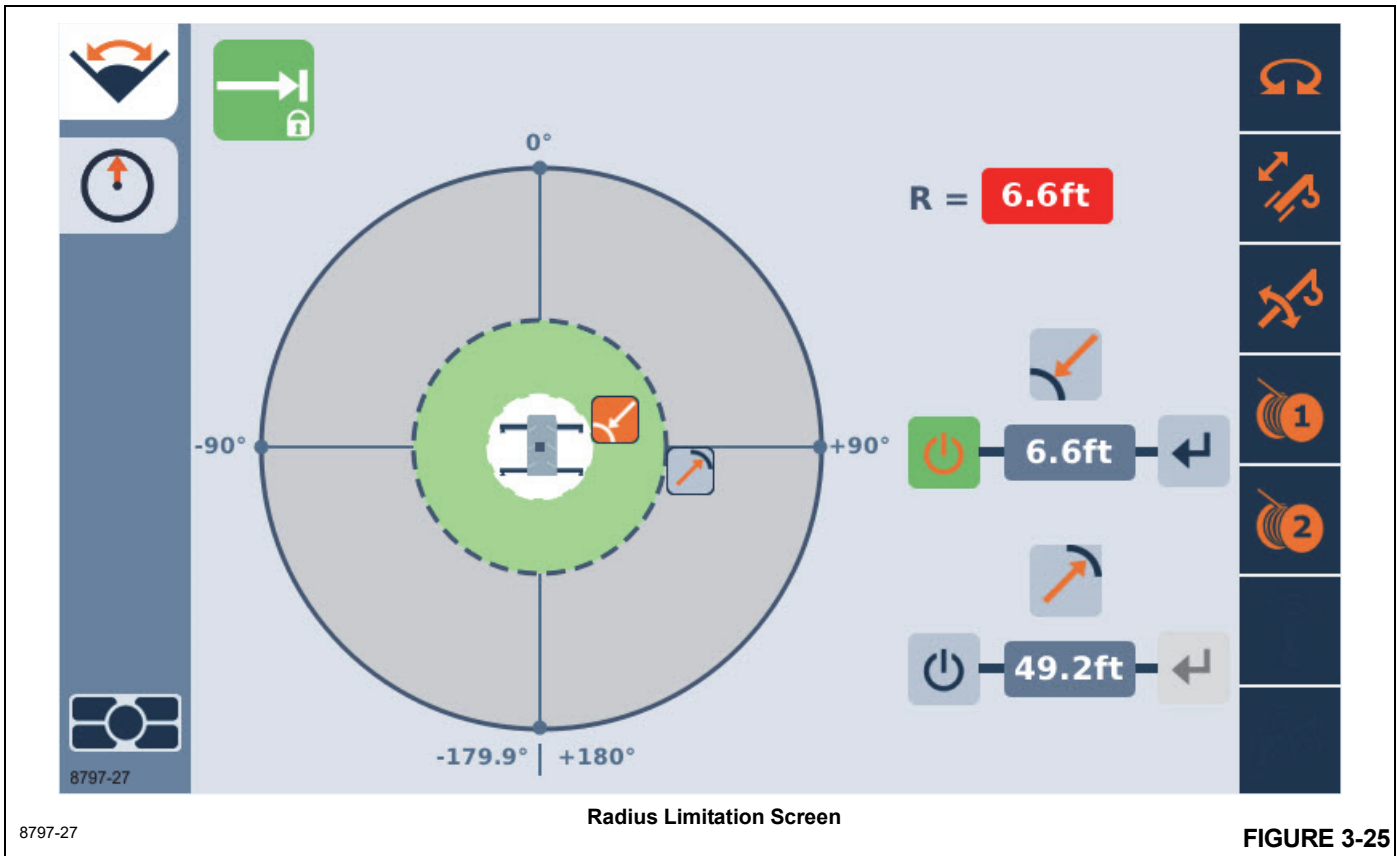
### ***Boom Up/Down Limitation Disable Procedure***

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 3-24) 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 3-5:).
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.

### **Radius Limitation**

If the Radius Limitation is selected from the menu of WRL limitations, then the Radius Limitation Screen will be shown (Figure 3-25).



Radius Limitation Screen



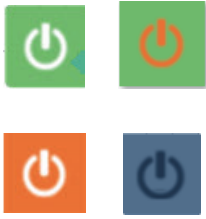



FIGURE 3-25

Using the Left Arrow and Right Arrow function on the display 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 3-25, one can see that the






symbol for minimum radius is selected since it has the orange color highlighting. Table 3-6: shows the objects available on the Radius Limitation Screen. Note that the boom angle cannot be typed in (as is possible with the Height Limitation).

Table 3-6: Screen Symbols

Symbol	Description
 	<p>Lockout symbol - this symbol indicates the selection for affecting crane functions (lockout) or just alarm/warning. This symbol will not appear if the WRL is not configured for the lockout option. Furthermore, in some countries, regulations may require the use of the lockout configuration, and lockout will always be enabled (so it may not be able to change from lockout to alarm/warning). The selection for this option is toggled with an OK button (item 2, Figure 3-20). The top symbol indicates that the crane functions will be affected (lockout). The bottom symbol indicates that the crane functions will not be affected (but warnings will still be indicated).</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 3-25) is to be shown on the display.
3. Use the Left Arrow and/or Right Arrow function to highlight the Lockout symbol (orange color; refer to Table 3-6:). If this symbol is not shown, then only alarm/warning option is available).
4. Use an OK button to change the lockout option to either affect controls (including lockout), if desired, or to just get warning indicators from the display. Again, this step can be ignored if this symbol is not shown.
5. Use the Right Arrow function to highlight the inner radius Enable symbol.
6. Use an OK button (item 2, Figure 3-20) 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).
7. Use the Right Arrow function once to highlight the inner radius Accept Crane Position symbol (refer to Table 3-6:). Use an OK button to accept the current crane position (such as the 6.6 ft value shown in Figure 3-25) 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 cease the alarm. Refer to Table 3-2: for how the alarm performs when the lockout option is not used. Refer to Figure 3-20 for the button to cancel an audible alarm (once boom motion has stopped).
8. 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 3-25) is to be shown on the display.

3. Use the Left Arrow and/or Right Arrow function to highlight the Lockout symbol (orange color; refer to Table 3-6:). If this symbol is not shown, then only alarm/warning option is available).
4. Use an OK button (item 2, Figure 3-20) to change the lockout option to either affect controls (including lockout), if desired, or to just get warning indicators from the display. Again, this step can be ignored if this symbol is not shown.
5. Use the Right Arrow function to skip the Inner Radius symbols and then highlight the Outer Radius Enable symbol.
6. 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).
7. Use the Right Arrow function once to highlight the outer radius Accept Crane Position symbol (refer to Table 3-6:). Use an OK button to accept the current crane position (such as the 49.2 ft value shown in Figure 3-25) 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 3-2: for how the alarm performs when the lockout option is not used. Refer to Figure 3-20 for the button to cancel an audible alarm (once boom motion is no longer apparent).
8. The Outer Radius Limitation is now defined and enabled. Crane operations can be resumed with the WRL working with this specified limitation.

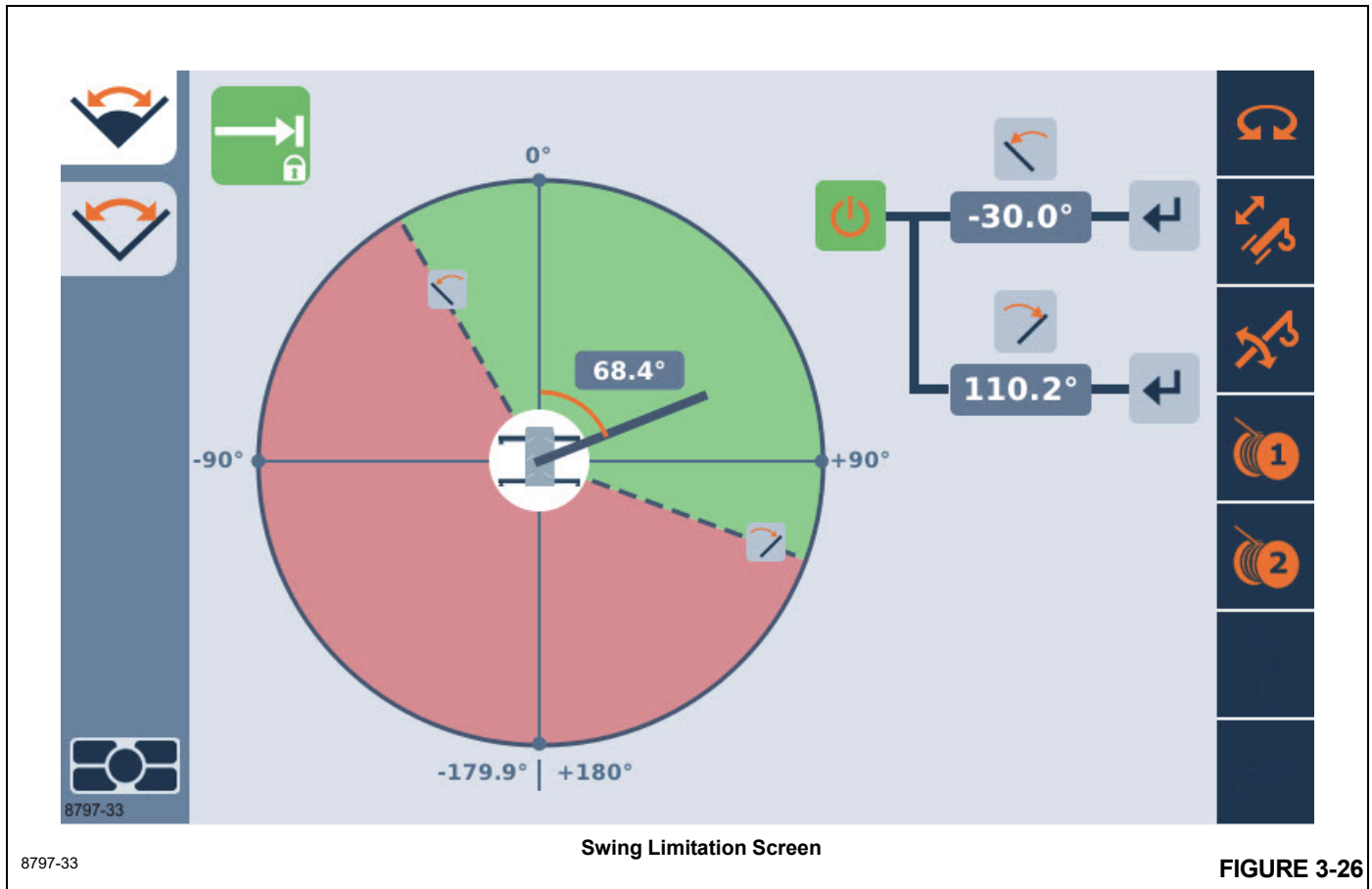
### ***Radius Limitation Disable Procedure***

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 3-25) 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 3-6:).
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**

If the Swing Limitation is selected from the menu of WRL limitations, then the Swing Limitation Screen will be shown (Figure 3-26).



3

Using the Left Arrow and Right Arrow function on the display 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 3-26, one can see that the



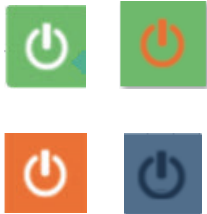





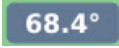
 symbol is selected since it has the orange color highlighting. Table 3-7: shows the objects available on the Swing Limitation Screen.

Table 3-7: Screen Symbols

Symbol	Description
	<p>Lockout symbol - this symbol indicates the selection for affecting crane functions (lockout) or just alarm/warning. This symbol will not appear if the WRL is not configured for the lockout option. Furthermore, in some countries, regulations may require the use of the lockout configuration, and lockout will always be enabled (so it may not be able to change from lockout to alarm/warning). The selection for this option is toggled with an OK button (item 2, Figure 3-20). The top symbol indicates that the crane functions will be affected (lockout). The bottom symbol indicates that the crane functions will not be affected (but warnings will still be indicated).</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 3-26) is to be shown on the display.
3. Use the Left Arrow and/or Right Arrow function to highlight the Lockout symbol (orange color; refer to Table 3-7:). If this symbol is not shown, then only alarm/warning option is available).
4. Use an OK button (item 2, Figure 3-20) to change the lockout option to either affect controls (including lockout), if desired, or to just get warning indicators from the display. Again, this step can be ignored if this symbol is not shown.
5. Use the Right Arrow function to highlight the Enable symbol (refer to Table 3-7:).
6. 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).
7. Use the Right Arrow function once to highlight the swing left Accept Crane Position symbol (refer to Table 3-7:). Use an OK button to accept the current crane position (such as the 68.4 deg value shown in Figure 3-26) 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 cease the alarm. Refer to Table 3-2: for how the alarm performs when the lockout option

is not used. Refer to Figure 3-20 for the button to cancel an audible alarm (once boom motion has stopped).

8. Position the crane to have the desired swing angle position for the swing right limitation. If lockout 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.
9. Use the Down Arrow function once to highlight the swing right Accept Crane Position symbol (refer to Table 3-7:). 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 cease the alarm.
10. The Swing Limitation is now defined and enabled. Crane operations can be resumed with the WRL working with this specified limitation.

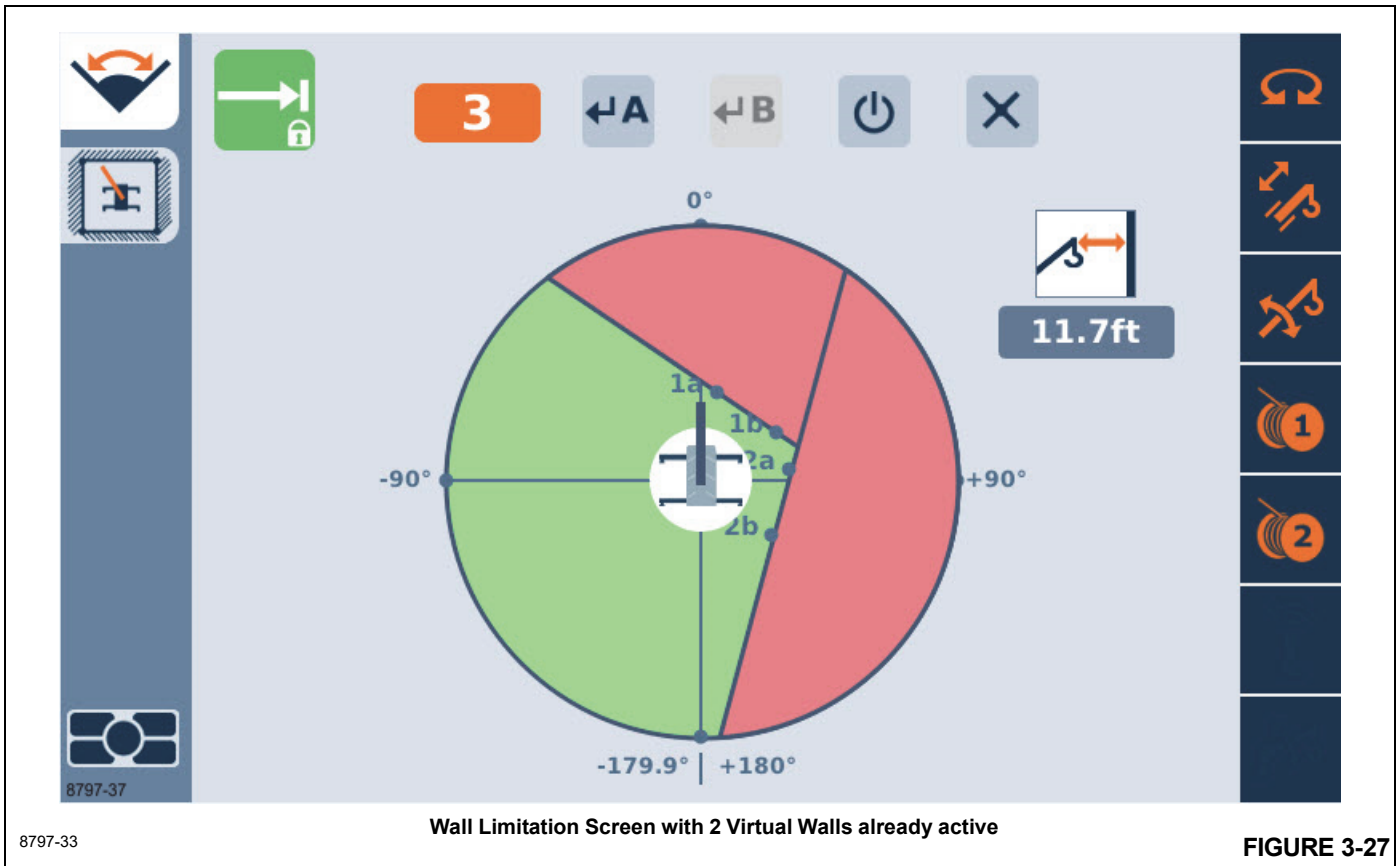
### **Swing Limitation Disable Procedure**

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 3-26) 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.

### **Wall Limitation**


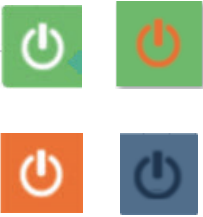




If the Wall Limitation is selected from the menu of WRL limitations, then the Wall Limitation Screen will be shown (Figure 3-27).




Using the Left Arrow and Right Arrow function on the display 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 3-27, one can see that the wall number symbol is selected since it has the orange color highlighting. Table 3-8: shows the objects available on the Wall Limitation Screen.

Table 3-8: Screen Symbols

Symbol	Description
	<p>Lockout symbol - this symbol indicates the selection for affecting crane functions (lockout) or just alarm/warning. This symbol will not appear if the WRL is not configured for the lockout option. Furthermore, in some countries, regulations may require the use of the lockout configuration, and lockout will always be enabled (so it may not be able to change from lockout to alarm/warning). The selection for this option is toggled with an OK button (item 2, Figure 3-20). The top symbol indicates that the crane functions will be affected (lockout). The bottom symbol indicates that the crane functions will not be affected (but warnings will still be indicated).</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 Wall Limitation Screen (Figure 3-27) is to be shown on the display (and in this case there would not be any virtual walls shown as defined or active).
2. Use the Left Arrow and/or Right Arrow function to highlight the Lockout symbol (orange color; refer to Table 3-8:). If this symbol is not shown, then only alarm/warning option is available).
3. Use an OK button (item 2, Figure 3-20) to change the lockout option to either affect controls (including lockout), if desired, or to just get warning indicators from the display. Again, this step can be ignored if this symbol is not shown.
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 3-8:).
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 of '1a'.
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 3-8:).
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 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 3-27). 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 wall limitation, so alarms are most likely sounding. The boom can now be moved away from the wall to cease the alarm. Refer to Table 3-2: for how the alarm performs when the lockout option is not used. Refer to Figure 3-20 for the button to cancel an audible alarm (once boom motion has stopped).
10. 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 Wall Limitation Screen (similar to Figure 3-27) is to be shown on the display.
2. Use the Right Arrow function to highlight the Virtual Wall Number (refer to Table 3-8:).
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 3-20) 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 3-8:).
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 3-8:).
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 wall limitation, so alarms are most likely sounding. The boom can now be moved away from the wall to cease the alarm. Refer to Table 3-2: for how the alarm performs when the lockout option is not used. Refer to Figure 3-20 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.

**Wall Limitation Disable Procedure**

To disable the active Wall Limitation, the following steps can be used:

1. The Wall Limitation Screen (Figure 3-27) is to be shown on the display.
2. Use the Right Arrow function to highlight the Virtual Wall Number (refer to Table 3-8:).
3. If the wall number shown is not the correct number for wall to be disabled, use an OK button (item 2, Figure 3-20) 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. Use the Left Arrow and/or Right Arrow function to highlight the Enable symbol (refer to Table 3-8:).
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 Wall Limitation Procedure**

To delete a Virtual Wall the following steps can be used:

1. The Wall Limitation Screen (Figure 3-27) is to be shown on the display.
2. Use the Right Arrow function to highlight the Virtual Wall Number (refer to Table 3-8:).
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 3-8:). Use an OK button to delete the wall.

**ECONOMY MODE**

In Economy (ECO) Mode the crane software will control the throttle command to the engine over J1939. Based on the state of the crane and inputs from the throttle pedal and the Increment/Decrement Throttle 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.

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 joystick 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 active 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 cabin.

**Requirements**

ECO mode can be enabled by the crane operator on the Operating Display (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 had 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's 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's 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's 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 900 RPM when any crane function has been enabled.
- New feature added to Operating Display menu that allows user to turn on "ECO Mode" and set the operating RPM for the crane.
- When user turns ECO mode ON:



































- Crane ramps engine from idle to operating RPM using the first 15% of the joystick 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 RPM".
- Set point for engine operating speed is easily changed by the user.
- User can command additional engine speed at any time using the accelerator pedal.
- Lower idle speed is better for "creep speed" driving, and improves braking performance.

**Crane Control System (CCS) Symbols and Icons**

Symbol	Description	Symbol	Description
	3rd Wrap Warning		Bypass 3 Pressed
	4-Wheel Drive		Coolant Temp
	Auxiliary Hoist Status		Differential Lock
	Auxiliary Hoist Disabled		Engine Preheat
	Auxiliary Hoist Enabled		Engine Speed (RPM)
	Auxiliary Hoist Raise		Engine Warning (Error)
	Auxiliary Hoist Not In Use		Emergency Stop
	Auxiliary Hoist Lower		Fuel Level
	Battery Voltage		Hoist Limit Switch Shutdown

Symbol	Description	Symbol	Description
	Boom Lift Status		Hydraulic Oil Temp
	Boom No Load Chart		Information Group
	Bypass 1 Active		Jib Angle Difference
	Bypass 2 Active		Jib Angle Too High
	Bypass 3 Active		Jib Angle Too Low
	Bypass 1 Pressed		Jib Load Too High
	Bypass 2 Pressed		Jib No Load Chart
	Low Brake Pressure		Park Brake
	Low Steering Fluid Pressure		RCL Override
	Main Hoist Status		Status Light Bar Error
	Main Hoist Disabled		Swing Status
	Main Hoist Enabled		Swing Brake
	Main Hoist Raise		Swing Group
	Main Hoist Not In Use		SLI Early Warning
	Main Hoist Lower		SLI Shutdown
	Marker/Position/Side Light		Swing Brake
	Rear Wheels Not Centered		Telescope Menu

Symbol	Description	Symbol	Description
	Oil Feed Filter Contaminated		Telescope Manual Select
	Outrigger Button		Telescope Configuration
	Outrigger Front Left		Telescope Status
	Outrigger Front Right		Tools Group
	Outrigger Group		Transmission Temperature Warning
	Outrigger Rear Left		Transmission Status
	Outrigger Rear Right		WRL Area Limit
	WRL Height Limit		WRL Swing Angle Limit
	WRL Radius Limit		



## OPERATING PROCEDURES

### 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 your *Inspection and Lubrication Service Log*. One copy of the *Inspection and Lubrication Service Log* is provided in the original package of manuals shipped with the crane. Additional copies are available through the Grove distributor network.

### Fuel Supply

Fill fuel tank and ensure cap is on tight.

### Engine Oil

#### CAUTION

Do not overfill.

Check oil level in the crankcase and ensure 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 radiator coolant level and fill to the proper level. Do not overfill. Ensure radiator 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 ensure it is secure.

### Wire Rope

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

### Hook Block and 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 ensure 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 80 to 160 km (50 to 100 mi) 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 800 km (500 mi) thereafter.

### Safety Equipment

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

### Daily Lubrication

Ensure all components requiring daily lubrication have been serviced. Refer to *Maintenance and Lubrication*, page 5-1.

## Boom

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

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).

## 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.

A maintenance fault (Fault Code (FC) 5576) is initiated at the dirty filter restriction level, generating a blinking "Check Engine" light for 30 seconds at every key on until the intake air restriction drops below the dirty filter restriction threshold.

A severe warning fault (FC 3341) is initiated if the maintenance fault condition degrades to a severe restriction level for a given time period, generating a solid amber "Check Engine" light and initiating a progressive engine derate to protect engine from damage until intake restriction drops below dirty filter restriction threshold.

## Cold Weather Operation

The following recommendations are for operating Grove cranes in regions with ambient temperatures below -9°C (15°F) which are considered arctic.

**NOTE:** Additional information regarding cold weather operation is available through your Cummins dealer/service center under Service Bulletin 3379009.

Use particular care to ensure cranes operated in very cold temperatures are operated and maintained in accordance with procedures provided by Grove. Always ensure adequate lubrication during system warm-up and proper operation of all crane functions when operating in cold weather.

Regardless of crane lubricant viscosity, always follow cold weather start-up and operating procedures described in the *Operator Manual* to ensure adequate lubrication during system warm-up and proper operation of all crane functions, (Refer to *Arctic Lubricants and Conditions*, page 5-4).

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°C (-20°F) Package

- Battery heater
- Fuel line heater
- Engine hood insulation
- Fan clutch
- Radiator air shutters
- Air diverter
- Diesel fired cab heater
- Cold weather alternator
- Fluids suitable to -29°C (-20°F)
  - Arctic windshield washer fluid
  - Arctic fuel

### Down to -40°C (-40°F) Package

- Coolant heater (to circulate warm coolant through heaters and engine)
- Transmission heater
- Swivel heater
- Battery heater
- Fuel line 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°C (-40°F):
  - Arctic windshield washer fluid
  - Arctic fuel

Individual crane functions should be operated to ensure they are sufficiently warmed prior to performing a lift. Allow at least 30 minutes of engine run time for warm up.

Operation of cranes at full rated capacities in ambient temperatures between -9°C and -40°C (15°F and -40°F) or lower should be accomplished only by competent operators who possess the skill, experience, and dexterity to ensure smooth operation. Shock loading shall be avoided. See

Section 5 of this manual for more detailed information on operation of cranes down to -40°C (-40°F).

### Component 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 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, ensure fuel supply valve from heater fuel reservoir is turned to the ON position. Ensure battery disconnect switch is turned to the ON position and push the activation button at the heater control panel. A green light will illuminate indicating system is activated. The start-up and shutdown cycles may take approximately 2 minutes for initialization. Ensure 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 turn 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.

Ensure 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.

Ensure air diverter is switched to outside air intake in 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:

- Turn 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 down to an ambient temperature range from -40°C (-40°F) to 49°C (120°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 5-4 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, the engine warranty will be void. Engine performance will quickly deteriorate and it may stop running.

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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 taken 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, ensure 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

Operating transmission with a sump temperature below normal operating temperature 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. Engage parking brake and apply service brake.
2. Shift transmission into the highest gear and increase engine RPM to 1500 for 15 seconds, then allow engine RPM to return to idle.
3. Repeat Step 2 until transmission sump reaches normal operating temperature.

### Alternate Warm-up Procedures for Rough Terrain (RT) Cranes:

1. Setup crane on outriggers.
2. Engage transmission with 4-wheel drive selected (if equipped) and allow crane to run at idle until transmission sump reaches normal operating temperature.

**NOTE:** Warm-up operation of 4-wheel drive transmission engaged in 2-wheel drive only could cause transmission damage.

## Hoist

Warm-up procedures are recommended at every startup and required at ambient temperatures below 4°C (40°F).

### Warm-up Procedures:

1. Without operating the hoist function, warm the hydraulic oil (see *Hydraulic Oil System*, page 3-61).
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.

## 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 lift 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 lift 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 4-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 4-wheel drive transmission engaged in 2-wheel drive only could cause transmission damage.

## Hydraulic Oil System

### Operating Limits and Warm-up Procedures:

- **From 4°C to -10°C (40°F to 15°F):** Crane operation without a load is allowed with medium engine RPM and medium function speed (joystick 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.
- **From 10°C to 4°C (50°F to 40°F):** Crane operation with a load is allowed with medium engine RPM and medium function speed (joystick position) until fluid reaches at least 10°C (50°F).

- **From 95°C to 10°C (200°F to 50°F):** Crane operation with a load is allowed with no restrictions.

Above 95°C (200°F): No crane operation is allowed. Let hydraulic oil cool by running engine at idle with no functions actuated.

## 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 3-62.

### 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

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



## DANGER

Diesel engine exhaust can be harmful to your health. Only operate 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.

## CAUTION

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

Use correct grade of oil for prevailing temperature in the crankcase to prevent hard cranking. Diesel fuel should have a pour 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.

Ensure Battery Disconnect Switch handle (1) (Figure 3-28) is in the ON position (handle shown in the OFF position)

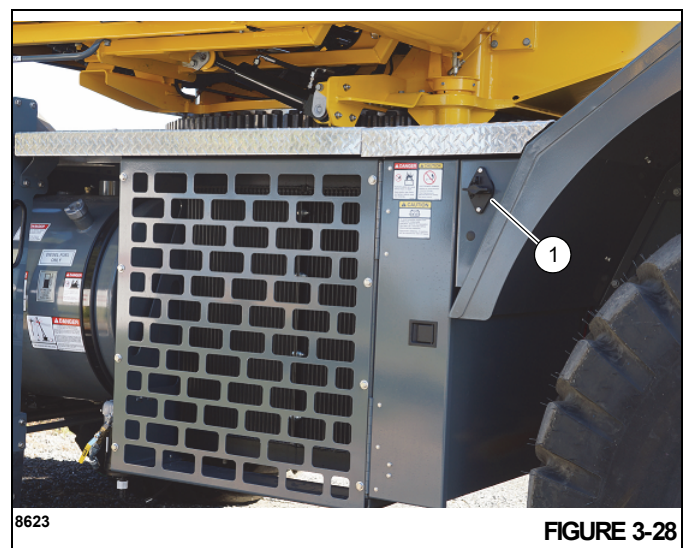


FIGURE 3-28

## Cold Engine

Engine warning and engine stop indicators illuminate and go off in sequence after about two seconds (as a check) when key is first turned on. If an indicator comes on and continues to blink after initial start-up, there is a problem that needs to be corrected. If engine warning icon is selected, a screen displays engine error codes.

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

1. Ensure emergency stop switch is not pressed.
2. Set parking brake ON and place transmission shift lever to Neutral.

**NOTE:** Engine will not crank unless transmission shift lever is in neutral.

**NOTE:** Engine “wait to start” indicator located on top left side of front console illuminates amber when ignition is turned to the on position. Do not crank engine until indicator turns off.

3. Turn key to first position. The CCS screen will provide data for various engine systems and alert operator to any detected fault codes.
4. Sound horn by pressing button on right joystick Figure 3-6.
5. Turn ignition switch to start (far right position). Release immediately when engine starts. Do not push or hold the throttle down. ECM automatically provides proper amount of fuel to start engine.

### CAUTION

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

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

## Idling Engine

Idling 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.

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

## 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.

## 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. Position ignition switch OFF (vertical position).
3. Drain fuel filter-water separator.

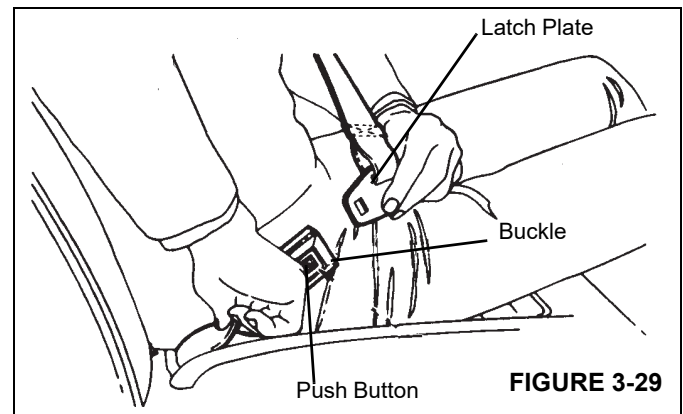
## Battery Disconnect



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

## Crane Travel Operation

### 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 3-29.

- 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

##### Inadvertent Operation Hazard!

Before traveling, ensure crane functions are fully disabled. The crane function enable switch is a spring return switch and cannot be put in a specific OFF position. This will prevent inadvertent operation of craning functions due to bumping controllers while traveling.

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

Although GRT machines 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 lockout will occur, making crane subject to tipping on uneven surfaces. Center boom over front, disable swing functions, and engage Turntable Lock Pin.

Fully retract boom. 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 cable(s) 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 slightly above horizontal.

Fully retract outrigger jacks and properly store pads.

Disengage pumps (if applicable) for extended traveling.

#### 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 pintle hook height, or severe damage may occur to the drivetrain.

Do not tow or pull by attaching to tie-down lugs unless attaching point is no higher than pintle hook height.

Use four-wheel drive when greater traction is necessary to avoid severe damage to the drivetrain.

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

- Use four-wheel drive only when greater traction is necessary. (Refer to *Four-Wheel Drive Operation*, page 3-68 for operating instructions.)
- Ensure 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.

Owner/lessee must take appropriate measures to ensure all persons operating or working with affected models are in compliance with Grove recommendations. Operator of the crane assumes responsibility for determining suitability of traveling conditions. Traveling under controlled conditions specified in these guidelines, must be conducted with the utmost diligence and care to ensure safety of all personnel performing the operation and/or working around the crane.

### 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:

- Ensure boom is in a horizontal position and not elevated above 0°.
- Ensure 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 3-68 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.

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### **CAUTION**

#### **Machine Damage Hazard!**

It is recommended to attach cables/straps to the optional pintle hook (if equipped) or evenly attach to the tie-down lugs if being towed by another vehicle.

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.

- 
- Ensure boom is in a horizontal position and not elevated above 0°.
  - Ensure 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.

Ensure wheel chocks are properly placed when parking crane with the parking brake disabled.

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 need to exercise caution whenever operating crane on uneven surfaces. Travel on slopes is permitted as long as the following conditions are met.

- Do not exceed a 15% (8.5°) slope side-to-side or fore-and-aft.
- Travel must be on an improved surface or hard-packed dry earth having a minimum 0.5 coefficient of adhesion.
- Limit travel to a forward direction only.
- Do not exceed a speed of 1.6 km/h (1 mph).
- Fully retract all boom sections.
- Stow or remove boom extension from crane.
- Lower boom to horizontal and position over front of crane.
- Engage swing brake and turntable lock pin.
- 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.
- Inflate tires to recommended pressure for pick and carry operations.
- Ensure hydraulic tank is filled to specified level. Ensure fuel tank is over half full.
- Ensure engine and transmission fluids are filled to the specified levels.
- Ensure axle differentials and planetary hub fluids are filled to the specified levels.
- Do not support any loads by the boom (i.e., no pick and carry loads) while traversing a slope.

- 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.
- Conduct all travel with assistance of a ground person to warn operator of any changing conditions of terrain being traversed.

#### Slope Limitations:

- On a side-to-side slope, do not exceed 15% (8.5°) and 1.6 km/h (1 mph).
- When traversing a fore-to-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-to-aft slope that is greater than 15% (8.5°) and less than 25% (14°), shift transmission to 4-wheel drive and limit travel speed to 1.6 km/h (1 mph). If crane must be parked, ensure the transmission is in 4-wheel drive and the wheels are chocked.
- When traversing a fore-to-aft slope that is equal to or greater than 25% (14°), use an assist vehicle and shift the crane's transmission to 4-wheel drive. Do not park crane on a slope equal to or greater than 25% (14°).
- Never exceed a fore-to-aft slope of 30% (16°).
- For slope limitations when traveling with an elevated boom, an erected boom extension and inserts, or a heavy counterweight installed, refer to the specific traveling instructions in this section.

Owner/lessee must take appropriate measures to ensure all persons operating or working with affected models are in compliance with Grove 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 ensure safety of all personnel performing the operation and/or working around the crane.

Should operator need to traverse slopes outside criteria defined in the above guidelines contact Grove 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.
- 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 and/or Inserts Erected*, page 3-67 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.
- Ensure adequate clearance to any overhead obstructions crane may be required to travel beneath.

- Ensure 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 and/or Inserts Erected**

#### **33 ft (10.1 m)/56 ft (17.1 m) Extension**

- Main Boom shall be fully retracted.
- 33 ft/56ft/76ft boom extension shall be erected at minimum (0 deg) offset.

**NOTE:** While traveling with 33ft extension, stinger section must remain stowed on main boom base section.

- Jobsite travel shall be only on firm, level surface.
- Maximum Travel speed: 2.5 mph.
- For 33ft/56ft boom extension: Main boom angle shall be between 0 degree and 30 degrees.
- For 76ft boom extension: Main boom angle shall be between 0 degree and 20 degrees.
- Main counterweight (Standard 22,000 lb or Heavy 27,000 lb) shall be installed.
- Boom shall be directly over Front. Swing lock shall be engaged.
- Hook block must be removed from main boom nose.
- Overhaul ball may be reeved over boom extension, hanging 3 ft below sheave.

#### **33 ft (10.1 m)/56 ft (17.1 m) Extension Plus 20 ft (6 m) Insert**

- Position the 33 ft (10.1 m) or 56 ft (17.1 m) boom extension plus 20 ft (6 m) insert at minimum offset. If traveling with just the 33 ft (10.1 m) extension and insert, stow the stinger section on the boom base section, not on the extension base section.
- Travel only on a firm, level surface.
- Fully retract the main boom.
- Limit main boom angle to a minimum of 0° and a maximum of 20°.
- Do not exceed a speed of 2.5 mph (4 km/h).
- Ensure main counterweight is installed.
- Position the boom over the front of the crane.
- Engage the swing brake and turntable lock pin.
- Remove hook block from main boom nose.
- Overhaul ball may be reeved over boom extension, hanging 3 ft (0.9 m) 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 transfer over extended distances. The higher static/creep 8 km/h (5 mph) inflation pressures may remain in the tire while operating the crane on site within a distance of less than 6.4 km (4 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 extended travel. Failure to engage lock pin may allow superstructure to swing uncontrolled, damaging machine and/or property.

1. With Transmission Shift Lever in neutral (N) position, start engine and allow it to adequately warm up.
2. Press Service Brake Foot Pedal.



#### **WARNING**

##### **Run-away Crane Hazard!**

Releasing parking brake while low service brake pressure indicator is illuminated and buzzer is sounding, indicating service brakes are inoperable, may result in crane rolling away freely without ability of operator to stop crane.

Never release parking brake while low service brake pressure indicator is illuminated 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 CCS

Display 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 CCS Display until Transmission Shift Lever is returned to the neutral (N) position. Transmission will not shift.

- 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**

Traveling in reverse is similar to traveling forward, except for shifting Transmission Shift Lever to reverse (R). Refer to *Traveling — Forward*, page 3-67.

**CAUTION**

**Machine Damage Hazard!**

Engage turntable lock pin for extended 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 rear steer control. These controls, used singly or together, provide front wheel steering, rear wheel steering, four-wheel steering, and crabbing capabilities Figure 3-30.

**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.



**WARNING**

**Unexpected Operation Hazard!**

Operate rear steer **ONLY** at slow speeds for added job site maneuverability.

**Rear Wheel Steering**

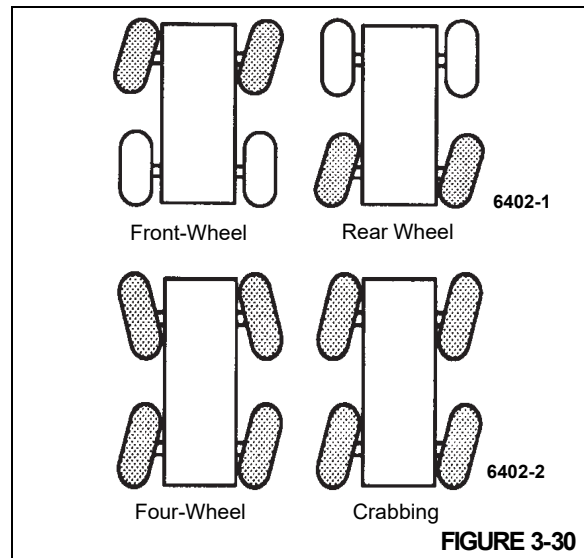
Rear wheel steering is controlled by the Rear Steer Control Switch. Moving control switch to the desired position activates the rear steer cylinders, steering crane in the selected direction.

**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.

**Crabbing**

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.



**FIGURE 3-30**

**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 low.

**NOTE:** If Drive Axle Selector Switch is positioned to four-wheel low, 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 3-67.
6. Return Drive Axle Selector Switch to two-wheel high 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 low to two-wheel high.

### **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 low 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.

Follow steps below when engaging/disengaging the differential lock function.

1. Lock differentials by pressing and holding the Axle Differential Control Switch in the lock position. Disengage the function by releasing the switch.
2. 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.

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:

1. Crane is moving very slowly (creep speed).
2. Wheels are not spinning at time of engagement.

When traveling with differentials locked, do not deviate from a straight path more than absolutely necessary. Engage differential locks by doing the following:

1. Position Axle Differential Lock Control Switch to 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, Axle Differential Locked Indicator illuminates.

2. Proceed over poor road condition cautiously.

When adverse condition have passed, disengage differential locks by doing the following:

1. Release 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 not be illuminated.

3. Resume driving at a normal speed using good driving judgment.

### **Axle Oscillation Lockouts Operation**

The following procedure should be used to periodically check the axle oscillation system and ensure it is in proper working condition.

1. Ensure 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 lockout 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.



### **DANGER** **Tipping Hazard!**

Do not operate crane if axle oscillation lockout system is not functioning properly.

Failure to comply with this warning may result in death or serious injury.

If axle oscillation lockout valve is functioning properly, crane will re-level itself; if valve is not working properly, crane will not re-level itself. If rear axle does not lock or unlock properly, evaluate lockout system and repair as necessary.

## **General Crane Operation**

### **Pump Drive**

Main #1 hydraulic pump is mounted to rear of transmission driven PTO.

The #2 hydraulic pump is direct engine driven and mounted to lower left side of engine.

### **Control Lever Operation**

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

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

### **Preload Check**

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

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

### **CAUTION**

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

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

### **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.

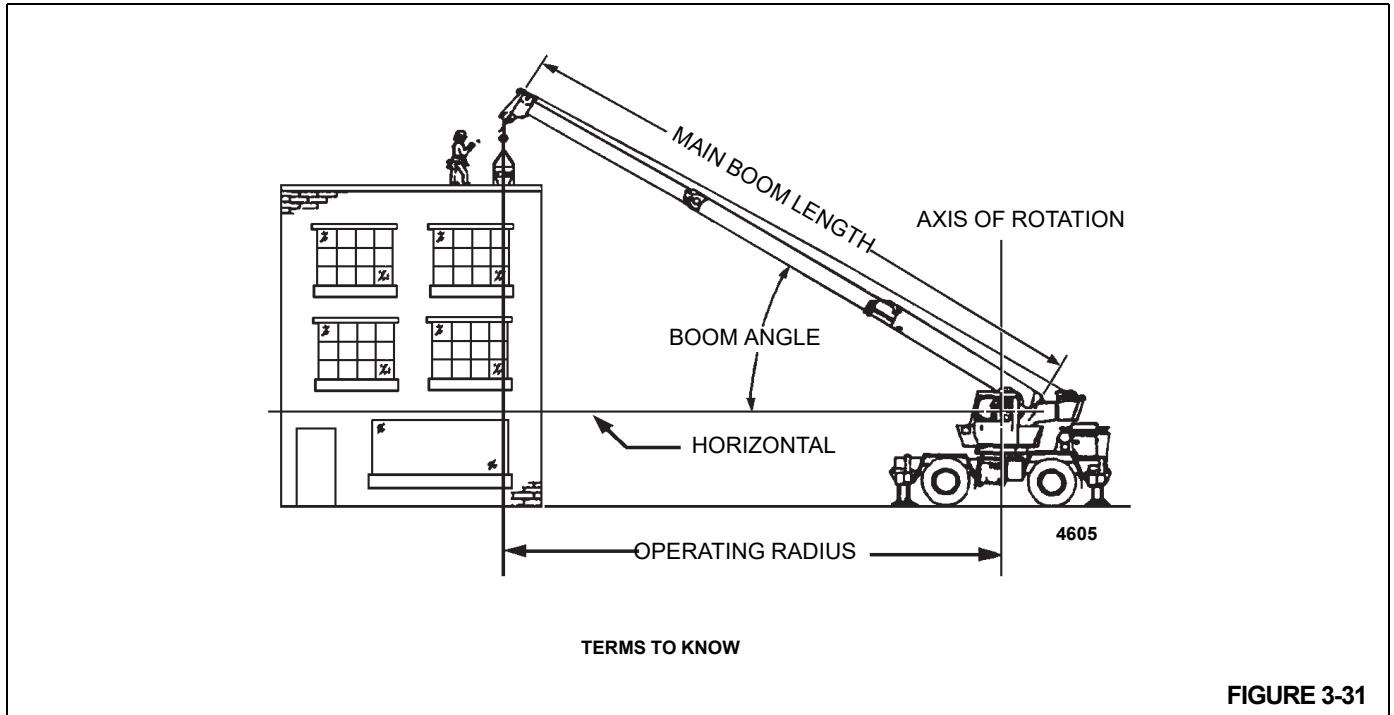
**NOTE:** Refer to Figure 3-31 for terms to know in determining lifting capacities.

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

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

The left column is the load radius, which is the distance from axis of crane rotation to load center of gravity. The top row lists various boom lengths from fully retracted to fully extended (with swingaway extension). The number at the intersection of the left column and top row is the total load limit for that load radius and boom length. The number in parentheses below the total load limit is required boom angle (in degrees) for that load. Use lower weight limit for the 2 boom lengths.

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.



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 Crane 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 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.

### Proper Crane Leveling

ASME B30.5 specifies 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 (for cranes fitted with a boom rest, boom shall be stowed onto the rest). Raise and level crane following instructions for *Using Outriggers*, page 3-72.

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 (for cranes fitted with a boom rest, the boom shall be stowed onto the rest). If necessary, relevel the crane following instructions for *Using Outriggers*, page 3-72.

**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. Extend and set outriggers. Level crane, as indicated by the level indicator, using the outriggers.
3. Place a miracle pointer level, carpenter level, or similar type device on a machined surface such as the turntable bearing or bearing mounting surfaces.
4. Using the outriggers, level crane as indicated on the leveling device used in step 3.
5. Using level indicator mounting screws, adjust level indicator to show level.

**Crane Functions**

**Using Outriggers**

Outriggers are operated from the front console in the cab or using jog dial on the armrest.



**DANGER**

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



**DANGER**

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



**WARNING**

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

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



**WARNING**

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

**NOTE:** The crane also allows operations with outriggers fully retracted. Reference the load chart for capacities.

**Setting Outriggers**

1. Engage Parking Brake.

**NOTE:** To enable outrigger functions: crane must be in four wheel drive, parking brake must be engaged, swing brake must be engaged, and all crane functions must be off.

2. Position outrigger pads directly out from each outrigger to where outriggers will be properly extended.

**CAUTION**

**Possible Equipment Damage!**

Always press one of the outrigger/selector switches before positioning the outrigger extension/retraction switch to extend or retract. Failure to do this may cause a hydraulic lock against individual solenoid valves, preventing them from opening.



**DANGER**

**Electrocution Hazard!**

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

3. If extending the outrigger to the mid-extend or fully extended position, use the Outrigger Function Enable Switch and the CCS menu with either the CCS display buttons or the jog dial to select the outrigger. The appropriate outrigger beam will extend. Refer to



*Engaging the Mid Extend Lock Pin*, page 3-73 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:** More than one outrigger beam can be extended at a time. To ensure each outrigger is fully extended, repeat step 3 for each outrigger after a multi-outrigger extension.

- After deploying the four outrigger beams to fully retracted, mid-extend, or fully extended positions, navigate to Jack Operation on the CCS screen. Select Jack Extend on the Outrigger Function Enable Switch.

Extend each outrigger jack, using either the CCS display buttons or the jog dial, positioning the pad as necessary, until the locking levers of the pad engage the jack cylinder barrel.

**NOTE:** More than one jack can be extended at a time.

- Extend front jacks approximately 8 to 10 cm (3 to 4 in).
- Extend rear jacks approximately 8 to 10 cm (3 to 4 in).

**NOTE:** Ensure tilting cab is in the lowered position before leveling machine.

- Repeat step 4 until all wheels 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 *Level Indicator Adjustment*, page 3-72.

**DANGER****Tipping Hazard!**

The mid-extend outrigger beam lock pin must be engaged before operating on any beam from the mid-extend 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 “The crane also allows operations with outriggers fully retracted. Reference the load chart for capacities.” on page 72.

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. When outriggers are at the proper position, the screen icon is transparent; if an outrigger is not in the proper position it will be shown as red. The RCL does not lock out the crane or select a different chart based on outrigger position.

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

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

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

### ***Stowing the Outriggers***

**NOTE:** To enable outrigger functions, crane must be in four wheel drive, parking brake must be engaged, and swing must be off.

- Use screen buttons or jog dial with Outrigger Function Enable Switch to select left or right rear outrigger on the CCS screen. Retract until rear jacks have adequate clearance.
- Use screen buttons or jog dial with Outrigger Function Enable Switch to select left or right front outrigger on the CCS screen. Retract until front jacks have adequate clearance.

**DANGER**

Keep feet and hands clear of outrigger pads when unlocking the pads from the jacks.

3. Repeat steps 1 and 2 until crane is resting on all wheels and outrigger jack pads are several inches off the ground.
4. Release locking levers and allow outrigger pads to drop to the ground.
5. Continue to retract jacks until fully retracted.
6. Use screen buttons or jog dial with Outrigger Function Enable Switch to select and retract each outrigger beam. Refer to *Stowing the Mid-Extend Lock Pin* below if crane was operated at mid-extend position.

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

7. Stow outrigger pads Figure 3-32.

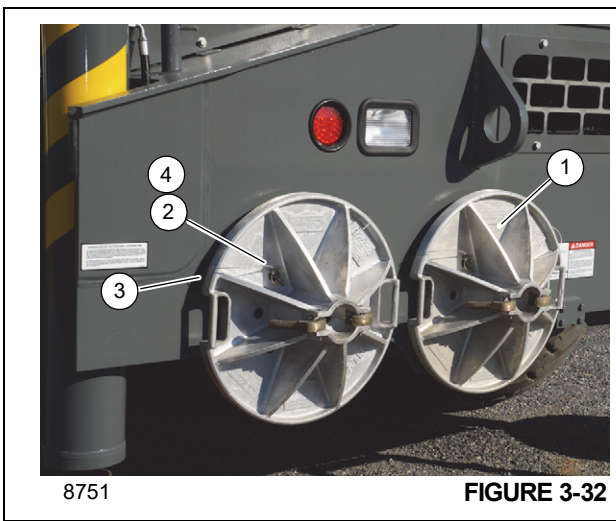


FIGURE 3-32

Item	Description
1	Outrigger Pad Assembly
2	Quick Pin with Lanyard
3	Rubber Bumper
4	Cotter Pin

**Stowing 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.

**Swinging Superstructure**

**! DANGER**  
**Crushing Hazard!**

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

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

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

**CAUTION**

Never push or pull swing control lever through neutral to the opposite direction to stop swing motion. Automatic swing brake is activated by the control lever to stop swing rotation.

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

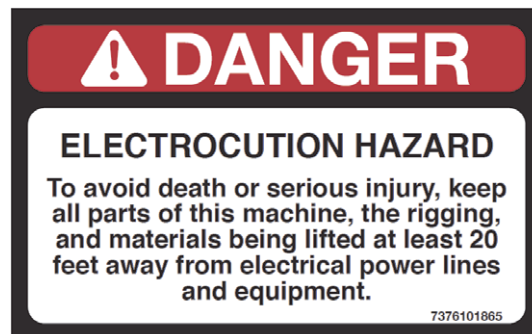
**NOTE:** Swing brake activates automatically when control lever is returned to the stop or neutral position to prevent further rotation.

**Elevating and Lowering Boom**

**Elevating Boom**

**! DANGER**  
**Crushing Hazard!**

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



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

**Lowering 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.

**CAUTION**

**Machine Damage!**

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

**CAUTION**

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

1. To lower boom, activate Lift Enable Switch, push controller on right hand armrest to the right (lowers boom). Hold until boom lowers to desired position.

**Telescoping Boom**

**NOTE:** Telescope function is controlled by a foot pedal or optionally by LH joystick controller. Telescope modes are selected using the RCL.

Mode	Description
A	T1 remains retracted until T2-4 are fully extended. Control system manages telescoping sequence.
X	T2-4 remain retracted until T1 is extended to 50%. Then T2-4 extend to 100%. Then T1 extends to 100% Control system manages telescoping sequence.
B	T2-4 remain retracted until T1 is fully extended. Control system manages telescoping sequence.
M	T1 and T2-4 have no defined extend or retract order. Operator controls telescoping sequence. Charted capacities strictly based on boom length, not percentage extension. No "out of sequence" possible.

**Telescope Control Pedal**

Activate telescope function with Telescope Enable Switch. Push top of pedal to extend boom.

**Extending Boom**



**DANGER**

**Crushing Hazard!**

Check *Load Chart* for maximum load at a given radius, boom angle, and length before extending boom with a load.

**CAUTION**

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

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

**Retracting Boom**



**DANGER**

**Crushing Hazard!**

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

Activate telescope function with Telescope Enable Switch, then push on bottom of pedal to retract boom.

**Lower and Raise Hoist Cable**



**DANGER**

**Crushing Hazard!**

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



**DANGER**

**Crushing Hazard!**

Do not jerk control lever when starting or stopping hoist. Jerking lever 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 controller remains in neutral.

**Lower Cable**

Turn on Hoist Enable Switch. Push main hoist (right hand armrest) or auxiliary hoist (left hand armrest) controller forward, away from operator. Hold until hook or load is lowered to desired height.

**Raise Cable**

Turn on Hoist Enable Switch. Pull main hoist (right hand armrest) or auxiliary hoist (left hand armrest) controller toward operator. Hold until hook or load is raised to desired height.

**Hoist Speed Range Selection**

2. Hold hoist selector switch for 1.5 seconds.
3. Double-click hoist enable switch.
4. On a dual axis joystick, tap thumb rocker switch towards operator to enable/disable high speed (persistent state).
5. On a dual axis joystick, hold thumb rocker switch away from operator to temporarily enable/disable high speed (momentary state). High speed mode is disabled when rocker switch is released.

**CAUTION**

Do not change speeds while hoist is active. Always select hoist speed before actuating the hoist up or down function.

**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. Remove or stow boom extensions if equipped.
3. Fully retract all boom sections.

4. Lower boom to normal travel position.
5. Engage swing brake and swing lock pin.
6. Retract all jack cylinders and outrigger beams.
7. 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.

8. Apply parking brakes and if necessary, chock wheels.
9. Ensure all operating controls are in neutral position.
10. Shut down engine following proper procedures specified in this *Operator Manual* and applicable engine manual.
11. Remove keys.
12. Close and lock, if applicable, all windows, covers, and doors.
13. Turn battery disconnect OFF if machine will be inactive for over 24 hours Figure 3-28.

**Unattended Crane**

 **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.

## SECTION 4 SET-UP AND INSTALLATION

### SECTION CONTENTS

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**GENERAL**

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

**HOIST PLATFORM**



**DANGER**

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

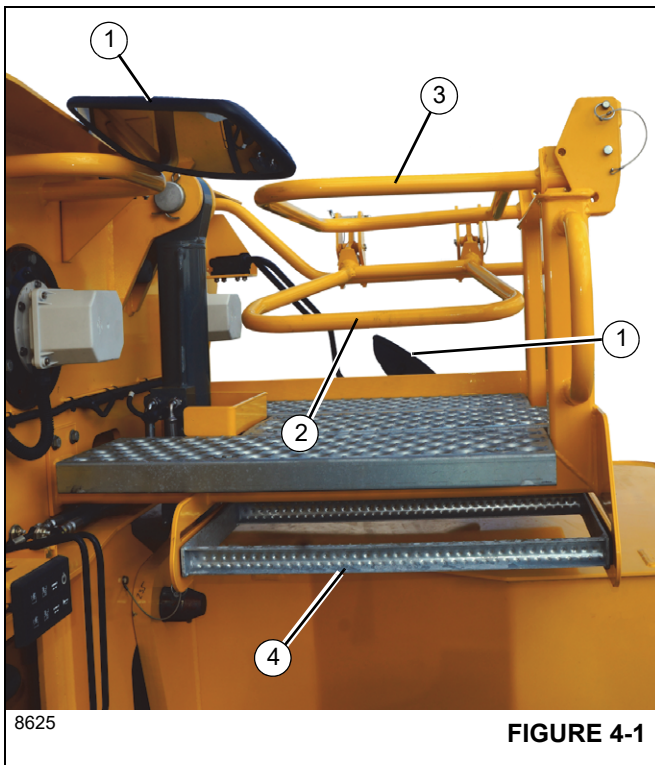
No storage of components are allowed on the platform.

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

**Travel Position**

Refer to Figure 4-1.

1. Lower two hoist mirrors (1).
2. Remove two pins and lower rear rail (2). Reinsert pins.
3. Remove two pins and lower side rail (3). Reinsert pins.
4. Lift and slide steps (4) into retaining bracket. Pull out on steps to ensure notch is engaged in bracket.



**FIGURE 4-1**

**Working Position**

Refer to Figure 4-2.

1. Lift and pull out steps (4) until they hang vertically from bracket.
2. Remove two pins and raise side rail (3). Reinsert pins.
3. Remove two pins and raise rear rail (2). Reinsert pins.
4. Raise two hoist mirrors (1) until they lock in position.



**FIGURE 4-2**

**INSTALLING CABLE ON HOIST**

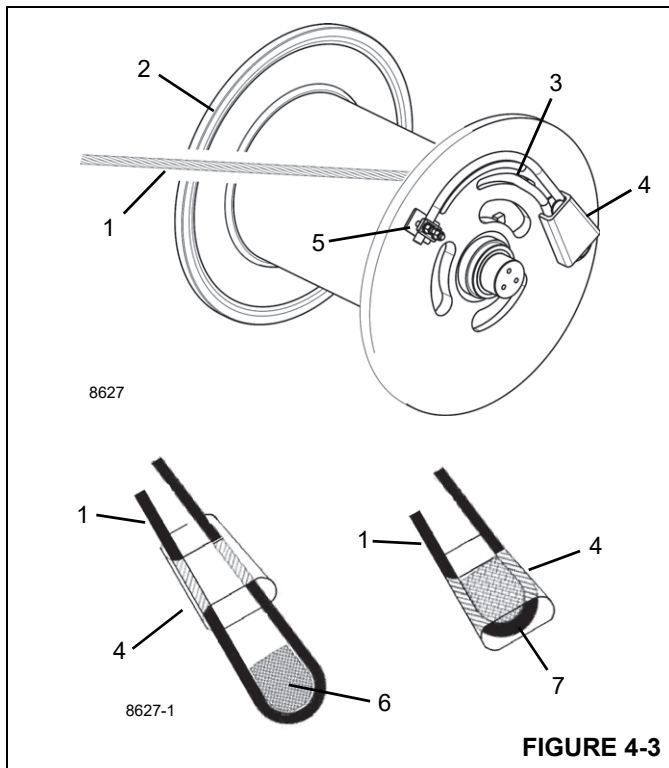
Refer to Figure 4-3.

**CAUTION**

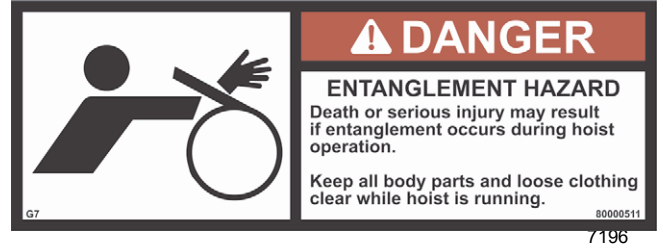
If cable is wound from storage drum, rotate reel in same direction as hoist.

**NOTE:** Straighten cable before installing on hoist drum.

1. Place cable (1) over boom nose sheave and route to hoist drum (2).
2. Rotate hoist drum so cable slot located on left side of drum is easily accessible.
3. Insert cable through slot (3) and wedge block (4). Loop around anchor wedge (6) and route back through wedge block to clamp (5). Ensure cable is routed over guide in side of drum. End of cable should extend approximately 50 mm (2 in) beyond clamp. Tighten clamp.
4. Adjust cable so clamp side is snug against guide. Position anchor wedge in wedge block. Pull firmly on inside hoist side of cable to secure the wedge.
5. If wedge does not seat securely in slot, carefully tap cable and top of wedge (7) with a mallet.



**FIGURE 4-3**



6. Slowly rotate drum and evenly wind first layer of cable.
7. Install remainder of cable as required.

**ANTI-TWO-BLOCK (A2B) SWITCH**

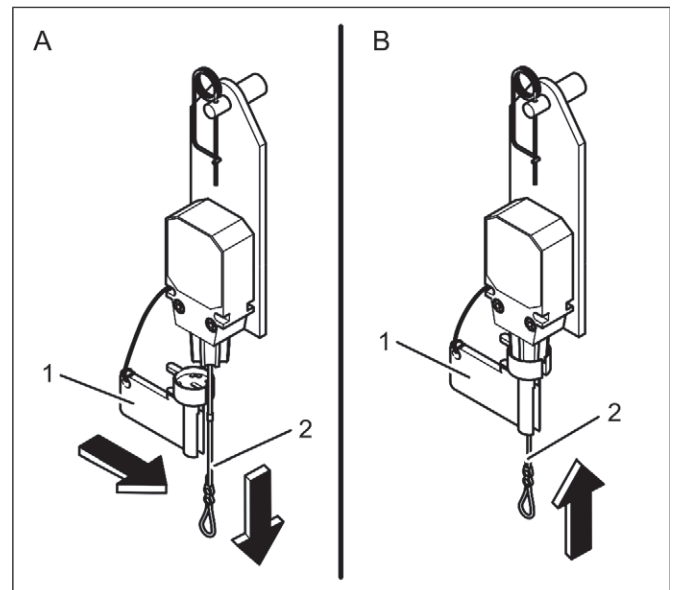
If a hoist rope has been reeved and two A2B switches are installed, the unused A2B switch must be locked (disabled) to allow all crane operations.

**Locking**

**CAUTION**

If the A2B switch is locked (disabled), the hook block could hit the main boom head or extension, resulting in damage to the hook block, main boom head or extension, and hoist rope. Never lock an A2B switch with a switch weight attached.

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).



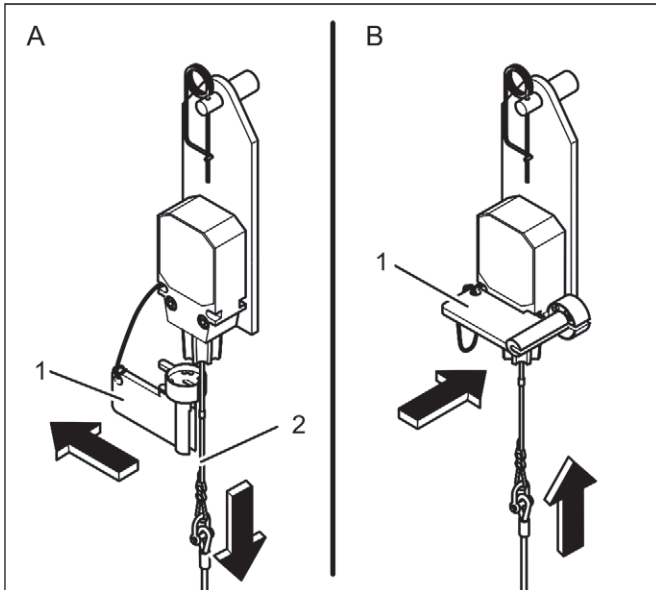
8684-1

**FIGURE 4-4**

## Unlocking

**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 4-5

## Checking Before Operation

Check the following electrical connections before operating the crane to ensure the 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 or lattice insert, no additional connections are necessary. It must however be ensured 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 or top section, the connecting cable must be mounted between the distributor socket on the extension or insert, 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.



## 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/top section.

### Machines 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/or with a lattice insert, 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 or lattice insert are in working position and if the main boom is not equipped with a hoist rope, then the weight of the A2B switch on the main boom must be removed to prevent endangering personnel or damaging equipment.

After electrical connections have been checked to ensure 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 spring cable drum for smooth running, initial drum tension, and correct cable winding.
4. Inspect mechanical and electrical installation of power measurement sockets on the lattice insert (if present).



## WARNING

The following tests must be performed with care to prevent personnel injury or crane damage. Proper functioning of the CCS requires successful completion of these tests before starting work.

If the operator cannot see the hook block approaching the pulley head, this task must be assigned to an assistant (slinger).

The crane operator must be prepared to stop the crane immediately if the CCS is not working correctly, i.e. when warning indicators do not display, the acoustic alarm does not sound, and crane movements such as raising, extending and luffing are not disabled.



Check *Hoist limit switch warning light* and acoustic alarm as follows:

1. Manually raise weight fitted on the A2B switch. As soon as weight is raised, the acoustic alarm should sound and A2B switch warning should display.
2. 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 switch warning should display, and the main hoist should switch off. Lower the hook block slightly to eliminate this condition.
3. Slowly lower the boom to bring about a potential hoist limit situation. As soon as the hook block raises the weight, the acoustic alarm should sound, the A2B switch warning should display, and the luffing gear should switch off. Lower the hook block slightly to eliminate this condition.
4. Slowly extend (telescope out) the boom to bring about a potential hoist limit situation. As soon as the hook block raises the weight, the acoustic alarm should sound, the A2B switch 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.

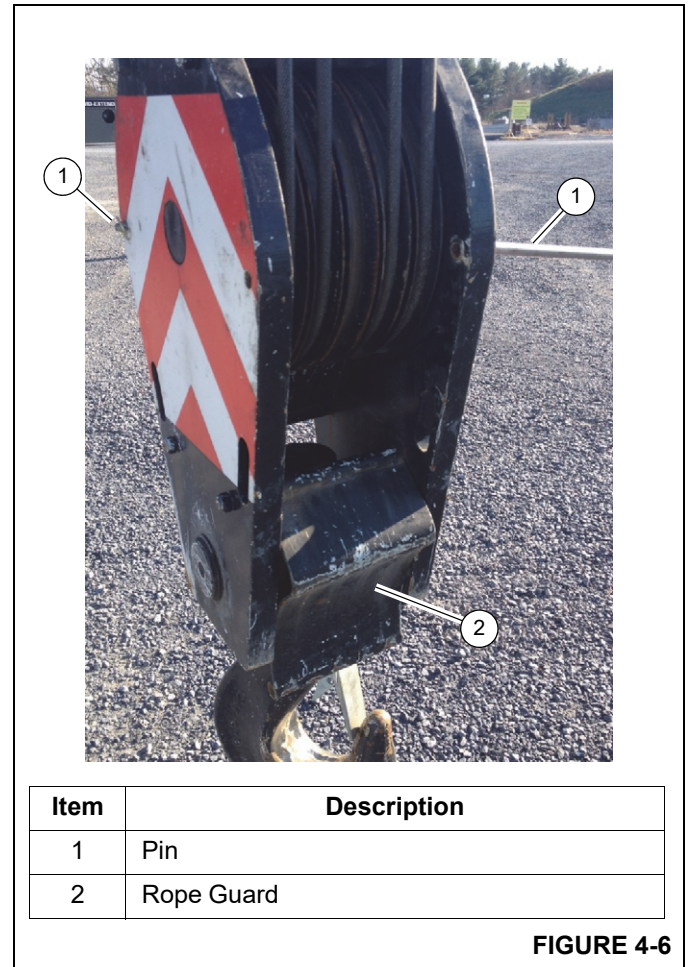
5. If crane is equipped with a boom extension or lattice insert, the inspection procedure must be repeated for the A2B switch of the extension/top section.
6. Verify display of main boom length agrees with actual boom length.
7. Verify display of main boom angle agrees with actual boom angles.
8. Verify display of the crane operating radius agrees with the actual radius.
9. 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 4-6 and Figure 4-11). 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 4-6), then drop the two rope guards (2) to their lowered position.



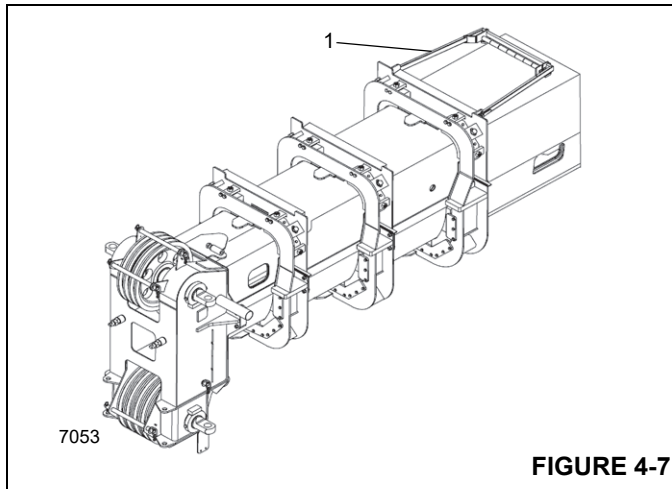
**Reeving the Hoist Rope Over the Boom**

**CAUTION**

Do not reeve auxiliary hoist rope through the rope guide.

Always reeve main hoist rope through rope guide (1, Figure 4-7). Always reeve auxiliary hoist rope *outside* rope guide.

**NOTE:** Also use the rope guide when using the Main Hoist with lattice inserts.



**FIGURE 4-7**

**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.

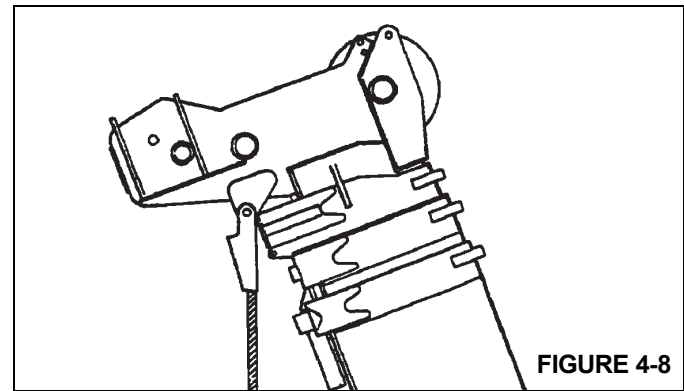
Other wire ropes and rigging accessories are available from various vendors. Different wire rope manufacturers have differing requirements for construction, handling, cutting, seizing, installation, termination, inspection, and replacement of wire ropes they produce. Their advice should be sought for 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.

When anchoring socket to the boom, ensure flat face of socket is toward boom sections as shown in Figure 4-8.



**FIGURE 4-8**

## 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. 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 4-9) 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.

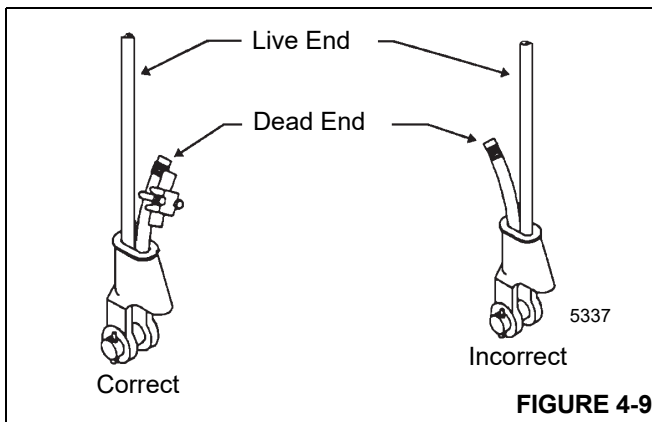


FIGURE 4-9

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. Ensure 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 4-10 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.

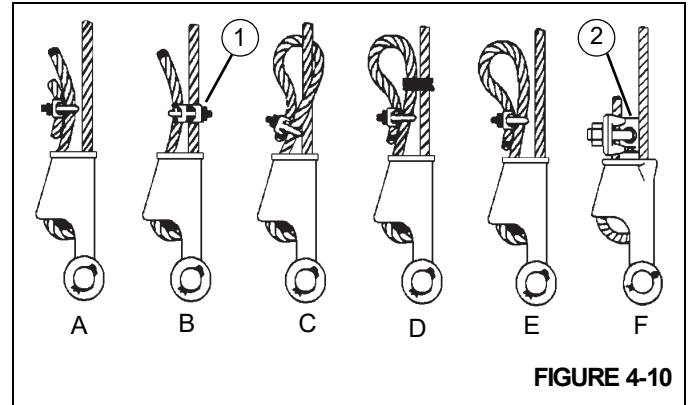


FIGURE 4-10

Of 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 and 20 rope diameters, but not less than 15.2 cm (6 in) for rotation resistant wire ropes.

When using method A, place a wire rope clip around the dead end by clamping a short extra piece of rope to the rope dead end. **DO NOT CLAMP 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 4-1.

**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) B30.5 applies to cableways, cranes, derricks, hoists, hooks, jacks, and slings.

It states, in section 5-1.7.3, “(c) Swagged, compressed, or wedge socket fittings shall be applied as recommended by the rope, crane or fitting 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 4-1. Wire Rope Clip Torque Values**

Clip Size		Torque*	
mm	In	Nm	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

Clip Size		Torque*	
mm	In	Nm	ft-lb
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.

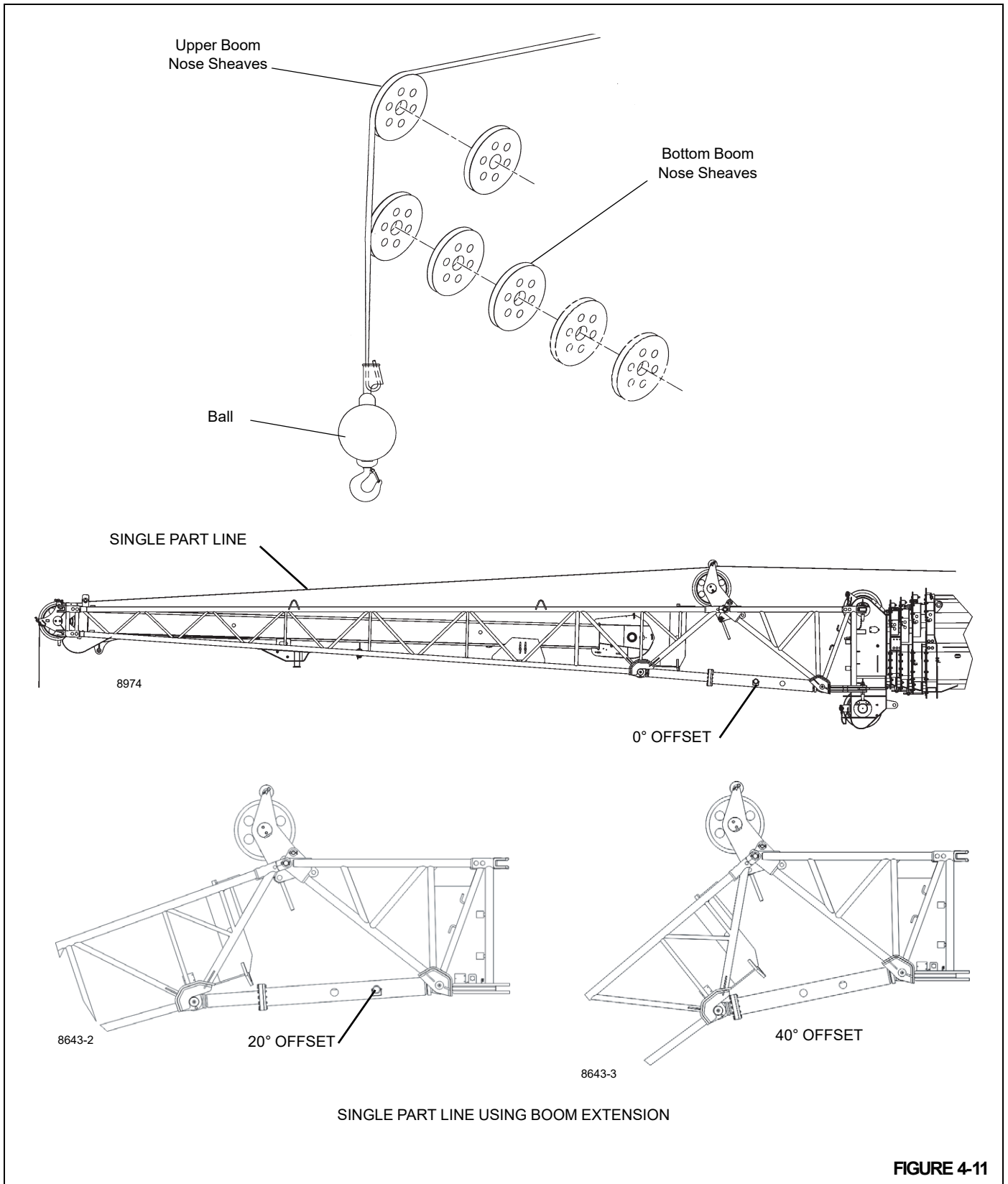


FIGURE 4-11

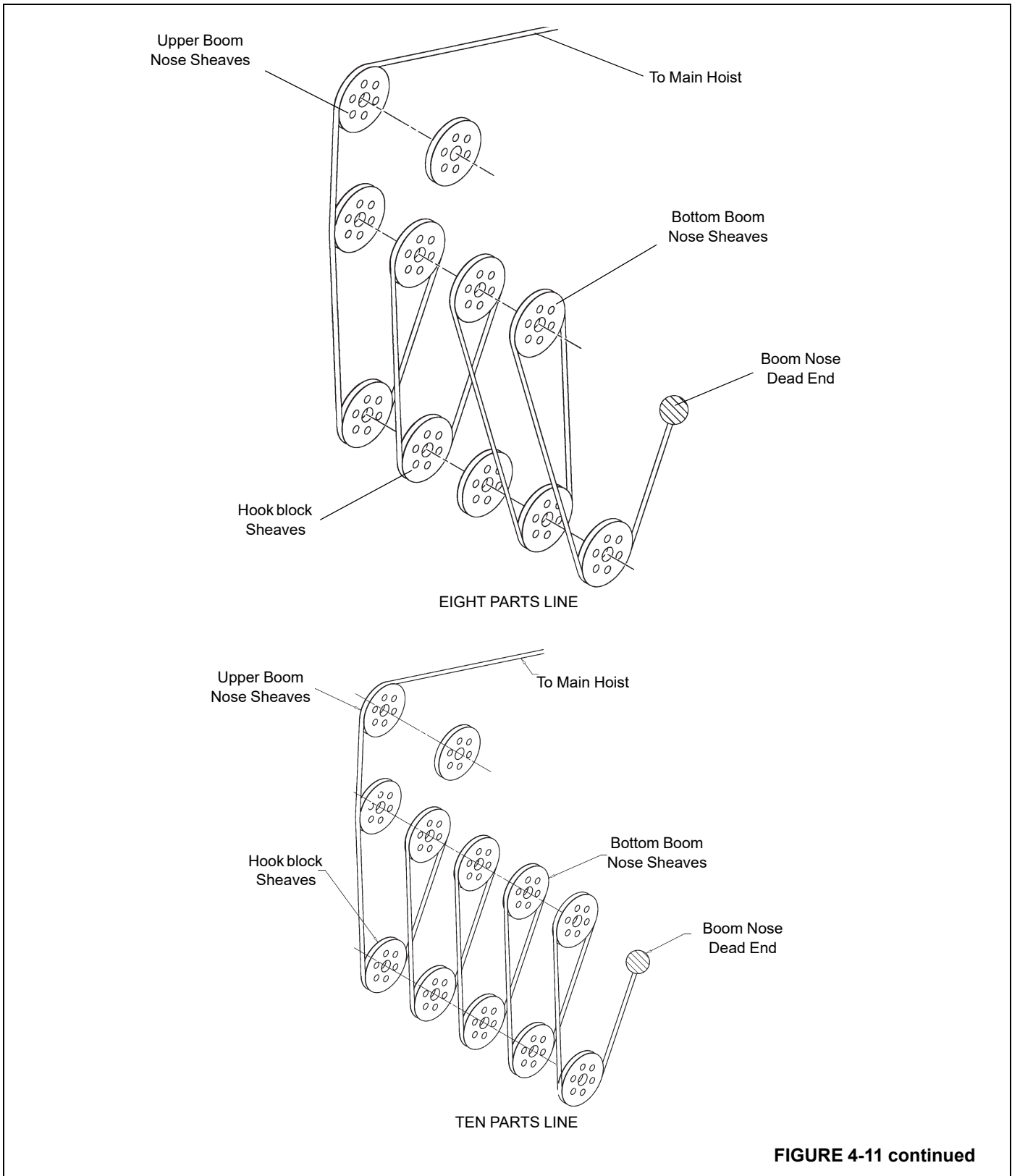
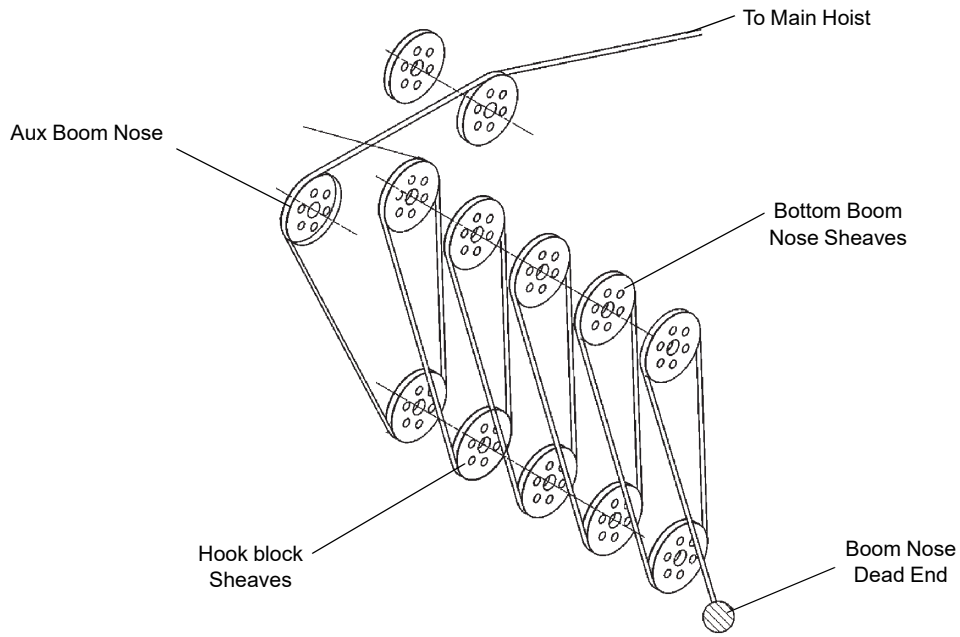
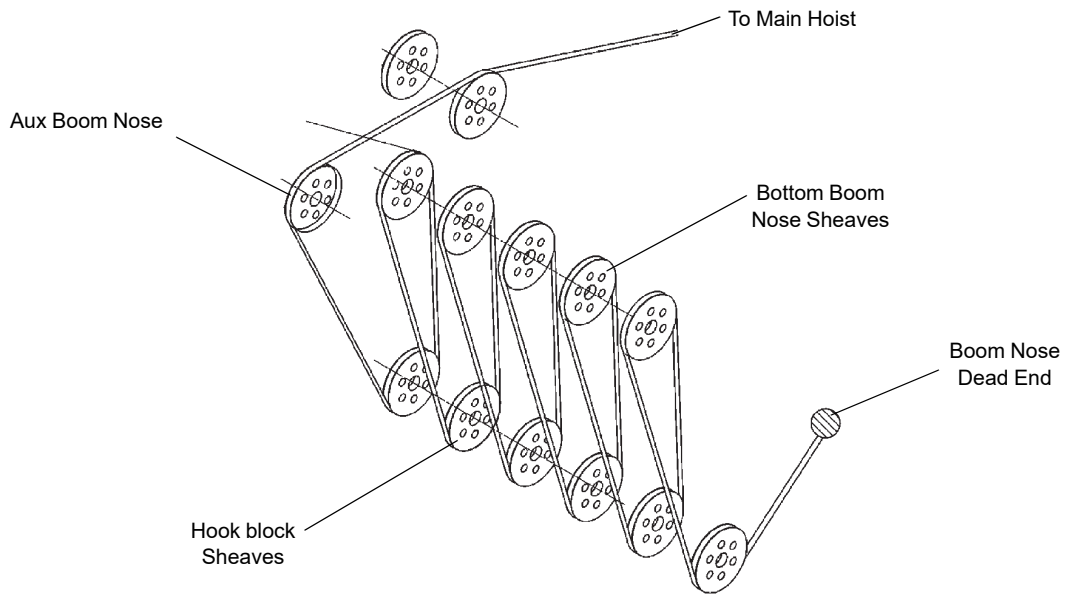


FIGURE 4-11 continued

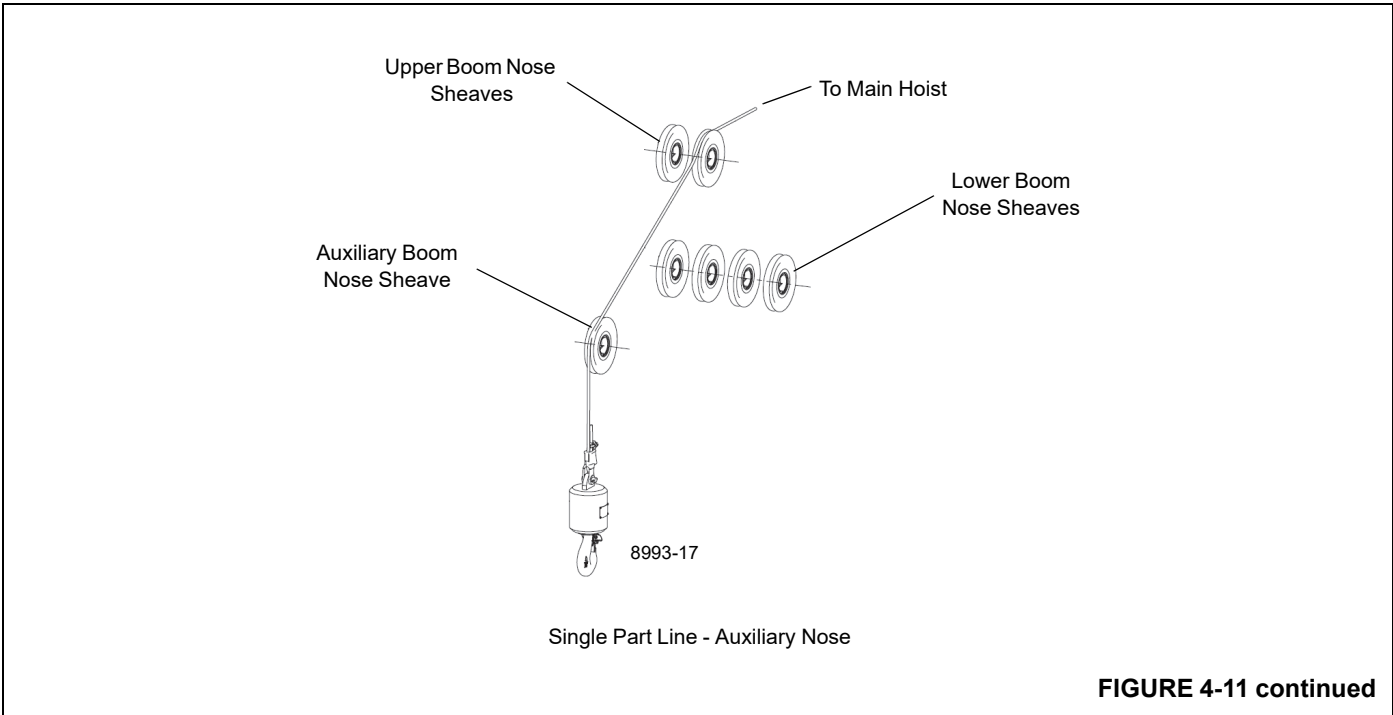


ELEVEN PARTS LINE



TWELVE PARTS LINE

FIGURE 4-11 continued





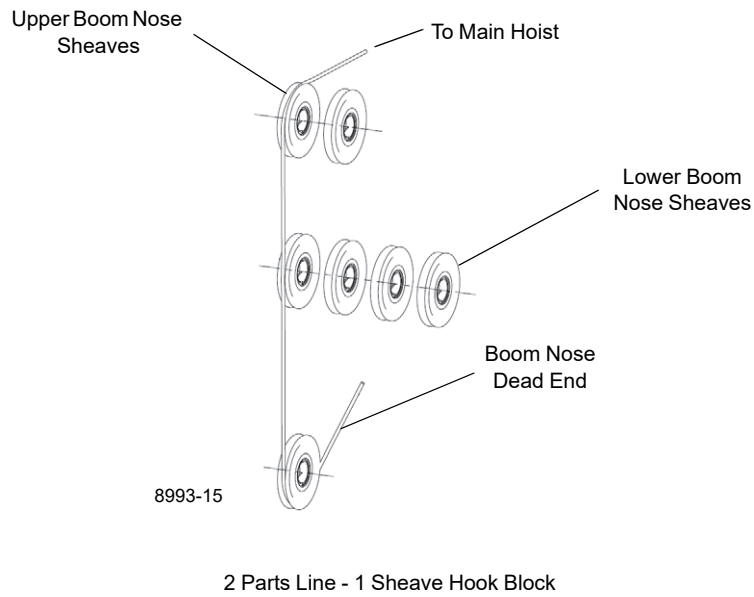
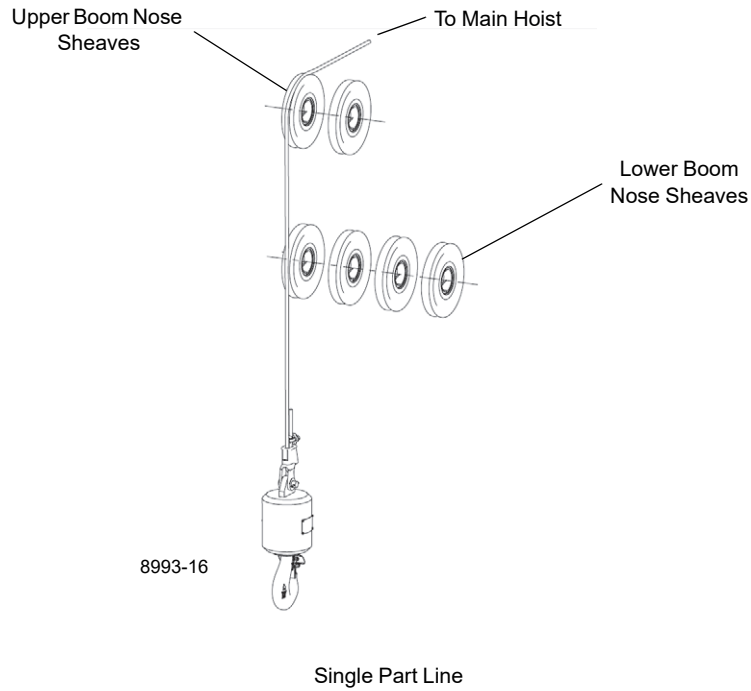
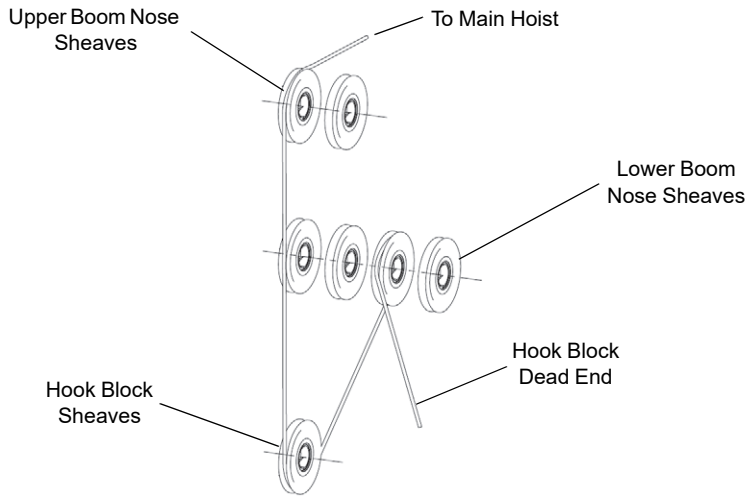
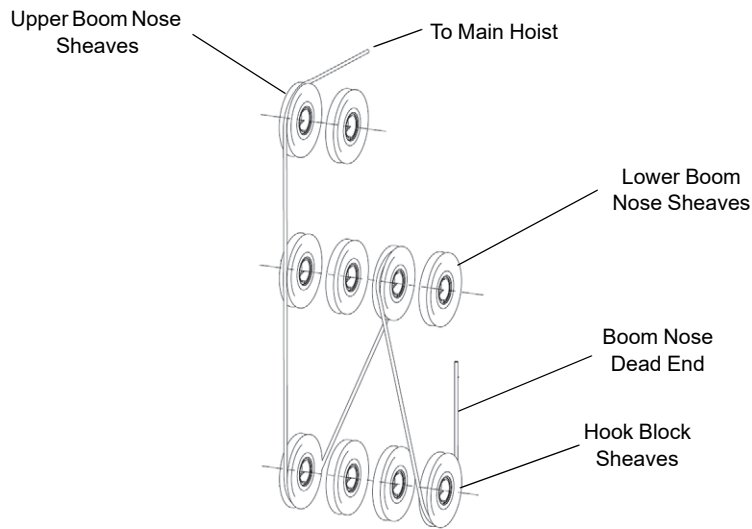


FIGURE 4-11 continued



8993-14

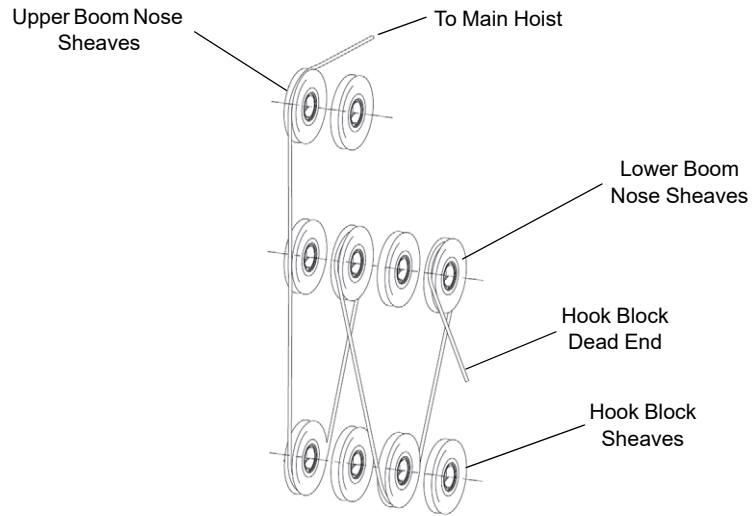
3 Parts Line - 1 Sheave Hook Block



8993-13

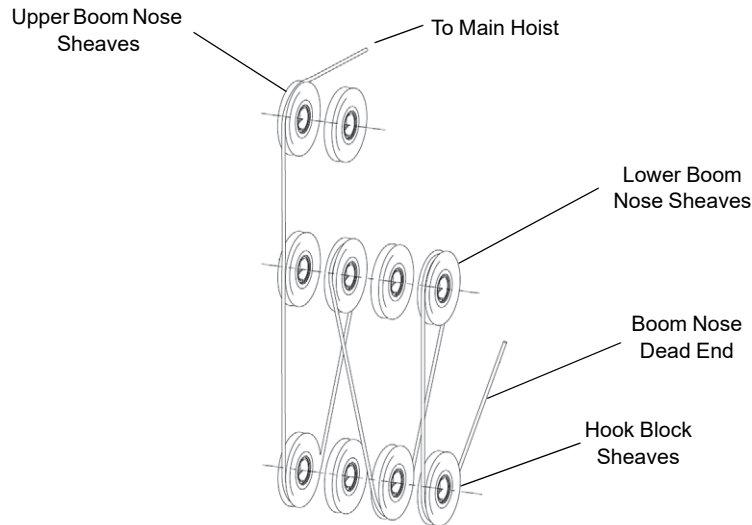
4 Parts Line - 4 Sheave Hook Block

FIGURE 4-11 continued



8993-12

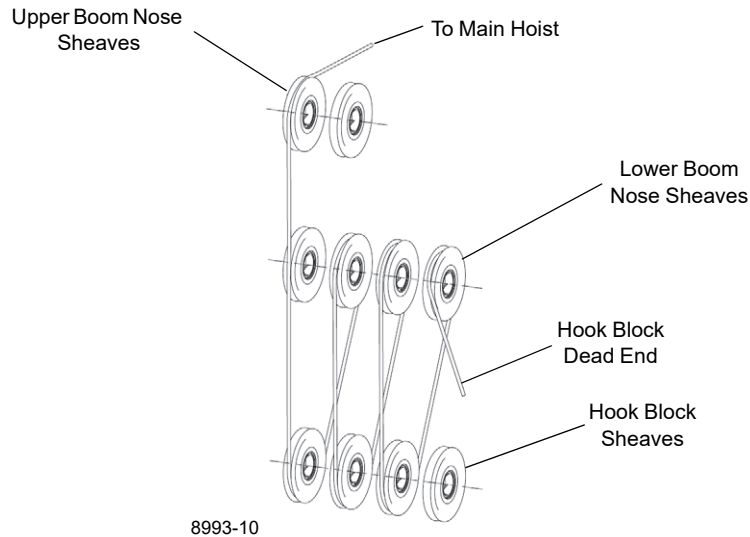
5 Parts Line - 4 Sheave Hook Block



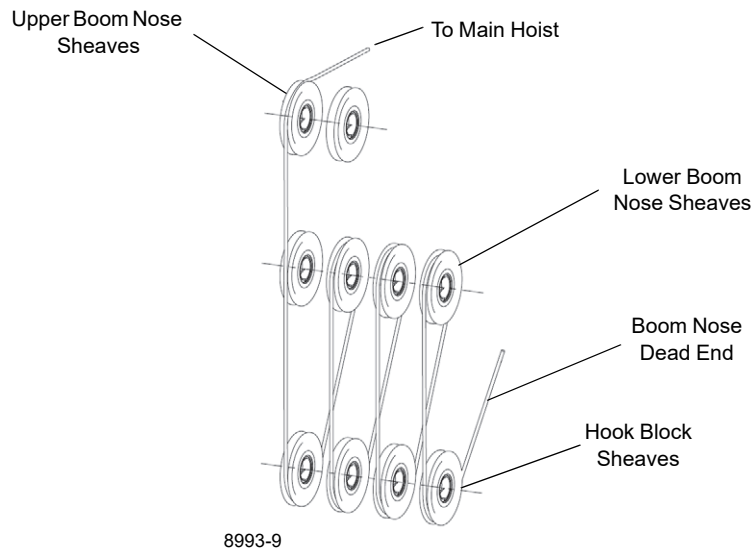
8993-11

6 Parts Line - 4 Sheave Hook Block

FIGURE 4-11 continued

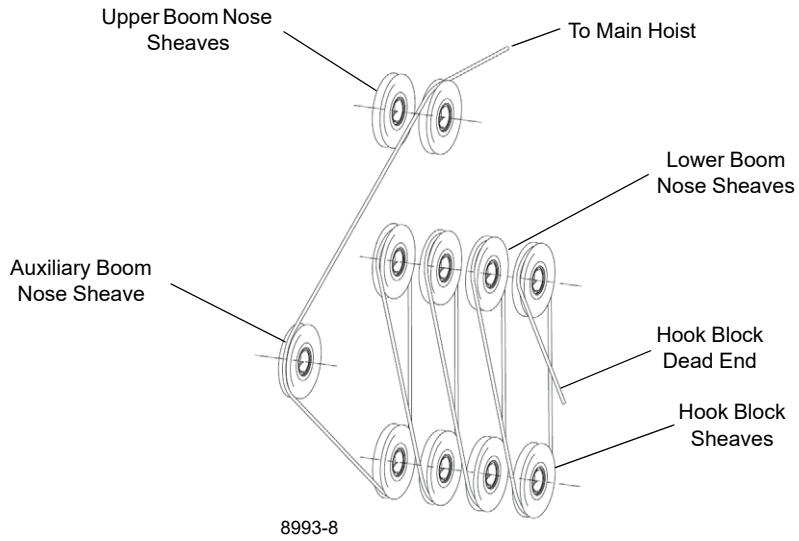


7 Parts Line - 4 Sheave Hook Block

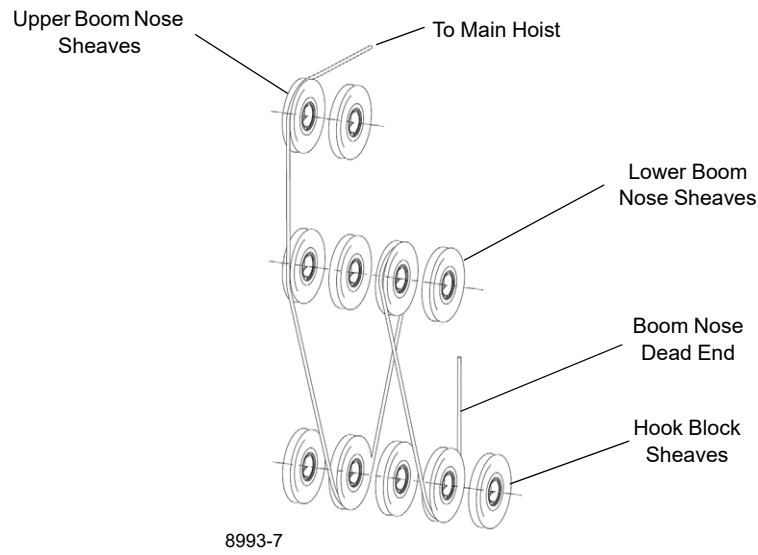


8 Parts Line - 4 Sheave Hook Block

FIGURE 4-11 continued

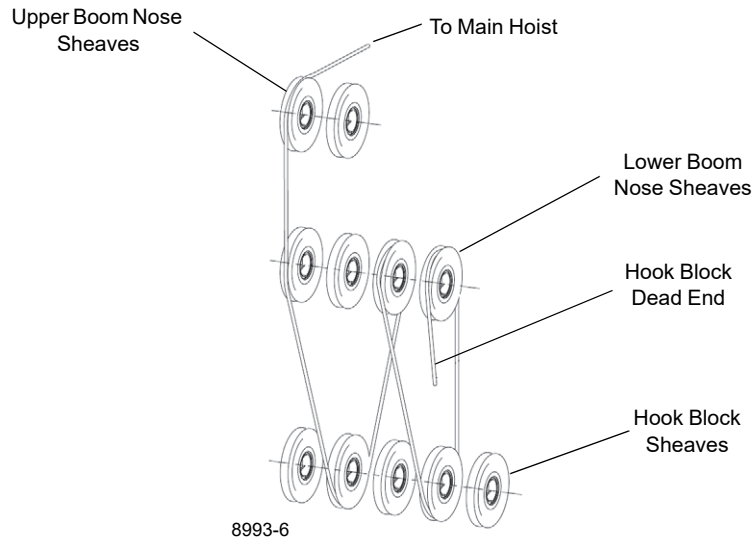


9 Parts Line - 4 Sheave Hook Block with Auxiliary Boom Nose

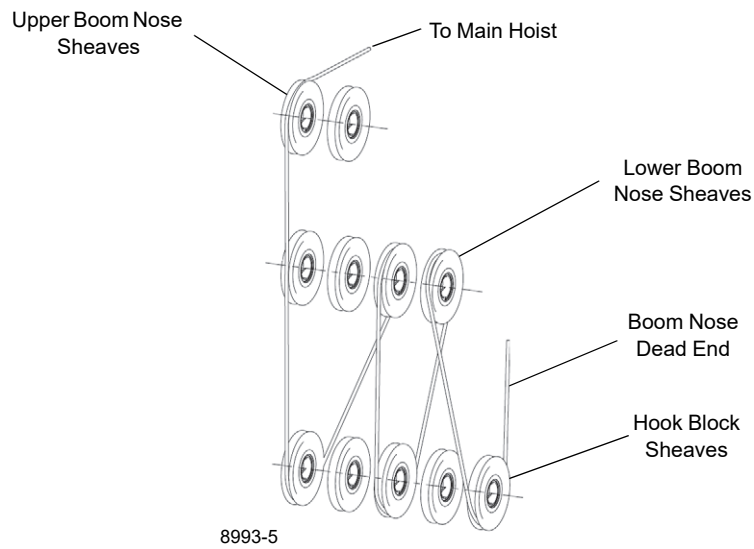


4 Parts Line - 5 Sheave Hook Block

FIGURE 4-11 continued

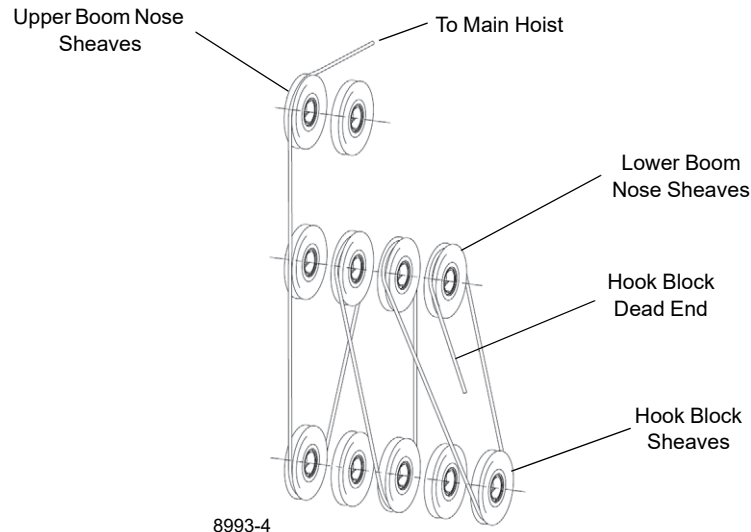


5 Parts Line - 5 Sheave Hook Block

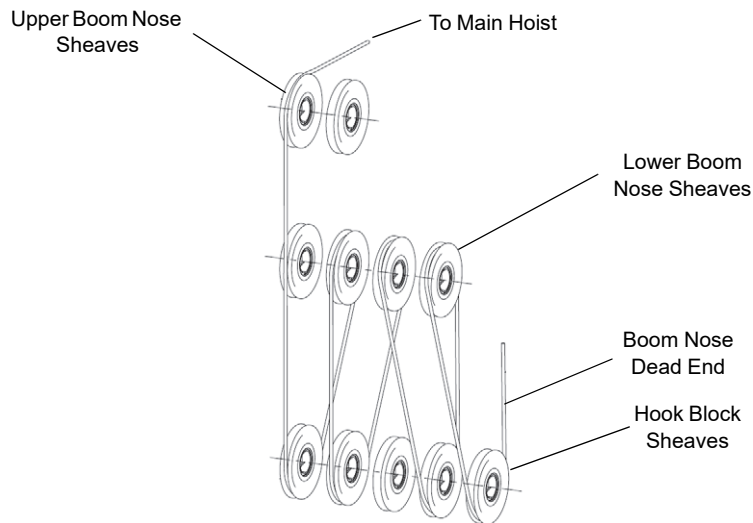


6 Parts Line - 5 Sheave Hook Block

FIGURE 4-11 continued

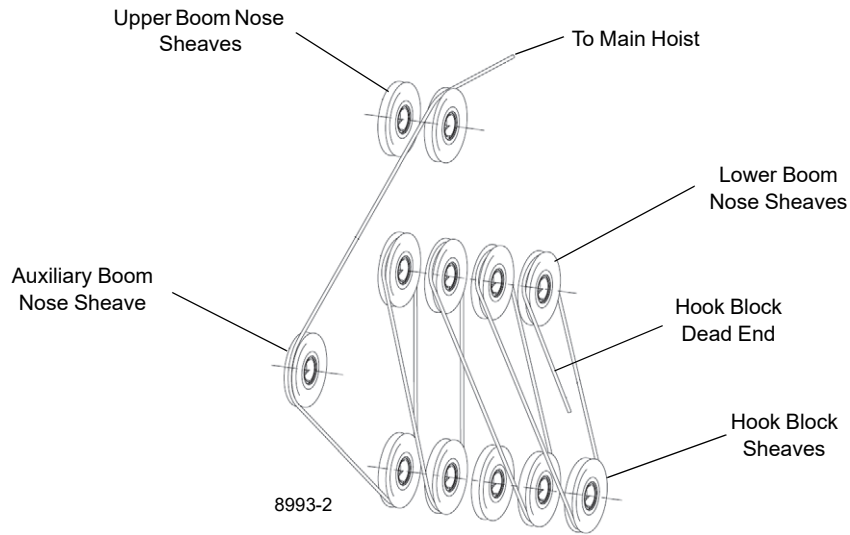


7 Parts Line - 5 Sheave Hook Block

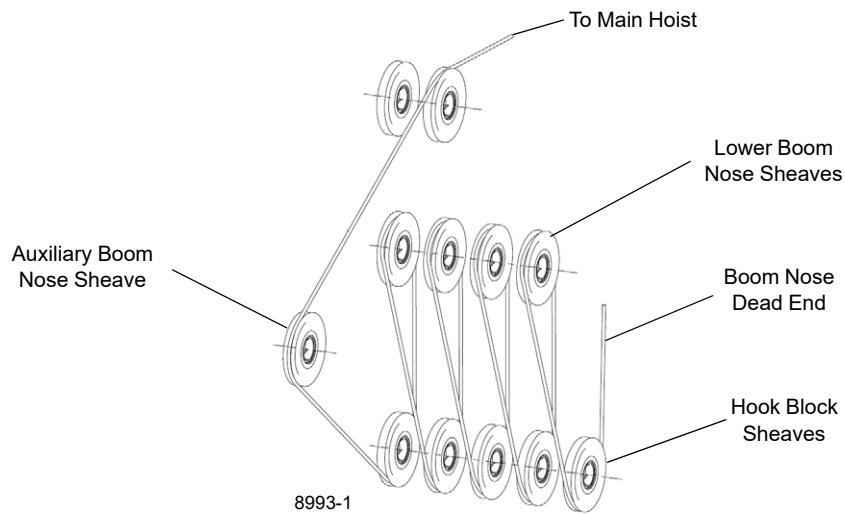


8 Parts Line - 5 Sheave Hook Block

FIGURE 4-11 continued



9 Parts Line - 5 Sheave Hook Block with Auxiliary Boom Nose



10 Parts Line - 5 Sheave Hook Block with Auxiliary Boom Nose

FIGURE 4-11 continued



## BI-FOLD SWINGAWAY, OFF-SETTABLE BOOM EXTENSION

**NOTE:** Manual and hydraulic off-settable boom extensions install and remove the same way.

### Description

A 10 m to 17 m (33 ft to 56 ft) bi-fold swingaway, manual or hydraulic off-settable boom extension provides additional boom reach. The boom extension weighs approximately 1,102 kg (2,430 lb).

The boom extension is stowed on the right side of the boom base and is easily attached or removed from the boom nose using a remotely operated electric extension support and two stowage pins.

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

Before attempting to erect or stow the boom extension, read and follow all safety decals installed on the boom, boom nose, boom extension, and stowage brackets.

Lifting over the boom extension base section is strictly prohibited when the boom extension fly section is erected or folded along side of the boom extension base section.



### DANGER

Extending boom sections 2 through 4 during erection or stowage of the boom extension can cause disengagement of the anti-roll guides and allow uncontrolled movement of the boom extension, resulting in death, personal injury, or property damage.

Always ensure crane is in B mode during erection or stowage of the boom extension. Never erect or stow the boom extension in recovery mode.

### Boom Extension Rigging Mode

This crane is equipped with a boom control system that enters a Boom Extension Rigging Mode when a minimum boom length is detected. The crane will not allow the following movements while in the Boom Extension Rigging Mode:

- Extension of boom in Auto Mode with A Mode selected.
- Extension of boom in Manual Mode, with Boom Section 2-4 selected.

The Boom Extension Rigging Mode requires the boom to be extended, in Auto Mode with B Mode selected or Manual Mode with Section 1 selected, until the boom automatically stops and is clear of the stowage ramps and stowage pins on the front stowage bracket.

To exit the Boom Extension Rigging Mode, the boom must be fully retracted, causing sections 1 and 2 proximity switches to activate. Boom operating mode restrictions are removed after exiting the Boom Extension Rigging Mode.

### Erecting Boom Extension

Refer to Figure 4-20.

1. Fully extend and set outriggers.
2. Position boom over front of crane.
3. Set boom manual/automatic mode selector switch to AUTO position.
4. Set boom A/B mode selector switch to B mode.
5. Fully retract all boom sections.
6. Lower boom to minimum elevation.
7. Lower front outriggers until front wheels are on ground.

**NOTE:** Auxiliary boom nose (rooster sheave) does not have to be removed. If reeved, remove hoist cable from sheave.

8. Rig main hoist or optional auxiliary hoist cable for single part line with only wedge socket on cable end.

### CAUTION

If boom extension fly section is not to be erected, disconnect it from boom extension base section and keep attached to boom stowage brackets on boom base.

9. Attach rope to tip of boom extension base section to help swing it around to the front of the boom nose.
10. Remove caps and connect boom extension mount control pendant to connector on front of boom base.

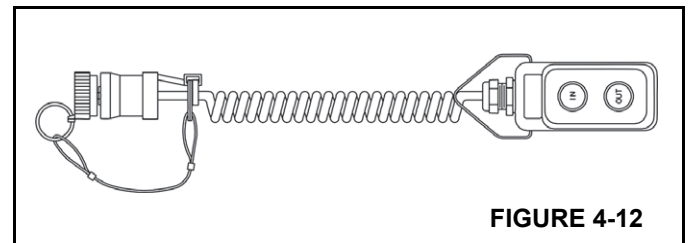


FIGURE 4-12

**NOTE:** If erecting boom extension base section with boom extension fly section, skip to step 13.

If erecting boom extension base section without boom extension fly section, perform steps 11 and 12.

11. Move locking bar (9, Figure 4-20; 2, Figure 4-13) to boom base attachment bar (1) and install pin (3). Secure with retaining clip.

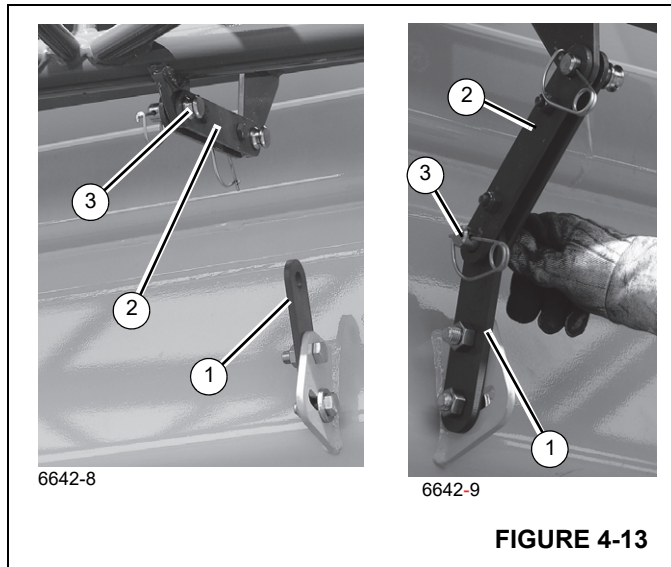


FIGURE 4-13

**DANGER**

Uncontrolled movement of the boom extension fly section can cause death, injuries, or damage to equipment. Ensure attachment pin securing the boom extension fly section to the boom extension fly section rear stowage bracket is in place.

12. Remove attachment pin connecting the boom extension fly section to the boom extension base section. Stow attachment pin in the stowage holder on the boom extension base section and secure with retaining clip.
- Skip to step 14.
13. Remove attachment pin securing the boom extension fly section to the rear stowage bracket assembly (1, Figure 4-20) on the boom base. Stow attachment pin in the stowage holder on the boom extension base section and secure with retaining clip.
14. Using control pendant, extend middle stowage bracket (10, Figure 4-20) until boom extension base section anchor fittings align with boom nose attachment fittings.
15. Remove attachment pins from stowage lugs on right side of boom extension base section and install into upper and lower right anchor and attachment fittings of

the boom extension base section and boom nose. Secure each attachment pin with a retaining clip.

16. Disconnect control pendant and replace caps.
17. Remove lock hitch pin (13, Figure 4-20) securing boom extension base section to the front stowage bracket (5, Figure 4-20) on the boom base. Stow lock hitch pin in the stowage holder underneath the stowage bracket and secure with retaining clip.

**DANGER**

When erecting the boom extension base section, keep all personnel and equipment clear of swing path.

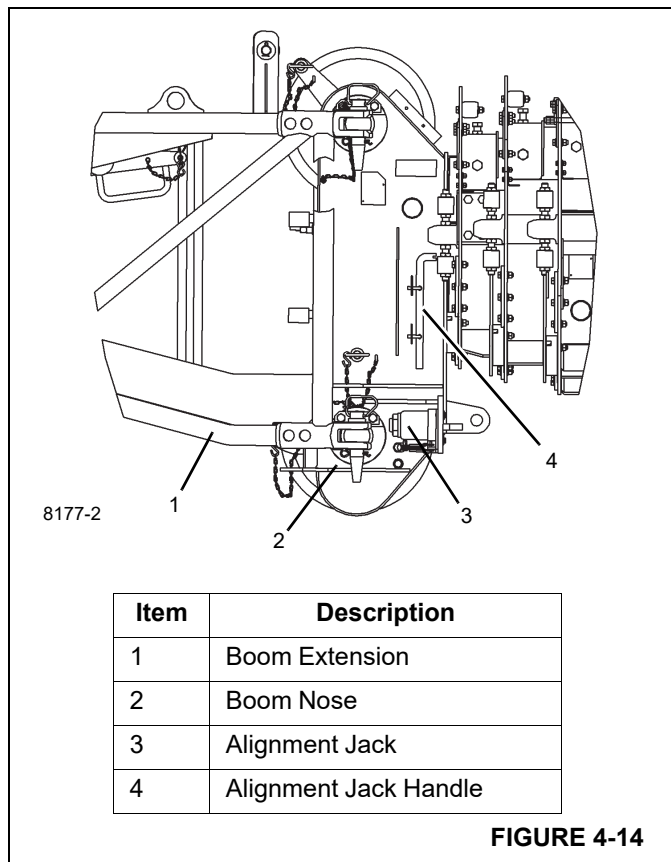
Uncontrolled movement of the boom extension base section can cause death, injuries, or damage to equipment.

18. Raise boom slightly above horizontal.
19. Extend boom until boom extension base section is clear of the middle stowage bracket ramp (10, Figure 4-20) and the front stowage bracket pins (14, Figure 4-20) on front stowage bracket assembly (5, Figure 4-20)
20. Slightly raise or lower boom to help control the boom extension swing. Using rope attached to tip of the boom extension base section, swing boom extension base section in front of the boom nose until boom extension base section anchor fittings engage with left side boom nose attachment fittings.

**DANGER**

Do not modify attachment anchors or fittings to allow installation of the attachment pin.

21. Install attachment pin into the upper left anchor and attachment fittings of the boom extension base section and boom nose. Secure attachment pin with a retaining clip.
22. Using the jack handle (4, Figure 4-14) stored on the left side of the boom nose, extend boom extension alignment jack (3, Figure 4-14) until the lower left anchor and attachment fittings of the boom extension base section and boom nose are aligned. Install attachment pin and secure with retaining clip.



23. Retract alignment jack to its original position. Return jack handle to its stowed position on left side of the boom nose.

**! DANGER**

Do not attempt to erect the boom extension fly section unless it was attached to the boom extension base section during initial erection procedure.

24. If required, erect the boom extension fly section by performing the procedures under *Erecting Boom Extension Fly Section*, page 4-23.

Raise and lock the mast assembly (6, Figure 4-20) into an upright position.

- a. Remove mast assembly pin from the stowed position lug of the mast assembly.
- b. Raise the mast assembly and install pin in the upright position lug.
- c. Secure with clip pin.
- d. Remove cable retainer pin and clip pin from mast.

25. Extend boom until it automatically stops. Reaching this stopping point is required for the Boom Extension Rigging Mode process.

26. Lower boom and remove rope from tip of boom extension base section.

27. Fully retract boom until section 1 and section 2 proximity switches are activated. Boom Extension Rigging Mode is complete and boom operating mode restrictions are removed.

28. Connect the anti-two-block cable(s). Refer to *Connecting and Disconnecting Boom Extension*, page 4-32.

29. Connect hydraulic lines (if required). Refer to *Connecting and Disconnecting Boom Extension*, page 4-32.

30. If only the boom extension base section is erected, remove cable retainer pins and clip pins from the boom extension base section sheave.

If the boom extension fly section is erected, remove cable retainer pins and clip pins from the boom extension fly section sheave

**NOTE:** Hoist cable shall not be routed over the boom extension base section sheave when using the boom extension fly section.

31. Route hoist cable over mast sheave, then reinstall cable retainer pin and secure with clip pin.

If only the boom extension base section is erected, route cable over boom extension base section sheave, then reinstall cable retainer pins and secure with clip pins.

If the boom extension fly section is erected, route cable over roller at rear of boom extension fly section, then over boom extension fly section sheave. Reinstall cable retainer pins and secure with clip pins.

**NOTE:** Do not reeve hoist cable through sheaves on boom nose.

32. Rig hoist cable.

33. If required, set manual boom extension offset to 20° or 40°. Refer to *Setting Boom Extension Manual Offset*, page 4-27.

**Erecting Boom Extension Fly Section**

Refer to Figure 4-20.

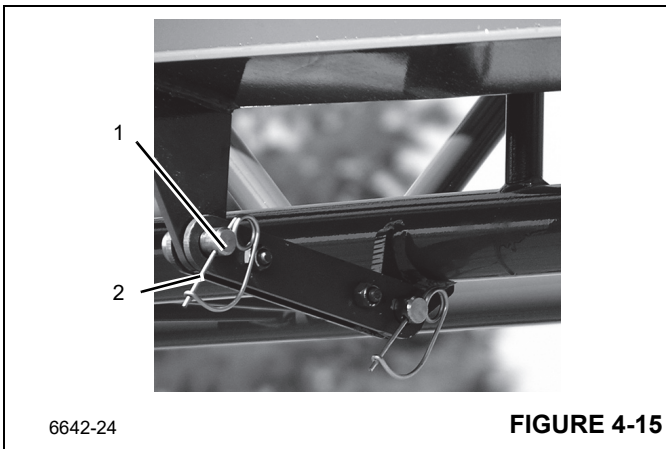
- 1. Attach rope to tip of boom extension fly section to help swing it around to the front of the boom extension base section.
- 2. Ensure attachment pin securing the right side of the boom extension base section to the boom extension fly section is in place.
- 3. Position boom to horizontal.

**DANGER**

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

Uncontrolled movement of the boom extension fly section can cause death, injuries, or damage to equipment.

4. Remove retainer clip (2, Figure 4-15) and remove pin (1).



6642-24

**FIGURE 4-15**

5. Slightly raise or lower boom to help control boom extension fly section swing. Using rope attached to tip of boom extension fly section, swing it in front of the boom extension base section until boom extension fly section attachment fittings engage with the left side boom extension base section anchor fittings.
6. Install attachment pin into left anchor and attachment fittings of the boom extension base section and boom extension fly section. Secure attachment pin with retaining clip.
7. Lower boom and remove rope from tip of the boom extension fly section.

**Stowing Boom Extension**

**NOTE:** Boom extension must be set at 0° offset. If boom extension is manually off-settable, refer to *Setting Boom Extension Manual Offset*, page 4-27.

Refer to Figure 4-20.

1. Fully extend and set outriggers.
2. Position boom over front of crane.
3. Fully retract all boom sections.
4. Set offset to 0° if not already done so. Refer to the applicable procedures in this section.
5. Lower boom to minimum elevation.

6. Lower front outriggers until front wheels are on ground.
7. Set boom manual/automatic mode selector switch to the AUTO position.
8. Set boom A/B mode selector switch to the B mode.
9. If the boom extension fly section is erected, remove the clip pins and cable retaining pins at the boom extension fly section sheave, then remove the hoist cable. Reinstall cable retaining pins and secure with clip pins.

If only the boom extension base section is erected, remove the clip pins and cable retaining pins at the boom extension base section sheave, then remove the hoist cable. Reinstall cable retaining pins and secure with clip pins.

Remove the clip pin and cable retaining pin at the mast sheave (6, Figure 4-20), then remove the hoist cable. Reinstall cable retaining pins and secure with clip pins.

10. Stow mast assembly:
  - a. Remove pin from the upright position lug of the mast assembly.
  - b. Lower the mast assembly and install the pin in the stowed position lug.
  - c. Secure with clip pin.
11. Disconnect hydraulic lines (if required) Refer to *Connecting and Disconnecting Boom Extension*, page 4-32.
12. Disconnect the anti-two block cable(s). Refer to *Connecting and Disconnecting Boom Extension*, page 4-32.
13. If erected, stow boom extension fly section as follows:
  - a. Attach rope to the boom extension fly section tip.
  - b. Raise the boom to horizontal.

**DANGER**

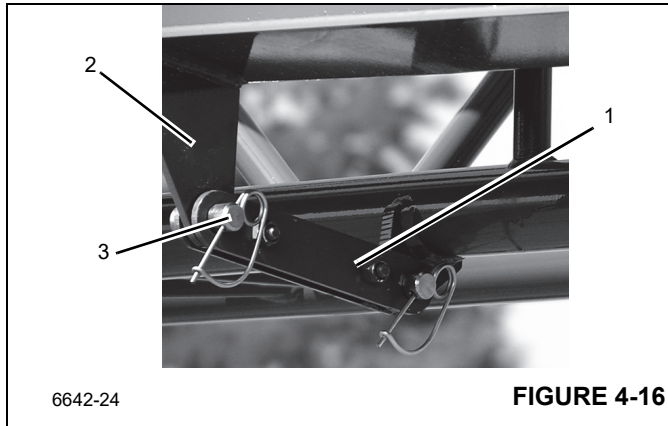
When stowing the boom extension fly section, ensure all personnel and equipment are kept clear of the swing path.

Uncontrolled movement of boom extension fly section can cause death, injuries, or damage to equipment.

- c. Remove left attachment pin connecting the boom extension fly section to the boom extension base section. Stow attachment pin in the stowage holder on the boom extension base section and secure with retaining clip.
- d. Slightly raise or lower boom to help control the boom extension fly section swing. Using rope attached to tip of boom extension fly section, swing

boom extension fly section to side of the boom extension base section.

- e. Connect locking bar (9, Figure 4-20; 1, Figure 4-16) to boom extension base section attachment bar (2) using pin (3). Secure with retaining clip.



- 14. Lower boom to minimum elevation and remove rope.
- 15. Attach rope to boom extension base section tip.
- 16. Raise boom to horizontal.
- 17. Extend boom approximately 12 in so boom extension base section stowage lugs will line up in front of the middle stowage bracket guide ramp (10, Figure 4-20) and stowage pins (14, Figure 4-20) on the front stowage bracket assembly (5, Figure 4-20) when the boom extension is positioned to the side of the boom base.
- 18. Using the jack handle (4, Figure 4-17) stored on the left side of the boom nose, extend boom extension alignment jack (3, Figure 4-17) until the lower left attachment pin is free from the anchor and attachment fittings of the boom extension base section and boom nose. Remove attachment pin and stow on boom extension base section, then secure with retaining clip.
- 19. Retract alignment jack to its original position, then return the jack handle to its stowed position.

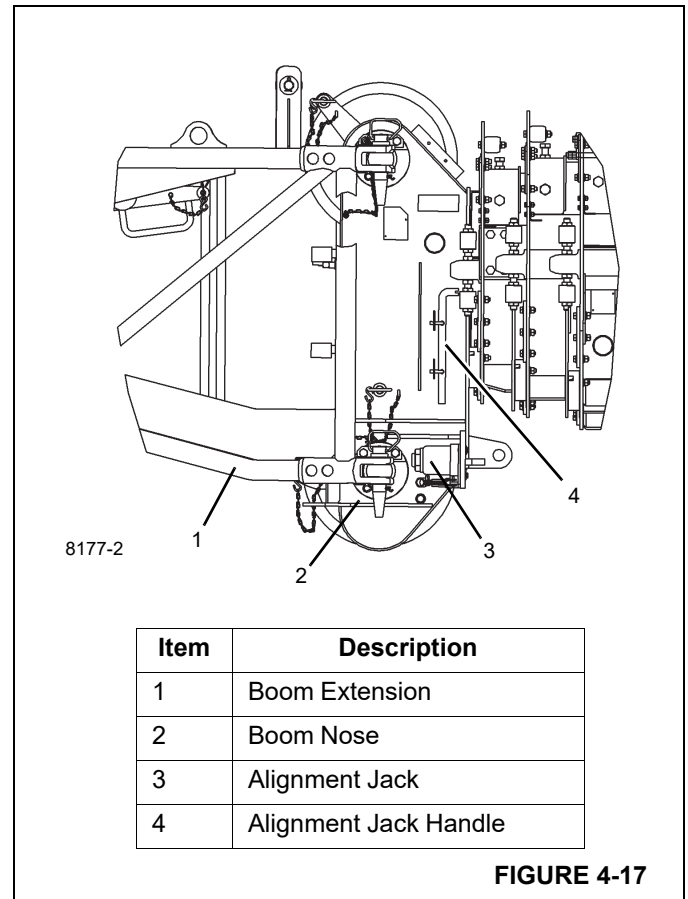


**DANGER**

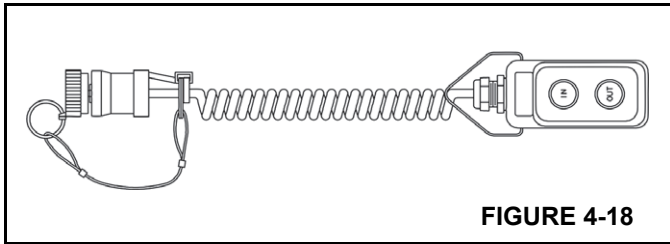
When stowing the boom extension base section, ensure all personnel and equipment are kept clear of swing path.

Uncontrolled movement of boom extension base section can cause death, injuries, or damage to equipment.

- 20. Remove top left attachment pin from the anchor and attachment fittings of the boom extension base section and boom nose. Stow attachment pin in boom extension base section and secure with retaining clip.



- 21. Slightly raise or lower boom to help control the boom extension base section swing. Using rope attached to tip of the boom extension base section, swing boom extension base section to the side of the boom base.
- 22. Elevate boom and push in on the boom extension base section to align the stowage lugs on the boom extension base section with the guide ramp and stowage pins on the stowage brackets, then fully retract the boom.
- 23. Fully lower boom.
- 24. Secure boom extension base section to front stowage bracket (5, Figure 4-20) on boom base using lock hitch pin (13, Figure 4-20). Ensure lock hitch pin is pushed in all the way, then secure with retaining clip.
- 25. Remove upper and lower right attachment pins from the anchor and attach fittings of the boom extension base section and boom nose. Stow attachment pins in the stowage lugs on the right side of the boom extension base section, then secure with retaining clips.
- 26. Remove caps and connect boom extension mount control pendant to connector on front of boom base.



### CAUTION

Failure to maintain proper clearance between the boom extension base section anchor fittings and boom nose attachment fittings could cause fittings to contact each other during operation of the boom.

27. Using control pendant, fully retract middle stowage bracket (10, Figure 4-20).

28. Ensure the two stowage lugs on the boom extension base section are fully engaged with the pins (14, Figure 4-20) on front stowage bracket (5, Figure 4-20).

**NOTE:** If boom extension fly section and boom extension base section are being stowed together, perform step 29.

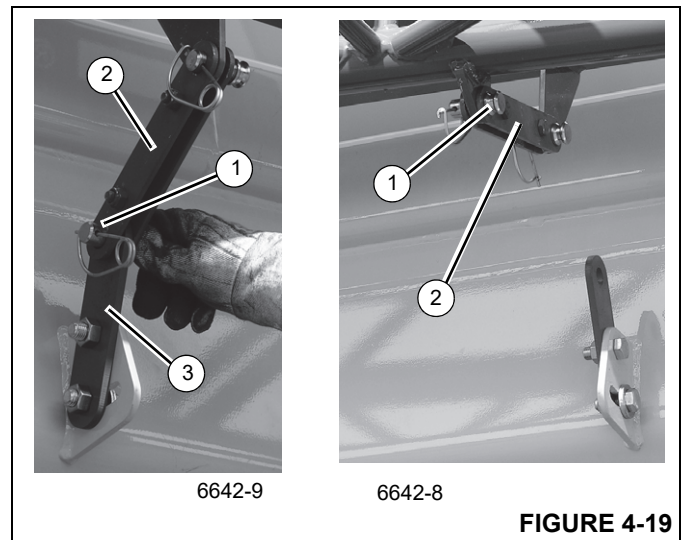
If boom extension fly section remained on boom stowage brackets, perform steps 30 through 31.

29. Secure boom extension fly section to rear stowage bracket (1, Figure 4-20) on the boom base using the attachment pin. Secure attachment pin with retaining clip.

Skip to step 32.

30. Remove attachment pin from stowage holder on the boom extension base section and use it to secure the boom extension fly section to the boom extension base section. Secure attachment pin with retaining clip.

31. Remove pin (1, Figure 4-19) from boom base attachment bar (3). Move locking bar (2, Figure 4-19; 10, Figure 4-20) to boom extension base section and install pin (1). Secure with retaining clip.



32. Disconnect control pendant and replace caps.

33. Extend boom in AUTO mode with B mode selected, or Manual Mode with Section 1 selected, until boom stops.

**NOTE:** Reaching this stopping point is required for the Boom Extension Rigging Mode process.

34. Retract boom until it stops.

**NOTE:** When boom reaches this stopping point and section 1 and section 2 proximity switches are activated, the Boom Extension Rigging Mode is complete and restrictions on the boom operating modes are removed.

35. Rig boom nose and hoist cable as desired. Operate crane using normal operating procedures.

## Setting Boom Extension Manual Offset



### DANGER

#### Crushing Hazard!

Ensure blocking material is adequate to support weight of extension assembly without tipping or falling.

Refer to Figure 4-11.

### Changing Offset from 0° to 20° or 40°

1. Extend and set outriggers. Swing boom over front of crane.
2. Raise and lock the mast assembly:
  - a. Remove mast assembly clip pin and pin from the stowed position on the extension
  - b. Raise the mast assembly to an upright position.
  - c. Install pin and clip pin.
  - d. Remove cable retainer pin and clip pin from mast.
3. Raise boom above horizontal.
4. Block under tip of boom extension section.

### CAUTION

#### Possible Equipment Damage!

Do not overload boom extension anchor fittings or boom extension base section when lowering the boom.

5. Slowly lower boom until weight is removed from offset assembly.
6. Remove offset clip and pin securing offset assembly in the lesser degree offset position. If going to maximum offset stow in the stowage lug. If going to intermediate (20°) offset, install in offset hole for that degree of offset.
7. Reeve hoist cable as described under normal erecting procedures.
8. Slowly elevate and telescope boom at the same time so boom extension does not move off of the blocking until offset assembly takes full weight of the boom extension.

### Changing Offset from 40° to 20° or 0°

### CAUTION

Do not overload boom extension anchor fittings or boom extension base section when lowering the boom.

1. Extend and set outriggers. Swing boom over front of crane.
2. Block under tip of boom extension section.

3. Slowly lower boom until weight is removed from offset assembly.
4. Remove clip and pins from offset assembly. Lower boom until holes for lesser degree offset position align in offset assembly. Install offset pin and clip.
5. Slowly elevate and telescope boom at the same time so boom extension does not move off blocking until offset links take full weight of the extension.
6. Stow mast assembly:
  - a. Remove pin from the upright position lug on the extension
  - b. Lower the mast assembly and install the pin in the stowed position lug.
  - c. Secure with clip pin.
  - d. Reeve hoist cable as described under normal erecting procedures.

## Setting Boom Extension Hydraulic Offset

1. Extend and set outriggers. Swing boom over front and raise above horizontal.
2. To change offset, press the Hydraulic Luffing Jib On/Off Switch to ON.
3. Using the Hydraulic Luffing Jib Adjustment Switch or the Luffing Jib Adjustment Switch on the luffing jib, press the appropriate button to increase or decrease the offset angle.

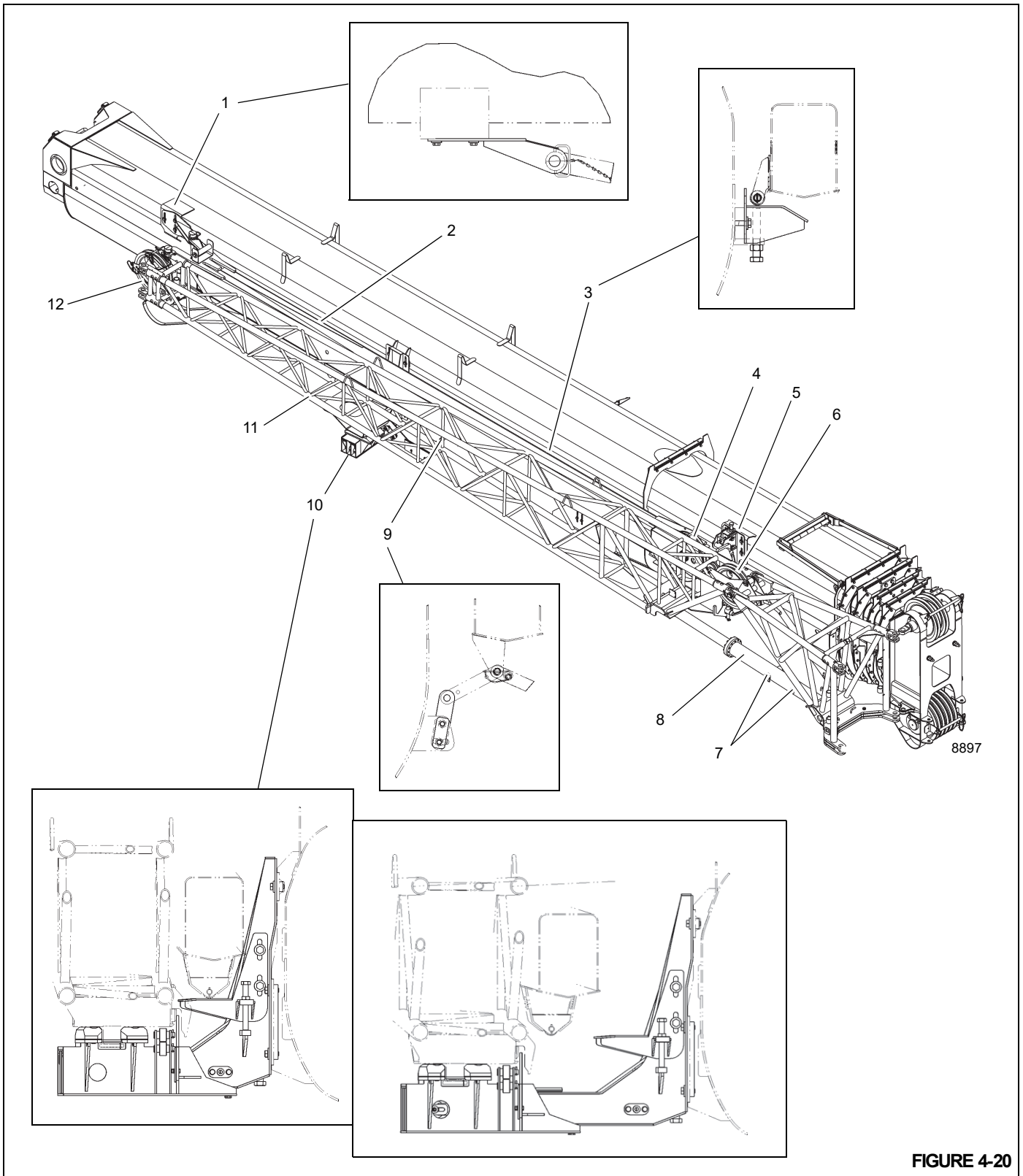


FIGURE 4-20



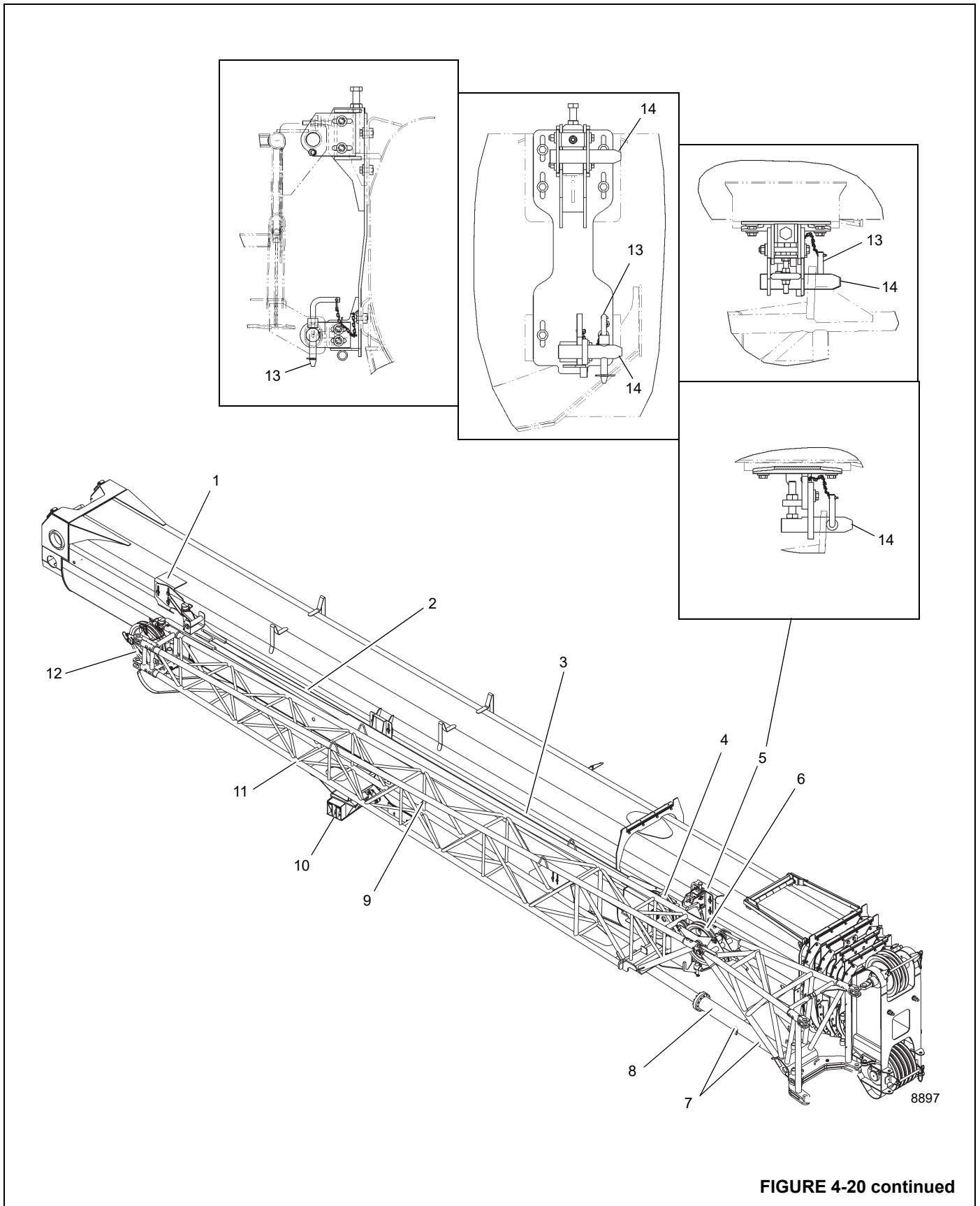


FIGURE 4-20 continued

Item	Description	Item	Description
1	Boom Extension Fly Section Rear Stowage Bracket Assembly	8	Offset Link
2	Boom Extension Fly Section	9	Boom Extension Locking Bar
3	Boom Extension Fly Section Front Stowage Ramp Assembly	10	Middle Stowage Bracket and Actuator Assembly
4	Boom Extension Fly Section Sheave	11	Boom Extension Base Section
5	Boom Extension Base Section Front Stowage Bracket Assembly	12	Boom Extension Base Section Sheave
6	Boom Extension Mast Assembly	13	Lock Hitch Pin
7	Offset Link Pinning Locations	14	Front Stowage Bracket Pins

## ERECTING AND STOWING BI-FOLD BOOM EXTENSION WITH 6 M (20 FT) INSERT



### DANGER

#### Crushing Hazard!

Before attempting to erect or stow boom extension with insert, read and follow all safety decals installed on boom/boom nose, boom extension, insert, and stowage brackets.

### Erecting

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

1. Fully extend and set outriggers.
2. Position boom over front of crane.
3. Fully retract the boom.
4. Lower boom to minimum elevation.
5. If not already done so, deploy the boom extension by performing the procedures under *Erecting Boom Extension*, page 4-21, but do not make the anti-two-block connection or hydraulic connection (if required) at the boom nose.
6. Extend boom as necessary to permit sufficient clearance for installation of the 6.1 m (20 ft) Extension Insert, then lower it until tip of boom extension is laying on the ground. Block under boom extension, approximately 2.4 m to 3.0 m (8 ft to 10 ft) ahead of the boom nose.
7. Remove four retainer clips and attachment pins that secure boom extension to the boom nose.
8. Retract boom leaving boom extension on blocking.

9. Using main or auxiliary hoist cable, lift Insert by the lifting lugs and position it at base end of boom extension.
10. Attach Insert to boom extension by installing the four attachment pins and retainer clips removed in step 7.
11. With hoist cable still attached to Insert, lift assembled unit. Move blocking erected in step 6, 2.4 m to 3.0 m (8 ft to 10 ft) ahead of boom nose attachment end of Insert.
12. Lower boom extension and insert assembly to blocks. Remove hoist cable.
13. Retract boom and lower to minimum elevation.
14. Rig hoist cable for single part line with only wedge socket on cable end.
15. Extend boom and mate anchor fittings on Insert with attachment fittings on boom nose. Raise or lower boom slightly to mate attachment anchor fittings as needed.

**NOTE:** If Insert anchor fitting holes are not in lateral alignment with holes in the boom nose attachment fittings to install the pins, adjust upper and lower cross strut adjustment screws on the Insert to align the holes.

16. Remove retainer clips from attachment pins stowed on Insert. Install in attachment and anchor fittings on both sides of boom nose. Install retainer clips.

### CAUTION

#### Possible Equipment Damage!

Do not attempt to swing boom extension to right side of insert. Damage to insert may result.

17. Make anti-two block electrical connections between the insert and the boom nose and boom extension. If required, make hydraulic connections between the insert and the boom nose and boom extension.
18. Slowly elevate boom and remove blocking from under Insert and boom extension.

19. If required, erect the boom extension fly section. Refer to *Erecting Boom Extension Fly Section*, page 4-23.

21. If required, set offset. Refer to the applicable procedures in this section.

20. Rig hoist cable.

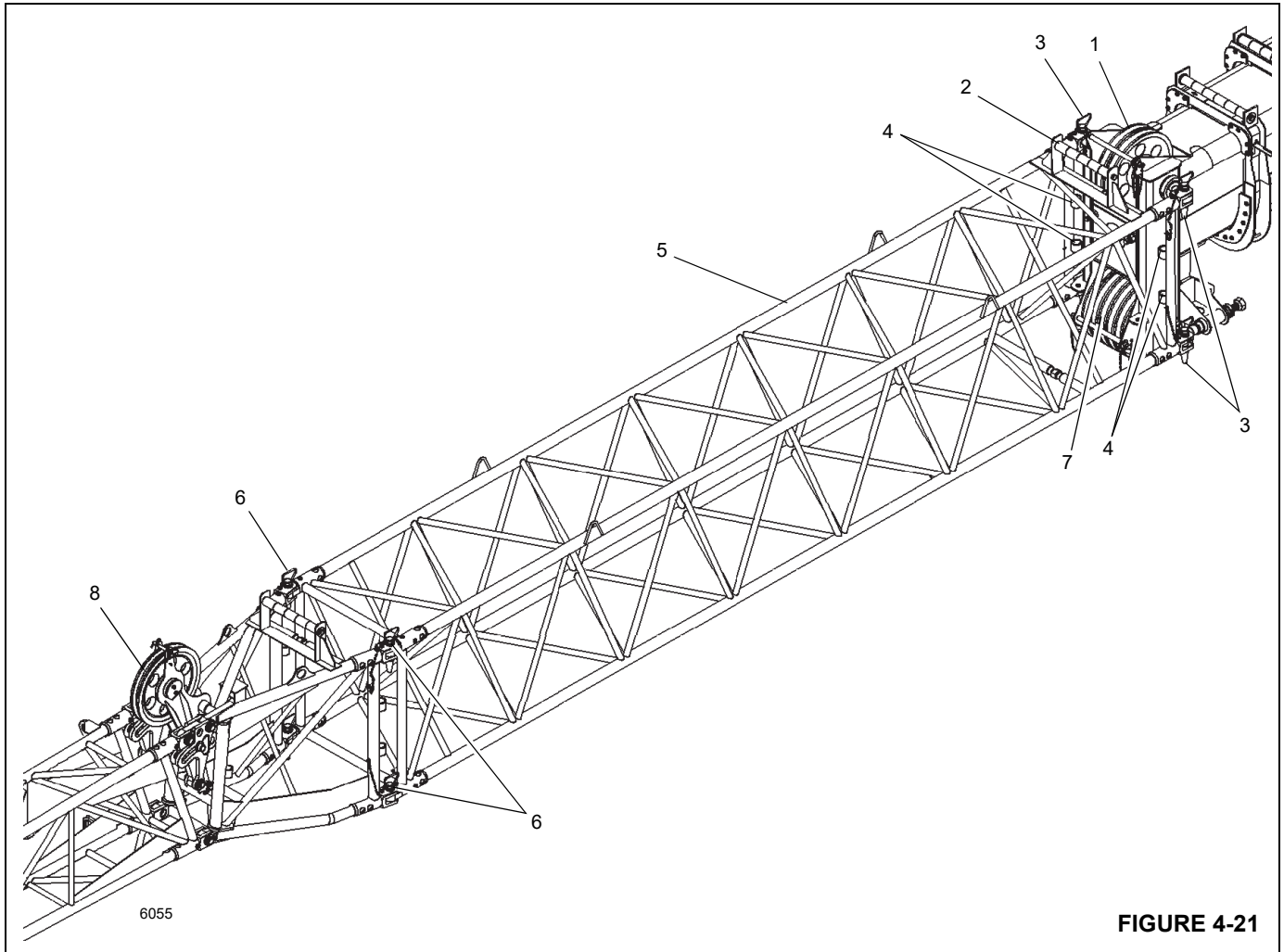


FIGURE 4-21

Item	Description	Item	Description
1	Boom Nose Upper Sheaves	5	6.1 m (20 ft) Insert
2	Cable Roller	6	Boom Extension Base Section Attachment Pins
3	Attachment Pins	7	Boom Nose Lower Sheaves
4	Attachment Pin Stowage Holder	8	Boom Extension Mast Assembly

## Stowing

**NOTE:** When removing the insert, the boom extension fly section of the boom extension may be in the erected position or folded against the boom extension base section.

1. Fully extend and set outriggers.
2. Position boom over front of crane.
3. Fully retract the boom.
4. Set offset to 0° if not already done so. Refer to the applicable procedures in this section.
5. Lower boom to minimum elevation.
6. Remove cable retainer pins and clip pins from boom extension tip and mast assembly (if required). Remove hoist cable from boom extension sheave and/or mast. Install cable retainer pins and clip pins.
7. Disconnect anti-two block electrical connections between the insert and the boom nose and boom extension. If required, disconnect hydraulic connections between the insert and the boom nose and boom extension.
8. If required, stow the boom extension fly section by performing step 13 under *Stowing Boom Extension*, page 4-24.
9. Extend boom approximately 1.22 m to 1.52 m (4 ft to 5 ft). Lower boom until sheave is on ground.
10. Block under insert approximately 2.4 m to 3.0 m (8 ft to 10 ft) forward of boom nose.
11. Remove retainer clips from four pins in the attachment and anchor fittings. Remove attachment pins and stow in holders on insert.
12. Retract boom, disengaging attachment fittings on boom nose from anchor fittings on insert.
13. Attach a hook to the hoist cable.
14. Attach hoist cable hook to lifting lugs on insert. Lift assembly and reposition blocking approximately 2.4 m to 3 m (8 ft to 10 ft) forward of insert to boom extension attachment points.
15. While supporting insert with hoist cable, remove retainer clips from four pins attaching insert to boom extension. Remove four pins.
16. Remove insert and position to one side of crane.
17. Position boom and extend to engage boom nose with boom extension. Install four attachment pins and retainer clips removed in step 15.
18. If required, stow the boom extension by performing procedures 10 through 35 under *Stowing Boom Extension*, page 4-24.

## CONNECTING AND DISCONNECTING BOOM EXTENSION

### Connecting

#### *Making Hydraulic Connection Between Boom Extension and Main Boom*



### WARNING

If hose couplings are detached from boom after hose drum lock pin has been released, do not release hose couplings until re-attached to boom. If hose couplings are released after being detached from boom, hoses will spring back uncontrollably due to hose drum spring force.

When working only with main boom for long periods of time, disconnect hydraulic connection between hose drum and main boom. This prevents unnecessary hydraulic hose reeling and unreeling.

If hoses are stowed on boom base holder, release hose drum (4) lock pin. Pull hydraulic hoses toward the boom nose. Anchor hydraulic couplings (1) at the boom nose holder (2). Route hydraulic hoses through guide rollers (3).

1. Unwind hoses on boom extension base section.
2. Remove dust caps from couplings on boom extension base section and drum hoses.
3. Connect boom extension base section hoses to drum hoses. Do not detach drum hoses from boom nose holder.

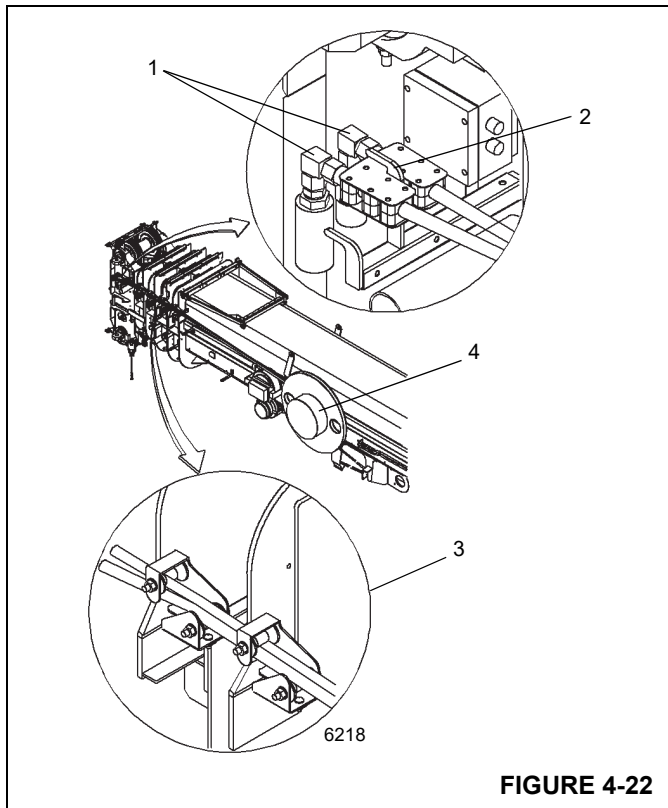


FIGURE 4-22

Item	Description
1	Hydraulic Couplers
2	Holder
3	Guide Rollers
4	Hose Drum

**Making Electrical Connection Between Boom Extension Base Section and Boom Nose**

1. Remove bypass plug from boom nose splitter connection and stow on cap near splitter connection.
2. Unwind cable from boom extension base section and connect to boom nose splitter connection.

**Making Electrical Connection Between Boom Extension Base Section and Boom Extension Fly Section**

1. Disconnect cable from boom extension base section anti-two block switch.
2. Connect boom extension base section cable to boom extension fly section cable.
3. Install cap onto anti-two block switch on boom extension base section.

**Disconnecting**

**Disconnecting Electrical Connection Between Boom Extension Base Section and Boom Nose**

1. Disconnect boom extension base section cable from boom nose splitter connection.
2. Install cap on cable and wind cable onto boom extension base section for storage.
3. Remove bypass plug from cap near splitter connection and install in splitter connection.

**Disconnecting Electrical Connection Between Boom Extension Base Section and Boom Extension Fly Section**

1. Remove cap from anti-two block switch on boom extension base section.
2. Disconnect boom extension base section cable from boom extension fly section cable.
3. Install cap onto plug of boom extension fly section cable.
4. Connect boom extension base section cable to anti-two block on boom extension base section.

**Disconnecting Hydraulic Connection Between Boom Extension and Boom Base**

**! WARNING**

If hose couplings are detached from boom after hose drum lock pin has been released, do not release hose couplings until they are attached to the boom. If hose couplings are released after being detached from the boom, hoses will spring back uncontrollably due to spring force in the hose drum.

1. Disconnect boom extension hoses from drum hoses. Do not detach drum hoses from boom nose.

When working with main boom for longer periods of time, hydraulic hoses should be disconnected from boom nose and retracted. This prevents unnecessary reeling and unreeling of the hose.

2. Remove hoses from boom nose. Retract hydraulic hoses to holder on boom base.
3. Engage hose drum lock pin into hole on drum.
4. Wind hoses on boom extension base section for storage.
5. Install dust caps on boom extension base section and drum hose couplings.

### 3.05 M (10 FT) HEAVY DUTY BOOM EXTENSION (OPTIONAL)

#### Description

A 3.05 m (10 ft) manual off-settable heavy duty boom extension provides additional boom reach designed for tilt-up panel operations. The extension weighs approximately 700 kg (1,543 lb).

#### Installing Heavy Duty Boom Extension

1. Fully extend and set outriggers.
2. Position boom over front of crane.
3. Fully retract all boom sections.
4. Lower boom to minimum elevation.
5. Using a suitable lifting device, lift the heavy duty boom extension in front of the boom nose aligning the anchor fittings with boom attachment fittings.
6. Install attachment pins in anchor fittings and attachment fittings of the boom nose. Install retaining clips in attachment pins.
7. As required, rig main hoist or optional auxiliary hoist cable for single through four part line.
8. Connect RCL cables:
  - a. Remove RCL cable end connector from boom extension and route through boom extension.
  - b. Remove dummy plug from junction box on boom nose.
  - c. Install cable end connector from boom extension where dummy plug was removed.

#### Setting Heavy Duty Boom Extension Manual Offset



#### **DANGER** Crushing Hazard!

Ensure blocking material is adequate to support weight of the extension assembly without tipping or falling.

#### *Changing Offset from 0° to 35° or 55°*

1. Extend and set outriggers.
2. Swing boom over front of crane.

3. Raise boom above horizontal.
4. Block under tip of boom extension.

#### **CAUTION**

##### **Possible Equipment Damage!**

Do not overload boom extension anchor fittings or boom extension base section when lowering the boom.

5. Slowly lower boom until weight is removed from offset assembly.
6. Remove offset clip and pin securing offset assembly in the lesser degree offset position. If going to maximum offset, stow pin in the stowage lug. If going to intermediate (20°) offset, install pin in offset hole for that degree of offset. Secure with clip.
7. Reeve hoist cable as described under normal erecting procedures.
8. Slowly elevate and telescope boom at the same time so boom extension does not move off of the blocking until offset assembly takes full weight of the boom extension.

#### *Changing offset from 55° to 35° or 0°*

#### **CAUTION**

Do not overload boom extension anchor fittings when lowering the boom.

1. Extend and set outriggers.
2. Swing boom over front of crane.
3. Block under tip of boom extension.
4. Slowly lower boom until weight is removed from offset assembly.
5. Remove clip and pins from offset assembly. Lower boom until holes for lesser degree offset position align in offset assembly. Install offset pin and clip.
6. Slowly elevate and telescope boom at the same time so boom extension does not move off blocking until offset links take full weight of the boom extension.
7. Reeve hoist cable as described under normal erecting procedures.

### Tilt-Up Panel Procedure Using the Heavy Duty Boom Extension

Refer to *Tilt-Up Panel Lifting*, page 2-21, in the *Safety Information* section for more information.

**! DANGER**

Death or serious injury may result if the permissible working loads and RCL programs are not observed.

Only lift loads weighing less than/or equal to the permissible load of the heavy duty boom extension in the appropriate working radius.

The load's center of gravity must move towards the crane (Figure 4-23, A & B). Any other use is considered non-intended use and is prohibited. For examples see Figure 4-24, C & D.

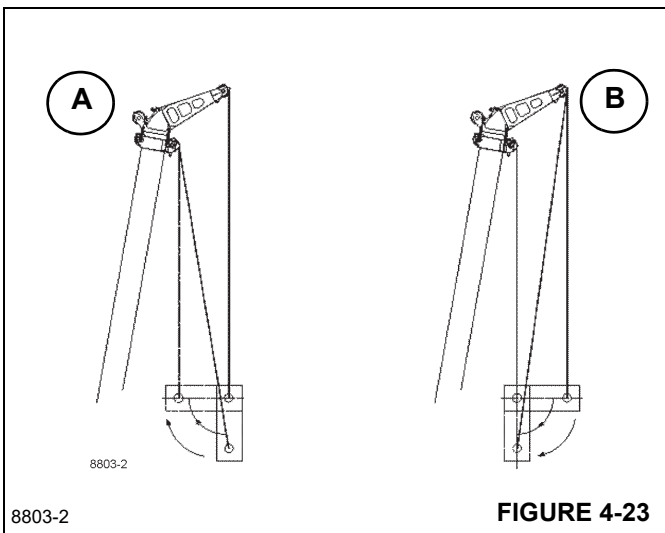
Movement of the load during tilting shall be done such that the moment decreases.

#### Tilting from Vertical to Horizontal

- Lift the load on the heavy duty boom extension (Detail A).
- The hoisting rope on the main boom remains unloaded at first but the rope must not become slack. Then lift the load via the main boom until the load is horizontal. Then lower the load uniformly using the two hoists.

#### Tilting from Horizontal to Vertical

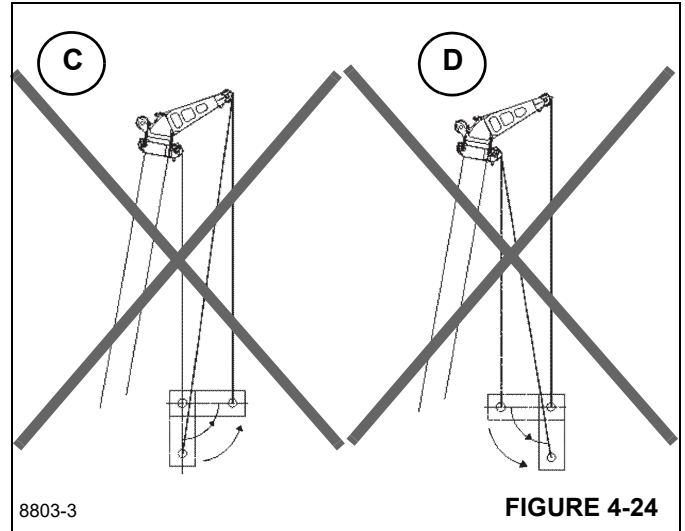
- Lift the load horizontally using the two hoists (Detail B).
- Then slacken the lifting rope of the boom extension until the load is suspended vertically. Lower the load via the main boom and pay-out the lifting rope of the boom extension. Ensure that the rope does not have slack.



**! DANGER**

Death or serious injury may result if the boom is overloaded.

If you proceed in accordance with Detail C / Detail D, the load will swing outward and the load torque will increase. This work method can cause the machine to tip or the boom system to become overloaded and is therefore strictly prohibited!



#### Removing Heavy Duty Boom Extension

1. Fully extend and set outriggers.
2. Position boom over front of crane.
3. Fully retract all boom sections.
4. Lower boom to minimum elevation.
5. Attach a suitable lifting device to the boom extension. Lift the boom extension enough to take the load off of the anchor fittings and attachment fittings.
6. Remove retainer clips from attachment pins. Remove attachment pins from anchor fittings and attachment fittings of the boom nose.
7. Lift the boom extension from in front of the boom nose.

REMOVABLE COUNTERWEIGHT



Falling counterweight can crush and cause death or serious injury.

Ensure all mounting pins are properly installed and locked, during and after operating the counterweight removal system.

Counterweight and optional attached slab are installed and removed using hydraulic cylinders controlled by a counterweight control panel located on each side of the superstructure.

Counterweight and slab are lowered or lifted from two centering pins located on the rear deck.



Travel is not permitted with removable counterweight on carrier deck.

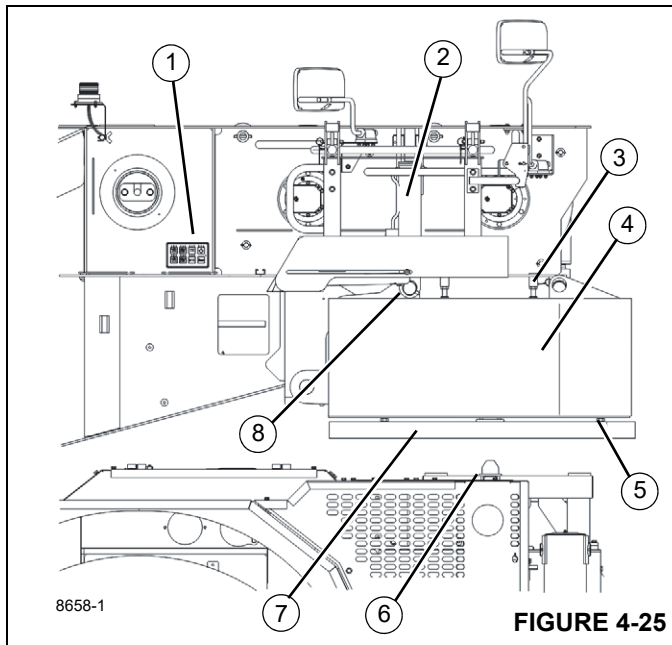


FIGURE 4-25

Item	Description	Item	Description
1	Control Panel	5	Leveling Bolts
2	Lift Cylinder	6	Centering Pins
3	Leveling Bolt (4 ea)	7	Optional Slab
4	Counterweight	8	Lock Cylinder

Counterweight Control Panel

Counterweight control panels are located on each side of the superstructure between the boom pivot and main hoist. Only one control panel can be used at a time. The crane engine must be running with parking brake ON and no other functions enabled for system to be fully operational.

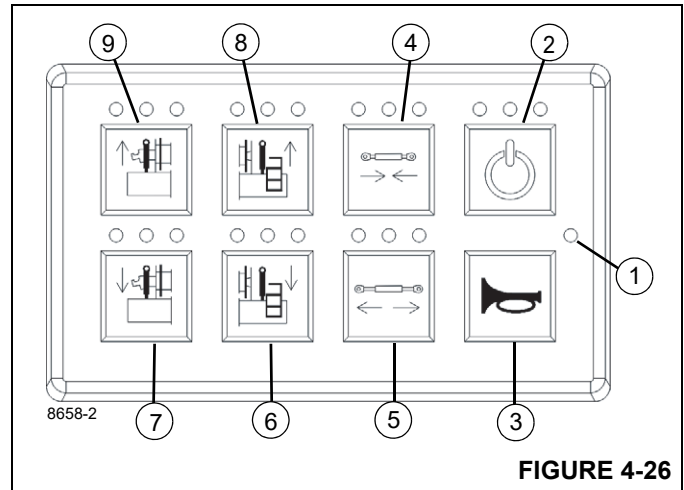


FIGURE 4-26

Item	Description
1	Main Power Indicator
2	Keypad Enable
3	Horn
4	Lock Cylinder Retract
5	Lock Cylinder Extend
6	Left Counterweight Cylinder Lower
7	Right Counterweight Cylinder Lower
8	Left Counterweight Cylinder Raise
9	Right Counterweight Cylinder Raise

Flashing green LED (1) indicates main power is on. Enable and Horn buttons are illuminated and active.

Three LED's above each button indicate:

Green - Function enabled.

Yellow - Error condition.

Red - Function not available or system not enabled.

**NOTE:** The horn button (3) is always active. Enable does not have to be pressed before using the horn.

The Enable button (2) must be pressed and released before selecting a function. The function must be selected within five seconds after pressing the Enable button or the system will time out and the Enable button must be pressed again.

If the Enable button is pressed and held for more than 2 seconds, the red LED will illuminate. No other functions are available until the button is released and pressed again.



## Removing

Refer to Figure 4-26.

1. Position crane on a firm level surface. Fully extend and set outriggers.
2. Place superstructure in normal travel position with counterweight centered at rear of vehicle. Engage turntable lock.
3. Remove locking pins from lock cylinder rods on each side of superstructure.
4. Press and release Enable button (2). Press and hold Lock Cylinder Retract button (4) until lock cylinder rods are completely retracted.
5. Check area is clear around counterweight and carrier rear deck. Press horn button (3).
6. Press and release Enable button (2). Press and hold Left (6) and Right (7) Counterweight Cylinder Lower buttons until counterweight is completely lowered on centering pins and rear deck.
7. Remove lock pins and retaining pins from lift cylinders and counterweight.

**NOTE:** Operate left or right cylinder as needed to remove pins.

8. Press and release Enable button (2). Press and hold Left (8) and Right (9) Counterweight Cylinder Lift buttons until cylinder rods are completely retracted. Reinstall retaining pins and lock pins.

**NOTE:** Do not leave cylinder rods extended. Corrosion or other damage may occur.



### DANGER

Travel is not permitted with removable counterweight on carrier deck.

**NOTE:** Counterweight weighs 9,979 kg (22,000 lb). Optional 2,268 kg (5,000 lb) pinned slab increases counterweight to 12,247 kg (27,000 lb).

9. Release turntable lock. Rotate superstructure 90° for clear access to rear deck.
10. Lift counterweight from carrier deck to transport vehicle.
11. Select proper "Without Counterweight" operating code on the RCL.

## Installing

Refer to Figure 4-26.

1. Position crane on a firm level surface. Fully extend and set outriggers.

**NOTE:** Counterweight weighs 9,979 kg (22,000 lb). Optional 2,268 kg (5,000 lb) pinned slab increases counterweight to 12,247 kg (27,000 lb).

2. Rotate superstructure 90° for clear access to rear deck.
3. Lift counterweight from transport vehicle and position on rear deck centering pins.
4. Place superstructure in normal travel position with counterweight centered at rear of vehicle. Engage turntable lock.
5. Remove lock pins and retaining pins from lift cylinders.
6. Press and release Enable button (2). Press and hold Left (6) and Right (7) Counterweight Cylinder Lower buttons until cylinder rod ends engage counterweight.
7. Install lock pins and retaining pins in lift cylinders and counterweight.

**NOTE:** Operate left or right cylinder as needed to install pins.

8. Press and release Enable button (2). Press and hold Left (8) and Right (9) Counterweight Cylinder Lift buttons until counterweight engages superstructure and lock cylinder holes are aligned with lock cylinder rods on both sides.

**NOTE:** Operate left or right cylinder as needed to align lock cylinder holes with lock cylinder rods.

9. Press and release Enable button (2). Press and hold Lock Cylinder Extend button (5) until lock cylinder rods are completely extended.
10. Install locking pins in counterweight lock cylinder rods on each side of superstructure.
11. Adjust four counterweight bolts and jam nuts to provide a consistent stop and proper alignment with pinning holes.
12. Select proper counterweight operating code on the RCL.
13. Crane is now ready for operation with counterweight installed.

### Installing Optional Counterweight Slab

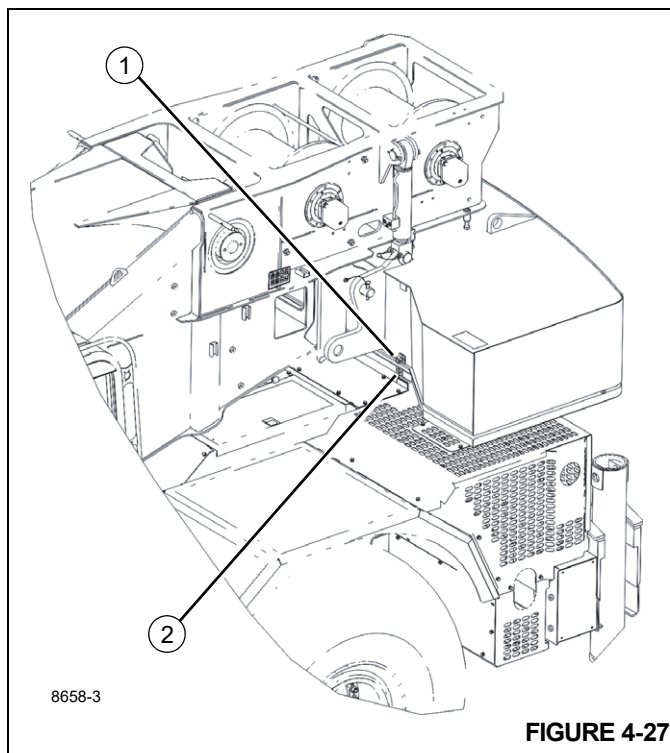
1. Position crane on a firm level surface. Fully extend and set outriggers.
2. Operate crane to place slab on rear deck centering pins.

**NOTE:** Pinned slab weighs 2,268 kg (5,000 lb) and increases 9,979 kg (22,000 lb) Counterweight to 12,247 kg (27,000 lb).

3. Follow operating instructions for Remove and Install Counterweight on previous page, except DO NOT remove lock pins and retaining pins from lift cylinders and counterweight.

**NOTE:** Operate left or right cylinder as needed to align holes in slab and counterweight.

4. Remove attach pins from slab stowage bushings (2) and install them in counterweight lugs (1).
5. Push in on pins and turn to lock pin in notch.
6. Raise and lock counterweight and slab assembly in normal operating position.
7. Adjust three counterweight leveling bolts and jam nuts to reduce movement between counterweight and slab. Maintain a gap of 2 mm - 3 mm to allow for easy pin removal when counterweight is lowered.
8. Select proper counterweight operating code on the RCL.
9. Crane is now ready for operation with counterweight slab installed.



### Removing Optional Counterweight Slab

1. Follow operating instructions for Remove and Install Counterweight on previous page, except DO NOT remove lock pins and retaining pins from lift cylinders and counterweight.

**NOTE:** Pinned slab weighs 2,268 kg (5,000 lb). Removal reduces counterweight from 12,247 kg (27,000 lb) to 9,979 kg (22,000 lb).

2. Lower counterweight and slab assembly to rear deck centering pins.
3. Push in on pins and turn to remove from counterweight lugs (1).
4. Install pins in slab stowage bushings (2).
5. Raise and lock counterweight in normal operating position.



### DANGER

Travel is not permitted with removable counterweight slab on carrier deck.

6. Operate crane to remove slab from rear deck to transport vehicle.
7. Select proper counterweight operating code on the RCL.
8. Crane is now ready for operation with counterweight slab removed.

## SECTION 5 MAINTENANCE AND LUBRICATION

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### SECTION CONTENTS

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## GENERAL

Following designated lubrication procedures is 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.

Refer to your *Inspection and Lubrication Service Log* for routine checks which will help maintain the safety, dependability, and productivity designed into your crane. One copy of the *Inspection and Lubrication Service Log* is provided in the original package of manuals shipped with the crane. Additional copies are available through the Grove distributor network.

Refer to your Service Manual for specific maintenance and adjustment procedures.

## 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.

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### 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.

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## 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 5-1 for a list of the recommended standard lubricants.

**Table 5-1: Standard Lubricants [Down to -9°C (15°F)]**

Lubricant/Fluid	Grove Spec.	Recommended Lubricant		
		Type	Grade	Classification
<b>Axle Gear Oil</b> <b>Hoist Gear Oil</b>	6829014058	Petro-Canada Traxon E Synthetic CITGO, Synthetic Gear Lube Eaton, Roadranger EP Mobil, Mobilube SCH Shell, Spirax S Sunoco Duragear EP	75W-90	
<b>Engine Oil</b>	6829104182	Conoco Fleet Supreme EC Mobil Delvac 1300 Super	15W-40	CJ-4
<b>Hydraulic/Transmission Oil</b>	6829006444	Phillip 66 PowerTran XP Exxon Mobil 424	ISO 46/68	Must Meet John Deere Std. JDM J20c
<b>Swing Drive Oil</b>	6829100213	Mobil: Mobilegear 600XP 150 Texaco: Meropa 150		AGMA No. 4 EP
<b>Grease, Multipurpose</b>	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	
<b>Open Gear Lube</b>	6829102971	Fuchs Ceplattyn 300 Spray	NLGI 1-2	
<b>Antifreeze Coolant</b>	6829101130	Old World Industries, Inc. Fleet Charge SCA Caterpillar DEAC Fleetguard Complete EG	Mix 50/50	
<b>Supplemental Coolant Additive (SCA)</b>	6829012858	Fleetguard DCA4 Fleetguard DCA2 Penray Pencool 3000		
<b>Diesel Exhaust Fluid (DEF)</b>	80019225	Fleetguard StableGuard™ Urea 32 Premix AdBlue® TerraCair Ultrapure® DEF		
<b>Extreme Pressure 3% Moly Grease</b>	6829015304	Citgo Lithoplex CM2 Mobil Mobilgrease CM-P Ipiranga IPIFLEX LI-COMP MOLY 2	NLGI 2	

## 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 the *Operator Manual* 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 5-2) and -40°C (-40°F) (Table 5-3). But, 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 following accessories:

#### **-29°C (-20°F) Package**

- Battery heater
- Fuel line heater

- Engine hood insulation
- Fan clutch
- Radiator air shutters
- Air diverter
- Diesel fired cab heater
- Cold weather alternator
- Fluids suitable to -29°C (-20°F)
  - Arctic windshield washer fluid
  - Arctic fuel

#### **-40°C (-40°F) Package**

- Coolant heater (to circulate warm coolant through heaters and engine)
- Transmission heater
- Swivel heater
- Battery heater
- Fuel line heater
- Hydraulic reservoir 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°C (-40°F):
  - Arctic windshield washer fluid

Table 5-2: Cold Weather Lubricants [Down to -29°C (-20°F)]

Lubricant/Fluid	Grove Spec.	Recommended Lubricant		
		Type	Grade	Classification
<b>Axle Gear Oil</b> <b>Hoist Gear Oil</b>	6829014058	Petro-Canada Traxon E Synthetic CITGO, Syntetic Gear Lube Eaton, Roadranger EP Mobil, Mobilube SCH Shell, Spirax S Sunoco Duragear EP	75W-90	
<b>Engine Oil</b>	80056036	Shell Rotella® T6 Mobil Delvac 1 ESP Caterpillar Cat DE0-ULS Cold Weather	0W-40	CJ-4
<b>Transmission Oil</b>	6829101559	Petro-Canada Duratran Synthetic THF Chevron All Weather THF Texaco TDH Oil SS		Must Meet John Deere Std. JDM J20c & J20d
<b>Swing Drive Oil</b>	6829103636	Petro-Canada ENDURATEX Synthetic EP 150 Mobil SHC629		AGMA No. 4 EP
<b>Grease, Multipurpose</b>	6829104275	Petro-Canada Precision Synthetic EP1 Mobil, Mobilith SHC 220	NLGI 2	
<b>Open Gear Lube</b>	6829102971	Fuchs Ceplattyn 300 Spray	NLGI 1-2	
<b>Antifreeze Coolant</b>	6829101130	Old World Industries, Inc. Fleet Charge SCA Caterpillar DEAC Fleetguard Complete EG	Mix 50/50	
<b>Supplemental Coolant Additive (SCA)</b>	6829012858	Fleetguard DCA4 Fleetguard DCA2 Penray Pencool 3000		
<b>Hydraulic Oil</b>	6829006993	Exxon Mobil Univis HVI	26	
<b>Diesel Exhaust Fluid (DEF)</b>	80019225	Fleetguard StableGuard™ Urea 32 Premix AdBlue® TerraCair Ultrapure® DEF		
<b>Windshield Washer fluid</b>	90037773	Splash De-icer		
<b>Diesel Fuel</b>	80069407	NOCO Kerosene, 3, UN1223, III Product #1	#1	NLOCK08
<b>Extreme Pressure 3% Moly Grease</b>	6829104275	Mobil Mobilith SHC 220 Petro-Canada Precision Synthetic EP1	NLGI 2	

Table 5-3: Cold Weather Lubricants [Down to -40°C (-40°F)]

Lubricant/Fluid	Grove Spec.	Recommended Lubricant		
		Type	Grade	Classification
<b>Axle Gear Oil</b> <b>Hoist Gear Oil</b>	6829014058	Petro-Canada Traxon E Synthetic CITGO, Syntetic Gear Lube Eaton, Roadranger EP Mobil, Mobilube SCH Shell, Spirax S Sunoco Duragear EP	75W-90	
<b>Engine Oil</b>	80056036	Shell Rotella® T6 Mobil Delvac 1 ESP Caterpillar Cat DE0-ULS Cold Weather	0W-40	CJ-4
<b>Transmission Oil</b>	6829101559	Petro-Canada Duratran Synthetic THF Chevron All Weather THF Texaco TDH Oil SS		Must Meet John Deere Std. JDM J20c & J20d
<b>Swing Drive Oil</b>	6829103636	Petro-Canada ENDURATEX Synthetic EP 150 Mobil SHC629		AGMA No. 4 EP
<b>Grease, Multipurpose</b>	6829104275	Petro-Canada Precision Synthetic EP1 Mobil, Mobilith SHC 220	NLGI 2	
<b>Open Gear Lube</b>	6829102971	Fuchs Ceplattyn 300 Spray	NLGI 1-2	
<b>Antifreeze Coolant</b>	6829104212	Old World Industries, Inc. Fleet Charge SCA Pre-charged Fleetguard Compleat EG Petro-Canada	Mix 60/40	
<b>Supplemental Coolant Additive (SCA)</b>	6829012858	Fleetguard DCA4 Fleetguard DCA2 Penray Pencool 3000		
<b>Hydraulic Oil</b>	6829006993	Exxon Mobil Univis HVI	26	
<b>Diesel Exhaust Fluid (DEF)</b>	80019225	Fleetguard StableGuard™ Urea 32 Premix AdBlue® TerraCair Ultrapure® DEF		
<b>Windshield Washer fluid</b>	90037773	Splash De-icer		
<b>Diesel Fuel</b>	80069407	NOCO Kerosene, 3, UN1223, III	#1	NLOCK08
<b>Extreme Pressure 3% Moly Grease</b>	6829104275	Mobil Mobilith SHC 220 Petro-Canada Precision Synthetic EP1	NLGI 2	



## 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 Manitowoc 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 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!**

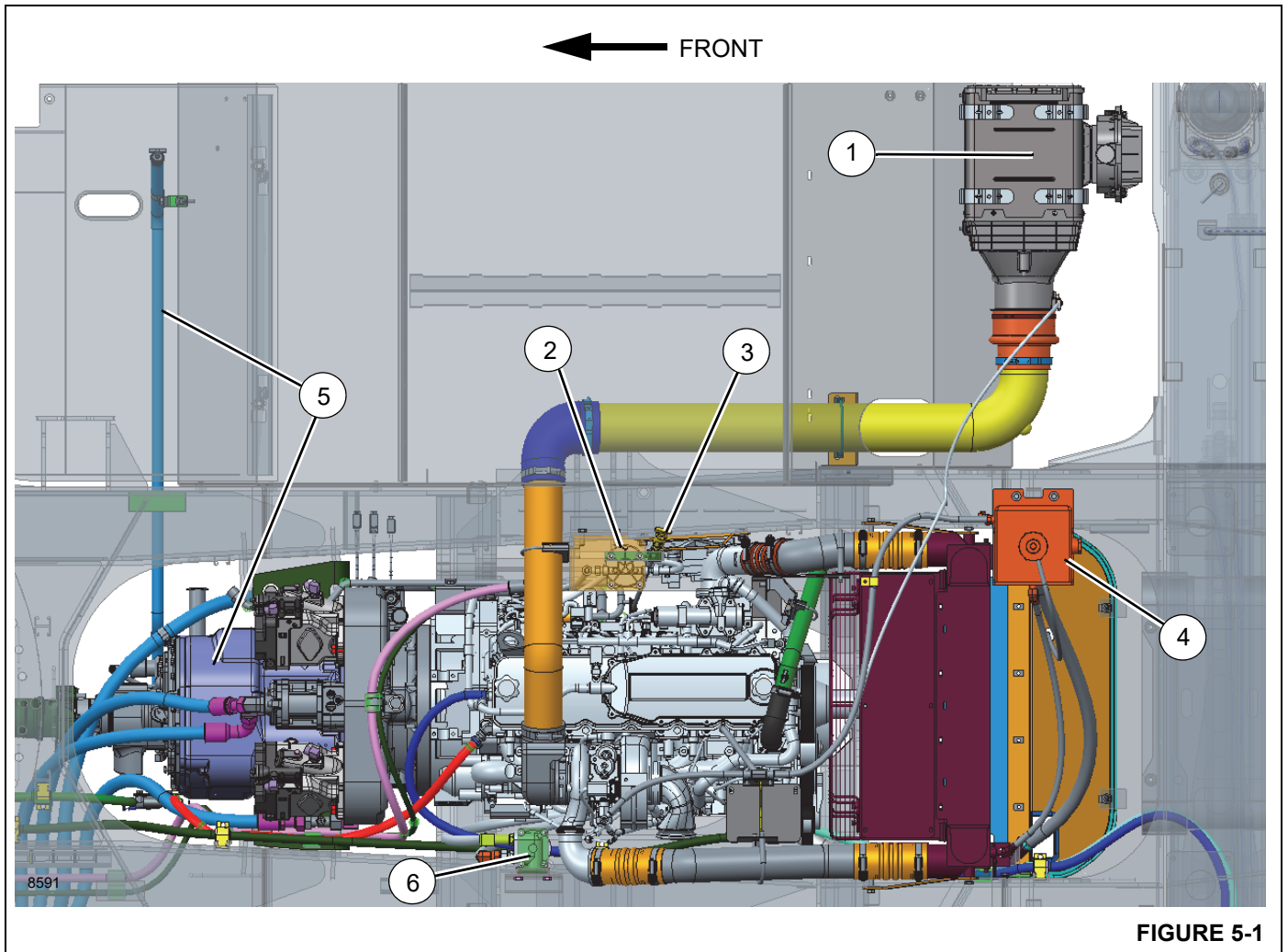
Movement of the superstructure and the boom may create a crushing and/or pinching hazard. Failure to observe this warning could result in death or serious injury if the message is ignored.

**Table 5-4 Approved Lubricant Reference Table**

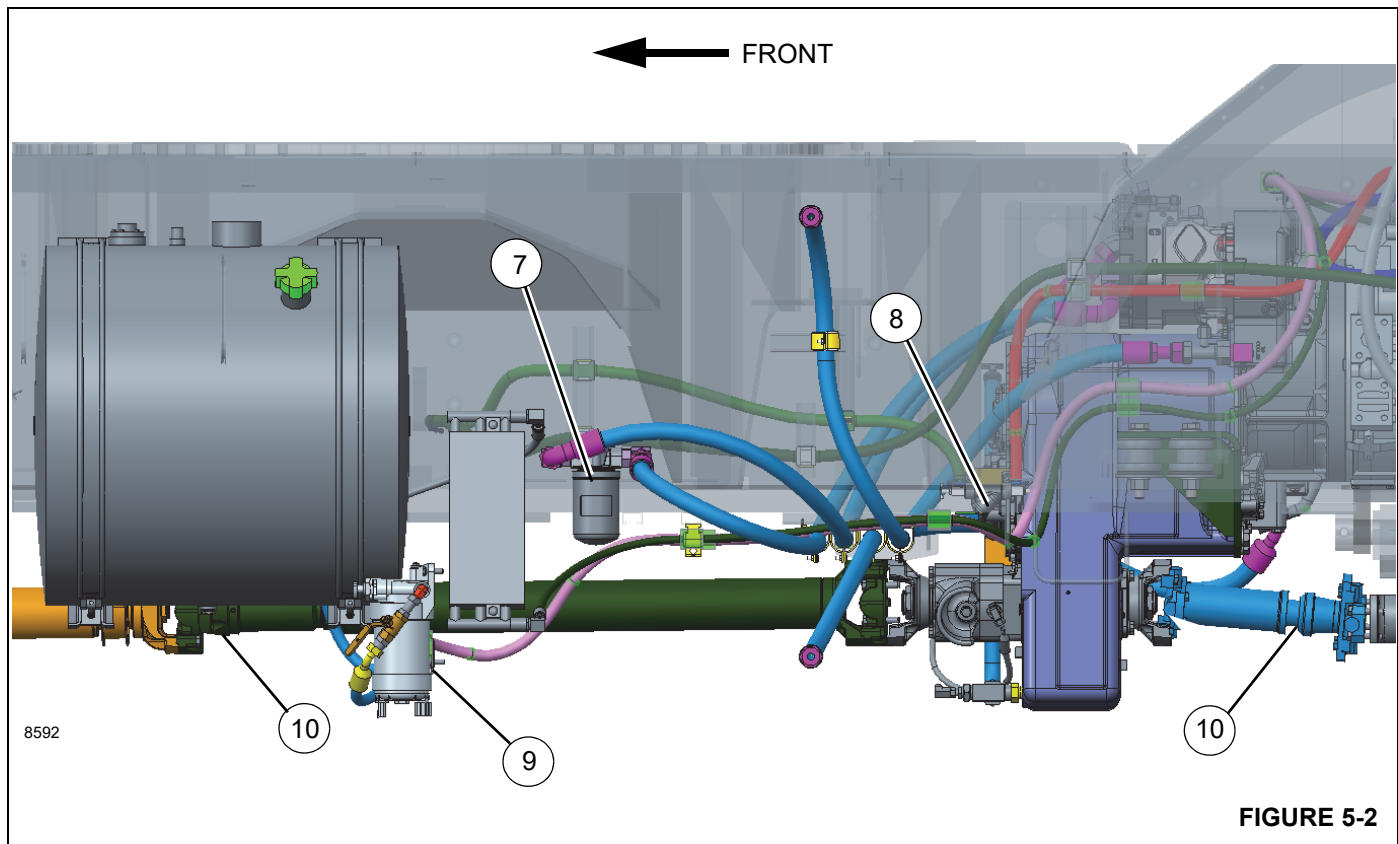
Ref.	Approved Lubricant	Lube Specification Down To -9°C (15°F)	Lube Specification Down To TO -29°C (-20°F)	Lube Specification Down To -40°C (-40°F)
A	Extreme Pressure Multipurpose Grease	6829003477	6829104275	6829104275
B	Gear Lube (GL-5)	6829014058	6829014058	6829014058
C	Fully Formulated Anti-Freeze Coolant	6829101130	6829101130	6829104212
D	Liquid Coolant Conditioner	6829012858	6829012858	6829012858
E	Tractor Hydraulic Fluid	6829006444	6829101559	6829101559
F	Engine Oil SAE	6829104182 (15W-40)	80056036 (0W-40)	80056036 (0W-40)
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

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
<b>Drive Train</b>						
1	Air Cleaner Filter	Figure 5-1	---	---	<ul style="list-style-type: none"> <li>Replace filter element when indicator shows red.</li> </ul>	
2	Fuel Filter	Figure 5-1	---	---	Change filter every 500 hours or 6 months.	Fuel filter is located on inside right hand side of frame beside engine.
3	Engine Crankcase	Figure 5-1	F Tier 3 and Tier 4	20 L (21 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 5-1	C, D	52.7 L 40 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>	<ul style="list-style-type: none"> <li>Check level in sight glass at rear of crane.</li> <li>Superstructure must be rotated to access filler on top of carrier.</li> </ul>
5	Transmission, Torque Converter	Figure 5-1	E	37.9 L (55.6 qt)	<ul style="list-style-type: none"> <li>Check level every 10 hours or daily</li> <li>Drain and refill every 1000 hours or 6 months</li> </ul>	Through fill pipe to FULL mark on dipstick

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
<b>Drive Train (Continued)</b>						
5	Transmission, Torque Converter	Figure 5-1	E	37.9 L (55.6 qt)	<ul style="list-style-type: none"> <li>• Check level every 10 hours or daily</li> <li>• Drain and refill every 1000 hours or 6 months</li> </ul>	Through fill pipe to FULL mark on dipstick
<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 82°C to 93°C (180°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, i.e, 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 filters are located on the outside left hand frame in the area of the hydraulic oil cooler.</li> <li>• To add fluid:                             <ol 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 82°C to 93°C (180°F to 200°F). Add oil to bring oil level to FULL mark on dipstick.</li> </ol> </li> </ul>						
6	Engine Oil Filter	Figure 5-1	Refer to Item 3.		<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>	



Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
<b>Drive Train (Continued)</b>						
7	Transmission Filter	Figure 5-2			Change transmission filter after first 50 and 100 hours of service, then every 500 hours thereafter	Refer to Item 5 NOTE.
8	Coolant Strainer (Cab Heater)	Figure 5-2	---	---	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 5-2	---	---	Drain water trap every 10 hours or daily.	Water Separator is located next to hydraulic oil cooler.
	Fuel/Water Separator Filter	Figure 5-2	---	---	Change filter every 500 hours or 6 months.	
<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 5-2	A	Until grease extrudes	500 hours or 3 months	2 grease fittings



Drive Train (Continued)						
Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
11	DEF Supply Module Filter (Tier 4)	Figure 5-3	---	---	Check filter every 4500 hours.	
12	DEF Tank (Tier 4)	Figure 5-3	K	18.9 L (20 qt)	Check and fill every 10 hours or daily.	Indicator in cab illuminates when fluid level is low.
<p><b>CAUTION:</b> Use caution when adding Diesel Exhaust Fluid (DEF) to avoid spills during vehicle fill-up.</p> <p><b>CAUTION:</b> DEF is corrosive to certain metals and paint and should be washed off with mild soap and water, if spilled.</p>						
13	DEF Tank Filter (Tier 4)	Figure 5-3	---	---	Check filter every 1 year.	

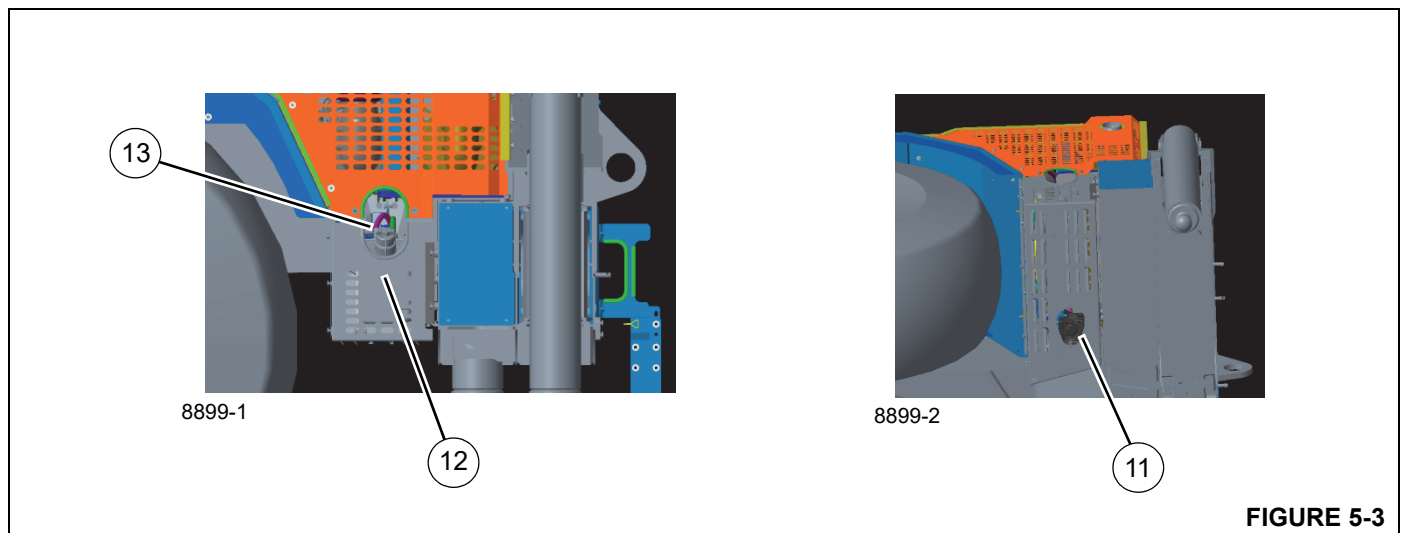
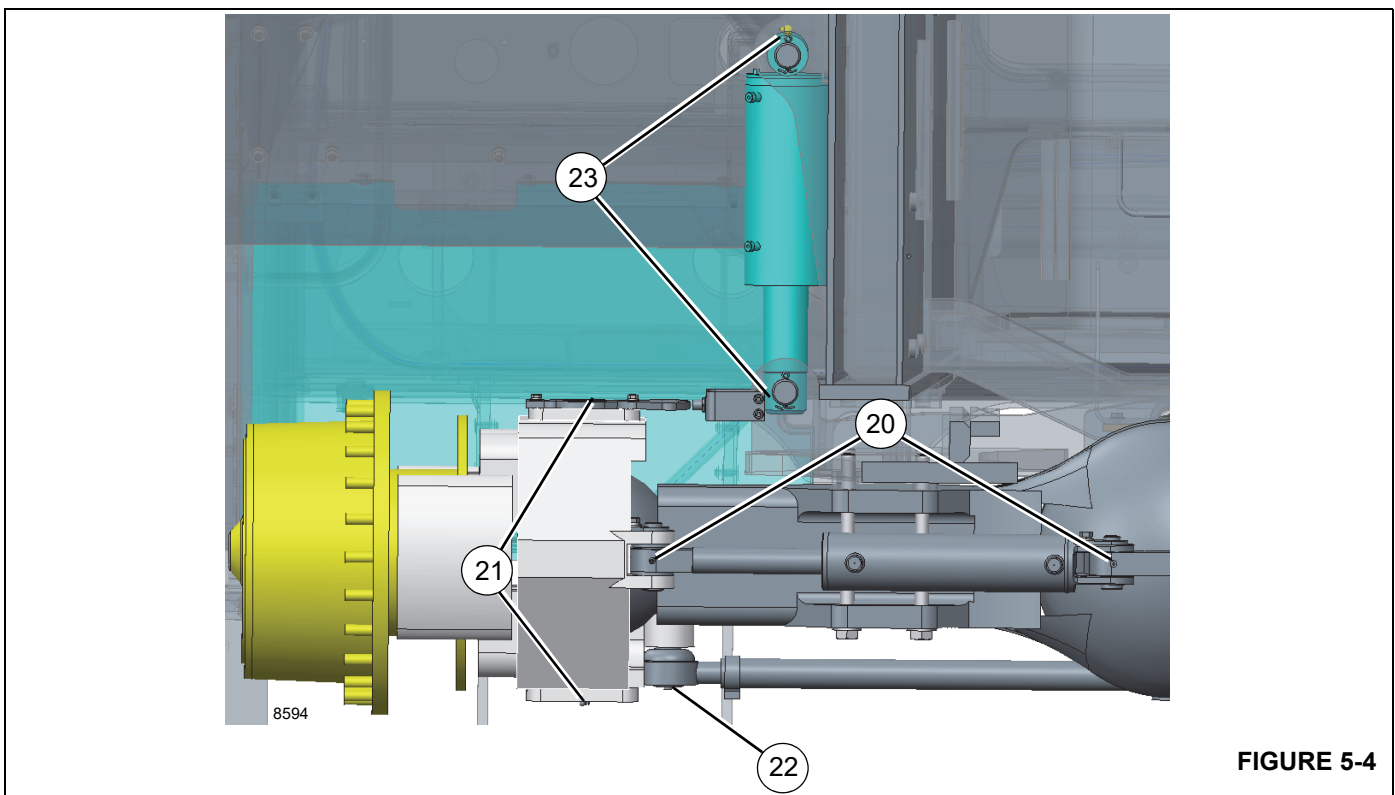


FIGURE 5-3

Steering and Suspension						
Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
20	Steer Cylinder Pivot Pins	Figure 5-4	A	Until grease extrudes	500 hours or 3 months	8 grease fittings
21	Upper and Lower King Pins	Figure 5-4	A	Until grease extrudes	500 hours or 3 months	8 grease fittings
22	Tie Rod Pivot Pins	Figure 5-4	A	Until grease extrudes	500 hours or 3 months	4 grease fittings
23	Lockout Cylinder Pivot Pins	Figure 5-4	A	Until grease extrudes	500 hours or 3 months	4 grease fittings





Steering and Suspension (Continued)						
Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
24	Fifth Wheel Pivots	Figure 5-5	A	Until grease extrudes	500 hours or 3 months	2 grease fittings

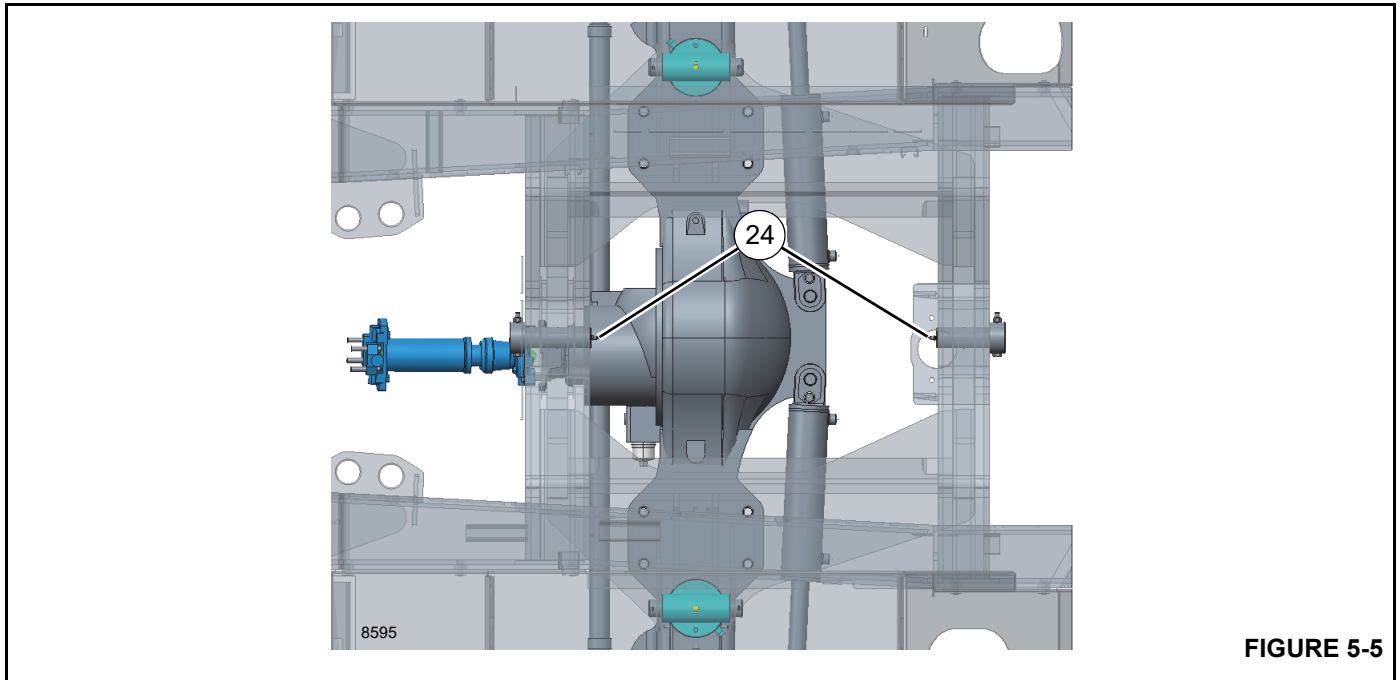


FIGURE 5-5

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
<b>Axles</b>						
30	Differentials	Figure 5-6	B	24.6 L (52 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 bottom of hole in rear right-hand side of housing
<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 5-6	B	6.6 L (14 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>						

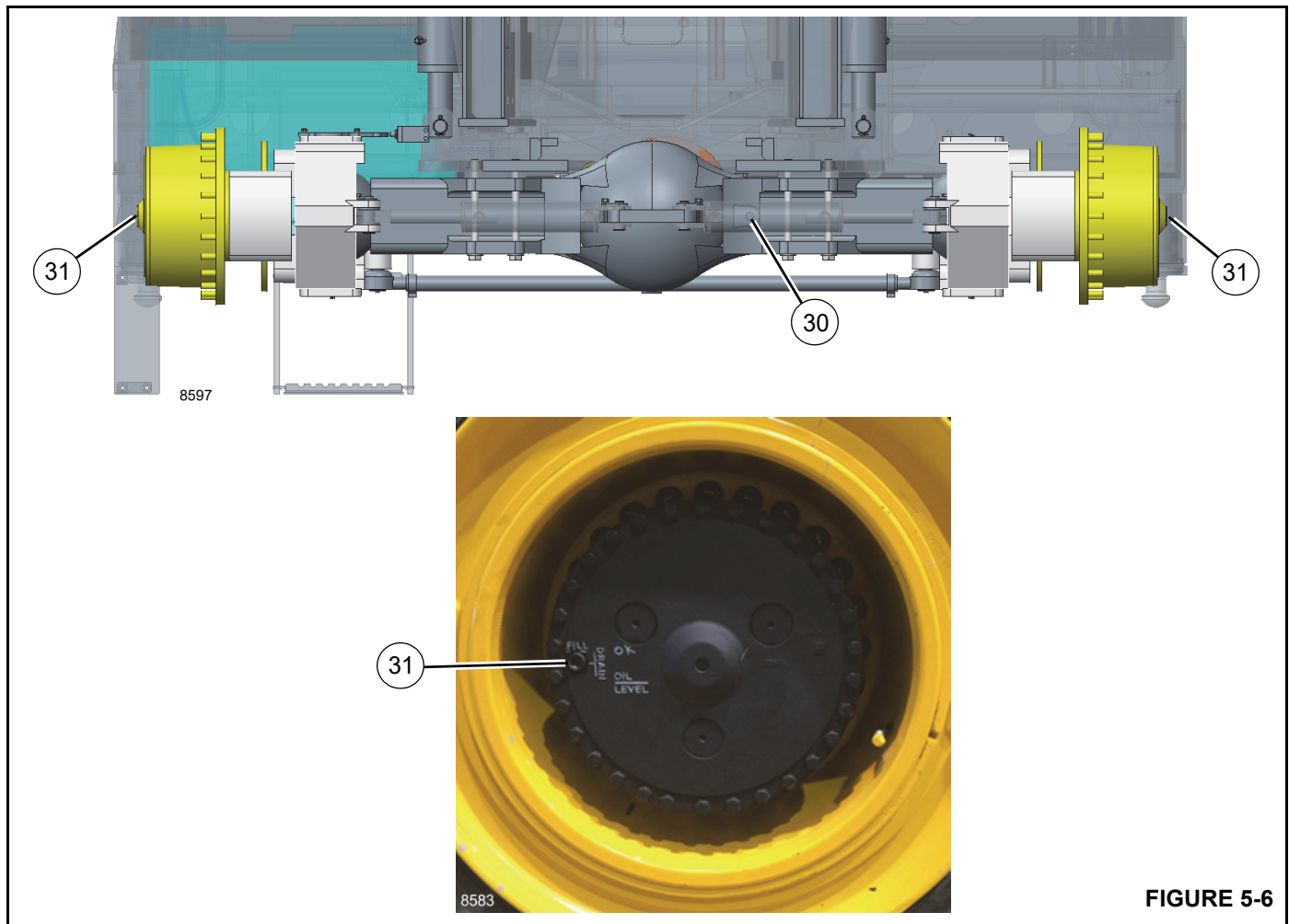


FIGURE 5-6

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
<b>Turntable</b>						
40	Turntable Gear Box	Figure 5-7	H	5.4 L (5.7 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 to dipstick markings. Dipstick is on swivel side of the gearbox.
41	Turntable Gear and Drive Pinion	Figure 5-7	G	Coat all teeth	500 hours or 6 months	Spray on
42	Turntable Bearing	Figure 5-7	A	Until grease extrudes from entire bearing circumference	500 hours or 6 months	2 grease fittings at front of turntable.

**NOTE:** Rotate turntable 90° and apply grease to fittings. Continue rotating in 90° increments and grease fittings until entire bearing is greased.

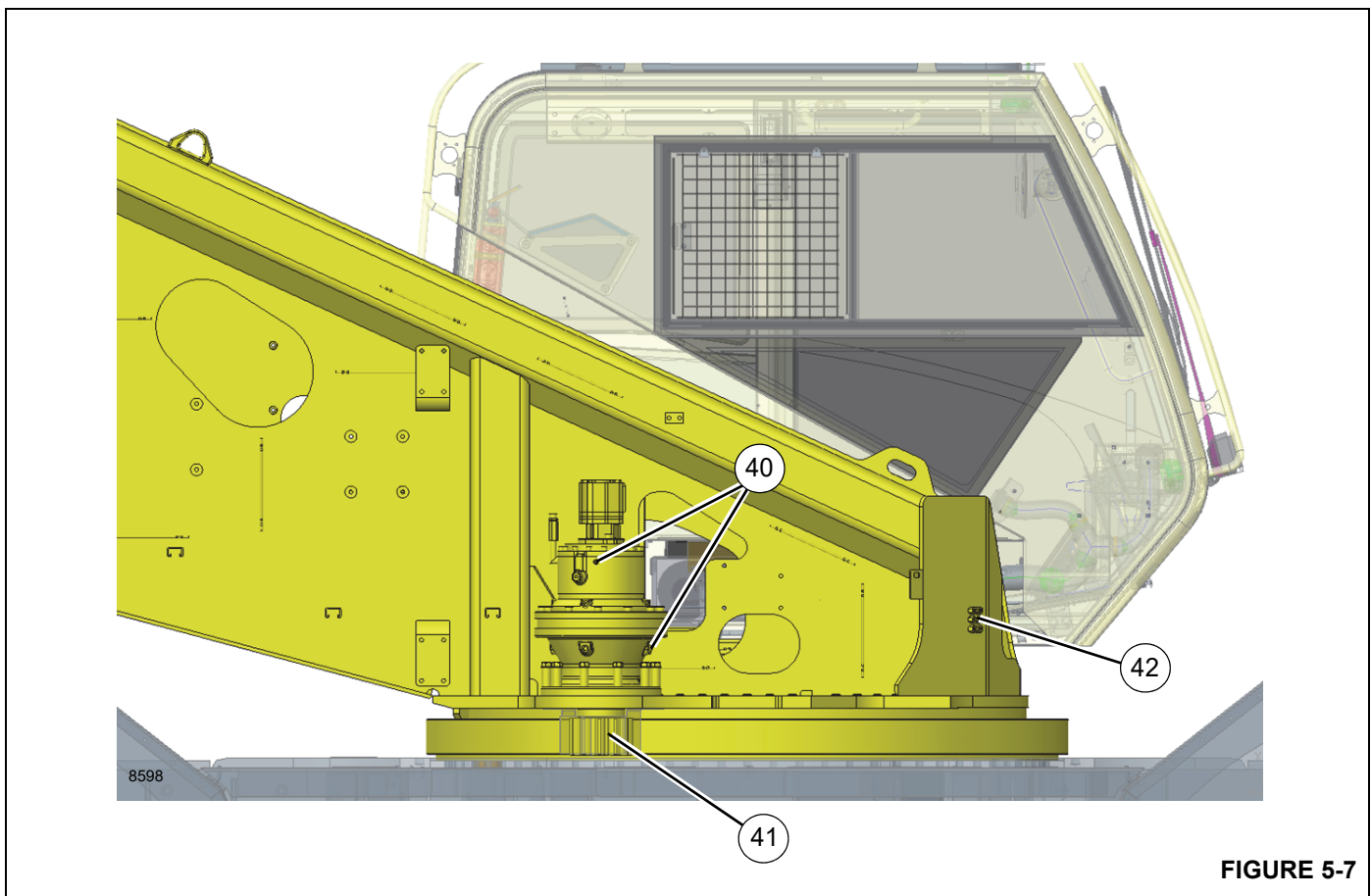


FIGURE 5-7

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
<b>Turtable (Continued)</b>						
43	Turntable Swivel Lock Pin	Figure 5-8	G	Coat pin	500 hours or 6 months	Spray on
<b>Cab Tilt</b>						
50	Tilt Cylinder Pivot Pins	Figure 5-8	A	Until grease extrudes from entire bearing circumference	500 hours or 6 months	Spray on
51	Pillow Block	Figure 5-8	A	Until grease extrudes from entire bearing circumference	500 hours or 6 months	2 grease fittings at front of turntable.

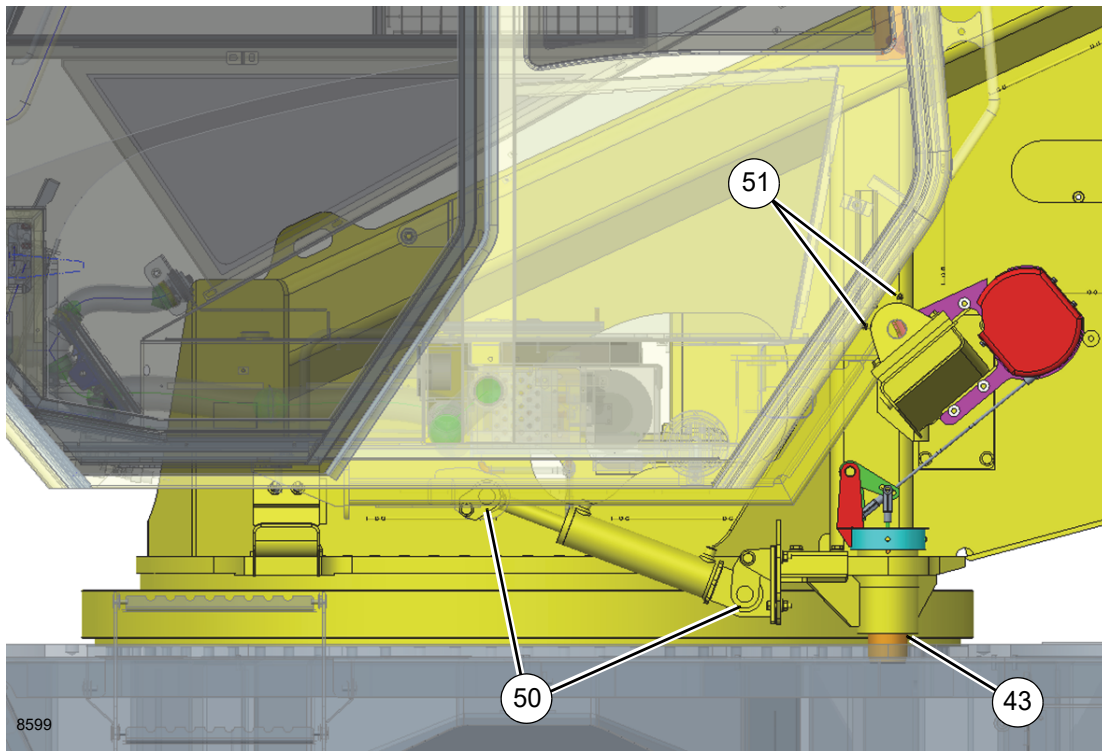


FIGURE 5-8

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
<b>Outriggers</b>						
60	Wear Pads	Figure 5-9	L	---	50 hours or 1 week	Brush on
61	Outrigger Beams	Figure 5-9	L	---	50 hours or 1 week	Brush on

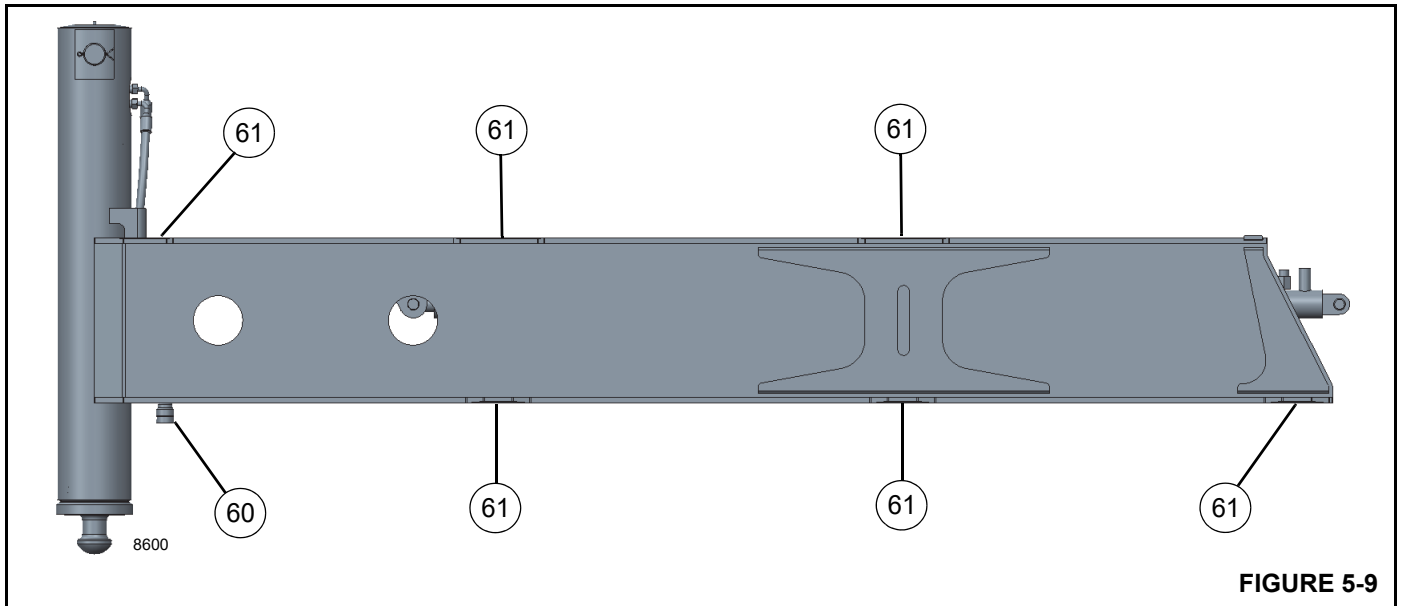
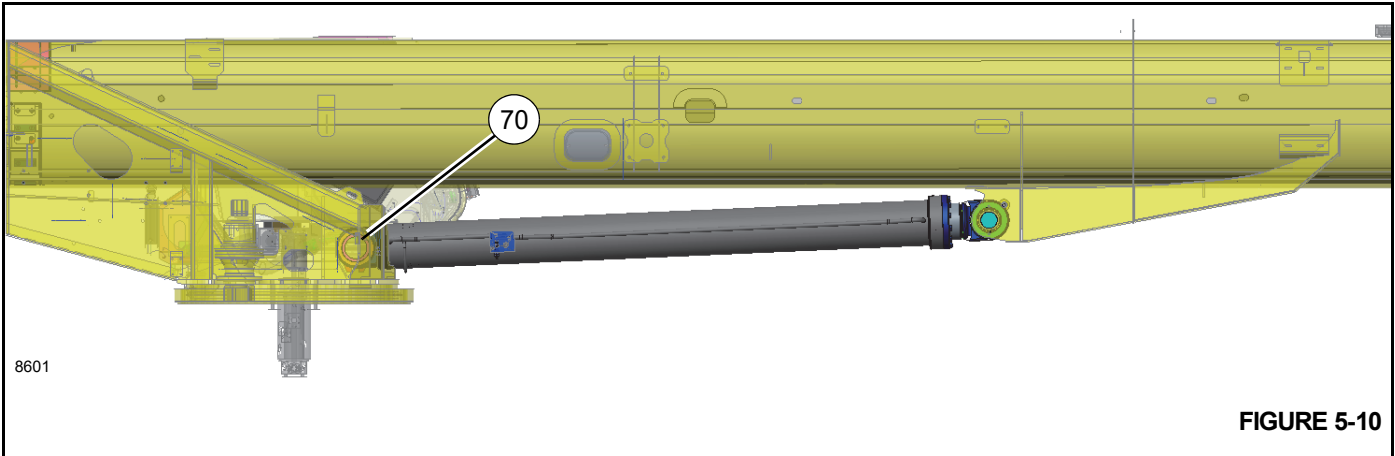


FIGURE 5-9

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
<b>Lift Cylinder</b>						
70	Lower Lift Cylinder Pin	Figure 5-10	L	Until grease extrudes	500 hours or 3 months	1 grease fitting



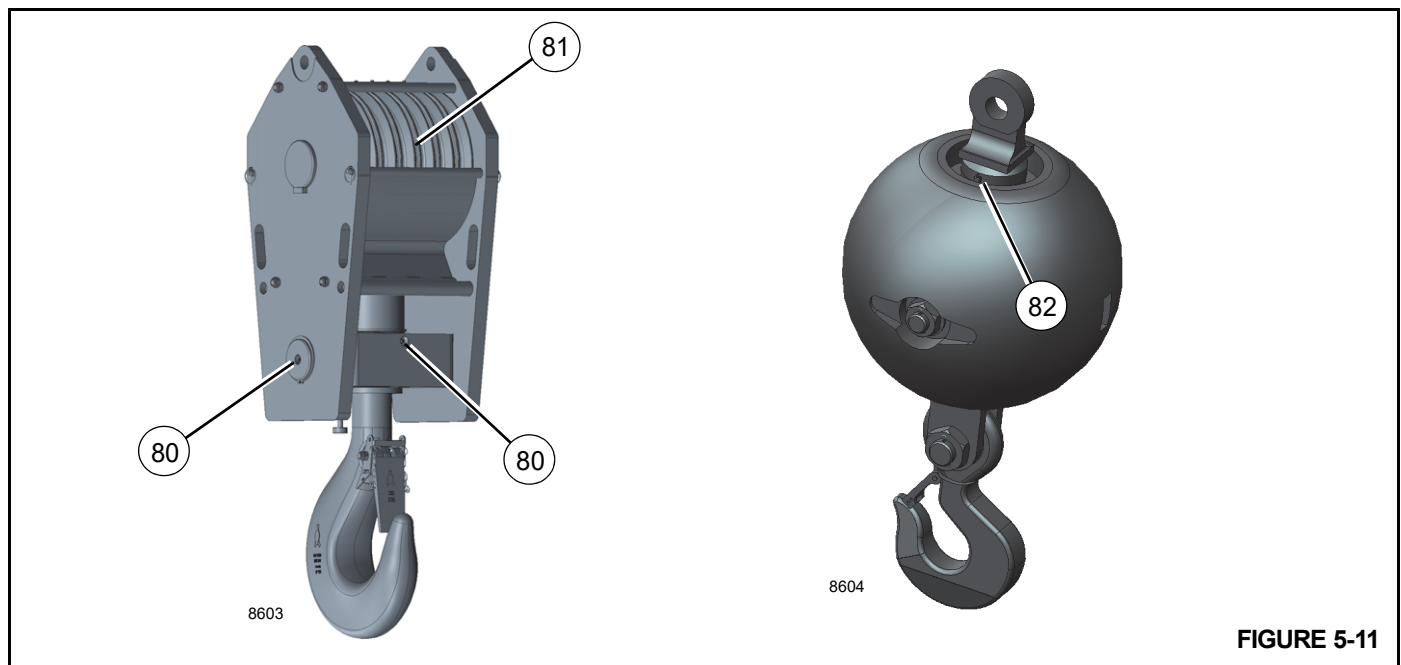
**Boom**

**NOTE:** Crane Setup: Machine shall be set up on firm level surface with fully extended outriggers and minimum 9979 kg (22,000 lb) counterweight installed. Ensure crane is level.

- Boom must be directly over the front with house lock engaged.
- Set boom angle at zero degrees (0°).
- Do not exceed 38.2 m (125.5 ft) boom length in Auto Mode A.
- Do not exceed 33.8 m (111.1 ft) boom length in Auto Mode B.
- All lubrication points can be accessed by operating crane in the 0001 RCL mode using A or B boom configurations.

**CAUTION:** Do not operate crane in RCL bypass to lubricate the boom.

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
80	Hook Block Swivel Bearing	Figure 5-11	A	Until grease extrudes	250 hours or 3 months	3 grease fitting
81	Hook Block Sheaves	Figure 5-11	N/A	N/A	250 hours or 3 months	Inspect
<b>NOTE:</b> Rotate sheaves and check for rough or dry operation. Look for grease leakage. Replace sheave if either is found.						
82	Overhaul Ball	Figure 5-11	A	Until grease extrudes	250 hours or 3 months	1 grease fitting



**Boom (Continued)**

**NOTE:** Crane Setup: Machine shall be set up on firm level surface with fully extended outriggers and minimum 9979 kg (22,000 lb) counterweight installed. Ensure crane is level.

- Boom must be directly over the front with house lock engaged.
- Set boom angle at zero degrees (0°).
- Do not exceed 38.2 m (125.5 ft) boom length in Auto Mode A.
- Do not exceed 33.8 m (111.1 ft) boom length in Auto Mode B.
- All lubrication points can be accessed by operating crane in the 0001 RCL mode using A or B boom configurations.

**CAUTION:** Do not operate crane in RCL bypass to lubricate the boom.

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
83	Telescope Cylinder Wear Pads	Figure 5-12	L	Coat thoroughly	Apply grease at assembly or tear-down.	<ul style="list-style-type: none"> <li>• 12 places</li> <li>• Extend boom for access through holes in side of sections 3 &amp; 4</li> </ul>
84	Internal Side and Bottom Wear Pads - Inner Sections	Figure 5-12 & Figure 5-13	L	Thoroughly coat all areas wear pad moves on	250 hours/3 months	23 locations
85A	Boom Section Rear Upper Wear Pads - Tele 1	Figure 5-12	L	Thoroughly coat all areas the wear pad moves on	50 hours/1 week	<ul style="list-style-type: none"> <li>• 2 locations</li> <li>• Extend Tele 1 to 57.8 FT and 67.8 FT, so the access holes line up with the grease fittings.</li> </ul>
85B	Boom Section Rear Upper Wear Pads - Tele 2 - 4	Figure 5-12 & Figure 5-13	L	Thoroughly coat all areas wear pad moves on	50 hours/1 week	<ul style="list-style-type: none"> <li>• 6 locations</li> <li>• Extend Tele 2 to 124.9 FT, so the access holes line up with the grease fittings.</li> </ul>
86	Boom Section Lower & Upper Wear Pads	Figure 5-12 & Figure 5-13	L	Thoroughly coat all areas wear pad moves on	50 hours/1 week	12 locations
87	Extend Cable Sheave	Figure 5-12	A	Until grease extrudes	250 hours or 3 months	6 locations



88	Retract Cable Sheaves	Figure 5-12 & Figure 5-13	A	Until grease extrudes	250 hours or 3 months	<ul style="list-style-type: none"> <li>• 4 grease fittings</li> <li>• Extend Tele 2 to 125.3 FT, so the access holes line up with the grease fittings.</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>						

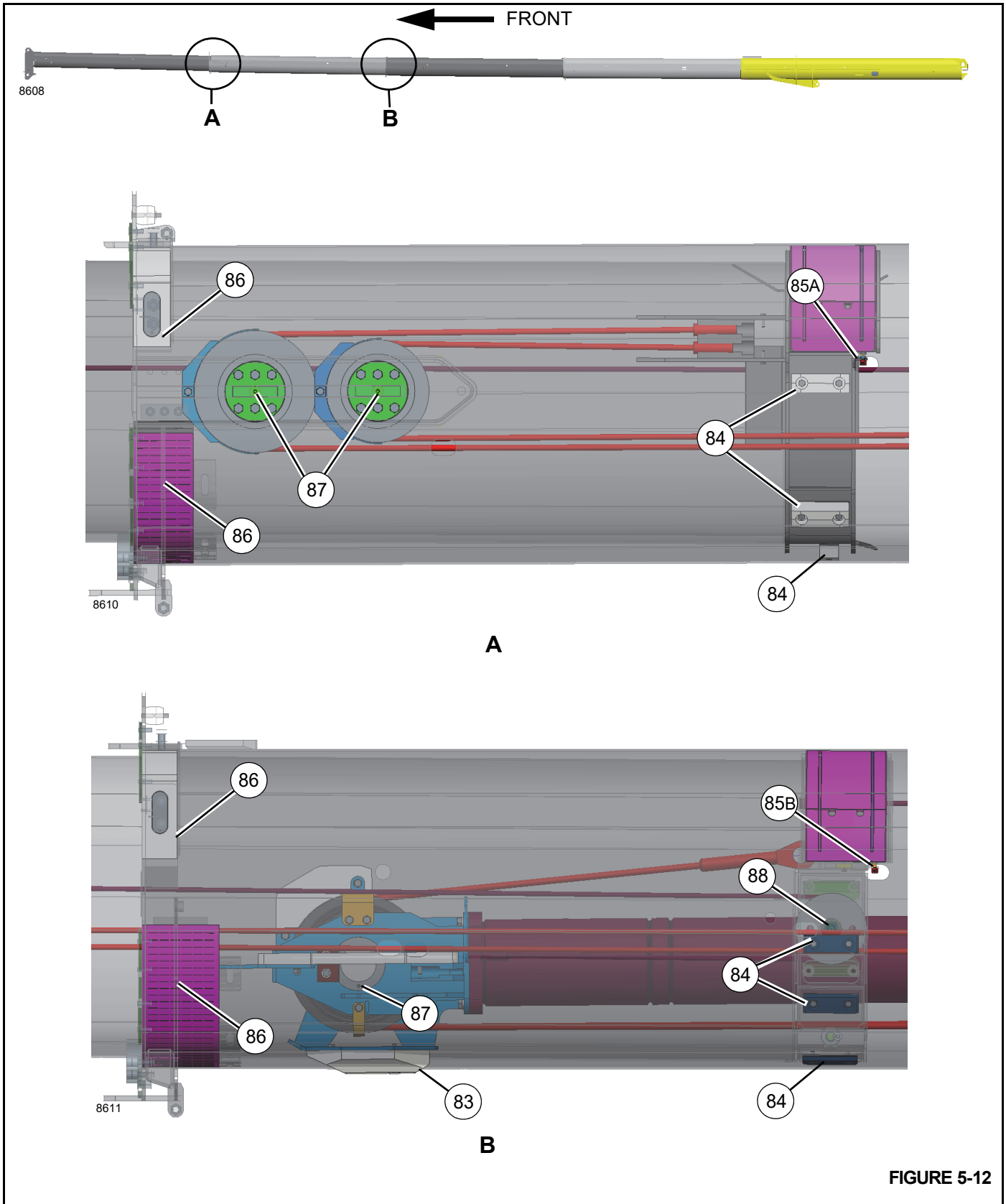


FIGURE 5-12

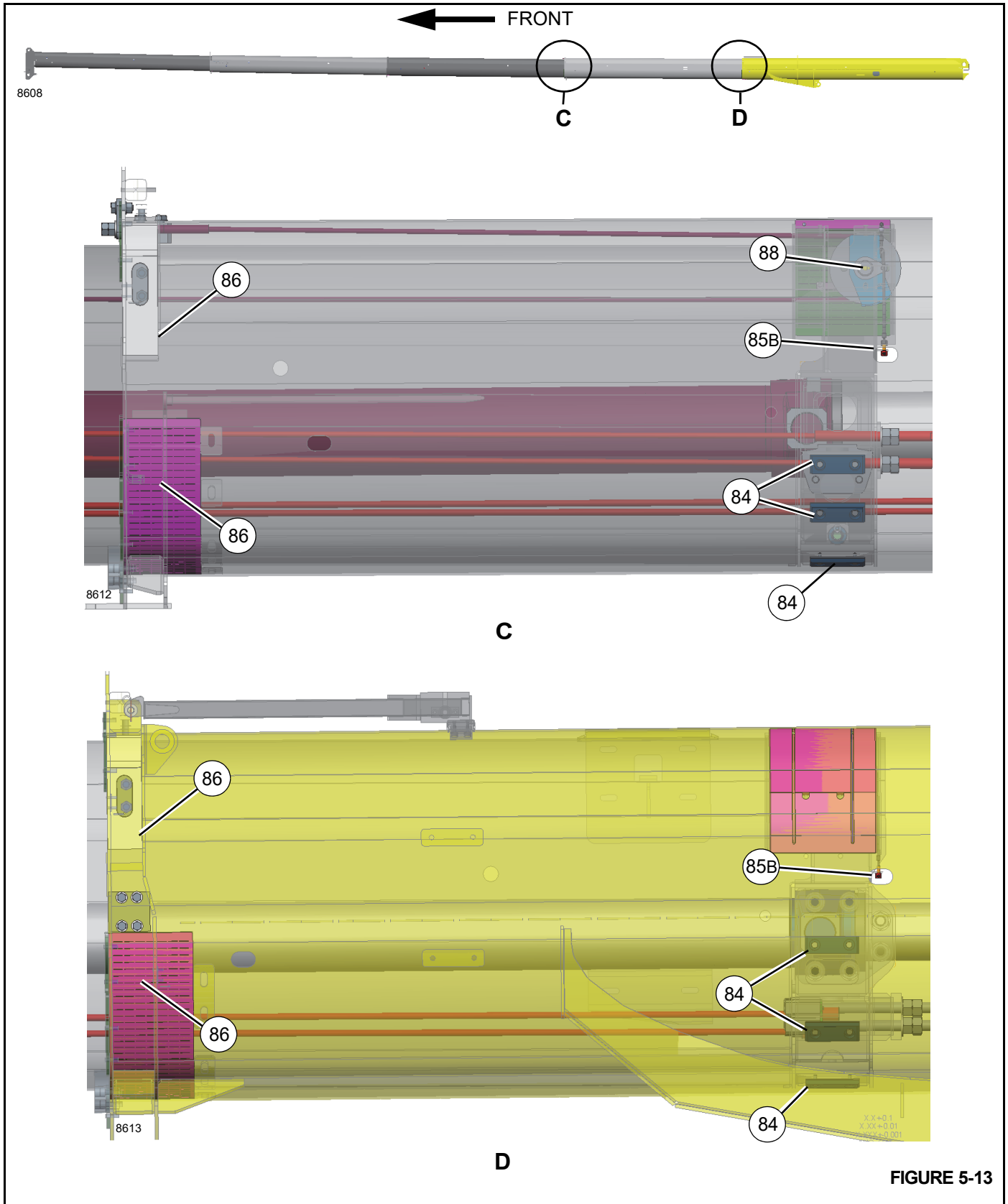


FIGURE 5-13

**Boom (Continued)**

**NOTE:** Crane Setup: Machine shall be set up on firm level surface with fully extended outriggers and minimum 9979 kg (22,000 lb) counterweight installed. Ensure crane is level.

- Boom must be directly over the front with house lock engaged.
- Set boom angle at zero degrees (0°).
- Do not exceed 38.2 m (125.5 ft) boom length in Auto Mode A.
- Do not exceed 33.8 m (111.1 ft) boom length in Auto Mode B.
- All lubrication points can be accessed by operating crane in the 0001 RCL mode using A or B boom configurations.

**CAUTION:** Do not operate crane in RCL bypass to lubricate the boom.

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
89	Boom Pivot Shaft	Figure 5-14	L	Until grease extrudes	250 hours or 3 months	4 grease fittings
90	Upper Boom Nose Sheave	Figure 5-14	A	Thoroughly coat	Apply grease at assembly or tear down.	2 grease points (1) per sheave
91	Lower Boom Nose Sheave	Figure 5-14	A	Thoroughly coat	Apply grease at assembly or tear down.	5 grease points (1) per sheave
92	Auxiliary Boom Nose Sheave	Figure 5-14	A	Until grease extrudes	250 hours or 3 months	1 grease fitting
93	Mast Sheave	Figure 5-14	A	Until grease extrudes	500 hours or 12 months	1 grease fitting
94	Jib Sheaves	Figure 5-14	A	Until grease extrudes	250 hours or 3 months	2 grease fittings

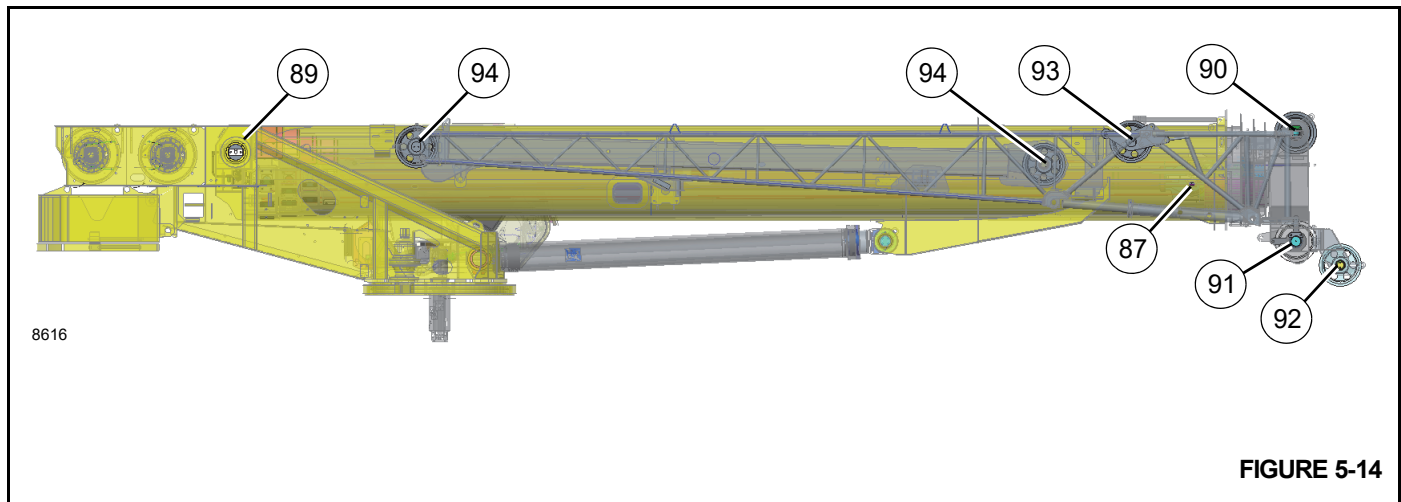


FIGURE 5-14

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
<b>Hoist</b>						
100	Main Hoist	Figure 5-15	B	4.7 L (5.0 qt)	<ul style="list-style-type: none"> <li>Check and fill every 50 hours or weekly</li> <li>Drain and fill every 1000 hours or 12 months</li> </ul>	Oil level must be between the high and low marks on the sight glass.
101	Auxiliary Hoist	Figure 5-15	B	4.7 L (5.0 qt)	<ul style="list-style-type: none"> <li>Check and fill every 50 hours or weekly</li> <li>Drain and fill every 1000 hours or 12 months</li> </ul>	Oil level must be between the high and low marks on the sight glass.
<b>NOTE:</b> Hoist oil level must be between the high and low marks on the sight glass (100, 101). Remove the plug or hose from the bottom of the sight glass to drain oil. Remove the vent or hose from the top of the sight glass to add oil.						
102	Cable Roller (Arms)	Figure 5-15	A	Thoroughly coat	250 hours or 3 months	Brush on
103	Hoist Bearing	Figure 5-15	A	Until grease extrudes	250 hours or 3 months	2 Grease Fittings
<b>NOTE:</b> Lubricate more frequently than interval indicated if environmental and/or operating conditions required.						

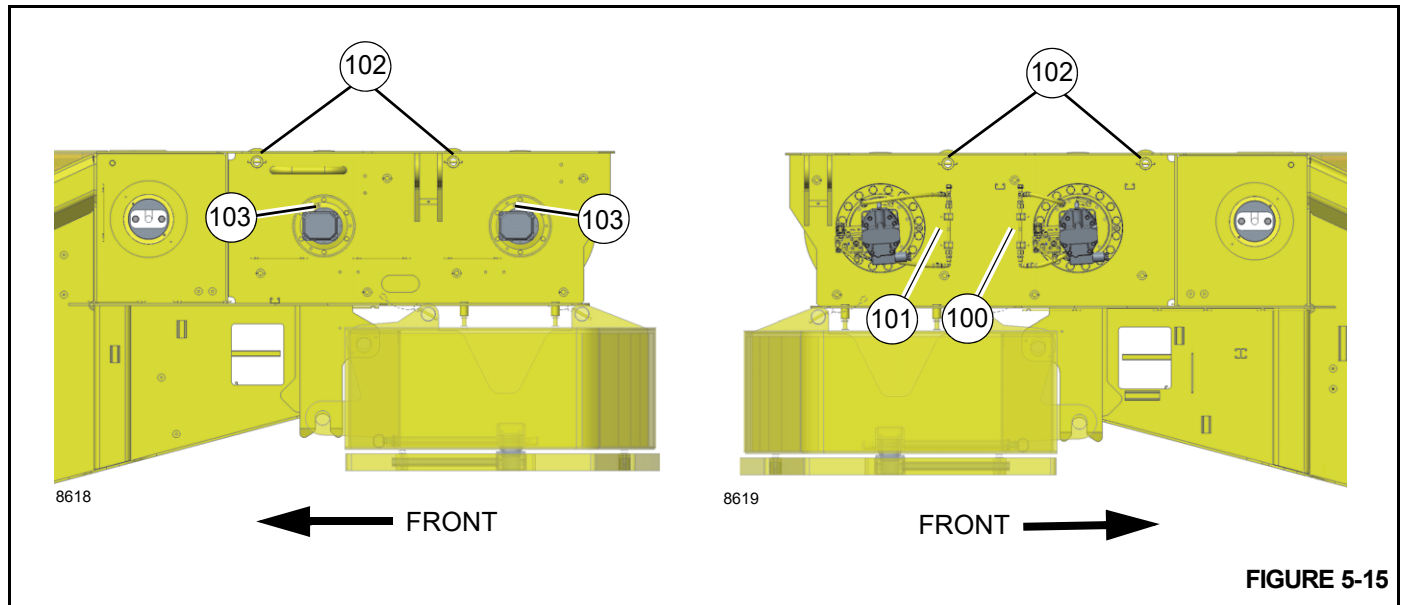


FIGURE 5-15

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
<b>Hydraulic</b>						
110	Hydraulic Tank (Tank Only)	Figure 5-14	J	894 L (236 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 down and all outrigger cylinders retracted.</li> <li>Drain and refill as necessary</li> </ul>
<p><b>NOTE:</b></p> <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 5-14	---	---	Change filter element when indicator is red.	Oil must be at operating temperature.

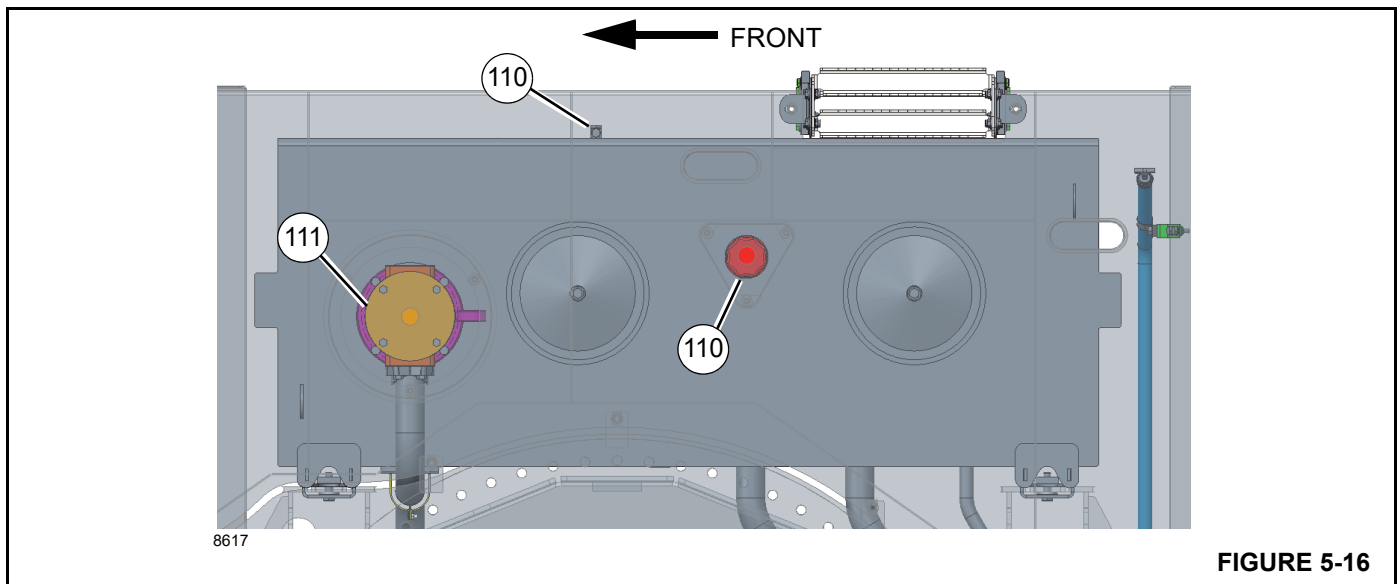


FIGURE 5-16

## 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 (CFC), 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 Grove 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.

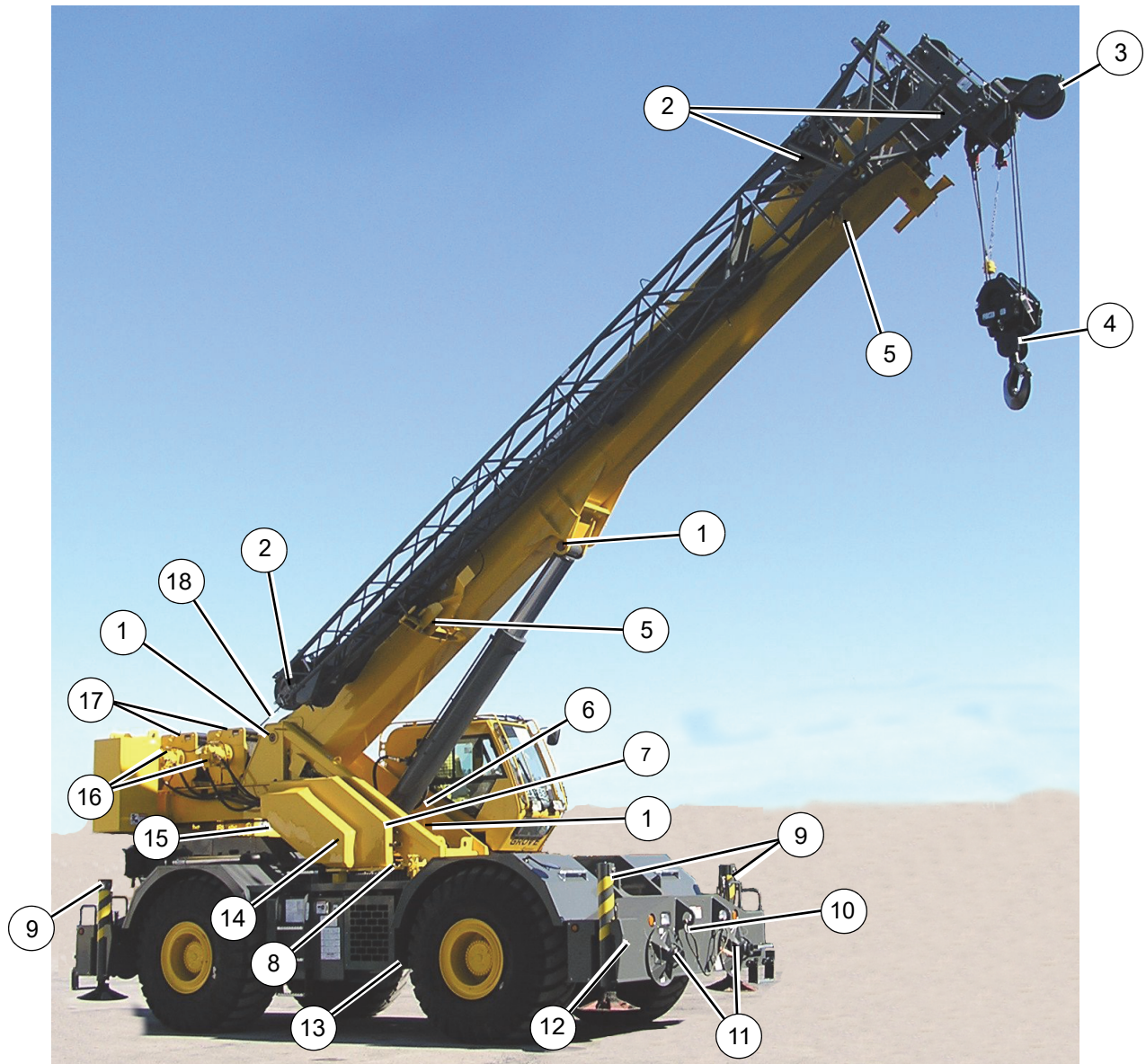
Contact Grove Crane or Manitowoc Crane Care should you have any questions.

### Areas of Application

Refer to (Figure 5-17) and (Figure 5-18).

- 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.

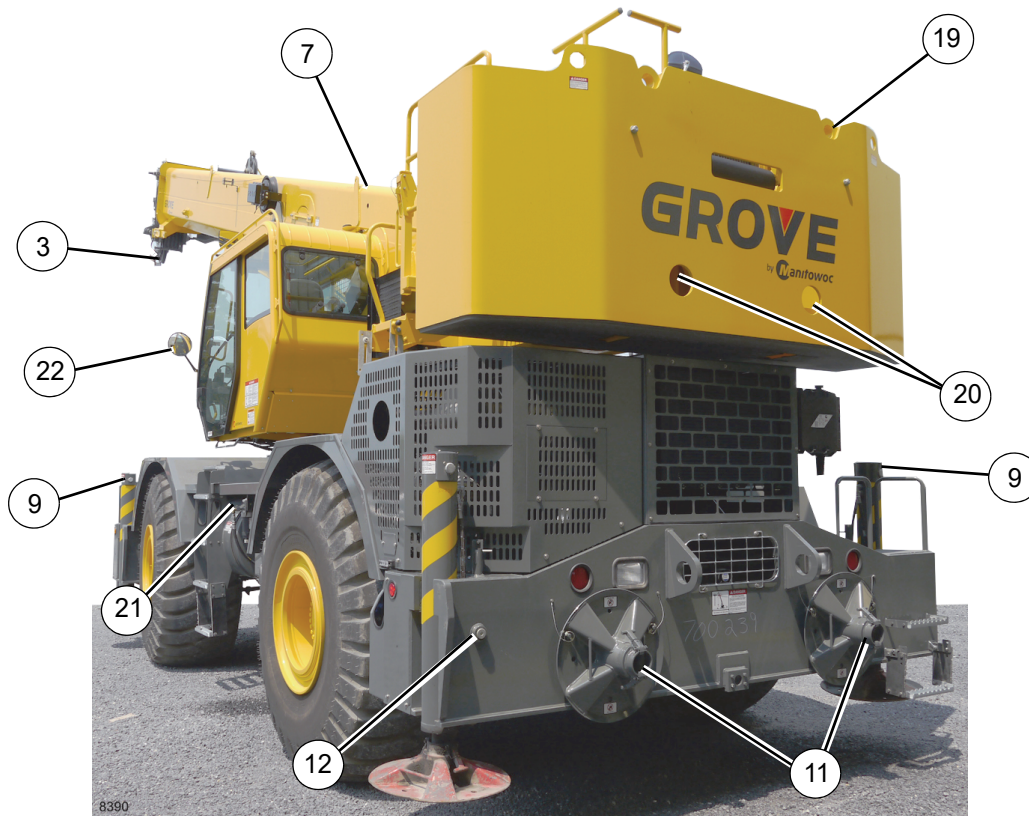




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Picture may not be same model as your machine, it is for reference only.

Figure 5-17



Picture may not be same model as your machine, it is for reference only.

Figure 5-18

TABLE 5-1. 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

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