

Grove RT765E-2

Operator Manual





WARNING

California Proposition 65

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

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

For more information, go to www.P65warnings.ca.gov/diesel

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

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.

The original language of this publication is English.

OPERATOR MANUAL

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

RT765E-2

Crane Model Number

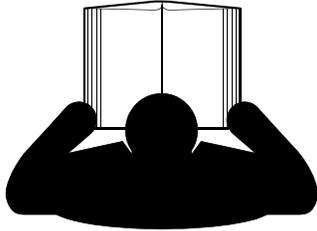
This Manual is divided into the following sections:

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

NOTICE

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

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

	<h2 style="text-align: center;">⚠ DANGER</h2> <p>An untrained operator subjects himself and others to death or serious injury. Do not operate this crane unless:</p> <ul style="list-style-type: none">• You are trained in the safe operation of this crane. Manitowoc is not responsible for qualifying personnel.• You read, understand, and follow the safety and operating recommendations contained in the crane manufacturer's manuals and load charts, your employer's work rules, and applicable government regulations.• You are sure that all safety signs, guards, and other safety features are in place and in proper condition.• The Operator Manual and Load Chart are in the holder provided on crane.
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*For
Reference
Only*

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GENERAL

NOTE: Throughout this handbook, 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's 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 RT765E-2 Grove Crane.

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

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

The superstructure is capable of 360° rotation in either direction. All crane functions are controlled from the fully-enclosed cab mounted on the superstructure. The crane is equipped with a four-section, 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 optional auxiliary hoist.

Customer Support

Manitowoc 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 and complete the form.

NOISE/VIBRATION TEST RESULTS

Noise Level Test Results

- When equipped with the CE certification package, the guaranteed sound power level at the operator's station



with closed cab operation 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.

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.

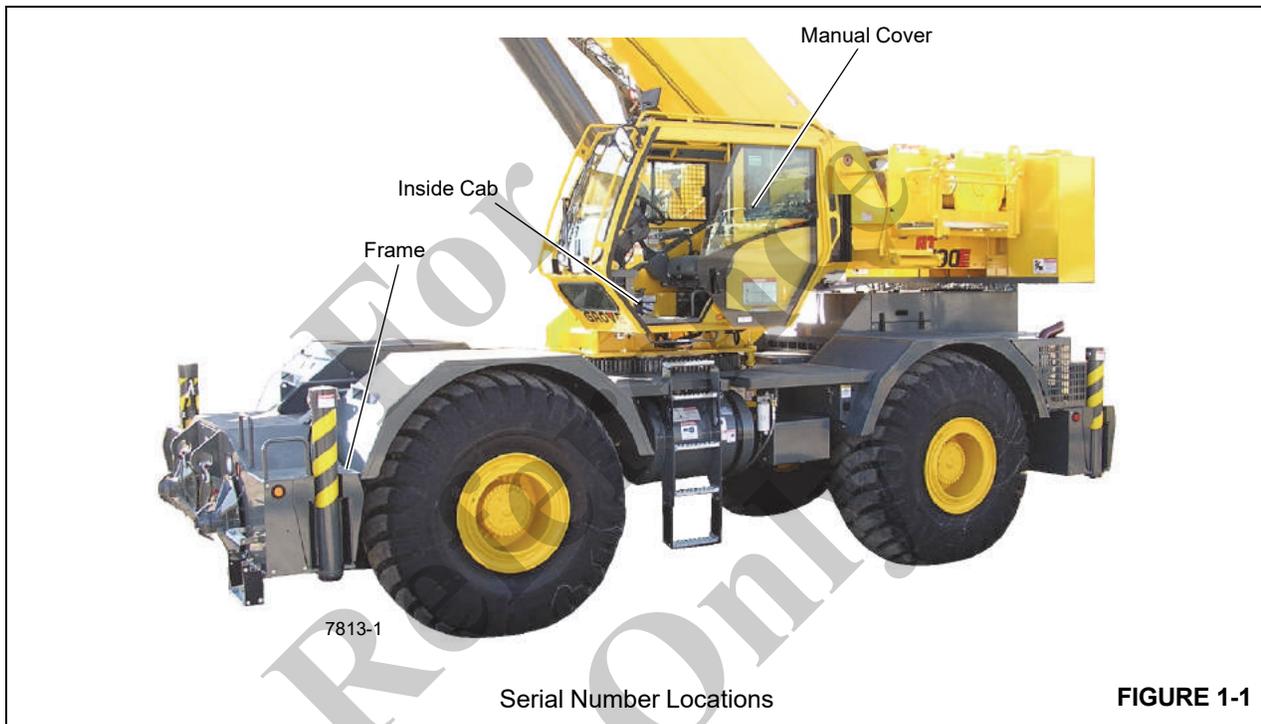
Vibration Level Test Results

- At the operator's station with closed cab operation, vibration levels are less than 0.5 m/s/s for Whole Body Vibration exposure and are less than 2.5 m/s/s for Hand Arm Vibration exposure when measured according to 89/392/EEC Community Legislation on Machinery per standard ISO 2631/1 - Evaluation of Human Exposure to

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.



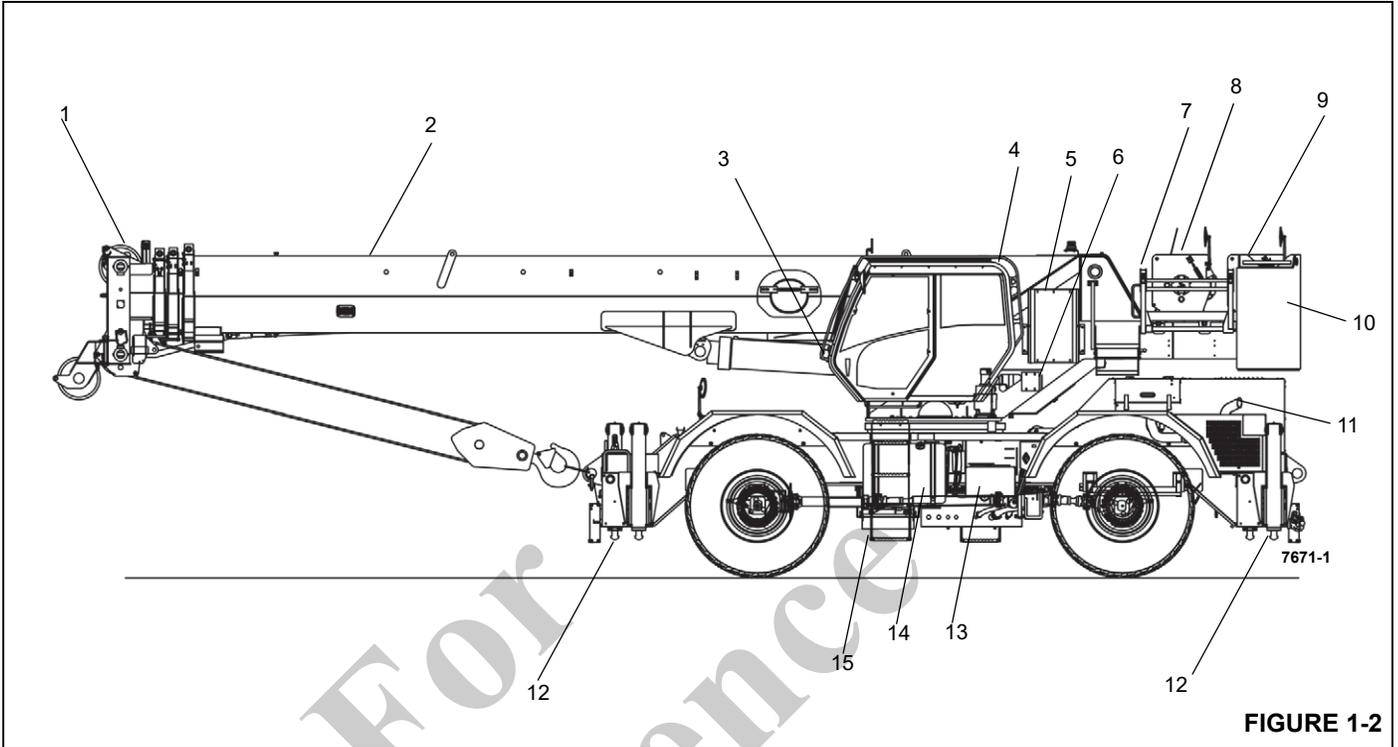


FIGURE 1-2

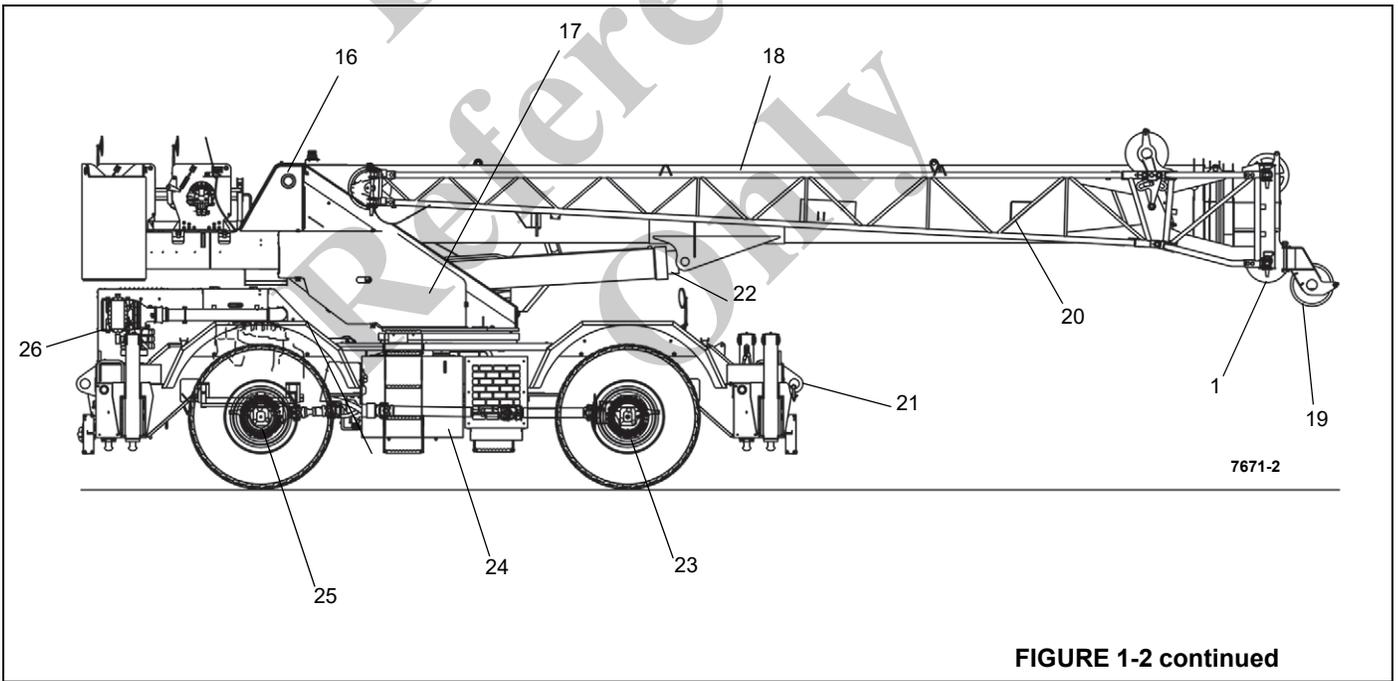


FIGURE 1-2 continued

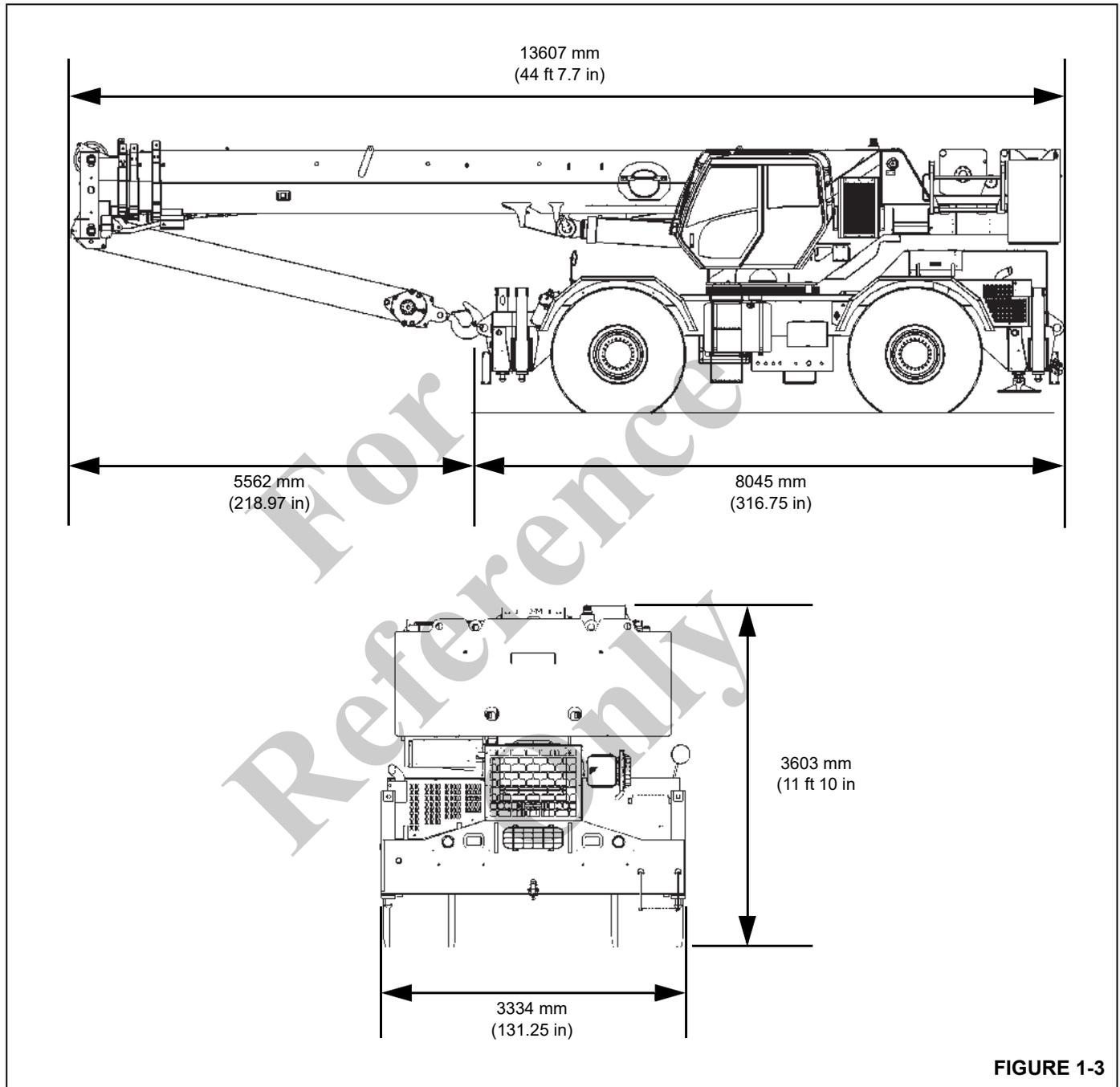
Item	Description
1	Boom Nose Sheaves
2	Boom
3	Work Lights
4	Cab
5	Air Conditioning Components
6	Windshield Washer Fluid Container
7	Hoist Access Platform (Fixed Counterweight Units Only)
8	Main Hoist
9	Auxiliary Hoist
10	Counterweight
11	Muffler
12	Outrigger Jack Cylinder
13	Battery

Item	Description
14	Fuel Tank (Tier 4 engines require Low Sulphur Fuel only!)
15	Crane Steps
16	Boom Pivot Pin
17	Hydraulic Valves and Swing Motor Cover
18	Swingaway Extension
19	Auxiliary Boom Nose
20	Boom Extension
21	Outrigger Floats
22	Lift Cylinder
23	Front Axle
24	Hydraulic Fluid Tank
25	Rear Axle
26	Air Intake Cleaner

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CRANE DIMENSIONS

For overall dimensions of the crane, refer to Figure 1-3.



LIST OF SPECIFICATIONS

General

Model	RT765E-2 Series
Rated Capacity	See Load Chart in cab
Drive	4 x 4 x 4
Gross Weight	See Axle Weight Distribution Table in the Service Manual.

Dimensions

NOTE: Dimensions listed are for a crane with all components fully retracted in the travel mode with 29.5 x 25 tires.

Wheelbase	13 ft 4 in (4.06 m)
Overall Crane Length	44 ft 2.33 in (13,470 mm)
Overall Crane Width	10 ft 11 in (3.53 m)
Overall Crane Height	11 ft 10 in (3.6 m)
Outside Turning Radius	
2 Wheel Steer	37 ft 2.55 in (11,342 mm)
4 Wheel Steer	22 ft 1.5 in (6,744 mm)
Outside Curb Clearance	
2 Wheel Steer	38 ft 5.88 in (11.7 m)
4 Wheel Steer	23 ft 3.5 in (7.1 m)
Outrigger Spread	
Retracted	10 ft 5 in (3.17 m)
Mid Extend	17 ft 4 in (5.28 m)
Fully Extended	23 ft 4 in (7.11 m)

Capacities

Fuel Tank	74 gal (280 liters)
Coolant System	See Engine Specifications
Engine Lubrication System	See Engine Specifications
Hydraulic Tank (Reservoir Capacity)	
Total	150 gal (568 l)
Hoists	
Model GHP-30A	15.5 qt (14.7 l)
Swing Gearbox	5.25 qt (4.9 l)
Axle Planetary Ends	8 pt (4 l)
Axle Differentials	48 pt (23 l)
Transmission (includes Torque Converter)	40 qt (38 l)

Torque Converter

Stall Ratio	1.82:1
Charge Pump Capacity	20 gpm (76 l/min)
	@ 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

Type	4 cycle, Diesel, Turbocharged
Number of Cylinders	6
Horse Power Rating	179 kW (240 hp) @ 2500 rpm
Oil Pan Capacity	18.5 qt (15.6 l)
Coolant System	40 qt (38 l)

Axles

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

Brakes

Type	Hydraulic Disc
Size	18.5 x 0.63 in (470 x 16 mm)

Wheels and Tires

Lugs	24
Torque	340 to 360 lb-ft (461 to 488 Nm)
Tire Size	
Standard	29.5 x 25, 28 ply rating
Optional	29.5R25, 34 ply rating

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

Swing Gearbox

Reduction Ratio	36:1
Output Torque	45,000 in-lb

Boom

Length	35.6 to 110 ft (10.8 to 33.5 m)
Power	4 Section, Full Power
Elevation	-3 to +78 degrees
Extensions	
Fixed*	32.6 ft (10 m)
Folding*	32.6 or 56 ft (10 or 17 m)
*Extensions are offsettable at 0, 25, or 45 degrees.	

Swivel Assembly

Electrical	20 Slip Rings
Hydraulic	12 ports
Water	2 ports

Hydraulic Pumps

NOTE: Pump output figures are theoretical.

Pump #1

Type	Gear
Sections	2
Output - @ loaded engine speed	
Section 1	50.4 gpm (191 l/min)
Section 2	25.1 gpm (95 l/min)

Pump #2

Type	Gear
Sections	1
Output - @ loaded engine speed	
Section 1	27.8 gpm (105 l/min)

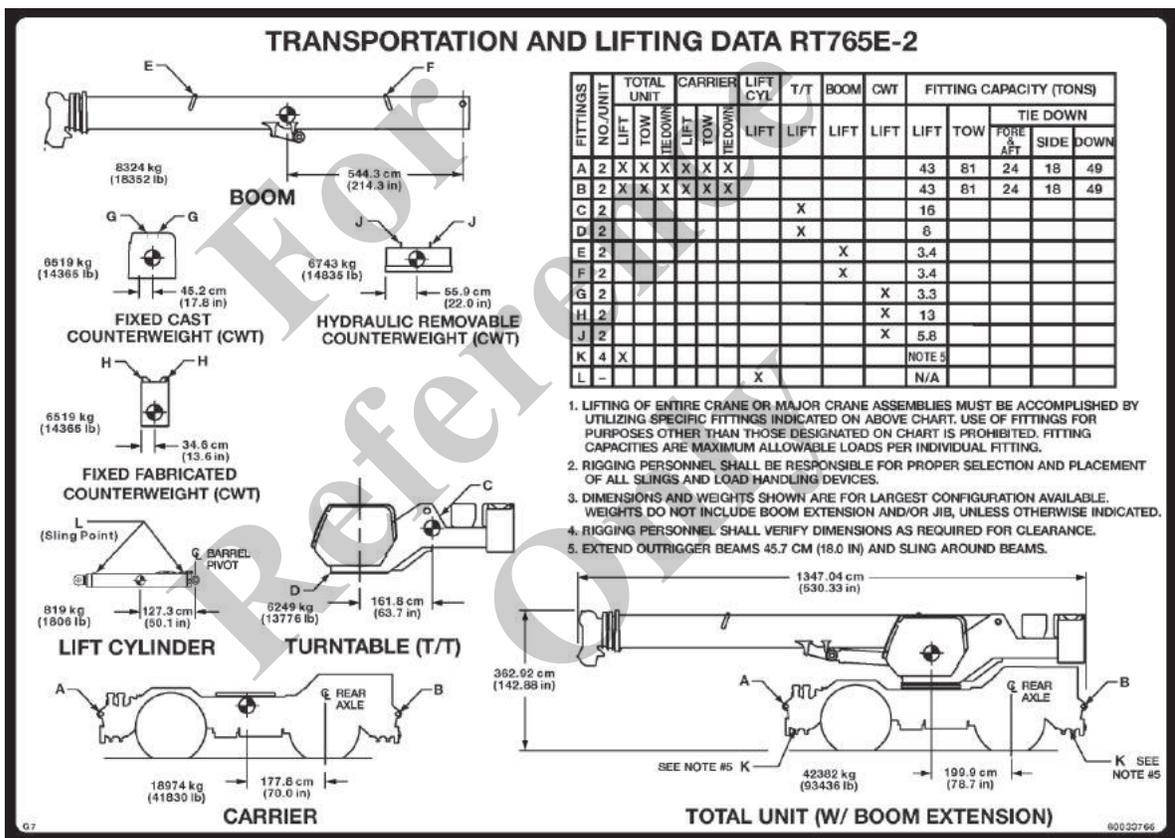
Pump #3

Type Gear
 Sections 1
 Output - @ loaded engine speed
 Section 1 19.8 gpm (75 l/min)

Max. Permissible Line Pull (6x36)
 16,800 lb (74.7 kN)
 Max. Single Line Speed 500 fpm (153 m/min)

Hoists

Drum Dimensions
 Diameter 15 in (381 mm)
 Length (Standard) 18.38 in (467 mm)
 Cable
 Diameter 0.75 in (19 mm)
 Length-Main 650 ft (198 m)
 Length-Aux 653 ft (199 m)



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FIGURE 1-4

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SAFETY INFORMATION

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SAFETY MESSAGES

General

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

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

Safety Alert Symbol



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

Signal Words



DANGER

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



WARNING

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



CAUTION

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

CAUTION

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

NOTE: Emphasizes operation or maintenance procedures.

GENERAL

It is impossible to compile a list of safety precautions covering all situations. However, there are basic principles that **must** be followed during your daily routine. Safety is **your primary responsibility**, since any piece of equipment is only as safe as **the person at the controls**.

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

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

Because you are the only part of the crane that can think and reason, your responsibility is not lessened by the addition of operational aids or warning devices. Indeed, you must guard against acquiring a false sense of security when using them. They are there to assist, not direct the operation. Operational aids or warning devices can be mechanical, electrical, electronic, or a combination thereof. They are subject to failure or misuse and should not be relied upon in place of good operating practices.

You are the only one who can be relied upon to assure the safety of yourself and those around you. Be **professional** and follow the **rules of safety**.

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

Safety Decals

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

ACCIDENTS

Following any accident or damage to equipment, the Grove distributor must be immediately advised of the incident and consulted on necessary inspections and repairs. Should the distributor not be immediately available, contact should be made directly with Grove Product Safety at the address below. The crane must not be returned to service until it is thoroughly inspected for any evidence of damage. All damaged parts must be repaired or replaced as authorized by your Grove distributor and/or Manitowoc Crane Care.

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

Grove U.S. L.L.C.
 1565 East Buchanan Trail
 Shady Grove, PA 17256-0021
 Phone: 888-777-3378 (888-PSR.DEPT)
 717-597-8121
 Fax: 717-593-5152
 E-mail: product.safety@manitowoc.com

OPERATOR INFORMATION

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

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

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

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



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

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

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

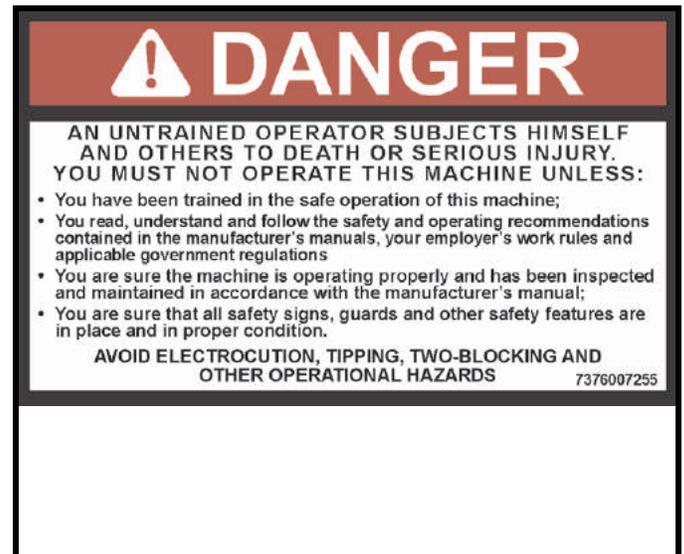
OPERATOR QUALIFICATIONS

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

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

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

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



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

You must not operate this crane unless:

- You have been trained in the safe operation of this crane.
- You read, understand, and follow the safety and operating recommendations contained in the manufacturer's manuals, your employer's work rules, and applicable government regulations.
- You are sure the crane has been inspected and maintained in accordance with the manufacturer's manuals and is operating properly.
- You are sure that all safety decals, guards, and other safety features are in place and in proper condition.

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

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

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

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

OPERATIONAL AIDS

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

Grove remains committed to providing reliable products that enable users and operators to safely lift and position loads. Grove has been an industry leader in the incorporation of operational aids into the design of its cranes. Federal law requires that cranes be properly maintained and kept in good working condition. The manuals that Grove provides that are specific for each crane and the manufacturer's manuals for the operational aids shall be followed. If an operational aid should fail to work properly, the crane user or owner must

assure that repair or recalibration is accomplished as soon as is reasonably possible. If immediate repair or recalibration of an operational aid is not possible and there are exceptional circumstances which justify continued short-term use of the crane when operational aids are inoperative or malfunctioning, the following requirements shall apply for continued use or shutdown of the crane:

- Steps shall be taken to schedule repairs and recalibration immediately. The operational aids shall be put back into service as soon as replacement parts, if required, are available and the repairs and recalibration can be carried out. Every reasonable effort must be made to expedite repairs and recalibration.
- When a *Load Indicator, Rated Capacity Indicator, or Rated Capacity Limiter* is inoperative or malfunctioning, the designated person responsible for supervising the lifting operations shall establish procedures for determining load weights and shall ascertain that the weight of the load does not exceed the crane ratings at the radius where the load is to be handled.
- When a *Boom Angle or Radius Indicator* is inoperative or malfunctioning, the radius or boom angle shall be determined by measurement.
- When an *Anti-Two-Blocking Device, Two-Blocking Damage Prevention Device or Two-Block Warning Device* is inoperative or malfunctioning, the designated person responsible for supervising the lifting operations shall establish procedures, such as assigning an additional signal person to furnish equivalent protection. This does not apply when lifting personnel in load-line supported personnel platforms. Personnel shall not be lifted when anti-two-block devices are not functioning properly.
- When a *Boom Length Indicator* is inoperative or malfunctioning, the designated person responsible for supervising the lifting operations shall establish the boom lengths at which the lift will be made by actual measurements or marking on the boom.
- When a *Level Indicator* is inoperative or malfunctioning, other means shall be used to level the crane.

Rated Capacity Limiter (RCL) Systems

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

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

Under **no condition** should it be relied upon to replace the use of *Load Charts* and operating instructions. Sole reliance

upon these electronic aids in place of good operating practices can cause an accident.

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

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

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

Anti-Two-Blocking Device

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

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

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

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

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

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



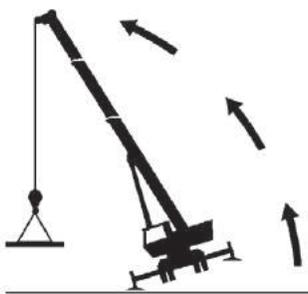
Example decal. For reference only.

Working Area Limiter (If Equipped)

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

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

! DANGER

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

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FOLLOW INSTRUCTIONS IN OPERATOR'S AND SAFETY HANDBOOK.
7376 100 175

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CRANE STABILITY/STRUCTURAL STRENGTH

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

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

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

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

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

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

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

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

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



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

Load Charts

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

Load Chart capacities are based on freely suspended loads.

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

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

Do not remove the *Load Charts* from the crane.

Work Site

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

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

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

WIND FORCES

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

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

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

Wind can have a significant effect on loads that may be lifted by a crane. Wind forces act differently on a crane depending upon the direction from which the wind is blowing (e.g., wind on the rear of the boom can result in decreased forward stability, wind on the underside of the boom can result in decreased backward stability, wind on the side of the boom can result in structural damages, etc.)

Wind forces can exert extreme dynamic loads. Grove recommends that a lift not be made if the wind can cause a loss of control in handling the load.

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

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

Table 2-1 Beaufort Wind Scale

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

Wind Speeds

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

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

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

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

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

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

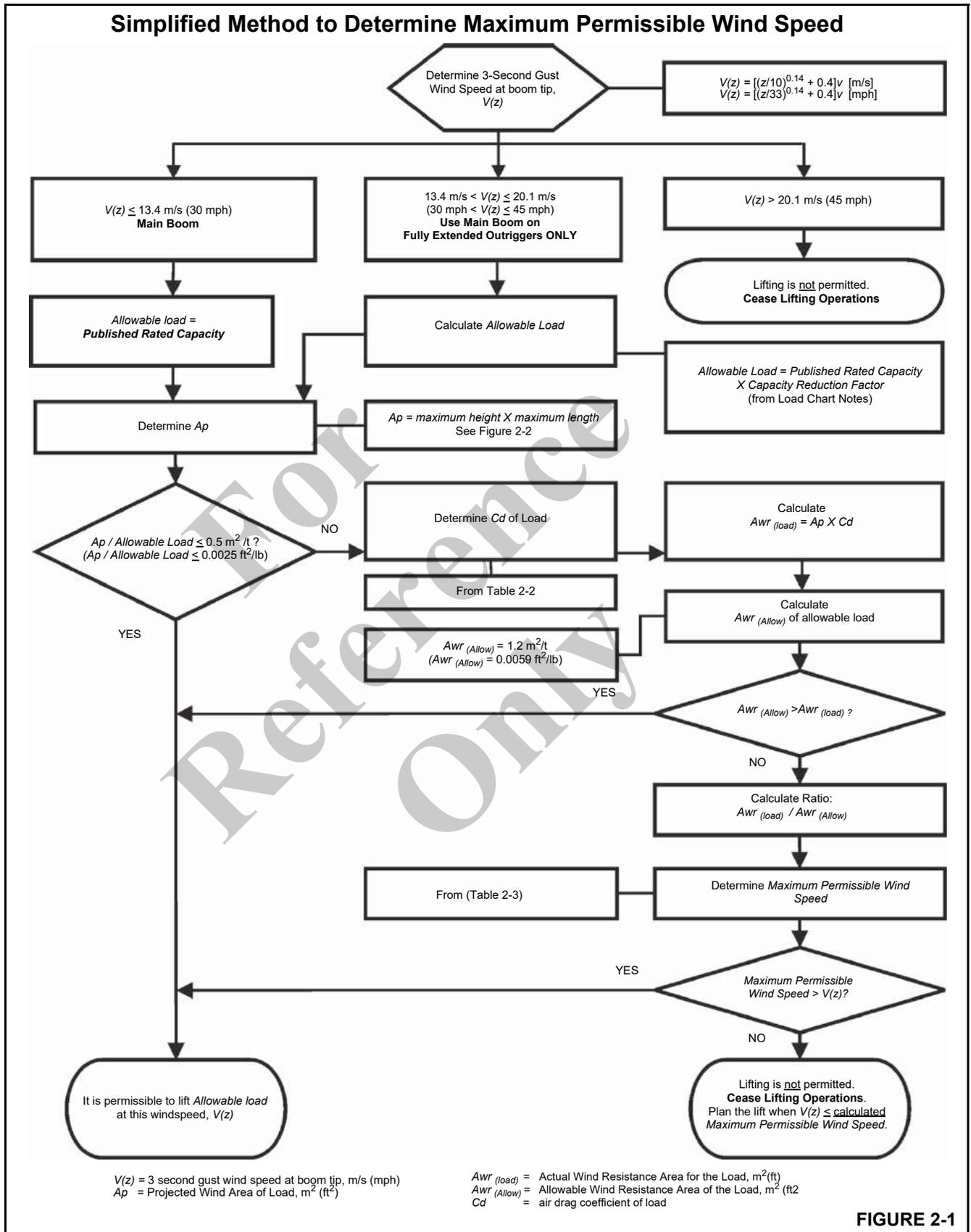


FIGURE 2-1

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

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

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

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

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

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

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

where:

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

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

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

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

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

then:

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

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

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

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

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

Size and Shape of the load:

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

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

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

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

where:

$Awr_{(load)}$ [m²] [ft²] - Wind resistant area of the load

Ap [m²] [ft²] - projected wind area,

Cd - wind drag coefficient.

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

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

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

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

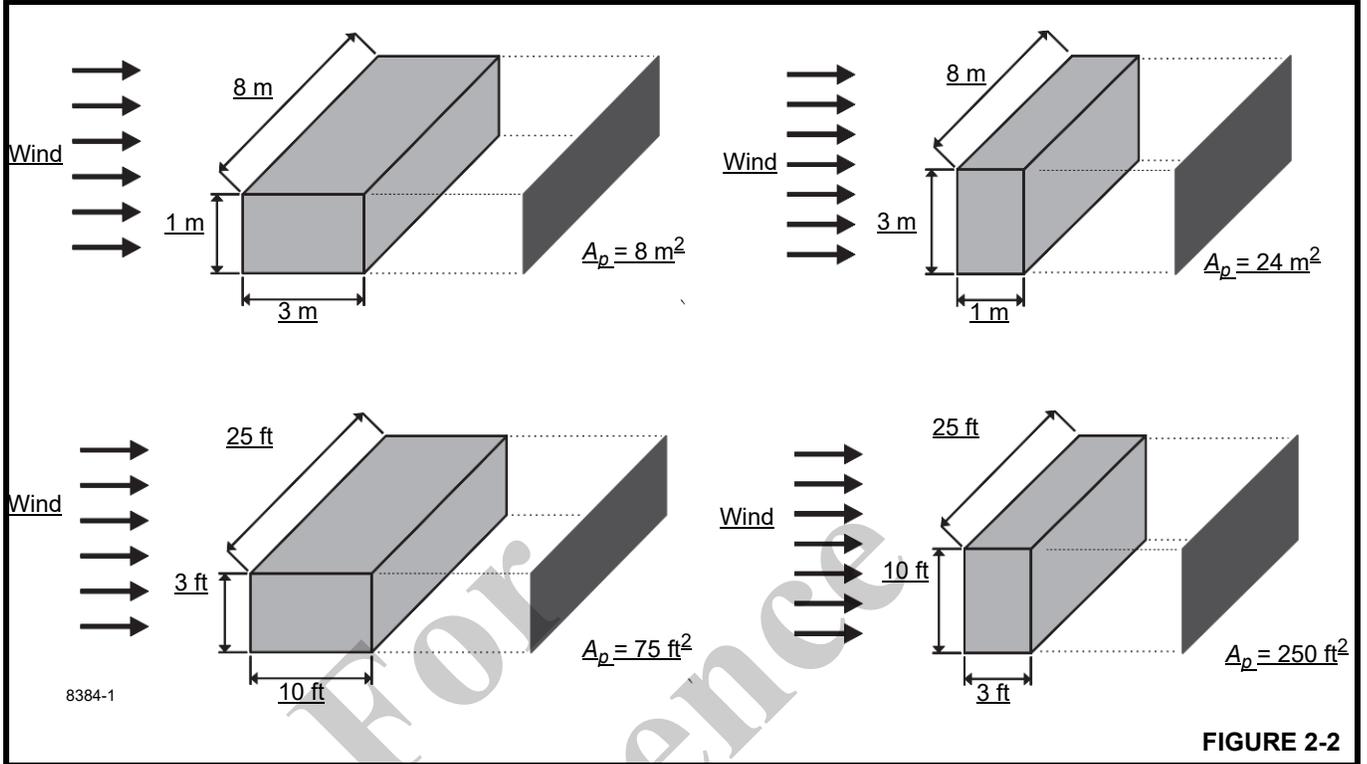
$$Awr_{(allow)} = 0.0012 \times m_{(load)} \quad (2.4)$$

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

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

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

Calculation of Projected Wind Area (A_p):



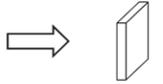
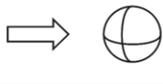
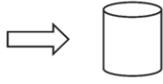
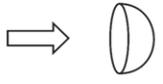
Determining Wind Drag Coefficient (C_d)

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

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

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

Table 2-2 Wind Drag Coefficient

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

Turbine Blade or Complete Rotor

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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)	15,125 (66)	13,725 (67.5)	12,700 (70.5)	11,400 (72.5)
12			14,025 (35)	12,575 (45.5)	12,575 (53.5)	12,125 (60)	11,600 (63)	10,725 (66.5)	10,050 (69)
14				9,000 (35)	9,360 (46)	9,730 (53.5)	9,955 (58.5)	9,205 (62)	8,620 (65)
16				6,750 (19)	7,110 (37.5)	7,475 (47)	7,920 (53)	7,980 (57.5)	7,470 (61.5)
18					5,960 (47)	5,960 (39.5)	6,340 (47.5)	6,525 (53)	6,530 (57.5)
20						4,755 (30.5)	5,145 (41)	5,320 (48)	5,495 (53)
22							3,790 (16.5)	4,210 (33.5)	4,545 (48.5)
24								3,435 (23.5)	3,780 (43.5)
26									2,975 (28)
28									2,400 (16)
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:

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

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

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

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

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

Example and Sample Calculations (metric)

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

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

Example 1: Crane Configuration:

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

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

The maximum allowable wind resistance area of load is:

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

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

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

- Maximum load 15,050 kg
- Maximum wind resistance area of load 18.06 m²

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 m²

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 m².

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 m²,
- 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_(load)** less than **Awr_(allow)**?
13.8 m² ≤ 14.45 m² 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 m²,
- 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_(load)** less than **Awr_(allow)**?
13.08 m² ≤ 14.45 m² 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_(load)**,

- Load to be lifted of 14,000 kg,
- Projected Wind Area **Ap** = 21.85 m²,
- 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) < 13.4 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_(load)** less than **Awr_(allow)**?
26.22 m² ≤ 18.06 m² 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_(load)**,

- Load to be lifted of 8,000 kg,
- Projected Wind Area **Ap** = 15.25 m²,
- Wind Drag Coefficient **Cd** = 1.3

the wind resistance area of load can be estimated as

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



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

- Is the load to be lifted less than allowable load?
8,000 kg ≤ 12,040 kg YES
- Is $Awr_{(load)}$ less than $Awr_{(allow)}$?
19.83 m² ≤ 14.45 m² NO

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

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

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

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

For
Reference
Only

Rated Load Chart Example - Non-metric

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

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

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

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

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

FIGURE 2-4



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

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

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

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

Wind resistance area of load, **Awr_(load)**, shall not exceed maximum allowable wind resistance area **Awr_(allow)**.

Maximum allowable wind resistance area of load, **Awr_(allow)** = 0.0059 x calculated reduced capacity in lb.

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, **Awr_(allow)**, 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_(allow)** 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 ft²

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 ft²

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 ft².

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 ft²,
- 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_(load)** less than **Awr_(allow)**?
105 ft² ≤ 119 ft² 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 ft²,
- 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_(load)** less than **Awr_(allow)**?
108 ft² ≤ 119 ft² 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_(load)**,

- Load to be lifted of 22,000 lb,
- Projected Wind Area **Ap** = 180 ft²,
- 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_(load)** less than **Awr_(allow)**?
216 ft² ≤ 149 ft² 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_(load)**,

- Load to be lifted of 12,000 lb,
- Projected Wind Area **Ap** = 125 ft²,
- 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 ≤ 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 ft² \leq 119 ft² 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 2-20 for additional lifting instructions.

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

Multiple Crane Lifts

Multiple crane lifts are not recommended.

Any lift that requires more than one crane must be precisely planned and coordinated by a qualified person. If it is necessary to perform a multi-crane lift, the operator shall be responsible for assuring that the following minimum safety precautions are taken:

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

Lifting Multiple Loads

Grove recommends lifting only one load at a time.

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

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

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

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

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

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

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

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

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

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

Tilt-Up Panel Lifting

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

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

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

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

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

Counterweight

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

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

Outrigger Lift Off

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

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

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

PILE DRIVING AND EXTRACTING

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

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

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

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

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

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

Crane Equipment

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

Crane Inspection

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

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

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

ELECTROCUTION HAZARD

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

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

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



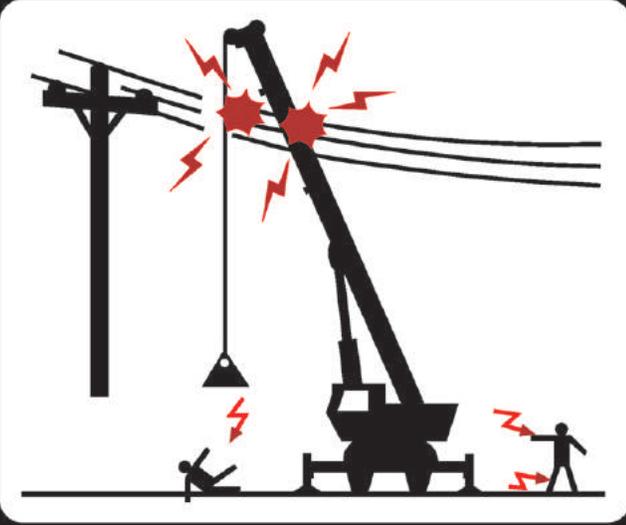
DANGER

Electrocution Hazard!

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

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

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



! DANGER

ELECTROCUTION HAZARD
 TO AVOID DEATH OR SERIOUS INJURY

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

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

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

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

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THIS CRANE IS NOT INSULATED.

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

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

This crane is **not insulated**. Always consider all parts of the load and the crane, including the hoist rope, wire rope, pendant cables, and tag lines, as conductors. You, the operator, are responsible for alerting all personnel of dangers associated with electrical power lines and equipment. Do not allow unnecessary personnel in the vicinity of the crane while operating. Permit no one to lean against or touch the crane. Permit no one, including riggers and load handlers, to hold the load, load lines, tag lines, or rigging gear.

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

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

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

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

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

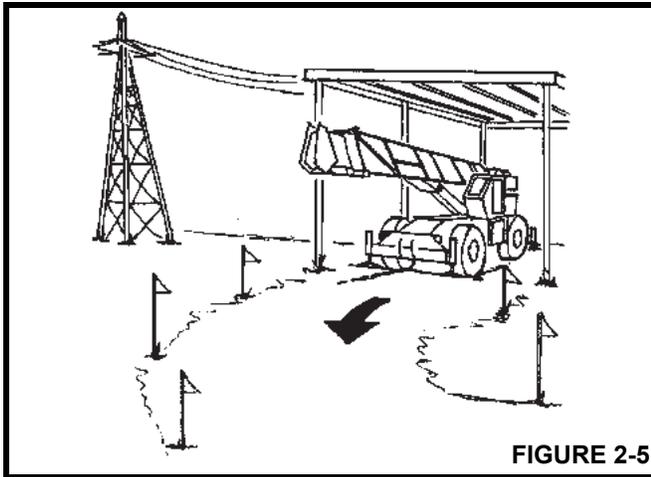
Set-Up and Operation

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

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

A suitable barricade should be erected to physically restrain the crane and all attachments (including the load) from entering into an unsafe distance from electrical power lines or equipment.

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



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

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

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

Do not store materials under power lines or close to electrical power sources.

Electrocution Hazard Devices

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

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

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

Boom cages and boom guards afford limited protection from electrocution hazards. They are designed to cover only the

boom nose and a small portion of the boom. Performance of boom cages and boom guards is limited by their physical size, insulating characteristics, and operating environment (e.g. dust, dirt, moisture, etc.). The insulating characteristics of these devices can be compromised if not kept clean, free of contamination, and undamaged.

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

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

Some variables you must know and understand are:

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

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

Electrical Contact

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

1. Stay in the crane cab. **Don't panic.**
2. Immediately warn personnel in the vicinity to stay away.
3. Attempt to move the crane away from the contacted power source using the crane's controls which may have remained functional.
4. Stay in the crane until the power company has been contacted and the power source has been de-energized. **No one** must attempt to come close to the crane or load until the power has been turned off.

Only as a last resort should an operator attempt to leave the crane upon contacting a power source. If it is absolutely necessary to leave the operator's station, **jump completely clear of the crane. Do not step off.** Hop away with both feet together. **Do not** walk or run.

Following any contact with an energized electrical source, the Grove distributor must be immediately advised of the incident and consulted on necessary inspections and repairs. Thoroughly inspect the hoist rope and all points of contact on the crane. Should the distributor not be immediately available, contact Manitowoc Crane Care. The crane must not be returned to service until it is thoroughly inspected for any evidence of damage and all damaged parts are repaired or replaced as authorized by your Grove distributor or Manitowoc Crane Care.

Special Operating Conditions and Equipment

Never operate the crane during an electrical thunderstorm.

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

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

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

Grounding the Crane

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

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



WARNING

Risk of accidents due to electric shock!

Ground the crane before you start to work with it

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

Use electrically conducting material for grounding.

1. Hammer a metal rod (3, Figure 2-6) (length of approximately 2.0 m (6.6 ft)) at least 1.5 m (5 ft) into the ground.
2. Moisten the soil around the metal rod (3) for better conductivity.
3. Clamp an insulated cable (2) to the metal rod (3), cross-section of at least 16 mm² (0.025 in²) (AWG 5).
4. Connect the free end of the cable with a clamp (1) to a good electrically conductive location on the frame.

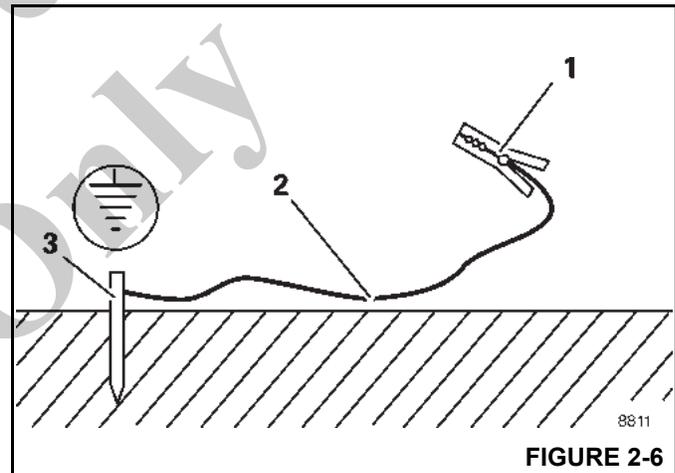


FIGURE 2-6



WARNING

Risk of accidents due to electric shock!

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

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

PERSONNEL HANDLING

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

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

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

General requirements. The use of a crane or derrick to hoist employees on a personnel platform is prohibited, except when the erection, use, and dismantling of conventional means of reaching the worksite, such as a personnel hoist, ladder, stairway, aerial lift, elevating work platform or scaffold, would be more hazardous or is not possible because of structural design or worksite conditions.

Additional requirements for crane operations are stated in ASME B30.5, *Mobile and Locomotive Cranes*, ASME B30.8, *Floating Cranes and Floating Derricks*, and in OSHA regulations 29CFR1910.180 for *General Industry* and 29CFR1926.1431 for *Construction*.

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

- The requirements of the applicable national, state and local regulations and safety codes are met.
- A determination has been made that use of a crane to handle personnel is the least hazardous means to perform the work.
- The crane operator shall be qualified to operate the specific type of hoisting equipment used in the personnel lift.
- The crane operator must remain at the crane controls at all times when personnel are off the ground.

- The crane operator and occupants have been instructed in the recognized hazards of personnel platform lifts.
- The crane is in proper working order.
- The crane must be equipped with a boom angle indicator that is visible to the crane operator.
- The crane's *Load Chart* is affixed at the operator's station and readily accessible to the operator. The total weight of the loaded personnel platform and related rigging shall not exceed 50 percent of the rated capacity for the radius and configuration of the crane.
- The crane is level within one percent of level grade and located on a firm footing. Cranes with outriggers shall have them all deployed following manufacturer's specifications.
- The crane's *Operator Manual* and other operating manuals are at the operator's station and readily accessible to the operator.
- The platform meets the requirements as prescribed by applicable standards and regulations.
- For hoist rope suspended platforms:
 - The crane is equipped with a hook that can be closed and locked, eliminating the throat opening.
 - The crane is equipped with a functional anti-two-block device.
 - The platform is properly attached and secured to the load hook.
- For boom mounted platforms:
 - The platform is properly attached and secure.

To avoid death or serious injury:

- NEVER use this crane for bungee jumping or any form of amusement or sport.
- NEVER handle personnel on the loadline unless the requirements of applicable national, state and local regulations and safety codes are met.
- NEVER permit anyone to ride loads, hooks, slings or other rigging for any reason.
- NEVER get on or off a moving crane.
- NEVER allow anyone other than the operator to be on this crane while the machine is operating or traveling.
- NEVER allow anyone on the hoist access platform while traveling.

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

- *ASME (formerly ANSI) B30 Series American National Safety Standards For Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings; ASME B30.5, Mobile And Locomotive Cranes, and ASME B30.23, Personnel Lifting Systems*, are available by mail from the ASME, 22 Law Drive, Fairfield, New Jersey, 07007-2900.

- or - check online at:

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

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

ENVIRONMENTAL PROTECTION

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

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

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

When filling and draining crane components, observe the following:

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

MAINTENANCE

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

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

Shut down the crane while making repairs or adjustments.

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

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

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

Routine maintenance and inspection of this crane must be performed by a qualified person(s) according to the recommendations in the *Inspection and Lubrication Service Log*. Any questions regarding procedures and specifications should be directed to your Grove distributor.

Service and Repairs



WARNING

Fall Hazard!

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

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

Service and repairs to the crane must only be performed by a qualified person. All service and repairs must be performed in accordance with manufacturer's recommendations, this manual, and the service manual for this machine. If there is any question regarding maintenance procedures or specifications, contact your Grove distributor for assistance.

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

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

All replacement parts must be Grove approved.

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

Hydraulic Fluid

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

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

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



WARNING

Pressurized Fluid Hazard!

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

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

Moving Parts

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

Before maintenance or repairs

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

- The boom should be fully retracted and lowered and the load placed on the ground.
- Do not get under a raised boom unless the boom is blocked up safely. Always block up the boom before doing any servicing that requires the boom to be raised.

- Stop the engine and disconnect the battery.
- Controls should be properly tagged. Never operate the crane if it is **tagged-out** nor attempt to do so until it is restored to proper operating condition and all tags have been removed by the person(s) who installed them.

After maintenance or repairs

- Replace all guards and covers that have been removed.
- Remove all tags, connect the battery, and perform a function check of all operating controls.
- Consult with Manitowoc Crane Care to determine if load testing is required after a structural repair is performed.

Lubrication

The crane must be lubricated according to the manufacturer's recommendations for lubrication points, time intervals, and types. Lubricate at more frequent intervals when working under severe conditions.

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

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

Tires



WARNING

Possible equipment damage and/or personal injury!

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

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

Make sure that all lug nuts are properly torqued.

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

HOIST ROPE

Synthetic Hoist Rope

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

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

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

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

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

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

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

Wire Rope

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

- For rotation-resistant running ropes: more than two (2) broken wires in a length of rope equal to six (6) times the rope diameter, or more than four (4) broken wires in a length of rope equal to thirty (30) times the rope diameter.
- For running ropes other than rotation resistant: six (6) broken wires in one rope lay or three (3) broken wires in one strand.
- One valley break where the wire fractures between strands in a running rope is cause for removal.
- Abrasion of the rope resulting in a 5% reduction in the original wire diameter.
- Any kinking, bird caging, crushing, corrosion, or other damage resulting in distortion of the rope structure.
- Rope that has been in contact with a live power line or has been used as a ground in an electric circuit (e.g., welding) may have wires that are fused or annealed and must be removed from service.
- In standing ropes, more than three (3) breaks in one rope lay in sections beyond the end connection or more than two (2) broken wires at an end connection.
- Core deterioration, usually observed as a rapid reduction in rope diameter, is cause for immediate removal of the rope.

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

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

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

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

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

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

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

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

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

Installing a new rope

- Keep all parts of your body and clothing away from rotating hoist drums and all rotating sheaves.
- Never handle the wire rope with bare hands.
- Follow proper instructions for removing rope from a reel.
- Apply back tension to the storage/payoff reel of the new rope to ensure tight, even, spooling onto the hoist drum.
- Operate the new rope—first through several cycles at light load—then through several cycles at intermediate load, to allow the rope to adjust to operating conditions.

Reference Only

When using a wedge socket

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

Sheaves

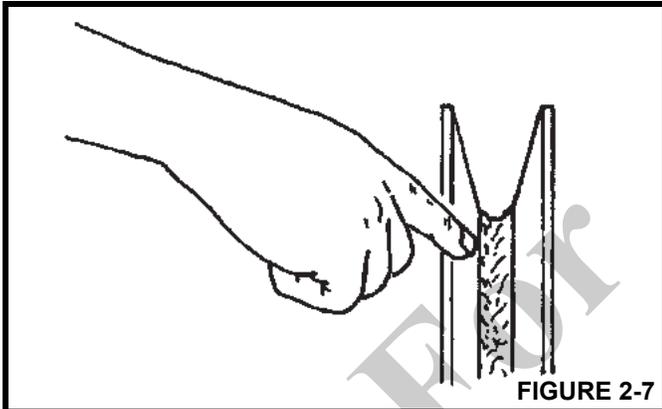


FIGURE 2-7

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

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

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

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

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

Batteries

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

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

- Wear safety glasses when servicing batteries.
- If equipped, disconnect battery with the battery disconnect switch before disconnecting the ground battery cable. For cranes with a Cummins engine using an engine ECM:
 - a. Make sure that the key switch has been off for 2 minutes.
 - b. Turn the battery disconnect switch to the OFF position.
 - c. Remove the ECM power fuse.
 - d. Remove negative battery cables.
- Do not break a live circuit at the battery terminal. Disconnect the ground battery cable first when removing a battery and connect it last when installing a battery.
- Do not short across the battery posts to check charge. Short circuit, spark, or flame could cause battery explosion.
- If applicable, maintain battery electrolyte at the proper level. Check the electrolyte with a flashlight.
- If applicable to your crane, check battery test indicator on maintenance-free batteries.
- Check battery condition only with proper test equipment. Batteries shall not be charged except in an open, well-ventilated area that is free of flame, smoking, sparks, and fire.

Super Capacitor (If Equipped)

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

When checking and maintaining capacitor, exercise the following procedures and precautions:

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

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

General Maintenance

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

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

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

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

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

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

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

TRANSPORTING THE CRANE

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

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

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

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

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

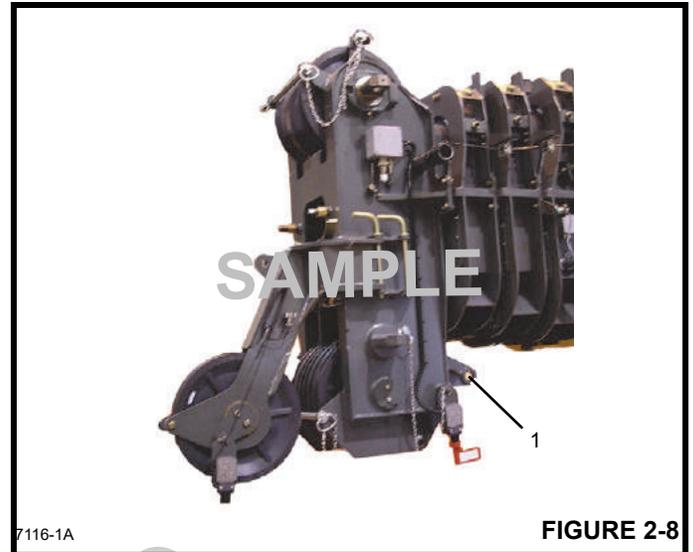


FIGURE 2-8

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

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

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

TRAVEL OPERATION

Only the crane operator shall occupy the crane when traveling.

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

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

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

**WARNING**
Crushing Hazard!

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

Keep clear of revolving tires.

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

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

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

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

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

Watch clearances when traveling. Do not take a chance of running into overhead or side obstructions.

When moving in tight quarters, post a signal person to help guard against collisions or bumping structures.

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

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

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

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

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

Keep lights on, use traffic warning flags and signs, and use front and rear flag vehicles when necessary. Check state and local restrictions and regulations.

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

Stay alert at the wheel.

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

For Reference Only

Slopes

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

WORK PRACTICES

Personal Considerations

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

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

Crane Access



WARNING

Fall Hazard!

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

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

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

Never exit or enter the crane cab or deck by any other means than the access system(s) provided (i.e., steps and grab handles). Use the recommended handholds and steps to maintain a three-point contact when getting on or off the crane.

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

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

Do not step on surfaces on the crane that are not approved or suitable for walking and working. All walking and working surfaces on the crane should be clean, dry, slip-resistant, and have adequate supporting capacity.

Do not walk on a surface if slip-resistant material is missing or excessively worn.

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

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

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

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

Do not allow ground personnel to store their personal belongings (clothing, lunch boxes, water coolers, and the like) on the crane. This practice will prevent ground personnel from being crushed or electrocuted when they attempt to access personal belongings stored on the crane.

Job Preparation

Before crane use

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

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

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

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

Working

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

Know the location and function of all crane controls.

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

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

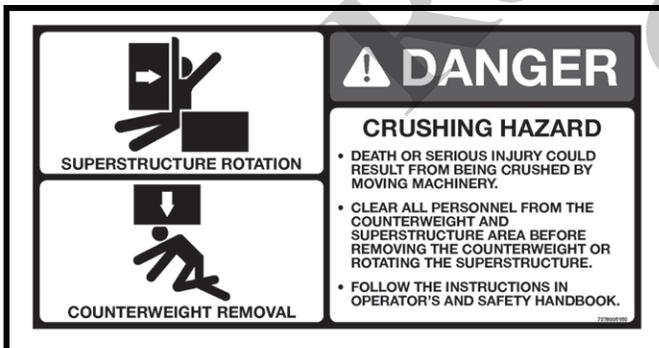
Carbon monoxide fumes from the engine exhaust can cause suffocation in an enclosed area. Good ventilation is very important when operating the crane.

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

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

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

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



Keep unauthorized personnel clear of the working area during operation.

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

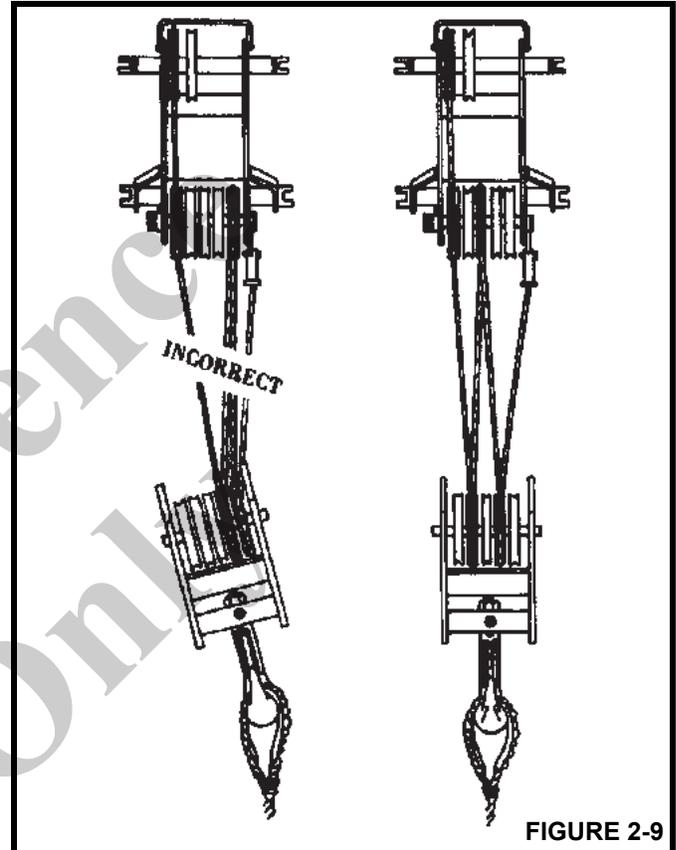
You must always be aware of everything around the crane while lifting or traveling. If you are unable to clearly see in the direction of motion, you must post a look out or signal person before moving the crane or making a lift. Sound the horn to warn personnel

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

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

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

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



Lifting

Grove Crane recommends lifting only one load at a time. See "Lifting Operations" on page 2-19.

Use enough parts of line for all lifts and check all lines, slings, and chains for correct attachment. To obtain maximum lifting capacities, the hook block must be set up with enough parts of line. Too few parts of line can result in failure of the hoist rope or hoist. **No less than three wraps of rope** should remain on the hoist drum. When slings, ties, hooks, etc., are used, make sure that they are correctly positioned and secured before raising or lowering the loads.

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

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

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

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

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

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

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

Watch the path of the boom and load when swinging. Avoid lowering or swinging the boom and load into ground personnel, equipment, or other objects. Never leave the crane with a load suspended. Should it become necessary to leave the crane, lower the load to the ground and stop the engine before leaving the operator's station.

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

Stop the hook block from swinging when unhooking a load.

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

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

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

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

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

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

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

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

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

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

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

Hand Signals

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

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

At all times use standardized hand signals (Figure 2-10) that have been previously agreed upon and completely understood by the operator and signal person.

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

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

Obey a signal to stop from anyone.

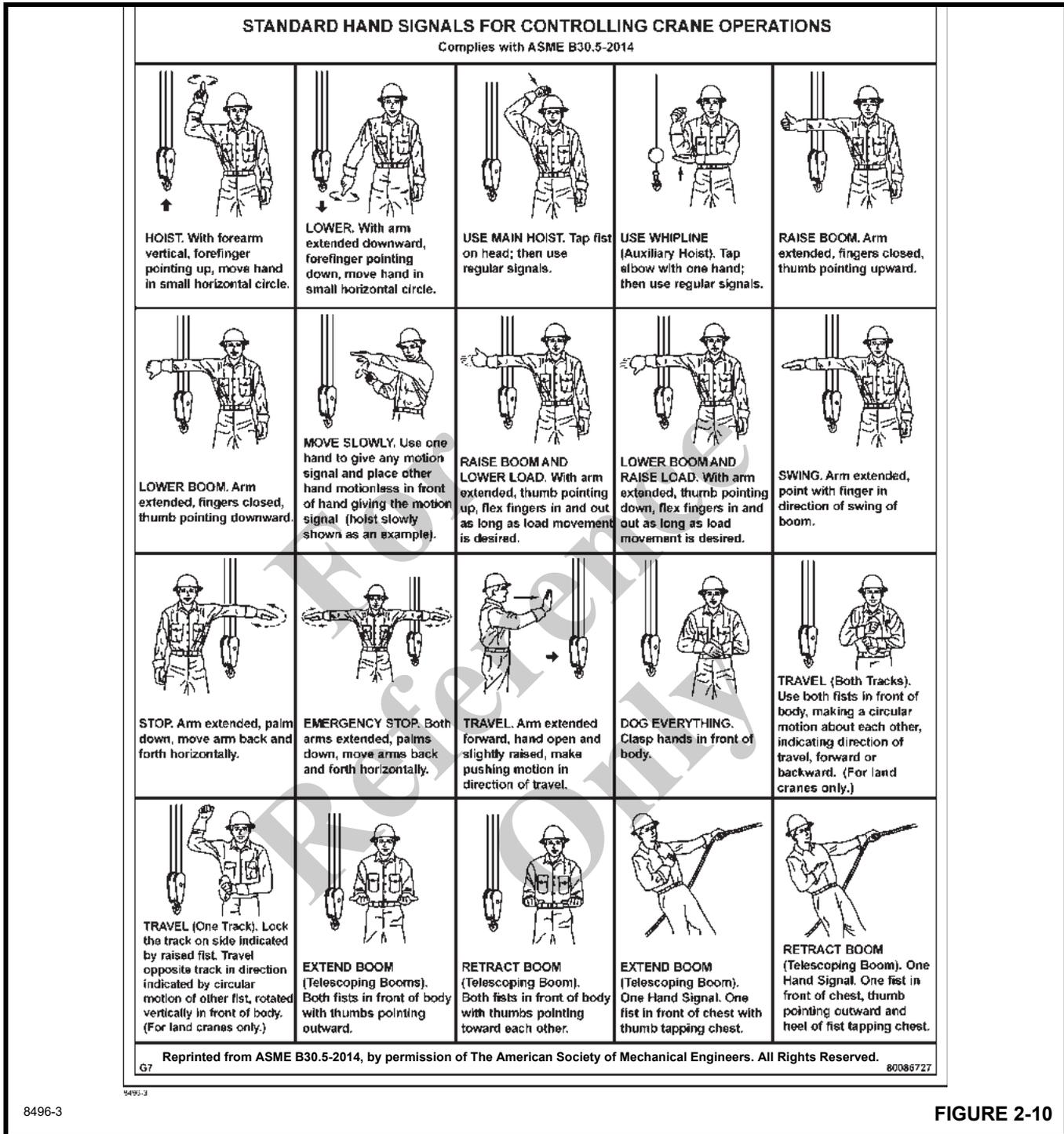


FIGURE 2-10

BOOM EXTENSION

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

Install and secure all pins properly.

Control movement of the boom extension at all times.

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



DANGER

Boom Extension Hazard!

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

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

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

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

Stay outside of boom extension sections and lattice work.

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

PARKING AND SECURING



DANGER

Tipping Hazard!

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

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

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

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

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

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

SHUT-DOWN

Use the following steps when shutting down the crane:

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

COLD WEATHER OPERATION

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

Check operating procedures in this manual for cold weather starting.

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

Clean the crane of all ice and snow.

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

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

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

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

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

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

Never store flammable materials on the crane.

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

TEMPERATURE EFFECTS ON HOOK BLOCKS

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

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

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

For
Reference
Only

TEMPERATURE EFFECTS ON HYDRAULIC CYLINDERS

Hydraulic oil expands when heated and contracts when cooled. This is a natural phenomena that happens to all liquids. The coefficient of expansion for API Group 1 hydraulic oil is approximately 0.00077 cm³ per cm³ of volume for 1°C of temperature change (0.00043 in³ per in³ of volume for 1°F of temperature change). **Thermal contraction will allow a cylinder to retract as the hydraulic fluid which is trapped in the cylinder cools.**

The change in the length of a cylinder is proportional to the extended length of the cylinder and to the change in temperature of the oil in the cylinder. For example, a cylinder extended 7.6 m (25 ft) in which the oil cools 15.5°C (60°F) would retract approximately 196 mm (7 3/4 in) [see Table 2-9 and Table 2-8]. The rate at which the oil cools depends on many factors and will be more noticeable with a larger difference in oil temperature verses the ambient temperature.

Thermal contraction coupled with improper lubrication or improper wear pad adjustments may, under certain conditions, cause a “stick-slip” condition in the boom. This “stick-slip” condition could result in the load not moving smoothly. Proper boom lubrication and wear pad adjustment is important to permit the boom sections to slide freely. Slow

movement of the boom may be undetected by the operator unless a load is suspended for a long period of time. To minimize the effects of thermal contraction or “Stick-slip” it is recommended that the telescope control lever is activated periodically in the extend position to mitigate the effects of cooling oil.

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

This situation will also occur in reverse. If a crane is set up in the morning with cool oil and the daytime ambient temperature heats the oil, the cylinders will extend in similar proportions.

Table 2-8 and Table 2-9 have been prepared to assist you in determining the approximate amount of retraction/extension that may be expected from a hydraulic cylinder as a result of change in the temperature of the hydraulic oil inside the cylinder. The chart is for dry rod cylinders. If the cylinder rod is filled with hydraulic oil, the contraction rate is somewhat greater.

Reference Only

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

Coeff. = 0.00043 (in ³ /in ³ /°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. (in³/in³/°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

STABILITY

The RT765E-2 on rubber load charts has a minimum radius of 9.8 ft (3 m) with a load. Without a load, a radius of 8.2 ft (2.5 m) is safe for 360° on rubber. A radius of less than 8.2 ft (2.5 m) must be avoided on rubber because of backward stability considerations.

ACCESS PLATFORM HAND RAIL

Ensure that the hoist access platform hand rail (1) (Figure 2-11) and step (2) (Fixed counterweight units only) are in the travel configuration. Remove pins from hand rail and rotate it down into the travel position, reinstall pins. Pull the step locking pin out, slide the step in to the travel position and release the lock pin.

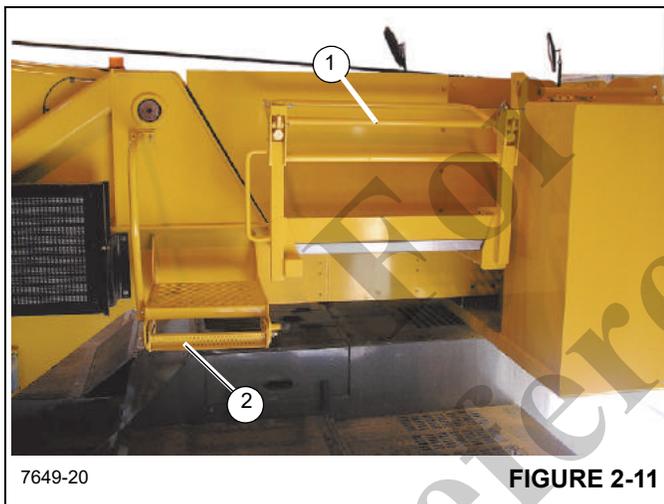


FIGURE 2-11

Use the hoist access platform (1) (Figure 2-12) when working in the hoist area (Fixed counterweight units only).

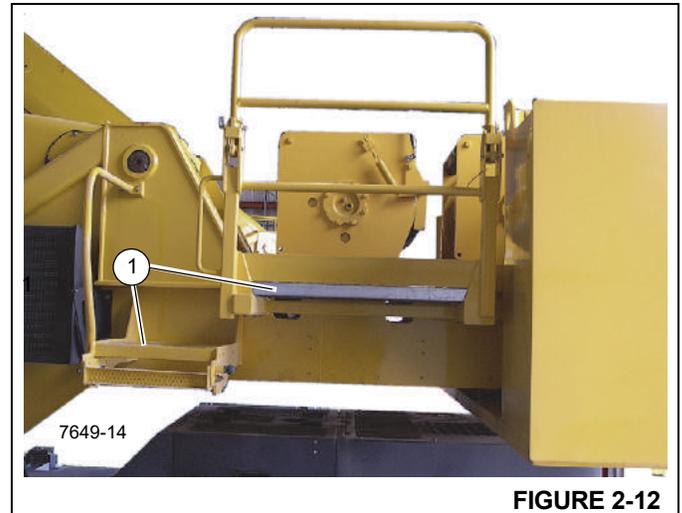


FIGURE 2-12

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.

WARNING Overload Hazard!

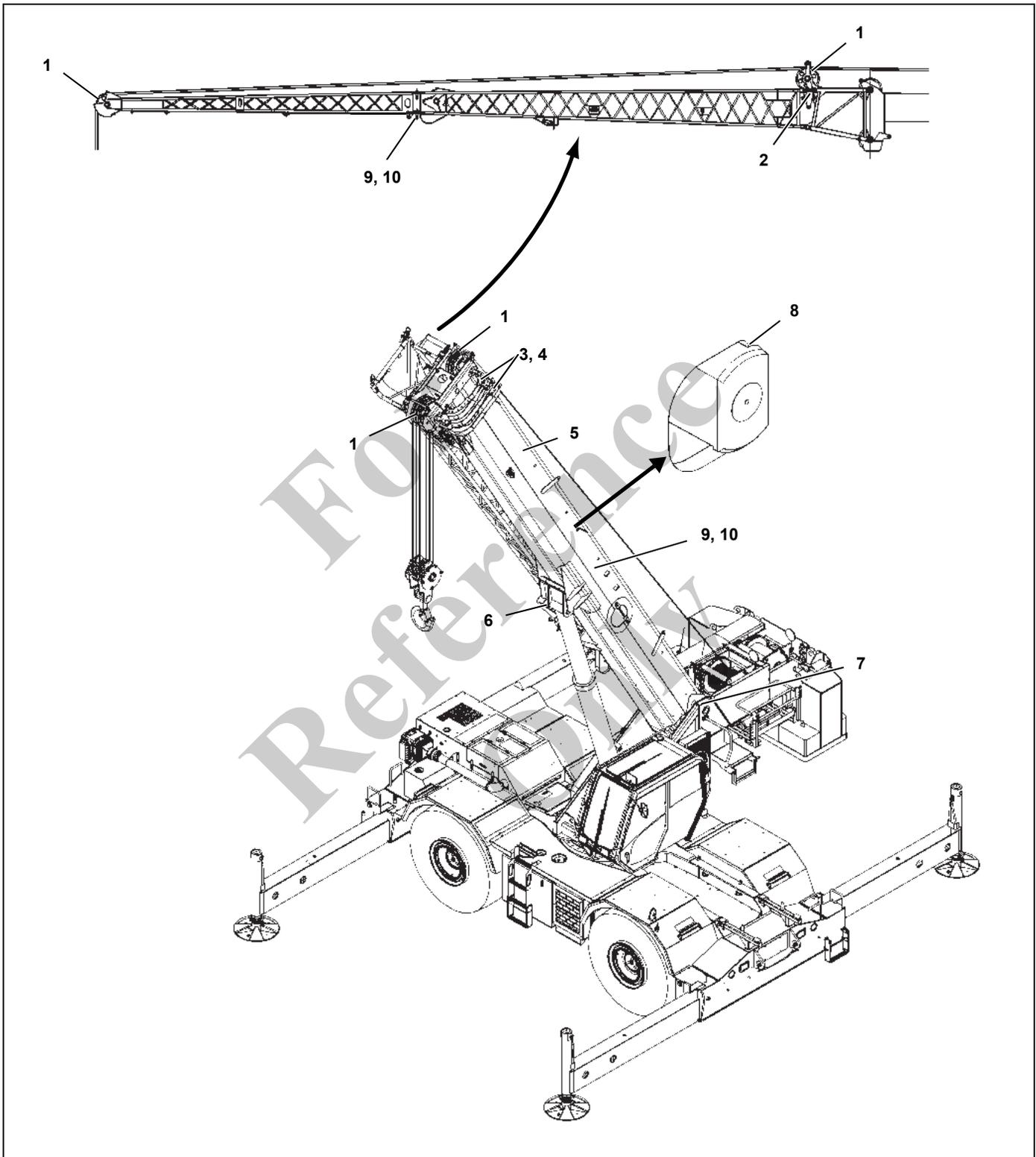
To avoid an accident caused by overload damage to your crane:

- 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.

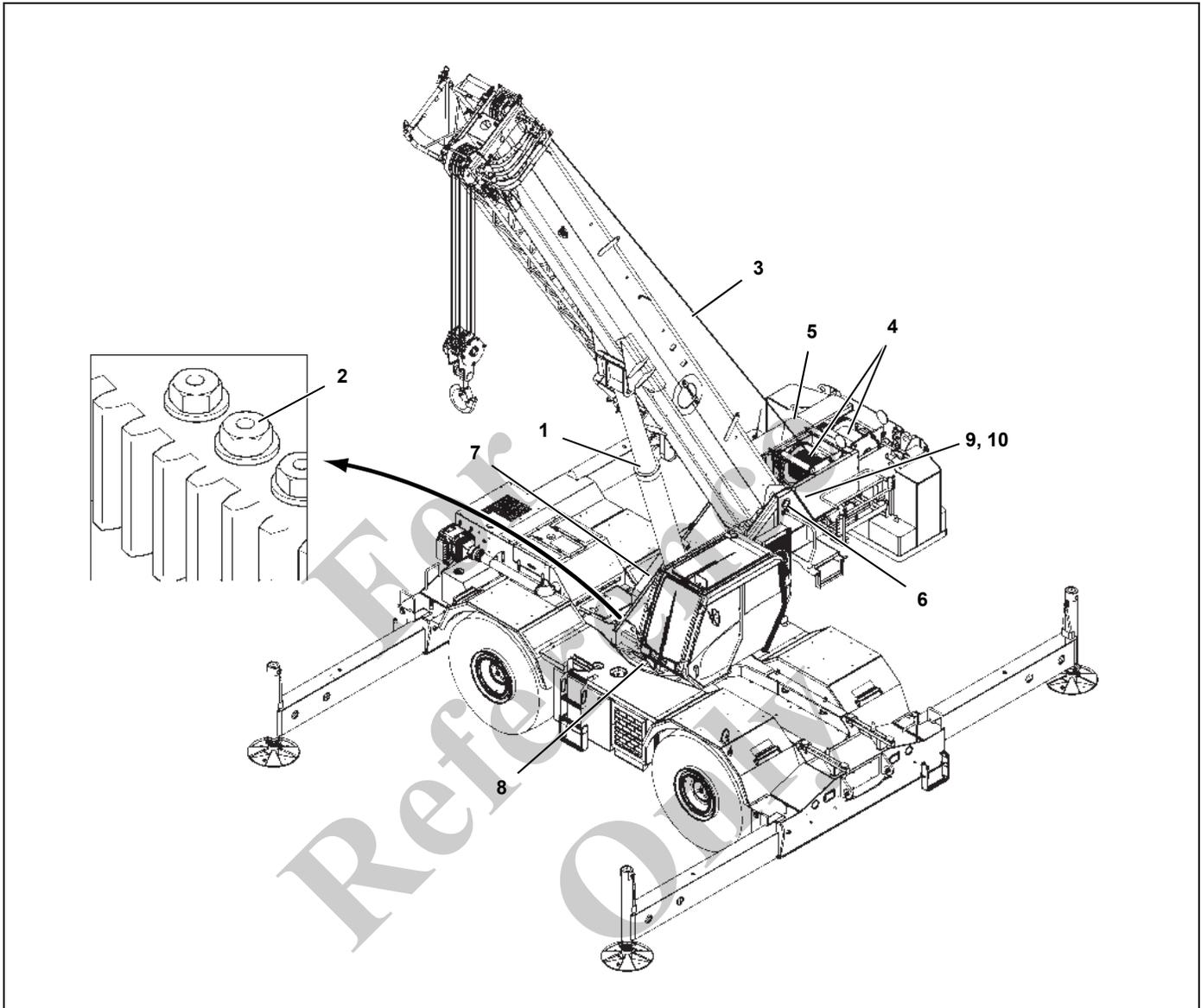
Boom Inspection



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

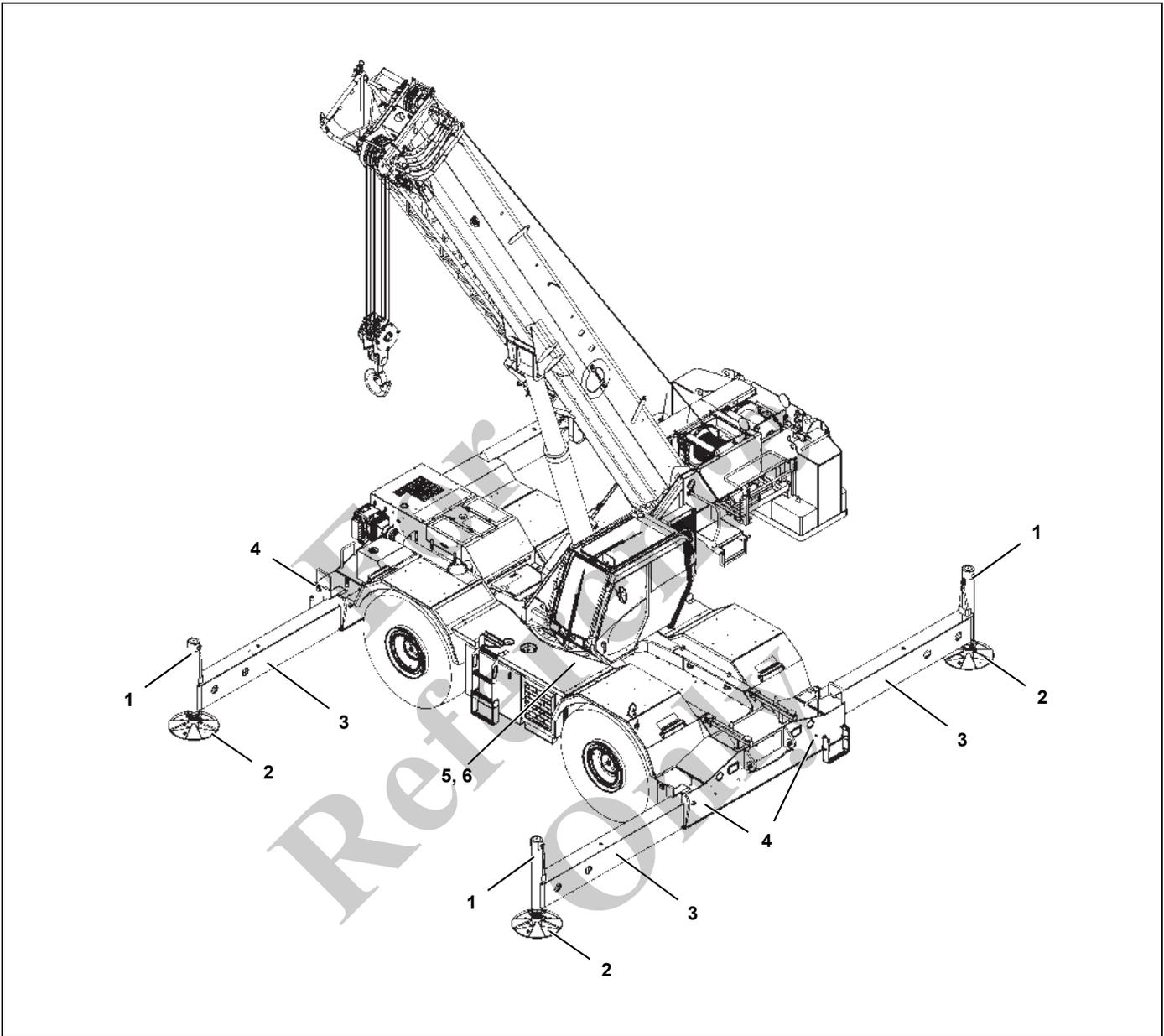
Overload less than 25%			
1	Sheaves	Inspect all for damage.	
2	Luffing Mechanism/ Cylinder	Inspect for damage/leaks.	
3	Collar-wear pads	Inspect all for damage.	
Overload from 25% to 49%			
1	Sheaves	Inspect all for damage.	
2	Luffing Mechanism/ Cylinder	Inspect for damage/leaks.	
3	Collar-wear pads	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



Overload less than 25%			
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.
Overload from 25% to 49%			
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



Overload less than 25%			
1	Jack Cylinders	Inspect for leaking.	
2	Outrigger Pads	Inspect for deformation and cracked welds.	
Overload from 25% to 49%			
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.	

For Reference Only

*For
Reference
Only*

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SECTION 3

OPERATING CONTROLS AND PROCEDURES

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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 of the inputs and sends commands to the fuel systems as well as vehicle and engine control devices. This *Operator Manual* does not include information on the engine ECM, however a separate manual as prepared in detail by the engine manufacturer is shipped with the crane at the factory.

All the controls and indicators to operate and monitor crane functions are found inside the crane cab Figure 3-2 and include the following:

1. Foot Pedals
2. Outrigger Control
3. Seat Joystick and Armrest Controls
4. Side Display Panel
5. Steering Column
6. Overhead Control Panels

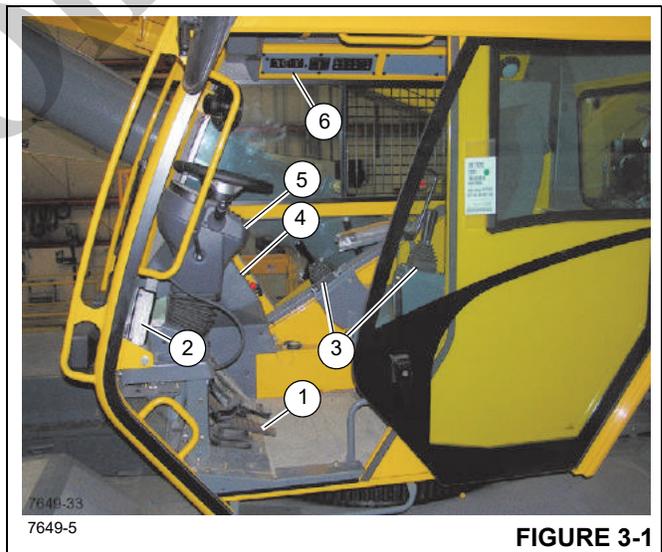


FIGURE 3-1

STEERING COLUMN

The steering column assembly in Figure 3-2 is a pedestal style tilt and telescoping steering column. It has the ability to

tilt forward 30° or be raised vertically approximately 60 mm (2.5 in). It also includes the ignition switch and the CANbus gauge display (11) (Figure 3-2).

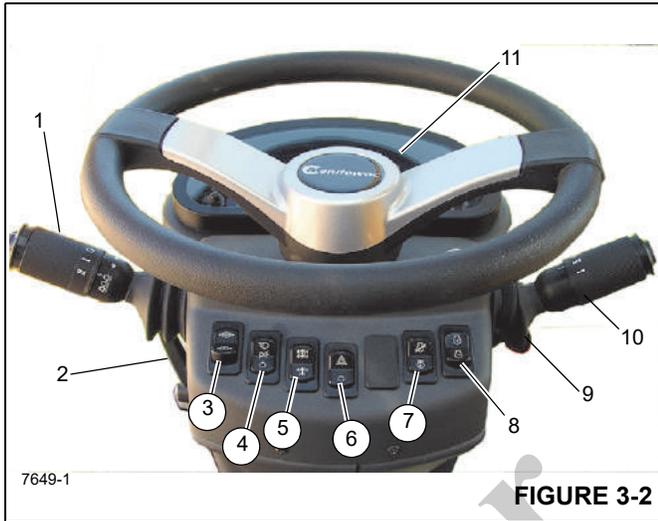


Figure 3-2 Item Numbers

Item	Description
1	Turn Signal Lever and Windshield Wiper/Washer/Headlight /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 Diagnostic/Speed Control Switch
8	Increment/Decrement Switch
9	Ignition Switch
10	Transmission Shift Lever
11	Gauge Display

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

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

The windshield wiper switch is incorporated in the turn signal lever. The knob of the lever has three positions: O, I, and II. Pushing the button in the end of the knob energizes the windshield washer pump to spray washer fluid on the windshield. Positioning the knob to I operates the wiper at

low speed and positioning the knob to II operates the wiper at high speed. Positioning the knob to O turns the wiper motor off and automatically returns the wiper to the parked position.

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

Steering Column Tilt Lever

The steering control column can be rotated forward approximately 30° and raised approximately 60 mm (2.5 in). Move the control lever (2) (Figure 3-2) down to lock the steering column in place; rotating the lever up releases the steering column for the require adjustments.

Park Brake Control Switch

The Park Brake Control Switch (3) (Figure 3-2) is located on the front of the 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 steering column is illuminated when the pressure switch in the brake release system is activated and the brake is applied.

Headlights Switch

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

Drive Axle Selector Switch

The Drive Axle Selector Switch (5) (Figure 3-2) is located on the front of the steering column. This two-position rocker switch is labeled two-wheel drive (high range) and four-wheel drive (low range). The switch controls a solenoid valve (energized for two-wheel drive) that operates the speed range and axle disconnect cylinders on the transmission. When the switch is in the four-wheel drive position, the Drive Axle Indicator light on the steering column is illuminated.

Hazard Lights Switch

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

Engine Diagnostics Switches

Two Engine Diagnostics Switches (Test Mode and Idle/Diagnostic) are located on the front of the steering column.



Test Mode Switch

The Test Mode Switch (7) (Figure 3-2) is used when servicing the engines electronic control system. It is a two position on/off rocker switch used to activate the diagnostic mode (fault codes). The ignition switch must be ON but the engine not running. When the Test Mode Switch is ON, and is used in conjunction with the Idle/Diagnostic Mode Switch, access will be gained to scroll up or down through the fault codes.

Idle/Diagnostic Mode Switch

The Idle/Diagnostic Mode Switch (8) (Figure 3-2) is a three position (+/-) momentary rocker switch that provides idle-control inputs that increases and decreases the engine idle (when the Test Mode Switch is in the OFF position) or scrolls up or down through the diagnostic mode fault codes when the test mode switch is in the ON position with the engine not running.

Press and release the top of the switch once to increase the engine to high idle. Press and release the bottom to return to low idle. Press and hold the switch, release when a predetermined idle speed is reached. Press the bottom to return to low idle.

Ignition Switch

The Ignition Switch (9) is located on the right side of the steering column and under the transmission shift lever(10).

The switch is key-operated and has four positions: ACC [3], OFF [0], RUN [1], and START [2]. In the OFF position, all electrical power is off except for the lights controlled by the Headlights Switch, turn/hazard/stop lights, dome light and work light. Positioning the switch to ACC energizes all electrical components except for the start solenoid and engine ECM. Positioning the switch to RUN is the same as ACC, but the ignition circuit is also energized. Positioning the 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 the engine, position the switch to OFF.

The Ignition switch has a mechanical anti-restart built into it. If the engine does not start after the first attempt, the key switch must go to the OFF position and then back to START in order to try and start the engine another time.

Transmission Shift Lever

The Transmission Shift Lever (10) (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 back on the lever first. To shift the transmission to first, second, or third gear, rotate the knob to 1, 2, or 3.

The transmission has six forward gears and six reverse gears. To use the three low gears, put the Drive Axle switch at 4WD LO. To use the three high gears, put the Drive Axle switch at 2WD HI.

CAB OVERHEAD CONTROLS

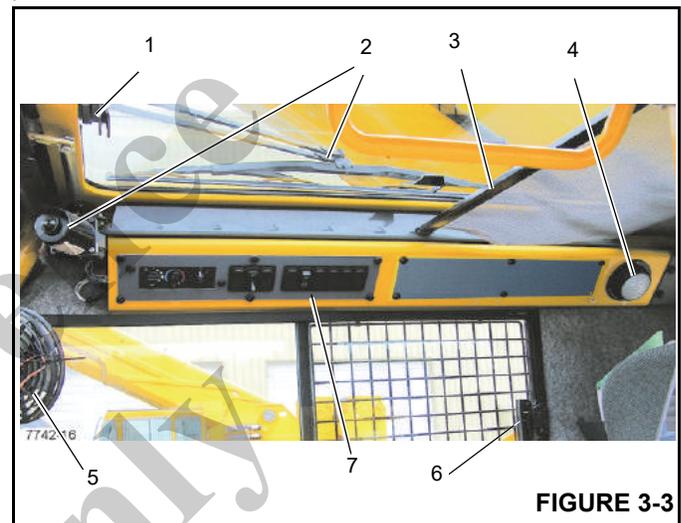


FIGURE 3-3

Item	Description
1	Skylight Window Latch
2	Skylight Wiper & Motor
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 the latch and slide the window to the rear to open. to close slide the 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.

CAUTION

Transmission Damage!

To prevent transmission damage: shift between two-wheel and four-wheel drive only with the crane stopped with the transmission in neutral or park.

Skylight Sunscreen

The Skylight Sunscreen (3, Figure 3-3) is used to diminish direct sunlight. The sunscreen is self retracting and can be set to screen all the light or adjusted rearward by moving it into the 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 the left front side of the 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

The window on the right side of the cab can be open. Squeeze latch (6, Figure 3-3) to release the window and slide forward. To close slide the window rearward until the latch engages.

OVERHEAD CONTROL PANEL

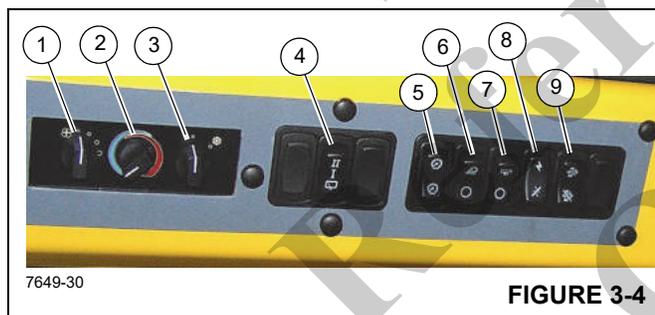


Figure 3-4 Item Numbers

Item	Description
1	Heater/Air Conditioner Fan Switch
2	Heater Control Switch
3	Air Conditioning Switch
4	Skylight Wiper Switch
5	Panel Dimmer Switch
6	Work Lights Switch
7	Boom Light Switch (Optional)
8	Crane Function Power Switch
9	DPF Regeneration Switch (Tier 4 engine only)

Heater/Air Conditioner Fan Switch

The Heater/Air Conditioner Fan Switch (1) (Figure 3-4) controls the cab fan's speed. Fan speed controls the volume of heated air output (or cooled air output) of the fan. Settings are off, low speed, medium speed, and high speed.

Heater Control Switch

The Heater Control Switch (2) (Figure 3-4) controls intensity of heating temperature. Turn the switch to the right (clockwise) to open the valve for heat. (Heat comes from heated fluid going through the heater coil.) Turn the switch to the left (counterclockwise) to close the valve to stop fluid flow and minimize heat.

Air Conditioner Switch

The Air Conditioning Switch (3) (Figure 3-4) controls the operation of the optional air conditioning system. Settings are off (O) and on (I).

Skylight Wiper Switch

The electrically-operated Skylight Wiper is installed to remove moisture from the skylight. The Skylight Wiper is controlled by the Skylight Wiper Switch (4) (Figure 3-4). This is a 3 position switch OFF/LOW speed/HIGH speed.

Panel Dimmer Switch

The Panel Dimmer Switch (5) (Figure 3-4) controls the lighting for the overhead heater/air conditioning controls and the Transmission Oil Temperature Gauge.(7) (Figure 3-3), push the switch to increase or decrease the panel lighting.

Work Lights Switch

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

Boom Lights Switch (Optional)

The Boom Lights Switch (7) (Figure 3-4) is located on the side display panel. This two-position rocker switch (ON/OFF) controls operation of the boom flood lights. Press the top of the switch to turn on the boom lights, press the bottom of the switch to turn the lights off.

Crane Function Power Switch

The Crane Function Power Switch (8) (Figure 3-4) is located on the side display panel. This two-position (ON/OFF) rocker switch permits the operator to disconnect power from the crane functions controlled by the hydraulic remote controllers on the armrests. Positioning the switch to OFF prevents inadvertent operation of functions due to bumping the controllers while roading or any other operation. With the

switch in the OFF position, operation of the high speed hoist is also prevented.

Hoist Rotation Indicator Display

The display is located in the front overhead panel Figure 3-9. Refer to *HRI Display*, page 3-14 for more information.

DPF Regeneration Switch (Tier 4 Engines Only)

! WARNING
Fire or Burn Hazard!

During the regeneration process the exhaust becomes very hot. Do not park the vehicle near flammable objects. Use caution near the exhaust tailpipe during regeneration as it will become very hot.

The Engine DPF (Diesel Particulate Filter) Switch (9) (Figure 3-4) is located on the right side of the overhead control panel. This switch is a three position switch, Inhibit Regen/Permit Regen/Start Regen. Press this switch to start engine regeneration or to disable regeneration:

- Start Regeneration  (7649-10)
- Inhibit Regeneration  (7649-11)

To manually regenerate, set the crane parking brake, the crane transmission must be in neutral and have all pedals released.

CAUTION

Avoid Crane Damage!

Do not engage the park brake while the vehicle is moving. Damage to the crane can occur. Disengage the park brake before driving. Damage to the crane can occur.

Set up a safe area around the crane's exhaust; remove tools, rags, grease or any debris from the engine exhaust area. As a warning, the light (1, Figure 3-5) below the exhaust pipe (2, Figure 3-5) will flash during regeneration.

With the engine idling push the DPF Regen Switch (9) to initiate regeneration.

Within 5 seconds the engine should rev up to 1000 to 1400 rpm. The engine will continue to run at this speed for up to 45 minutes.

Pressing the brake or throttle pedal during regeneration or activating the Inhibit Regen Switch will interrupt the regeneration process.

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

During this period the sound of the engine may change. When regeneration is complete the engine will return to its normal idle speed.



FIGURE 3-5

STEERING COLUMN INDICATOR AND GAUGE DISPLAY

As a system check, the indicators will come on for two seconds when the Ignition Switch is turned to the RUN position.

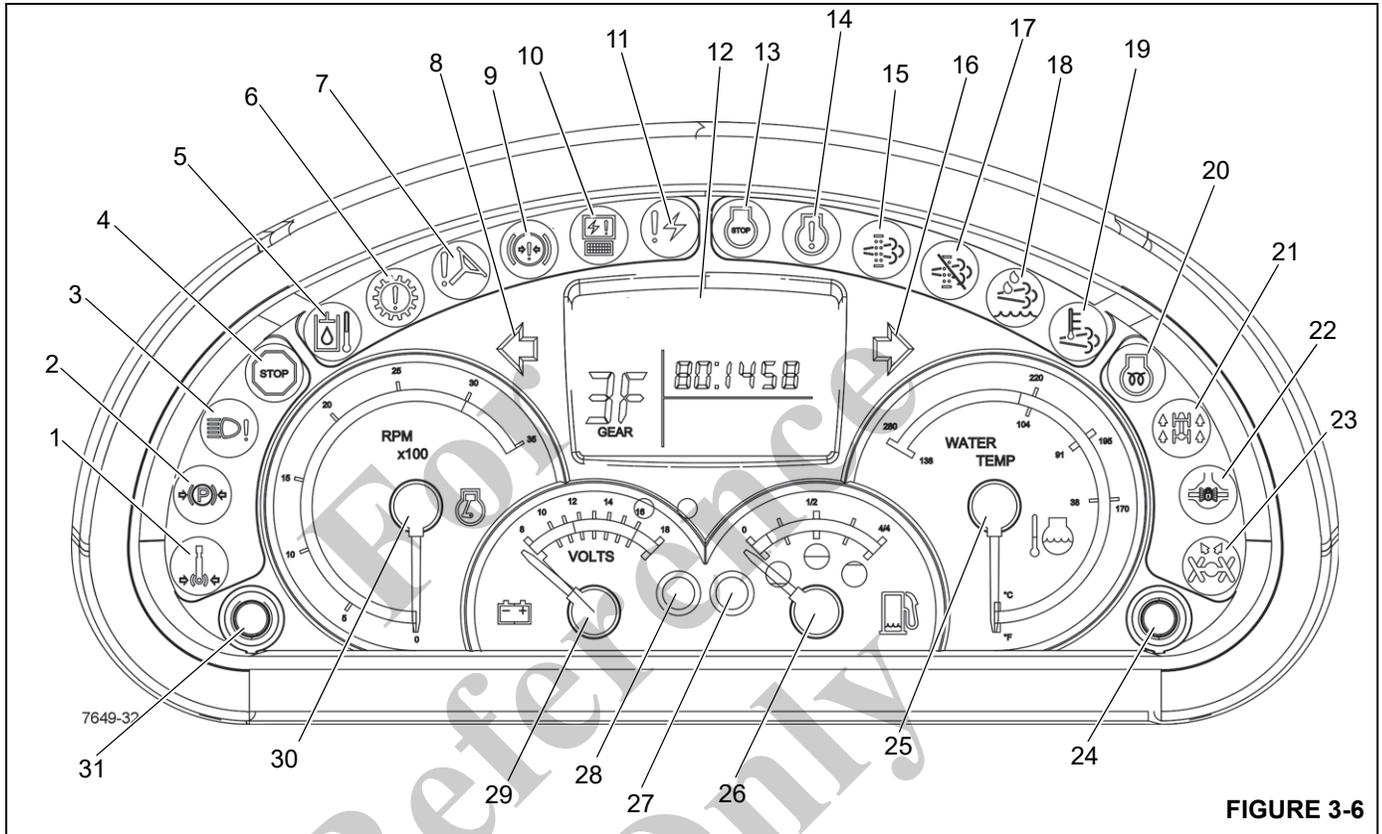


FIGURE 3-6

Figure 3-6 Item Numbers

Item	Description
1	Swing Brake Engaged
2	Parking Brake Engaged
3	Light Malfunction
4	Emergency Stop
5	Hydraulic Oil High Temperature
6	Transmission Warning
7	Low Steer Pressure
8	Left Turn Signal
9	Low Service Brake Pressure
10	Electronic Module Control
11	Electrical System Diagnostics
12	LCD Display
13	Engine Stop

Item	Description
14	Engine Warning
15	DPF, Regeneration Required
16	Right Turn Signal
17	Inhibit Regeneration
18	Not Used
19	High Exhaust System Temperature
20	Engine Wait to Start
21	Four-Wheel Drive Engaged
22	Axle Differential Locked
23	Rear Wheels Not Centered
24	Push Button Switch (not used)
25	Engine Coolant Temperature Gauge
26	Fuel Gauge
27	Low Fuel Level Indicator

Item	Description
28	Battery Charge Indicator
29	Voltmeter
30	Tachometer
31	Push Button Switch (not used)

Swing Brake Engaged

The Swing Brake Engaged Indicator (1) (Figure 3-6) is located in the steering column gauge display. It illuminates red when the Turntable Swing Motor Swing Brake is engaged preventing the rotation of the crane superstructure.

Parking Brake Engaged

The Parking Brake Engaged Indicator (2) (Figure 3-6) is located in the steering column gauge display. It illuminates red when the crane parking brake is engaged.

Light Malfunction

The Light Malfunction Indicator (3) (Figure 3-6) is located in the steering column gauge display. It illuminates amber when the crane headlights are malfunctioning.

Emergency Stop

The Emergency Stop Indicator (4) (Figure 3-6) is located in the steering column gauge display. It illuminates red when the Emergency Stop Switch is pushed in (refer to *Emergency Stop Switch*, page 3-15) and a warning buzzer will sound.

Hydraulic Oil High Temperature

The Hydraulic Oil High Temperature Indicator (5) (Figure 3-6) is located in the steering column gauge display. It illuminates red when the hydraulic oil temperature exceeds 200°F (93°C); a warning buzzer will also sound. When this indicator illuminates, set down the load as soon as possible, turn off the engine and try to find the cause of the high hydraulic oil temperature.

Transmission Warning

The Transmission Warning Indicator (6) (Figure 3-6) is located in the steering column gauge display. It illuminates red during high transmission oil temperature conditions. A warning buzzer will also sound.

Low Steer Pressure (Optional on CE Units)

The Low Steer Pressure Indicator (7) (Figure 3-6) is located in the steering column gauge display. It illuminates red when the hydraulic pressure is low. A warning buzzer will also sound.

Left Turn Signal Indicator

The Left Turn Signal Indicator (8) (Figure 3-6) is located in the steering column gauge display. It is a green arrow light that flashes when the turn signal lever is pushed down or the HAZARD light switch is positioned to ON.

Low Service Brake Pressure

The Low Service Brake Pressure Indicator (9) (Figure 3-6) is located in the steering column gauge display. It illuminates red when the pressure in the dual accumulator charge valve falls below normal operating requirements. A warning buzzer will also sound.

Electronic Module Indicator

The Electronic Module Indicator (10) (Figure 3-6) is located in the steering column gauge display. If any of the electronic modules are off-line and not communicating with the system the indicator illuminates red.

Electronic System Diagnostic

The Electronic System Diagnostic Indicator (11) (Figure 3-6) is located in the steering column gauge display. The indicator is a red light that is used for troubleshooting the CANBUS system.

LCD Display

The LCD Display(12) (Figure 3-6) is located in the steering column gauge display. The display shows the transmission gear being used, fault codes, and master software version.

If an active engine fault code is present, the display will show the code when the Ignition Switch is in the RUN position and the engine is off. The display will show the master software version when the Ignition Switch is in the ACC position.

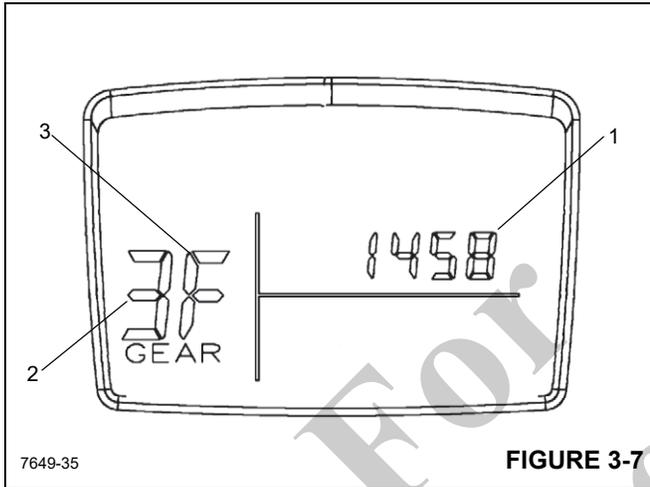


FIGURE 3-7

Figure 3-7 Item Numbers

Item	Description
1	Engine Fault Code, Master Software Version
2	Transmission Gear Selected
3	Forward or Reverse

Engine Stop

The Engine Stop Indicator (13) (Figure 3-6) is located in the steering column gauge display. It illuminates red when a signal is sent from the engine ECM. In addition, a warning buzzer will also sound.

If this indicator light illuminates, note the fault code, shut the engine off and refer to the Engine Operator Manual.

Engine Warning

The Engine Warning Indicator (14) (Figure 3-6) is located in the steering column gauge display. It illuminates amber when a signal is sent from the engine ECM.

If this indicator light illuminates, note the fault code and see Engine Operator Manual.

The Engine Warning Indicator may also illuminate with the Diesel Particulate Filter Indicator or Diesel Exhaust Fluid Indicator.

Diesel Particulate Filter (Tier 4 Engines Only)

The Diesel Particulate Filter (DPF) Indicator (15) (Figure 3-6) is located in the steering column gauge display. This indicator illuminates amber when the diesel particulate filter is getting filled with soot and needs to be cleaned out.

When the DPF indicator illuminates or flashes, start regeneration process.

The indicator will be lit continuously during the early stages of clogging. If the system continues to clog, the lamp will begin to flash and slight engine derate will occur.

If even more clogging occurs, the engine warning light (14) will illuminate in addition to the DPF indicator (15) and severe engine derate will occur.



WARNING Extreme Heat Hazard!

During the regeneration process the exhaust becomes very hot. Do not park the vehicle near objects that are flammable.

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

The regeneration process can take place in three different modes:

Passive: the exhaust is hot enough during normal working operation to burn off any hydrocarbon (soot) accumulation

Active: Active self-regeneration 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 all done without any operator intervention.

Manual: Manual or stationary, regeneration is the same as active regeneration but takes place while the equipment is not being operated. It offers the equipment operator the option, if needed, of performing regeneration outside the normal duty cycle.

Right Turn Signal Indicator

The Right Turn Signal Indicator (16) (Figure 3-6) is located in the steering column gauge display. It is a green arrow light that flashes when the turn signal lever is pushed up or the Hazard Light switch is positioned to ON.

Inhibit Regeneration

The Inhibit Regeneration Indicator (17) (Figure 3-6) is located in the steering column gauge display. When the Regen Switch (9) (Figure 3-4) is in the inhibit regeneration position, this amber indicator is illuminated and active and manual regeneration is prevented.

Diesel Exhaust Fluid (Tier 4 Engines—2014 and Later Only)

The Diesel Exhaust Fluid (DEF) Indicator (18) (Figure 3-6) is located in the steering column gauge display. The indicator has four different stages which will be triggered by the fluid level sensor in the DEF tank:

Low Tank - First warning to the operator is that the reducing agent in the tank is low. The DEF Indicator (18) will be lit continuously.

Derate - The DEF Indicator (18) will start to flash as a warning to the operator that a derate will be activated if the reducing agent in the DEF tank is not refilled.

Low Level Inducement - The DEF Indicator (18) will flash and the engine warning indicator (14) will be lit continuously. Derate will be activated at this stage.

Severe Inducement - Once the DEF (18) tank is empty, the crane operation will be restricted. The DEF Indicator (18) will flash and the Stop Engine Indicator (13) is solid red.

High Exhaust System Temperature

The High Exhaust System Temperature (HEST) Indicator (19) (Figure 3-6) is located in the steering column gauge display.

During regeneration it is possible for the engine exhaust to reach temperatures exceeding 1200° F. The HEST indicator will illuminate red to warn the operator of when temperatures reach 675°C (1247°F) and will stay on until the temperatures falls below 625°C (1157°F).

Warning lights near the tailpipe will flash during regeneration when high exhaust temperatures exist.

For more information on the regeneration process, refer to *Diesel Particulate Filter (Tier 4 Engines Only)*, page 3-9

Engine Wait-to-Start

The Engine Wait-to-Start Indicator (20) (Figure 3-6) is located in the steering column gauge display. It illuminates

amber for a period of time when the ignition switch is in the ON position. The engine should not be cranked until the Wait-To-Start light turns off. This light is controlled by the engine ECM.

Four-Wheel Drive Engaged

The Four-Wheel Drive Indicator (21) (Figure 3-6) is located in the steering column gauge display. It illuminates amber when the Drive Axle Selector Switch (5) (Figure 3-2) is in the four-wheel low position. This indicator will also blink if the crane is shifted between two-wheel high and four-wheel low and the brake pedal is not depressed and the transmission is not in neutral.

Axle Differential Locked

The Axle Differential Locked Indicator (22) (Figure 3-6) is located in the steering column gauge display. This indicator illuminates amber after the Differential Lock Switch (10) (Figure 3-8) is pressed to the LOCK position and the carrier differential lock switches located on each axle are closed. When in the LOCK position there is no differential action between the wheels.

Rear Wheels Not Centered Indicator

The Rear Wheels Not Centered Indicator (23) (Figure 3-6) is located in the steering column gauge display. The indicator is an amber light that will illuminate any time the rear wheels are not centered.

Engine Coolant Temperature Gauge

The Engine Coolant Temperature (water temp) Gauge (25) (Figure 3-6) is located in the steering column gauge display. The gauge indicates the engine coolant temperature on a dual scale calibrated from 38 to 138°C and 100 to 280°F. The gauge receives a signal from the engine ECM and a temperature sending unit in the engine cooling system.

Fuel Gauge

The Fuel Gauge (26) (Figure 3-6) is located in the steering column gauge display. The gauge indicates the quantity of fuel in the fuel tank and has a scale calibrated from zero [0] to 4/4. The fuel gauge receives a signal from a sending unit in the fuel tank.

CAUTION

Engine Damage Hazard!

Ultra low sulfur diesel fuel required in Tier 4 engines.

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

Low Fuel Level

The Low Fuel Level Indicator (27) (Figure 3-6) illuminates when the fuel level in the tank is nearing empty (15%). When this indicator comes on fuel should be added to the fuel tank immediately. The light will go out when the fuel tank level reaches 20% of capacity.

Battery Charge Indicator

With the engine running, the Battery Charge Indicator (28) (Figure 3-6) illuminates red if battery system voltage is below nine (9) volts, engine ECM voltage is below 9 volts, or there is no alternator charge signal present.

If the engine is running and the Battery Charge Indicator illuminates, investigate possible alternator, alternator fuse, or alternator wiring problems.

When the engine is not running and the Ignition Switch is in the ACC or RUN position, the Battery Charge Indicator turns

on to indicate the batteries are being drained and not being charged.

Voltmeter

The Voltmeter (battery gauge) (29) (Figure 3-6) is located in the steering column gauge display. The Voltmeter indicates the voltage being supplied to or from the batteries and has a scale of 8 to 18 volts.

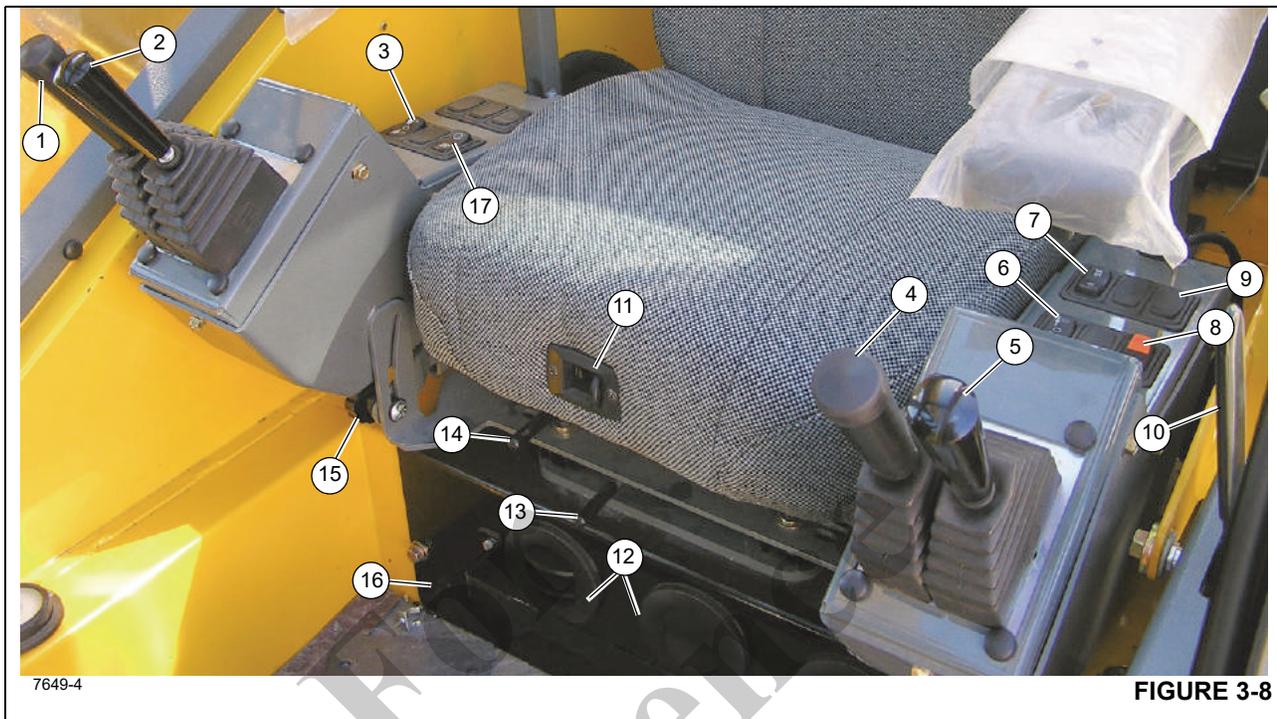
If the Ignition Switch is in the ACC or RUN position and the Voltmeter indicator is in the red, the batteries may need to be recharged or possibly replaced.

Tachometer

The Tachometer (30) (Figure 3-6) is located in the steering column gauge display. The tachometer registers engine rpm and is calibrated in rpm x 100 with a range of zero [0] to 35. The tachometer receives a signal from the engine ECM.

For
Reference
Only

CONTROL SEAT ASSEMBLY (SINGLE AXIS)



7649-4

FIGURE 3-8

Figure 3-8 Item Numbers

Item	Description
1	Main Hoist Control, Raise/ Lower
2	Boom Lift Control
3	Main Hoist Speed Switch
4	Boom In/Out (Auxiliary Hoist Raise/Lower)
5	Swing Control, Left/Right
6	Auxiliary Hoist Speed Switch
7	Rear Steer Switch
8	Swing Brake Control Switch
9	Axle Differential Lock Control Switch
10	Cab Door Release
11	Seat Back Adjustment
12	AC/Heater Vents
13	Seat Slide Lever
14	Whole Seat Slide Lever
15	Arm Rest Adjustment
16	AC/Heater Climate Control Unit
17	Hydraulic Boost Switch

Main Hoist Control (Single Axis Option)

The Main Hoist Control (1) (Figure 3-8) is located on the right armrest. The joystick, when placed forward, lowers the cable. When placed back, it raises the cable.

Boom Lift Control (Single Axis Option)

The Boom Lift Control (2) (Figure 3-8) is located on the right armrest. The joystick, when positioned forward lowers the boom or back raises the boom.

Boom Lift and Main Hoist Control Lever (Dual Axis Option — Not Shown)

The Boom Lift/main Hoist Control Lever is located on the right armrest. The controller, when pushed to the right lowers the boom or left raises the boom.

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

Main Hoist Speed Selector Switch

The Main Hoist Speed Selector Switch (3) (Figure 3-8) is a three positioned maintained switch (High/Off/Low) that is located on the right armrest. Positioning the switch to high position allows main hoist functions and energizes the Main Hoist High Speed Solenoid, resulting in high line speeds. Positioning the switch to the center off position will prevent hoisting. Positioning the switch to the low position allows

main hoist functions and de-energizes the Main Hoist High Speed Solenoid, resulting in low line speeds.

Telescope or Auxiliary Hoist Control (Single Axis Option)

The Telescope or Auxiliary Hoist (TELE or AUX) Control (4) (Figure 3-8) 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 any other function, sound horn and verify that all personnel are clear of rotating and moving parts.

The Swing Control joystick (5) (Figure 3-6) 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.

Swing and Telescope or Swing and Auxiliary Hoist Control Lever (Dual Axis Option—Not Shown)



DANGER Crushing Hazard!

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

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

The Swing and Telescope or Auxiliary Hoist (SWING/TELE or SWING/AUX) control lever is located on the end of the left armrest. The lever controls the swing and telescope

functions when the crane is not equipped with an auxiliary hoist. When equipped with an auxiliary hoist, the lever controls swing and auxiliary hoist functions and 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.

Auxiliary Hoist Speed Selector Switch (Optional)

The Auxiliary Hoist Speed Selector Switch (6) (Figure 3-8) is a three positioned maintained switch (High/Off/Low) that is located on the left armrest. Positioning the switch to high position allows auxiliary hoist functions and energizes the Auxiliary Hoist High Speed Solenoid, resulting in high line speeds. Positioning the switch to the center off position will prevent hoisting. Positioning the switch to the low position allows auxiliary hoist functions and de-energizes the Auxiliary Hoist High Speed Solenoid, resulting in low line speeds.

Rear Steer Switch

The Rear Steer Control Switch (7) (Figure 3-8) is a three-position, spring centered to off, rocker switch, located on the left armrest. Press the bottom of the switch to actuate a control valve to turn the rear wheels to the left, causing the crane to turn to the right. Press the top of the switch actuates a control valve to turn the rear wheels to the right, causing the crane to turn to the left. When the wheels are not centered the Rear Wheels Not Centered light on the steering column illuminates. Releasing the switch causes it to return to the center off position.

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

Swing Brake Control Switch

The Swing Brake Control Switch (8) (Figure 3-8) 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. Positioning the switch to ON will apply the swing brake and positioning the switch to OFF will release the swing brake. When the switch is in the ON position, the red indicator light on the steering column is illuminated. The switch has a lock to prevent accidental activation.

Axle Differential Lock Control Switch (Optional)

NOTE: The differential lock will only work when the crane is in the 4WD mode.

The Differential Lock (Axle Diff) Control Switch (9) (Figure 3-8) is located on the left arm rest. It is a two position, momentary rocker switch placarded LOCK and UNLOCK. When positioned to LOCK, the splines on the shift collar are engaged with the splines on the differential case and the axle shafts and the differential assembly are locked together and there is no differential action between the wheels. When positioned to UNLOCK, there is normal differential action between the wheels all the time. The amber indicator on the steering column is illuminated when the switch in each axle is activated.

Cab Door Release

Use the Cab Door Release Lever (10) (Figure 3-8) to open and close the cab door from inside the cab.

Seat Back Adjustment

To adjust the back of the seat press the adjustment knob (11) (Figure 3-8) and then adjust the seat as needed.

A/C Heater, Climate Control

The crane cab Air Conditioner/Heater Climate Control unit (16) (Figure 3-8) is located in the cab under the driver's seat. The vents (12) are part of the climate control unit and can be adjusted to direct the flow of air.

Seat Slide Lever

Moving the Seat Slide Lever (13) (Figure 3-8) will slide the seat only, either forward or backward.

Seat Frame Slide Lever

Moving the Seat Frame Slide Lever (14) (Figure 3-8) will slide the seat and the seat frame either forward or backward.

Armrest Adjustment

The Armrest and armrest controls can be adjusted using adjustment knob (15) (Figure 3-8). Loosen the knob and rotate the entire armrest to the desired position, retighten the knob when finished making the adjustment.

Hoist Rotation Indicators

The Hoist Rotation Indicators for the auxiliary and main hoist is located on top of each hoist control lever (1,4) (Figure 3-8). Each indicator is electronically driven by an input signal from a sensor attached to its related hoist and an output signal from a control module. Each hoist control lever (1,4) pulses when its hoist is running so the operator's thumb can sense it.

HRI Display

The display is located in the front overhead panel (Figure 3-9). The LED display illuminates to indicate the current hoist in operation and which direction the hoist is rotating.

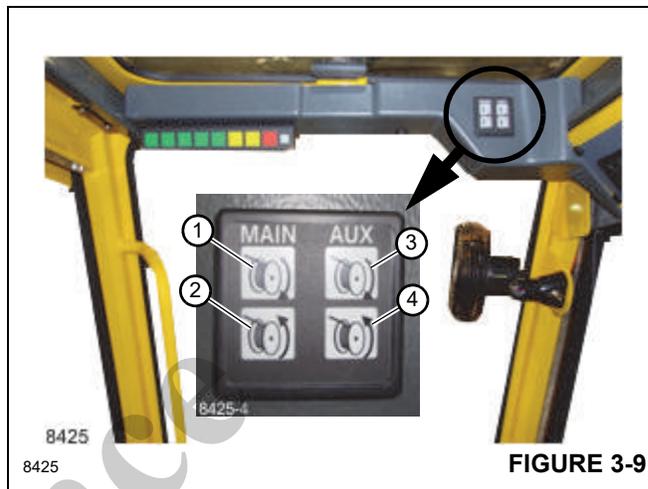


Figure 3-9 Item Numbers

Item	Description
1	Main Hoist UP (Clockwise)
2	Main Hoist Down (Counterclockwise)
3	Auxiliary Hoist UP (Clockwise)
4	Auxiliary Hoist DOWN (Counterclockwise)

Hydraulic Boost Switch

The Hydraulic Boost Switch (17) (Figure 3-8) is located on the right armrest. This two position switch is used to control the High Speed Boost Selector Valve. With the switch in the ON position, the solenoid valve is energized. In this state, the solenoid valve stops the flow of oil from Pump No. 1, Section 2 to the Rear Steer/Outrigger Valve. The poppet check valve opens to combine this flow of oil with the output from Pump No. 1, Section 1.

NOTE: The hydraulic boost function is disabled when outrigger extend or retract is selected, rear steer right or left is selected, or when the transmission is not in neutral.

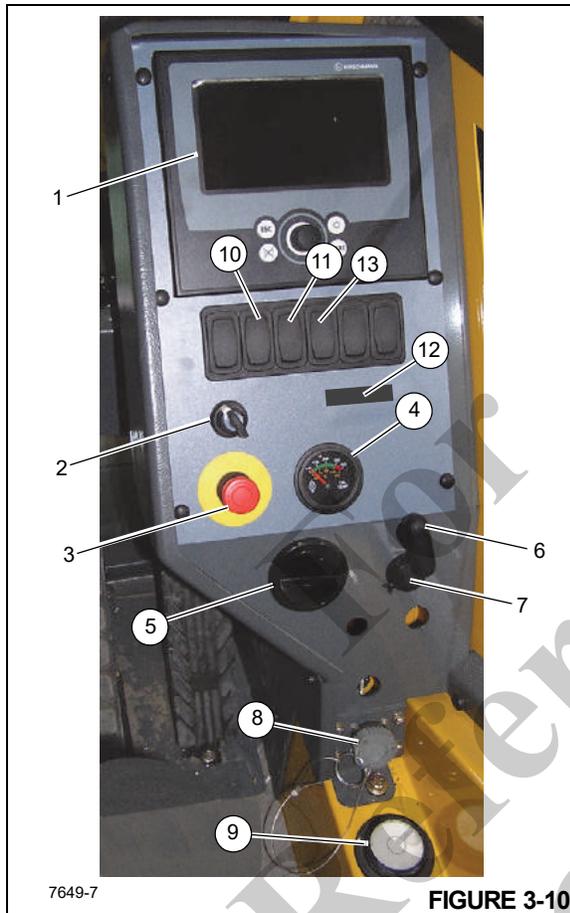
Armrest Switch (Not Shown)

The Armrest Switch is a proximity switch located in the lefthand armrest. The lefthand armrest must be in the down position before crane functions can be activated.

Seat Switch (Not Shown)

This switch is located in the seat. An operator must be sitting in the seat before the crane functions can be activated.

SIDE CONTROL PANEL



7649-7

FIGURE 3-10

Figure 3-10 Item Numbers

Item	Description
1	Rated Capacity Limiter (RCL) Display
2	Rated Capacity Limiter (RCL) Bypass Switch
3	Emergency Stop Switch
4	Transmission Oil Temp Gauge
5	AC/Heater Vent
6	Turntable Pin Swing Lock Control
7	12 Volt Receptacle
8	Diagnostic Connector
9	Bubble Level Indicator
10	3rd Wrap Indicator (optional)
11	Cold Weather Temperature Indicator (optional)

Item	Description
12	Ambient Temperature LED Indicator (optional)
13	Telescope Cylinder Charge Indicator (If Equipped)

Rated Capacity Limiter (RCL) and Work Area Definition System Control Panel

The RCL and Work Area Definition System Control Panel (1) (Figure 3-10) is located on the right side of the cab. It maintains the controls and indicators for the crane's Rated Capacity Limiter (RCL) System and Work Area Definition System. Refer to the RCL Manual for detailed information.

Rated Capacity Limiter (RCL) Bypass Switch

The RCL Bypass (Override) Switch (2) (Figure 3-10) is a momentary type switch. Turn and hold the key to the ON position (right) to disengage the RCL controls. Release the key to allow the RCL controls to re-engage.

The RCL will be bypassed only as long as the switch is in the ON position.

Turning the key switch to the ON position re-engages the boom down, telescope out and winch up functions, which are disabled when an overload condition is sensed by the Rated Capacity Limiter (RCL). It is important to read and understand the RCL Override Warning information in the RCL Operator Manual before using the RCL Bypass switch (2) or the RCL on/off switch.

Emergency Stop Switch

The crane Emergency Stop Switch (3) (Figure 3-10) is located on the cab 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 indicator on the steering column. Rotate the knob and pull out to resume normal operation.

Transmission Oil Temperature Gauge

The Transmission Oil Temperature (TRANS TEMP) Gauge (4) (Figure 3-10) is located in the center of the front console to the left of the steering column. The gauge indicates the transmission oil temperature on a dual scale calibrated from 60 to 160°C and 140 to 320°F. The gauge receives a signal from a temperature sending unit in the oil line at the torque converter.

Turntable Pin Swing Lock Control

The Turntable Pin Swing Lock Control Handle (6) (Figure 3-10) is located beside on the side control panel. The purpose of the pin swing lock is to lock the superstructure in position directly over the front for pick and carry loads.

When the control handle is pushed in and the superstructure is directly over the front, the swing lock pin drops into the socket on the carrier frame, locking the superstructure in place.

When the control handle is pulled out, the pin is pulled out of the socket, unlocking the superstructure.

CAUTION

Swing Lock Damage!

Do not engage the Pin Swing Lock while superstructure is in motion. Center boom over the front and engage Pin Swing Lock to prevent superstructure rotation during travel.

12V Receptacle

This 12 volt accessory outlet (7) (Figure 3-10) is located on the lower part of the control panel and is designed to mate with most 12 volt adapter plugs.

Diagnostic Connector

The Diagnostic Connector (8) (Figure 3-10) is located on the lower part of the front control panel. It is used for servicing the crane's electrical system.

A laptop computer with a nine pin cable connector and the appropriate service software are required. Contact your local Grove distributor or Manitowoc Crane Care for assistance.

Bubble Level Indicator

The Bubble Level Indicator (9) (Figure 3-10) is located on the left side of the cab by the door latch plate. The indicator provides the operator with a visual aid in determining the levelness of the crane.

Hoist Third Wrap Indicator (Optional—Standard on CE)

The Hoist 3rd Wrap Indicator (10) (Figure 3-10) is located on the right side console. The indicator will illuminate red when three wraps or less of cable remains on either hoist.

Cold Weather Indicator (Optional)

The optional Cold Weather Indicator (11) (Figure 3-10) is located on the right side console. The indicator comes on when ambient temperature is at or below -29°C (-20°F). It serves as a warning for the operator to stop operation in extreme cold.

Telescope Cylinder Charge Indicator (If Equipped)

The Telescope Cylinder Charge Indicator (13, (Figure 3-10)) is located on the right side control panel and is part of the telescope cylinder charge system. The telescope cylinder charge system is designed to prevent boom retraction due to thermal contraction under the following operating conditions: If the crane is operated with a long boom length and low boom angle, and the hydraulic oil in the telescope cylinders cools and contracts, the friction forces in the extended boom will prevent the boom from retracting. Then, if the operator begins to elevate the boom without telescoping out slightly, the crane may reach a boom elevation angle where the weight of the boom sections and load overcomes the friction forces in the boom sections, causing the boom to retract until the column of oil inside the cylinders once again supports the boom sections. The telescope cylinder charge system will prevent the boom from retracting under these conditions by automatically replenishing the volume of hydraulic oil lost in the telescope cylinders due to thermal contraction.

The telescope cylinder charge system operates automatically and does not require any operator input. The indicator illuminates amber and the buzzer sounds (2, (Figure 3-13)) when the boom is elevated above 35° and the telescope cylinder charge system is not functioning properly. If the buzzer sounds and the indicator illuminates, the operator should immediately telescope out slightly to manually charge the telescope cylinders, stop operation, then have the system repaired as necessary.

NOTE: The telescope cylinder charge system does not prevent thermal contraction of hydraulic oil due to a drop in temperature and will only prevent boom retraction when the crane's engine is running and the boom angle is greater than 35°. The system is designed only to prevent boom retraction that may occur due to thermal contraction under the operating conditions previously described.

Ambient Temperature LED Indicator

The Ambient Temperature LED Indicator (12) (Figure 3-10) is located on the right side console. When the ambient temperature outside the crane reaches below -29°C (-20°F) the LED indicator will illuminate and send a signal to the RCL system. This temperature control is to prevent operation of crane lifting functions in temperatures below -29°C (-20°F). The system will initiate lockout of the following crane functions: hoist up, boom down, and boom telescope-extend. Hoist lowering, boom up and boom telescope-retract along with lockout override, will still be operational to lower the load.

OUTRIGGER CONTROL

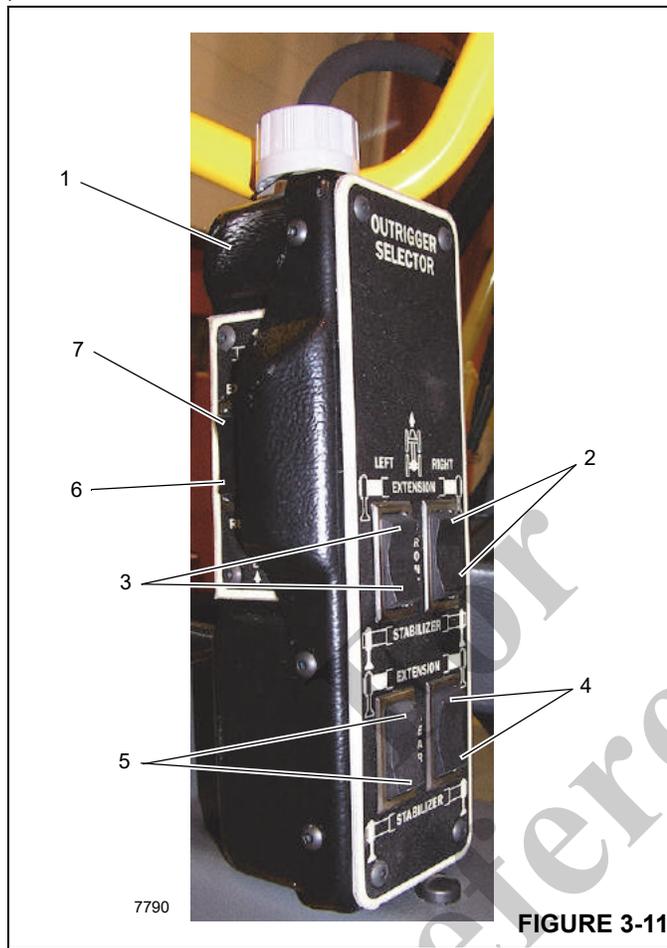


FIGURE 3-11

Item	Description
1	Outrigger Control Box
2	Right Front Extension/Jack Cylinder
3	Left Front Extension/Jack Cylinder
4	Right Rear Extension/Jack Cylinder
5	Left Rear Extension/Jack Cylinder
6	Retract O/R
7	Extend O/R

The Outrigger Control Box (1, Figure 3-11) is stowed in the cab (Figure 3-1) and is used to control the outriggers from inside the cab.

NOTE: The park brake must be engaged for the outriggers to operate.

Extend/Retract Switch

The Extend/Retract Switch (6,7 Figure 3-11) is located on the side of the Outrigger Control Box and is used in

conjunction with the Outrigger Selector Switches (2,3,4,5 Figure 3-11) to control the outrigger functions.

Outrigger Selector Switches

There are four Outrigger Selector Switches (2,3,4,5 Figure 3-11) on the Outrigger Control Box. To extend or retract an outrigger component, first select the component with the Outrigger Selector Switch (2,3,4,5), then select extend or retract with the Extend/Retract Switch (6,7 Figure 3-11).

FOOT PEDAL CONTROLS

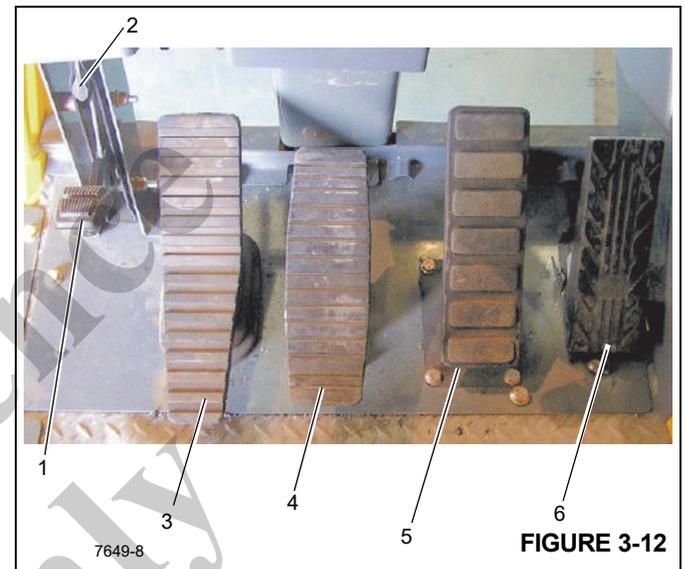


FIGURE 3-12

Figure 3-12 Item Numbers

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

360° Swing Lock Pedal

The 360° Swing Lock Pedal (1) (Figure 3-12) is located on the left side of the crane cab floor. The pedal is used to activate the swing lock to prevent the turret from turning. To release the swing lock, pull up on the 360° Swing Lock Release Lever (2).

Swing Brake Pedal

The Swing Brake Pedal (3) (Figure 3-12) is located on the left side of the cab floor. The swing brake pedal is used to

actuate the swing brake to slow or stop swing motion. Braking is proportional to pedal depression. With the pedal not depressed and the swing brake control valve disengaged, hydraulic pressure is applied to the brake, overcoming spring pressure and releasing the brake. Depressing the pedal actuates a swing power brake valve to apply pressure to the brake assembly. This pressure aids the spring pressure to overcome the hydraulic pressure being applied to the brake release circuit and applies the spring brake according to the pressure from the swing power brake valve.

Telescope Control Foot Pedal (Optional)

The Telescope Control Foot Pedal (4) Figure 3-12 is supplied when the crane is equipped with an auxiliary hoist, is located on the left side of the cab floor. Pushing forward on the top of the pedal will extend the boom and pushing down on the bottom of the pedal will retract the boom.

Service Brake Foot Pedal

The Brake Foot Pedal (5) (Figure 3-12) is the second pedal from the right on the cab floor. Depressing the pedal controls the application of the service brakes.

Foot Throttle Pedal

The Foot Throttle Pedal (6) (Figure 3-12) is located under the RCL display module, on the floor. It is used to control 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 Panel

The fuse panel (1) (Figure 3-13) is located behind the cab seat and on the cab fuse and relay panel assembly. It contains up to 20 fuses that protect the various electrical components of the crane.

Buzzer

The buzzer (2), located behind the cab seat, sounds when the following conditions exist:

- the ignition switch is turned to RUN; buzzer will sound for two seconds

- after the engine is started until the proper hydraulic oil pressure is reached
- engine stop
- emergency stop switch activated
- transmission service
- 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)

Rated Capacity Limiter (RCL) Emergency Override Switch (Non-CE Certified Cranes)



WARNING

Loss of RCL Monitoring Hazard!

The RCL Emergency Override switch is to be used in emergency situations only.

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

The RCL system, when programmed accurately, will lockout the three craning functions—boom 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 three functions prevents the overload or two-block condition from worsening.

The RCL emergency override switch (3, Figure 3-13) is a key operated switch that is located inside the operator's cab on the panel assembly behind the seat. When actuated (turned clockwise), the switch will override and prevent the RCL from locking out the three craning functions (boom down, telescope extend, and hoist up) should an overload or two-block condition occur.

Overriding the RCL with this switch should only be done in the case of an emergency or when servicing the boom.

A flashing light on the RCL display indicates the switch has been activated.

Refer to the *RCL Operator Manual* for more information.

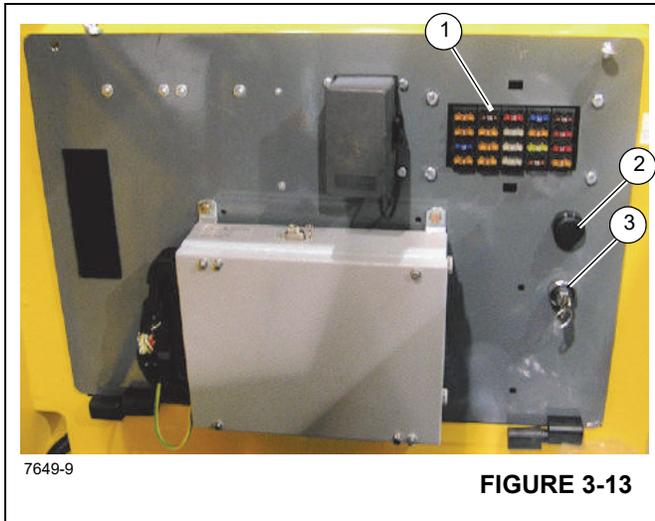


FIGURE 3-13

Figure 3-13 Item Numbers

Item	Description
1	Fuse Panel
2	Buzzer
3	Rated Capacity Limiter (RCL) Emergency Override Switch

Rated Capacity Limiter (RCL) Emergency Override Switch and Indicator (CE Certified Cranes)



WARNING

Loss of RCL Monitoring Hazard!

The RCL Emergency Override Switch is to be used in emergency situations only.

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

The RCL system, when programmed accurately, will lockout the three craning functions—boom 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 three functions prevents the overload or two-block condition from worsening.

The RCL emergency override switch is located inside a key-locked single-door enclosure (1, Figure 3-14) that is attached to the outside rear of the operator's cab. The switch is a two-position momentary rocker switch with integral indicator that, when actuated, will override and prevent the RCL, for a period of 30 minutes, from locking out the three craning functions (boom down, telescope extend, and hoist up) should an overload or two-block condition occur.

Overriding the RCL with this switch should only be done in the case of an emergency or when servicing the boom.

The indicator in the override switch will illuminate red and the RCL and A2B override indicators on the RCL display will flash to indicate the switch has been activated. Upon activation, all craning function movements are reduced to 15% of their normal maximum speeds.

The RCL override function is automatically cancelled after 30 minutes. The RCL override function can also be cancelled by the operator by either pressing the RCL emergency override switch a second time, by turning off the engine, or by turning the crane function power switch off.

Refer to the *RCL Operator Manual* for more information.

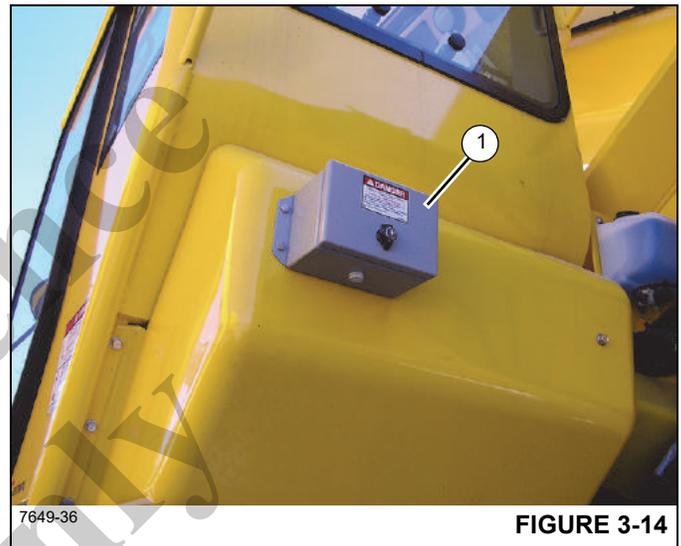


FIGURE 3-14

Rated Capacity Limiter (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 over hoist conditions that could cause damage to equipment and personnel.

Strobe Light or Beacon (Optional) (Not Shown)

The strobe light or beacon is on the roof of the cab. It is on when the ignition switch is on.

Backup Alarm (Not Shown)

The backup alarm is an audio system used to warn personnel outside the crane when the crane is backing up. The alarm system is electrical and consists of the backup alarm and its associated wiring. The alarm is connected to the electrical wiring for the transmission reverse solenoids. It is activated when the transmission shifter is in the reverse

position. The backup alarm is installed in the rear outrigger box behind the grill plate.

Emergency Exit

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

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 safety of operation. Refer to the 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.

Check the following items to make sure that the crane is prepared for starting the day's work.

Fuel Supply

Check the fuel level and make sure the cap is on tight.

Engine Oil

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

Engine Coolant

Check the coolant level in the radiator surge tank sight gauge and fill to the proper level. Do not overfill. Check to make sure the radiator and reservoir caps are secure.

Batteries

Check that the battery cables and clamps are tight and not corroded.

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.

Foot and Parking Brakes

Check the foot and parking brakes for proper operation.

Daily Lubrication

Make certain that all components requiring daily lubrication have been serviced. (Refer to Section 5, Lubrication.)

Hydraulic Reservoir and Filter

Check hydraulic fluid quantity level and filter condition indicator. Check breather for cleanliness and ensure it is secure.

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 Book* in the crane cab.

Wire Rope

Inspect wire rope in accordance with applicable Federal Regulations.

Inspect sheaves, guards, guides, drums, flanges, and any other surfaces that may come in contact with the rope for any condition that could cause possible damage to the rope.

Wire rope replacement should be determined by the following information excerpted from a National Consensus Standard as referenced by Federal Government Agencies and as recommended by Grove. All wire rope will eventually deteriorate to a point where it is no longer usable. Wire rope shall be taken out of service when any of the following conditions exist:

Kinking, crushing, birdcaging, or any other damage resulting in distortion of the rope structure.

- Evidence of any heat damage from any cause.
- Reductions from nominal diameter of more than 5%.
- In running ropes, six randomly distributed broken wires in one lay or three broken wires in one strand in one lay.
- In standing ropes, more than two broken wires in one lay in sections beyond end connections or more than one broken wire at an end connection.
- In rotation resistant rope, two randomly distributed broken wires in six rope diameters or four randomly distributed broken wires in 30 rope diameters.
- Severe corrosion as evidenced by pitting.
- Grove recommends that for cable extended booms, a single damaged wire rope assembly shall require replacement of the entire set of extension cables.
- Grove recommends for cable extended booms, that boom extension cables be replaced every seven (7) years.

Hook Block

Visually inspect for nicks, gouges, cracks, and evidence of any other damage. Replace any hook that contains cracks or shows evidence of excessive deformation of the hook opening, including twist. Be sure the safety latch is free and aligned.

Air Cleaner

Check the filter restriction indicator. Check filter and tubing for security.

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 that cranes being operated in very cold temperatures are operated and maintained in accordance with the procedures as provided by Grove. Therefore, always ensure adequate lubrication during system warm-up and proper operation of all crane functions 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, (Refer to *Arctic Lubricants and Conditions*, page 5-3.) If in doubt of the suitability of 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 sub-zero temperatures.

Grove recommends the crane is equipped with the following cold weather accessories:

Down to -29°C (-20°F) Package

- Battery heater
- Fuel 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 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.

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 the heater can be operated at the current site of the crane. There is a danger of explosion when using the heater around combustible objects! Do not park the vehicle near objects that are flammable.

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

NOTE: Operation of the heater is not permissible:

- 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 the heater in enclosed spaces (example: garages).

To activate the heater, ensure the fuel supply valve from the heater fuel reservoir is turned to the ON position. Ensure the 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 the system is activated. The start-up and shutdown cycles may take approximately 2 minutes for initialization. Ensure the coolant, transmission heater, swivel, battery heater, in-line fuel pump, in-line fuel heater, and hydraulic reservoir heater are heating properly.

To de-activate the heater, push the button at the heater control panel. The green light will turn off indicating the system is de-activated. The shutdown cycle may take approximately 2 minutes.

NOTE: Accelerated discharging of battery will occur when the crane engine is switched off. If you run the heater while the crane engine is stopped, the batteries voltage will need to be recharged after short periods of time.

Radiator Shutters

When starting the engine the shutters on the radiator will close and will open when the coolant temperature reaches 71°C (160°F).

Auxiliary Cab Heater

The superstructure crane cab is heated with an auxiliary air heating system that runs independently of the engine. The 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 the temperature control switch mounted in the overhead panel. The fan for the heating system delivers warm air into an air distribution box. The air is circulated according to the setting of the controls and then delivered into the crane cab by a fan through the various air extraction and air delivery vents. Do not cover the vents with bags, articles of clothing or any other objects. Keep the hot air inlet and hot air outlet free of dirt and foreign bodies. Soiled or blocked hot air lines may cause overheating, and result in damage. The crane auxiliary cab heater can be operated while the diesel engine is running or is stopped as part of the programmable auxiliary heating system). The standard hot water crane cab heater can also be turned on after the engine has started and is warmed to operating temperature.

NOTE: When using the heater at high altitudes, the factory heater setting will need to be re-calibrated for proper heater operation.

- Heating at altitudes up to 1,500 m (4,921 ft)
Unlimited heating is possible
- Heating at altitudes over 1,500 m - 3,000 m and (4,921 ft - 9,842 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 the crane engine is switched off. If you run the heater while the crane engine is stopped, the batteries voltage will need to be recharged after short periods of time.

Air Diverter

An air diverter directs warmed air collected from under the engine hood when the temperature is below -9°C (15°F) to preheat the air intake going to the engine.

If machine is equipped with cold weather package, ensure air diverter is switched to outside air intake in ambient temperatures above -9°C (15°F).

Battery Heater

An in-line battery coolant heater circulates warm coolant under the battery when the 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 assist with easy start-up conditions.

If machine is equipped with cold weather package, ensure battery heater coolant valve is switched off 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.

Charge of capacitor 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, reference 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 the correct grade of fuel for the 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.

NOTE: The addition of kerosene is NOT recommended for general use. Refer to the *Cold Weather Package and Lubricants*, page 5-3 of this operator manual.

CAUTION

Engine Damage Hazard!

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

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).

CAUTION

Crane Damage Hazard!

Operating the crane with the incorrect lubricants and fluids for the prevailing ambient temperature and/or failing to adequately warm the crane prior to cold weather operation can lead to a failure of a crane component or system.

Always use Grove recommended lubricants and fluids for the prevailing ambient temperature and properly start and warm the crane using the cold weather procedures found in this Operator's Manual and supplement before operating the crane at full load.

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. Set up 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 3-24).
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 Manitowoc 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

Starting and shutdown procedures for most diesel engines generally follow the same pattern. Therefore, the following procedures can be applied except where specific differences are noted. (Refer to the applicable engine manufacturers 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 3-24.

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.

Starting Procedure

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



CAUTION

Health Hazard!

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

Unexpected Operation Hazard!

Before starting the engine, apply the parking brake and engage the swing lock.

CAUTION

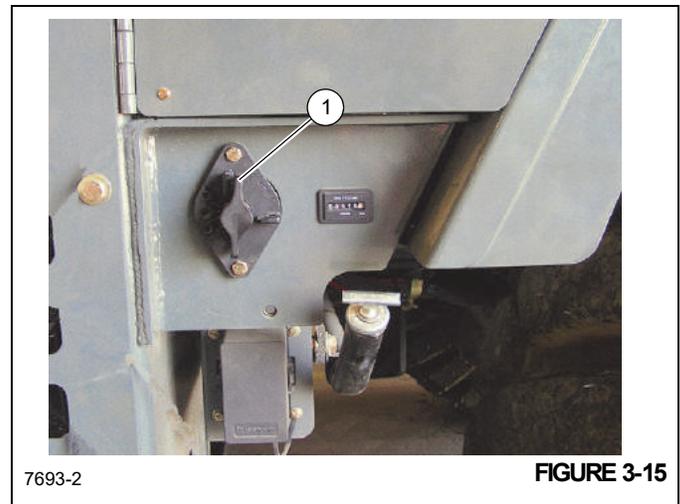
Machine Damage Hazard!

Never crank the engine for more than 30 seconds during an attempted start. If the engine fails to start after 30 seconds, stop and allow the starter motor to cool for approximately two minutes before attempting another start.

If the engine fails to start after four attempts, correct the malfunction before attempting further starts.

Use the correct grade of oil for the prevailing temperature in the crankcase to prevent hard cranking. Diesel fuel should have a cloud point of 6°C (10°F) less than the lowest expected temperature. In case of emergency, white 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. The addition of kerosene is NOT recommended for general use.

Ensure Battery Disconnect Switch handle (1) (Figure 3-15) is in the ON position (handle shown in the OFF position)



7693-2

FIGURE 3-15

Warm Engine

NOTE: The engine ECM monitors the engine and, under certain conditions, cycles the air heater on and off at start-up and during operation.

The engine is equipped with an electric air heater grid at the air inlet elbow to aid in cold starting and reduce white smoke at start-up. In the preheat mode, the engine should not be cranked until the Wait-to-Start lamp turns off.

1. Set the parking brake to On, position the transmission shift lever to neutral, and depress the service brake foot pedal.

CAUTION

Avoid Crane Damage!

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

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

NOTE: The engine will not crank unless the transmission shift lever is in neutral and the service brake foot pedal is depressed.

The buzzer will sound upon turning the Ignition Switch to START and turn off after proper hydraulic oil pressure is reached.

2. Turn the Ignition switch to START and release immediately when the engine starts. Do not push or hold the throttle down. The ECM will automatically provide the proper amount of fuel to start the engine.
3. Immediately check the engine instruments and warning lights for proper indication after starting.

CAUTION**Engine Damage Hazard!**

If any warning light stays on or indicator(s) do not display proper readings, shut down the engine and correct the malfunction before resuming operation.

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

Cold Engine**WARNING****Risk of Explosion!**

Do not spray starting fluid into the air inlet. The spray will contact the heater elements and could explode causing personal injury.

NOTE: The engine ECM monitors the engine and, under certain conditions, cycles the air heater on and off at start-up and during operation.

The engine is equipped with an electric air heater grid at the air inlet elbow to aid in cold starting and reduce white smoke at start-up. In the preheat mode, the engine should not be cranked until the Wait-to-Start lamp turns off.

1. Prior to starting a cold engine, ensure the Crane Function switch is positioned to OFF.
2. Set the parking brake to On, position the transmission shift lever to neutral, and depress the service brake foot pedal.

CAUTION**Avoid Crane Damage!**

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

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

NOTE: The engine will not crank unless the transmission shift lever is in neutral and the service brake foot pedal is depressed.

The buzzer will sound upon turning the Ignition Switch to START and turn off after proper hydraulic oil pressure is reached.

3. The Wait-to-Start lamp is illuminated during the preheat time that takes place when the Ignition switch is in the ON position during cold weather starting. To minimize cranking time during cold weather starting, the engine should not be cranked until the Wait-to-Start lamp turns off.
4. Turn the Ignition switch to START and release immediately when the engine starts. Do not push or hold the throttle down. The ECM will automatically provide the proper amount of fuel to start the engine.
5. Immediately check the engine instruments and warning lights for proper indication after starting.

CAUTION**Engine Damage Hazard!**

If any warning light stays on or indicator(s) do not display proper readings, shut down the engine and correct the malfunction before resuming operation.

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

Detailed cold weather starting and operating procedures are covered in the engine manual.

Idling the Engine

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

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

Racing the Engine

NEVER race the engine during the warm-up period. NEVER operate the engine beyond governed speed (as might occur in downhill operation or downshifting). Engine bearings, pistons, and valves may be damaged if these precautions are not taken.

Shutdown Procedure

1. Allow the engine to operate at idle for about five minutes to avoid high internal heat rise and allow for heat dissipation.
2. Turn the Ignition switch to OFF.

Transporting the Crane

CAUTION

Machine Damage Hazard!

Dead end lug not to be used as tie down point for boom during transportation. Failure to comply may result in machine damage. When the boom is secured for transport, boom shall not be constrained. All securement must allow for reasonable freedom of movement.

Crane Travel Operation

Traveling — General



WARNING

Inadvertent Operation Hazard!

Before traveling, ensure the crane function switch is in the off position. This will prevent inadvertent operation of craning functions due to bumping of the controllers while traveling.

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

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



WARNING

Tipping Hazard!

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

Do not drive the crane with the boom off center because automatic oscillation lockout will occur, making the crane subject to tipping on uneven surfaces. Center the boom over the front, turn the Swing Brake Switch to ON and engage the Turntable Lock Pin (if equipped).

Fully retract the boom and ensure the 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). Either remove the hook block and/or overhaul ball from the hoist cable(s) and stow securely or make sure the hook block or overhaul ball is properly secured to the tie down provided for that purpose.

Do not drive the crane with the lift cylinder bottomed. At a minimum, position the boom slightly above horizontal.

Fully retract the outrigger jack cylinders and properly store the floats.

Disengage Main Hydraulic Pump via pump disconnect for cold weather starting of the engine (Sub-Zero). Pump must be re-engaged for travel.

Use four-wheel drive only when greater traction is necessary. (Refer to *Four-Wheel Drive Operation*, page 3-33 for operating instructions.)

CAUTION

Machine Damage Hazard!

Grove 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.

- Use four-wheel drive only when greater traction is necessary. (Refer to *Four-Wheel Drive Operation*, page 3-33 for operating instructions.)
- Ensure the outrigger beams and jack cylinders are fully retracted with the floats properly stowed.
- Conduct all travel with the assistance of a ground person to warn the operator of any changing conditions in the terrain being traversed.

The owner/lessee must take appropriate measures to ensure that all persons operating or working with the affected models are in compliance with Grove U.S. L.L.C. recommendations. The operator of the crane assumes responsibility for determining the suitability of traveling

conditions. Traveling under the controlled conditions specified in these guidelines, must be conducted with the utmost diligence and care to ensure the safety of all personnel performing the operation and/or working around the crane.

Traveling — Towing/Pulling

CAUTION

Machine Damage Hazard!

Grove 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 the boom is in a horizontal position and not elevated above 0°.
- Ensure the outrigger beams and jack cylinders are fully retracted with the floats 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 3-33 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 recommends connecting to a pintle hook (if equipped) or evenly attaching to the tie-down lugs when being towed by another vehicle.

CAUTION

Machine Damage Hazard!

It is recommended to attach cables/straps to the optional pintle hook (if equipped) or 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 the boom is in a horizontal position and not elevated above 0°.
- Ensure the outrigger beams and jack cylinders are fully retracted with the floats properly stowed.

CAUTION

Machine Damage Hazard!

It is recommended to attach cables/straps to the pintle hook if one is available 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.

To avoid severe damage to the drive train while the 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 the parking brake may result in the 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 the assistance of a ground person to warn the operator of any changing conditions in the terrain being traversed.

Traveling on Slopes

Crane operators must exercise caution whenever operating the crane on uneven surfaces. Travel on slopes is permitted if the following conditions are met.

General Conditions

- Travel must be on an improved surface or hard-packed dry earth. Crane operators are required to inspect the surface for good tire adhesion.
 - All boom sections must be fully retracted.
 - Boom extension must be in stowed position or removed from the crane (if traveling with an erected boom extension, follow the requirements under the section *Traveling with Boom Extension and/or Inserts Erected*, page 3-31.
 - Boom must be positioned over the front of the crane. Boom angle must be as follows:
 - For fore/aft travel on grades less than 15%, the maximum allowable boom angle is 20°.
 - For fore/aft travel on grades greater than 15%, the boom angle must be limited to horizontal (0°).
 - For side slope travel on grades less than 10%, the maximum allowable boom angle is 20°.
 - For side slope travel on grades greater than 10%, the boom angle must be limited to horizontal (0°).
 - Swing brake must be applied and turntable lock pin engaged.
 - Either the hook block may be reeved over the main boom nose, or the overhaul ball may be reeved over the main boom nose or auxiliary boom nose; the other must be removed. If hook block or overhaul ball remains reeved on the boom, it must be secured at the tie down on the carrier to prevent swinging.
 - Tires must be inflated to the recommended pressure for pick and carry operations.
 - Hydraulic tank must be filled to specified level. Fuel tank must be over half full.
 - Engine and transmission fluids must be filled to the specified levels.
 - Axle differentials and planetary hub fluids must be filled to the specified levels.
- No loads may be supported by the boom (i.e., no pick and carry loads) while traversing a slope.
 - All cribbing or other non-standard accessories must be removed from the crane.
 - Avoid holes, rocks, extremely soft surfaces, and any other obstacles that might subject crane to undue stresses and possible overturn.
 - Operator is to check for changing road conditions and utilize a ground person if deemed necessary.

Slope Limitations - Fore/Aft Travel

- When traversing a fore/aft slope that is less than or equal to 15% (8.5°), follow the normal crane travel procedures outlined in this manual.
- When traversing a fore/aft slope that is greater than 15% (8.5°) and less than 25% (14°), transmission shall be in four-wheel drive. If crane must be parked, make sure the transmission is in 4-wheel drive and the wheels are chocked.
- When traversing a fore/aft slope that is equal to or greater than 25% (14°), use an assist vehicle and shift the crane's transmission to four-wheel drive. Do not park crane on a slope equal to or greater than 25% (14°).
- Travel on a fore/aft slope greater than 30% (16°), such as ramps, is permitted for short distances at low speed. Consideration must be given for the terrain at the end of the slope (for example, does the terrain level out so that the crane can stop).
- For mine applications and similar, where the slopes and the travel distance can be significant, brake fade must be taken into consideration. For extended travel, check cold tire pressure before start. (Refer to tire inflation chart in Load Chart Book.) After every one hour of travel time, regardless of ambient temperature, stop and allow tires to cool for at least 30 minutes. At destination, tires must be allowed to cool to ambient temperature before crane lifting on rubber.
- For slope limitations when traveling with an elevated boom or an erected boom extension and inserts, refer to the specific traveling instructions in this section.

Slope Limitations - Side Slope Travel:

- Side slope shall not exceed 15% (8.5°).

Operator should carefully consider the conditions and travel at the appropriate speed given the condition and should not exceed the maximum speeds in the following tables taking into consideration both fore/aft slopes and side slope.

Table 3-1 Fore and Aft Travel - No Load

Crane Condition	0 - 15% (0 - 8.5°)	15 - 25% (8.5 - 14°)	25 - 29% (14 - 16.7°)	30% + (16.7° +)
Two-Wheel Drive	Yes, no restrictions up to 37 kph (23 mph)	No	No	No
Four-Wheel Drive/Low Range	Yes, up to 10 kph (6 mph)	Yes, up to 10 kph (6 mph)	Yes, up to 5 kph (3 mph)	Yes, up to 1.6 kph (1 mph)
Park using Park Brake only	Yes	No	No	No
Park using Park Brake, Chock Wheels, and Four-Wheel Drive		Yes	No, do not park on slopes greater than 25%	No, do not park on slopes greater than 25%
Assist Vehicle Required for Braking and Propulsion	No	No	Yes	Yes
Short Distance Travel allowed (on ramps)				Yes, but do not park on slopes greater than 25%
Consider Brake Fade possibility if traveling long distance	Yes	Yes	Yes	Yes

Table 3-2 Side Slope Travel - No Load

Crane Condition	0 - 5% (0 - 2.9°)	5 - 10% (2.9 - 5.7°)	10 - 15% (5.7 - 8.5°)	15% + (8.5° +)
Two-Wheel Drive	Yes, up to 37 kph (23 mph)	Yes, up to 15 kph (9 mph)	No	No
Four-Wheel Drive/Low Range	Yes, up to 10 kph (6 mph)	Yes, up to 10 kph (6 mph)	Yes, up to 1.6 kph (1 mph)	No

Owner/lessee must take appropriate measures ensure that all persons operating or working with affected models are complying with these Grove Crane recommendations. Crane operator assumes responsibility for determining suitability of traveling on a slope.

Traveling on a slope should only be attempted under controlled conditions specified in these guidelines, and must be conducted with the utmost diligence and care to make sure safety of all personnel performing the operation and/or working around the crane.

Should operator need to traverse slopes outside the criteria defined in the above guidelines, contact Grove Crane for further guidance.

Traveling with Elevated Boom



WARNING

Overhead Objects Hazard

Contacting overhead objects while driving the crane may result in death, severe injury, and/or equipment damage. Traveling with the boom elevated should only be attempted under the controlled conditions specified in this section.

Exercise caution whenever driving the crane with the boom elevated. Travel with the boom elevated is permitted as long as the following steps are followed.

- Limit travel to firm, level surfaces.
- Inspect the route of travel prior to moving the crane. Pay particular attention to any changing conditions in the terrain being traversed. Also, avoid any overhead obstructions.

- Travel must be performed in a controlled fashion.
- Do not exceed a speed of 15 mph.
- Inflate tires to the recommended pressure for travel operations.
- When using the towing attachments, the boom must remain horizontal.
- Fully retract all boom sections.
- Refer to *Traveling with Boom Extension and/or Inserts Erected*, page 3-31 if the boom extension is in the erected position.
- Position the boom over the front of the crane.
- Engage the swing brake and turntable lock pin.
- The hook block may be reeved over the main boom nose. The overhaul ball may be reeved over the main boom nose or auxiliary boom nose. The block and ball may be suspended below the boom nose. It is also acceptable to secure the block or the ball to the tie down point on the carrier 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 the crane.
- Avoid holes, rocks, extremely soft surfaces and any other obstacles that might subject the crane to undue stresses and possible overturn.
- Ensure adequate clearance to any overhead obstructions that the crane may be required to travel beneath.
- Ensure that all personnel involved in the operation and those working around the crane are aware of any hazards that may be encountered and are trained about how to avoid the hazards.

Traveling with Boom Extension and/or Inserts Erected

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

Follow the steps below when traveling with the extension erected.

- Position the 33 ft (10.1 m) or 56 ft (17.1 m) boom extension at minimum offset. If traveling with just the 33 ft (10.1 m) extension, 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 40°.
- 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 hookblock from main boom nose.
- Overhaul ball may be reeved over boom extension, hanging 3 ft (0.9 m) below sheave.

33 ft (10.1 m)/56 ft (17.1 m) Extension Plus 20 ft (6.1 m) Insert

Follow the steps below when traveling with the extension and insert erected.

- Position the 33 ft (10.1 m) or 56 ft (17.1 m) boom extension plus 20 ft (6.1 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 hookblock from main boom nose.
- Overhaul ball may be reeved over boom extension, hanging 3 ft (0.9 m) below sheave.

33 ft (10.1 m) Extension Plus 40 ft (12.2 m) Insert

Follow the steps below when traveling with the extension and insert erected.

- Position the 33 ft (10.1 m) boom extension plus 40 ft (12.2 m) insert at the minimum offset. 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 minimum 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 hookblock 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 5 mph (8 km/h) inflation pressures may remain in the tire while operating the crane on site within a distance of less than 4 mi (6.4 km).

CAUTION

Tire Damage!

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

Traveling — Forward

CAUTION

Machine Damage Hazard!

Engage the turntable lock pin for extended travel. Failure to engage the lock pin may allow the superstructure to swing uncontrolled, damaging the machine and/or property.

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

WARNING

Run-away Crane Hazard!

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

Never release the parking brake while the low service brake pressure indicator is illuminated and the buzzer is sounding.

3. Disengage the parking brake.
4. Position the Drive Axle Switch to either two-wheel high or four-wheel low.

CAUTION

Use four-wheel drive only when more traction is required.

5. Lift the Transmission Shift Lever up out of its detent and push the lever to the forward (F) position, then rotate the Transmission Shift Lever Knob to the first (1) gear position. The gear selection "F1" will appear in the LCD Display to indicate that forward propulsion and first (1) gear have been selected; if the Service Brake Foot Pedal is not depressed prior to shifting to a gear, the gear selection will flash in the LCD Display until the Transmission Shift Lever is returned to the neutral (N) position and the transmission will not shift.
6. Release the Service Brake Foot Pedal and depress the Foot Throttle Pedal until maximum first gear speed is attained, then rotate the Transmission Shift Lever Knob to the second (2) gear position to continue to increase speed. For additional speed, continue shifting to a higher gear.

CAUTION

Possible Machine Damage!

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

Traveling — Reverse

Traveling in reverse is accomplished the same way as traveling forward, except for shifting the Transmission Shift Lever to reverse (R). Refer to *Traveling — Forward*, page 3-32.

CAUTION

Possible Machine Damage!

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

Steering

Steering is accomplished by the steering wheel and the rear steer control. These controls, used singly or together, provide front wheel steering, rear wheel steering, four-wheel steering, and crabbing capabilities (Figure 3-16).

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

Rear Wheel Steering

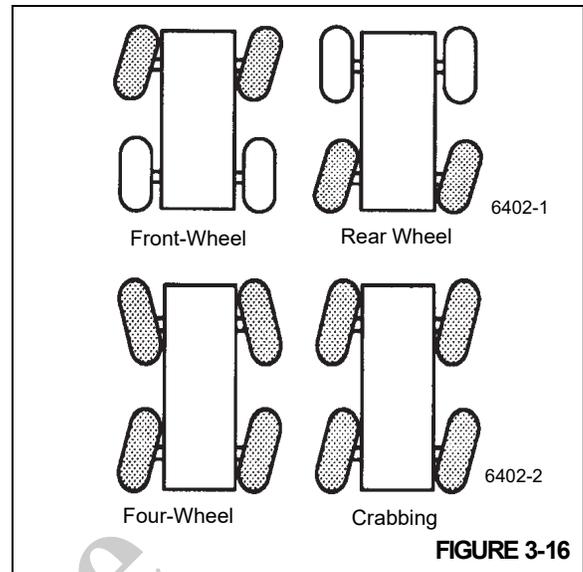
Rear wheel steering is controlled by the Rear Steer Control Switch. Moving the control switch to the desired position activates the rear steer cylinders, thereby steering the crane in the selected direction.

Four Wheel Steering

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

Crabbing

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

**Four-Wheel Drive Operation****CAUTION****Machine Damage Hazard!**

Do not tow or pull in 1st gear with the Drive Axle Selector Switch in two-wheel drive position. Severe damage to the drive train will result. Always engage four-wheel drive.

If more traction is required due to slipping or spinning wheels, engage the 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 the crane by depressing the Service Brake Foot Pedal.
2. Position the Transmission Shift Lever to the neutral (N) position.
3. Position the Drive Axle Selector Switch to four-wheel low.

NOTE: If the Drive Axle Selector Switch is positioned to four-wheel low and the Service Brake Foot Pedal is not depressed and the Transmission Shift Lever is not in neutral (N) position, the Four-Wheel Drive Indicator will flash and the four-wheel drive function will not engage.

4. Select gear speed and direction of travel using the Transmission Shift Lever and Knob.
5. Drive the crane as described under *Traveling — Forward*, page 3-32.
6. Return the Drive Axle Selector Switch to the two-wheel high position as soon as two-wheel traction will suffice and crane motion has stopped; again, the Service Brake Foot Pedal must be depressed and the Transmission Shift Lever must be in the neutral (N) position to shift from four-wheel low to two-wheel high.

Differential Lock Operation (Optional)

CAUTION

Unexpected Operation!

When using the differential lock, steering characteristics may be affected.

Try to use four-wheel drive to gain adequate traction before using the differential lock.

Do not operate the differential lock when traveling downhill; at speeds above 16 km/h (10 mph); on hard, dry surfaces; and/or during axle spin-out.

NOTE: The differential lock will not operate unless the Drive Selector Switch is in the 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 the differential locks are actuated, the clutch collar completely locks the differential case, gearing, and axle shafts together, thus 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), the differential locks should not be actuated. The axles should be allowed to operate with differential action between both wheels.

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

1. Lock the differentials by pressing and holding the Axle Differential Control Switch in the lock position; disengage the function by releasing the switch.
2. Lock/unlock the differentials only when the vehicle is standing still or moving at a constant low speed with the wheels not slipping.

CAUTION

Possible Machine Damage!

When driving on hard, dry surfaces with the differentials locked, do not turn the wheels. Damage to the drive line components can result.

Do not lock the differentials when the wheels are slipping. Damage to the differentials can result.

3. Locked differentials cause the crane's turning radius to increase, creating an understeer condition; use caution, good judgement and drive at low speeds when operating the vehicle with lock differentials.
4. Lock the differentials only when maximum traction is needed on poor road or highway surfaces.

CAUTION

Possible Loss of Vehicle Stability!

Do not lock the differentials when the vehicle is traveling down steep grades and traction is minimal.

5. Always unlock the differentials when the 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 the crane is stationary but may be engaged when moving, if the following conditions are met:

1. The crane is moving very slowly (creep speed).
2. The wheels are not spinning at the time of engagement.

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

1. Position the Axle Differential lock Control Switch to the locked position with the 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 the differential locks.

NOTE: When the differentials are locked, the Axle Differential Locked Indicator illuminates.

2. Proceed over the poor road condition cautiously.

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

1. Release the Axle Differential Lock control Switch, allowing it to return to the unlocked position while maintaining a slow speed.
2. Let up momentarily on the Foot Throttle Pedal to relieve torque on the differential gearing, allowing the differential to fully unlock.

NOTE: When the differentials are unlocked, the Axle Differential Locked Indicator will not be illuminated.

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

Axle Oscillation Lockouts Operation

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

1. Ensure the tires are inflated to the recommended pressure. Refer to the *Load Chart Book* in the crane cab for proper inflation pressures.
2. With the hook unloaded, the boom fully retracted and centered over the front at no more than a 10° to 15° boom angle, position the crane on a block or curb so that one rear tire is approximately 6 to 12 in (15 to 30 cm) above the level of the opposite tire.
3. Slowly swing the superstructure to the left or right until the axle oscillation lockout valve is activated. This will lock the rear axle out of level. Do not swing beyond the tire track.
4. After engaging the swing brake, slowly drive off of the block or curb and stop. The rear tires should both be touching the road surface and the opposite front tire should be light or slightly off the road surface.
5. Release the swing brake and swing the superstructure until it is centered over the front.



DANGER

Tipping Hazard!

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

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

If the axle oscillation lockout valve is functioning properly, the crane will re-level itself; if the valve is not working properly, the crane will not re-level itself. If the

rear axle does not lock or unlock properly, evaluate the lockout system and repair as necessary.

General Crane Operation

Pump Drive

The main hydraulic pumps are mounted on the torque converter drive pad. The pumps operate any time the engine is running.

Control Lever Operation

The control lever operation for all crane functions is standard, i.e. the closer the lever is to neutral (center), the slower the system responds. The control lever should be returned to neutral to hold the load. Never feather the hoist control lever to hold the load.

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

Preload Check

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

NOTE: Operate engine at or near governed speed during preload check of crane functions.

Carefully read and become familiar with all crane operating instructions before attempting a preload check or operating the crane under load.

1. Extend and set outriggers.
2. Raise, lower, and swing the boom a minimum of 45° right and left.
3. Telescope the boom in and out.
4. Raise and lower the cable a few times at various boom lengths. Ensure there is no kinking.

Using Your Load Chart

NOTE: One of the most important tools of every crane is the Load Chart found in the crane operator's cab.

The Load Chart contains a large amount of information, which must be thoroughly understood by the operator.

The Load Chart contains outrigger capacity charts for fully extended, mid extended outriggers for the main boom and boom extension, and fully retracted outrigger beams for main boom only. In addition, the Load Chart contains two on-rubber capacity charts: 360° stationary, and pick and carry over front.

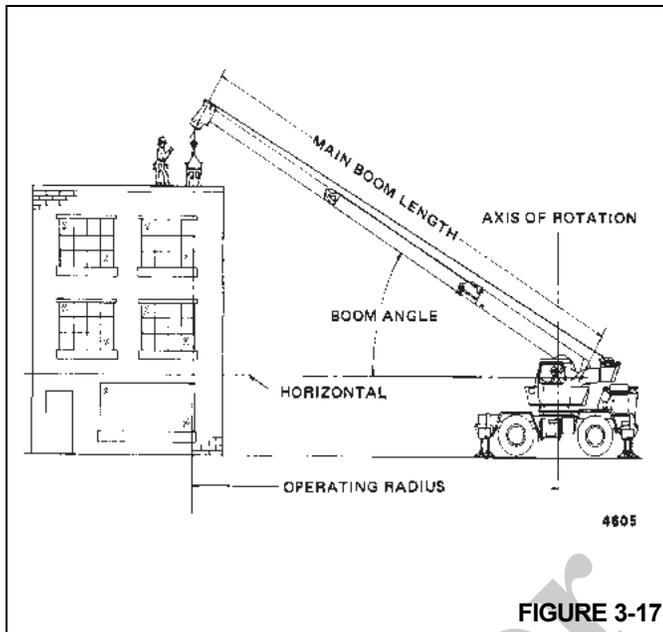


FIGURE 3-17

The Load Charts are divided into structural strength and stability limits. This is shown by the bold line across the chart. Capacities above the line are structural strength limits and capacities below the line are stability limits.

The left column is the load radius, which is the distance from the center of crane rotation to the load center of gravity. The top row lists various boom lengths ranging from fully retracted to fully extended or boom extension lengths and offsets. The number at the intersection of the left column and top row is the total load capacity for that load radius and boom length or boom extension lengths offset. The number in parentheses below the total load capacity is the required boom angle (in degrees) for that load. When the boom length or lift radius or both are between values listed, the smallest load shown at either the next larger radius or next longer or shorter boom length shall be used.

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

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

A boom extension capacity chart and notes are included to list the capacities for the extension length, load radius, and boom angle.

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

The load chart also gives weight reductions for load handling devices such as hook blocks, overhaul balls, boom extensions, etc., which must be taken into consideration as part of the load. Remember, the weight of any other load handling devices such as chains, slings, or spreader bars must be added to the weight of the load.

Proper Leveling of the Crane

ASME B30.5 specifies that if a crane is not level within 1% of grade, the allowable capacities must be reduced. Therefore, whether lifting on rubber or outriggers, it is essential that the crane is level to within 1% of grade. The bubble level that is provided on the crane is calibrated to be accurate within 1% of grade.

To properly level the crane, 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). Raise and level the crane using the outriggers; refer to *Setting the Outriggers*, page 3-37.

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 using the procedures under *Setting the Outriggers*, page 3-37.

Bubble Level Adjustment

The bubble level adjustment should be checked periodically; if it is suspected that the bubble level indicator is out of adjustment, verify and adjust the bubble level as follows:

1. Locate the crane on a firm, level surface.
2. Extend and set the outriggers. Level the crane, as indicated by the bubble level indicator, using the outriggers.
3. Place an inclinometer, spirit level, engineers level, or similar type device on a machined surface such as the turntable bearing or bearing mounting surfaces.
4. Using the outriggers, level the crane as indicated on the leveling device used in step 3.
5. Using the bubble level indicator mounting screws, adjust the bubble level indicator to show level.

Crane Functions

Setting the Outriggers

1. Engage the Parking Brake.

CAUTION

Avoid Crane Damage!

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

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

NOTE: The Parking Brake must be engaged to enable outrigger functions.

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

CAUTION

Possible Equipment Damage!

Always depress 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 the 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 m (20 ft) away from electrical power lines and equipment.

3. If extending the outrigger to the mid-extend or fully extended position, depress the desired Extension Switch on the Outrigger Selector Panel and hold the Outrigger Extension/Retraction Switch to EXTEND. The appropriate outrigger beam begins to extend. Refer to *Engaging the Mid-Extend Lock Pin*, page 3-38 if the crane is to be operated with any outrigger 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. However, to ensure that each outrigger is fully extended, repeat step 3 for each outrigger after a multi-outrigger extension.

4. After deploying the four outrigger beams to one of the three proper positions (fully retracted, mid-extend, fully extended), depress the desired Stabilizer Switch on the Outrigger Selector Panel and hold the Outrigger Extension/Retraction Switch to EXTEND. The appropriate jack cylinder begins to move.

Extend each jack cylinder, positioning the float as necessary, until the locking levers of the float engage the jack cylinder barrel.

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

5. Extend the front jack cylinders approximately 3 to 4 in (8 to 10 cm).
6. Extend the rear jack cylinders approximately 3 to 4 in (8 to 10 cm).

NOTE: If crane is equipped with tilting cab, ensure cab is in the lowered position before leveling machine.

7. Repeat step 4 until all wheels are clear of the ground and the crane is level as indicated by the bubble level indicator located on the right side of the cab.

NOTE: If it is suspected that the bubble level indicator is out of adjustment, verify and adjust the bubble level using the procedures under *Bubble Level Adjustment*, page 3-36.



DANGER

Tipping Hazard!

The mid-extend outrigger beam lock pin must be engaged before operating on any beam from the mid-extend position.

For cranes not equipped with an Outrigger Monitoring System, the operator must select the proper load chart and RCL program for the outrigger position selected.

NOTE: For cranes equipped with an Outrigger Monitoring System, outrigger positions are automatically monitored through the RCL. Refer to *Outrigger Monitoring System (OMS) (Optional—Standard in North America)*, page 3-38.

Outrigger Monitoring System (OMS) (Optional—Standard in North America)

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.

Set up of the outriggers is the same for cranes equipped with OMS; refer to *Setting the Outriggers*, page 3-37.

If the crane is setup on outriggers and “On Outriggers” is chosen when programming the RCL (Figure 3-18), then the OMS indicates to the RCL the horizontal position of each of the four outrigger beams. Based on this information, the RCL will default to the most conservative outrigger beam configuration; that is, if three outriggers are fully extended and one is retracted, the RCL will select retracted as the outrigger configuration. A confirmation of this outrigger configuration is all that is needed (Figure 3-19). Refer to the *Rated Capacity Limiter Operator Handbook* for detailed instructions.

NOTE: Figure 3-19 depicts all four outrigger beams in the mid-extend position as indicated by the OMS and RCL.

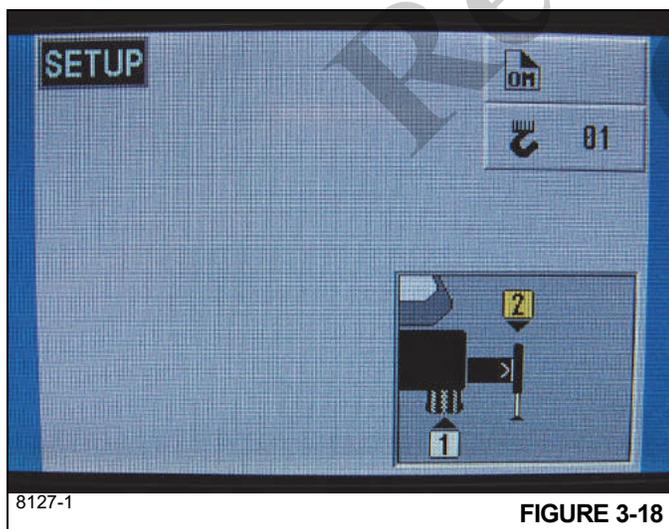


FIGURE 3-18

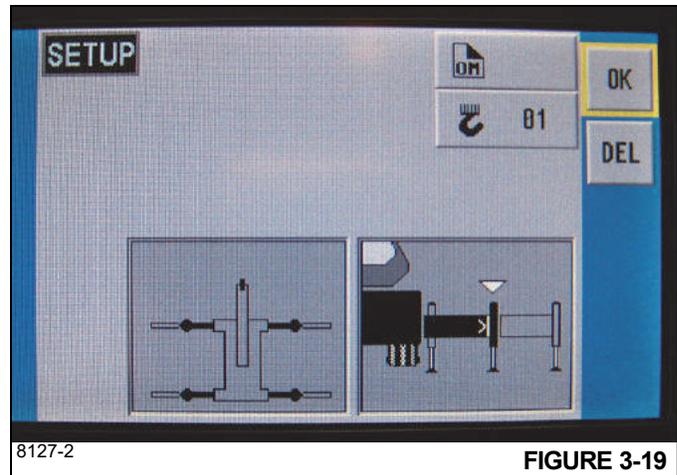


FIGURE 3-19

Engaging the Mid-Extend Lock Pin

1. Turn the locking pin 90° from its stowed position and allow the pin to rest on top of the outrigger beam.

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

2. Slowly extend or retract the outrigger beam, allowing the locking pin to drop into the hole in the top of the outrigger beam, engaging the outrigger beam at the desired length.

Stowing the Outriggers

1. Select the rear jack cylinders with the Stabilizer Selector switches and hold the Extension/Retraction switch to RETRACT until the rear jack cylinders have retracted several inches.
2. Select the front jack cylinder with the Stabilizer Selector switches and hold the Extension/Retraction switch to RETRACT until the front jack cylinders have retracted several inches.
3. Repeat steps 1 and 2 until the crane is resting on all four wheels and the jack cylinder floats are several inches off the ground



CAUTION

Crushing Hazard!

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

NOTE: Each jack cylinder float weighs approximately 70 lb (32 kg).

4. Release the locking levers and allow the floats to drop to the ground.

5. Continue to retract the jack cylinders until they are fully retracted.
6. Depress the desired Extension rocker switch on the Outrigger Selector panel and hold the outrigger Extension/Retraction rocker switch to RETRACT. The appropriate outrigger beam should begin to retract.

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

7. After all outriggers have been fully retracted, stow the outrigger floats.

Stowing the Mid-Extend Lock Pin

1. Retract the outrigger extension/retraction cylinder.

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

2. Lift the lock pin and turn it 90° to its stowed position.

Swinging the Boom



DANGER

Crushing Hazard!

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

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

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

CAUTION

Machine Damage!

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

NOTE: Automatic rear axle oscillation lockout will activate when the boom swings right or left of the crane centerline.

To swing the boom, the SWING control lever is pushed forward, away from the operator, to swing CLOCKWISE, or pulled back, toward the operator, to swing COUNTERCLOCKWISE. Always operate the control lever with a slow, even pressure. Use the swing brake foot pedal to stop rotation, then position the swing brake switch to ON to prevent further rotation.

Elevating the Boom



DANGER

Crushing Hazard!

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

To elevate the boom, pull the BOOM (lift) control lever back, toward the operator, and hold until the boom reaches the desired elevation level.

Lowering the Boom



DANGER

Crushing and/or Tipping Hazard!

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

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

CAUTION

Machine Damage!

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

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

To lower the boom, push the Boom Control Lever forward, away from the operator, and hold until the boom is lowered to the desired position.

Extending the Boom



DANGER

Crushing Hazard!

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

CAUTION

Machine Damage!

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

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

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

To extend the boom, push on the top of the Telescope Control foot pedal.

Retracting the Boom

 **DANGER**
Crushing Hazard!

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

To retract the boom, push on the bottom of the Telescope Control Foot Pedal.

Lowering and Raising the Hoist Cable

 **DANGER**
Crushing Hazard!

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

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

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

Lowering the Cable

Push the Main or Aux hoist control lever forward, away from the operator, and hold until the hook or load is lowered to the desired height.

Raising the Cable

Pull the Main or Aux hoist control lever back, toward the operator, and hold until the hook or load is raised to the desired height.

Hoist Speed Range Selection

CAUTION

Equipment Damage!

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

To change the speed range of the hoist(s), position the applicable switch (Main Hoist Speed or optional Aux Hoist Speed) to HIGH or LOW as applicable

Operational Aids



WARNING

Unexpected Operation Hazard!

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.

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's cab. When an overload condition is sensed, the system provides the operator with a visual and audible warning, and locks out the control levers to prevent lowering the boom, extending the boom, or raising the main or auxiliary hoist cables.

Three additional features are included within the RCL system:

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

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

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

CAUTION**Possible Machine Damage!**

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

**WARNING****Risk of Unexpected Operation!**

There are no machine cutouts associated with the swing angle set limitation or the work area definition features.

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

Refer to the RCL Operator Handbook for more detailed information on the function of the RCL system.

Control Lever Lockout System

The control lever lockout system consists of hydraulic solenoid valves (located in the directional control valves) which are in series between the hydraulic remote control valves in the cab and the pilot-operated directional control valves. When the valves are actuated, they prevent pilot flow between the hydraulic remote control valve in the cab and the appropriate directional control valve. The valves are activated in such a manner as to prevent worsening the condition, i.e. boom down, telescope out, or hoist up. The control lever lockout system is used with the anti-two-block system or the Rated Capacity Limiter (RCL) system.

Stowing and Parking**DANGER****Tipping Hazard!**

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

When parking the crane, do the following:

1. Park the crane on a stable surface.
2. Remove the load from the hook.
3. Stow the swingaway boom extension, if erected.
4. Fully retract the boom and position it in the normal travel position.
5. Engage the swing brake and/or swing lock pin.
6. Retract all jack cylinders and outrigger beams.
7. Apply the parking brake.

CAUTION**Avoid Crane Damage!**

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

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

8. Put all operating controls in the neutral position.
9. Position the Crane Function switch to OFF.
10. Shut down the engine following the proper procedures specified in this Handbook and the applicable Engine manual.
11. Remove the keys.

12. Close and lock all windows, covers, and doors.

CAUTION**Risk of Undesirable Operation!**

To avoid possible engine fault codes and undesirable operation, ensure the keyswitch has been off two minutes before disconnecting the batteries.

Disconnect batteries, if machine will be inactive for over 24 hours.

13. Turn Battery Disconnect to OFF position (shown) if machine will be inactive for over 24 hours (Figure 3-20).



Unattended Crane**DANGER****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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Travel Configuration	4-1	Stowing the Swing-Away Boom Extension	4-19
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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.

ACCESSING THE HOIST AREA (FIXED COUNTERWEIGHT UNITS ONLY)

Configure the hoist access area from the Travel Position (Figure 4-1) to the Working Position (Figure 4-2).



DANGER

Platform must not be used for hauling passengers as 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 Configuration

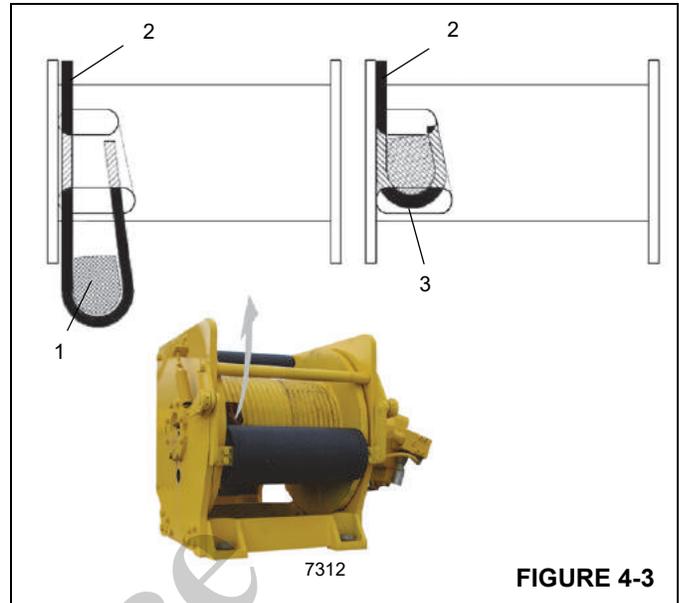
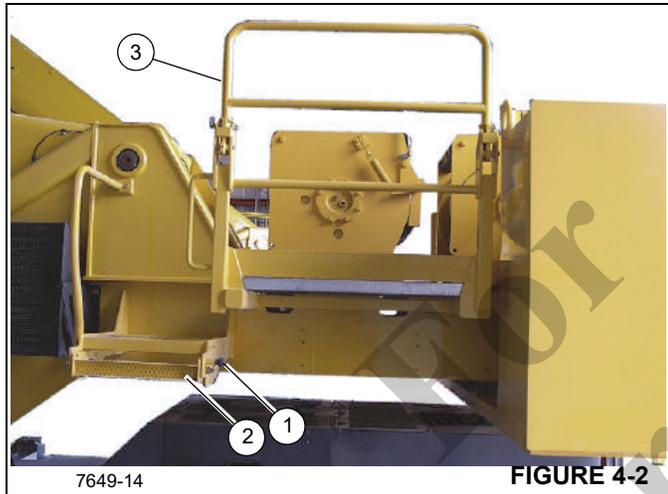


1. Railing (1) (Figure 4-1) is in the pinned and down position.
2. Pull the step locking pin out, slide the step (2) in to the travel position and release the lock pin to secure the step in travel position.

Working Position

Place the hoist access platform hand rail (1) (Figure 4-2) and step (2) (Fixed counterweight units only) into the working position:

1. Pull out on the step locking pin (1) (Figure 4-2), slide the step (2) out to the working position and release the locking pin into the locking hole.
2. Remove two locking pins from hand rail (3) and rotate it up into the working position, reinstall pins.



3. Insert the cable through the slot and position around the anchor wedge (1) (Figure 4-3).

NOTE: The end of the cable should be even with the bottom of the slot for the anchor wedge (1).

4. Position the anchor wedge in the drum slot; pull firmly on the free end (2) of the cable to secure the wedge.

NOTE: If the wedge does not seat securely in the slot, carefully tap (3) the top of the wedge with a mallet.

INSTALLING CABLE ON THE HOIST

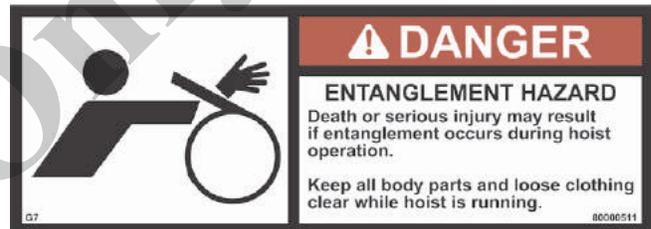
CAUTION

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

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

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

1. Position the cable over the boom nose sheave and route to the hoist drum.
2. Position the hoist drum with the cable anchor slot on top.



5. Slowly rotate the drum, ensuring the first layer of cable is evenly wound onto the drum.
6. Install the remainder of the cable, as applicable.
7. Return the hoist access platform to the travel configuration (Figure 4-1) when finished working in this area.

CABLE REEVING

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

Within the limits of the load and range charts and permissible line pull, multi-part lines allow the operator to raise a greater load than can be raised with a single part line. Various cable

reeving (part line) is possible with the boom nose and hook block (Figure 4-7) and (Figure 4-8). This reeving should be accomplished by a qualified rigger using standard rigging procedures.

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

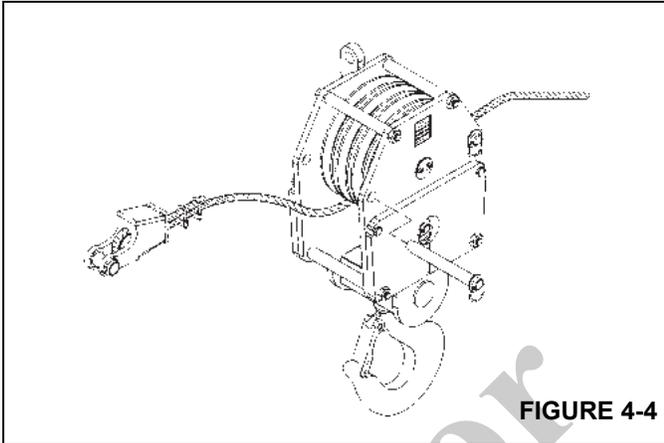


FIGURE 4-4

Boom Cable Reeving

When reeving the boom, always reeve the main hoist wire rope through the rope grab; if also reeving the auxiliary hoist rope, reeve the auxiliary hoist rope outside of the rope grab.

DEAD-END RIGGING/WEDGE SOCKETS

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

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

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

Grove specifies the size, type, class and line pulls for wire rope, predominately rotation resistant wire rope, and rigging accessories such as overhaul balls and hook blocks for use with each new crane that it manufactures. Other wire ropes and rigging accessories are available from various vendors. Different wire rope manufacturers have differing requirements for the construction, handling, cutting, seizing,

installation, termination, inspection and replacement of the wire ropes they produce. Their advice should be sought for each specific type of wire rope a crane user intends to install on a mobile crane.

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

CAUTION

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

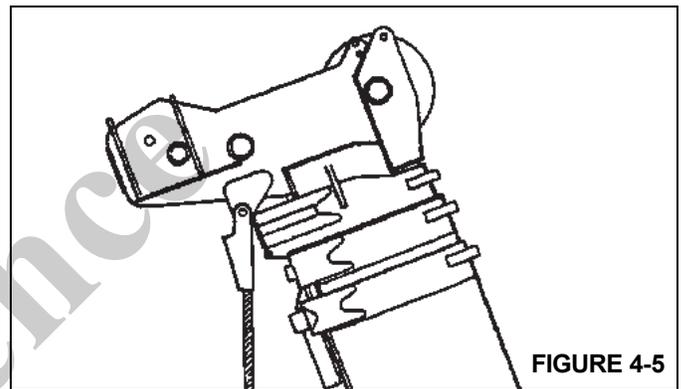


FIGURE 4-5

When anchoring the socket to the boom, ensure the flat face of the socket is in position, as shown, toward the boom sections (Figure 4-5).

INSTALLING WEDGE AND SOCKET

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

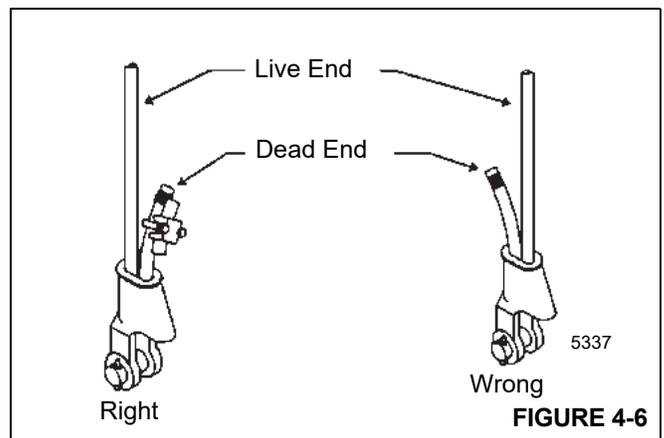


FIGURE 4-6

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

Sketches A through F (Figure 4-7) illustrate various methods for treating the dead-ends of wire ropes which exit a wedge socket assembly. While use of the loop-back method is acceptable, care must be exercised to avoid the loop becoming entangled with tree branches and other components during crane transport and with the anti-two block system and other components during use of the crane.

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

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

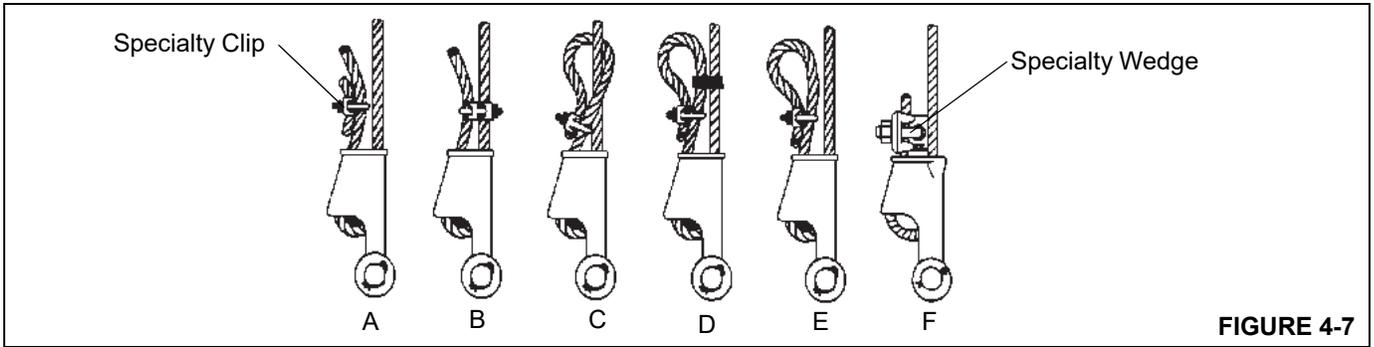
NOTE: The use of swivels is not allowed in conjunction with non-rotation resistant wire ropes

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

Table 4-1

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

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



For Reference Only

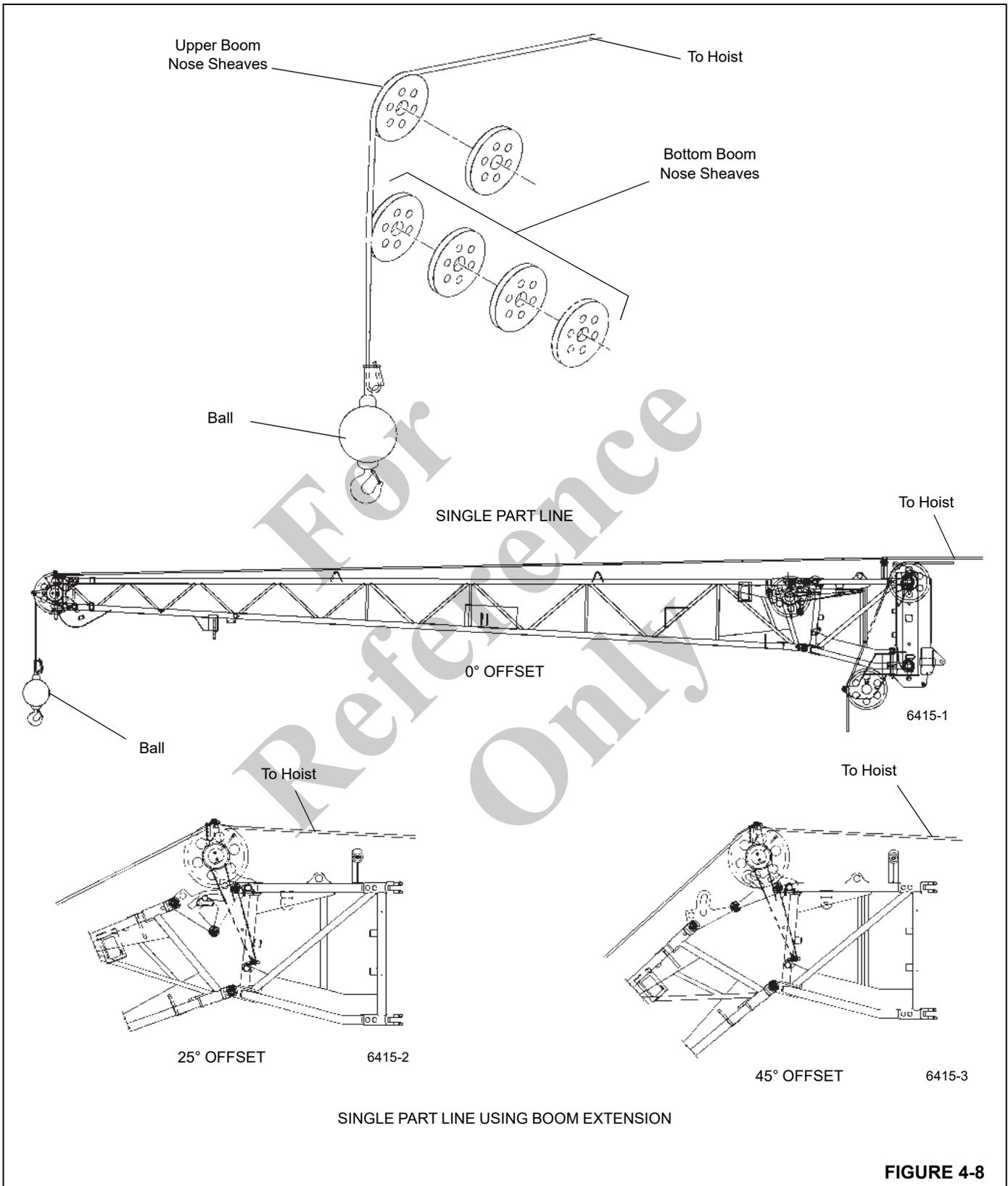


FIGURE 4-8

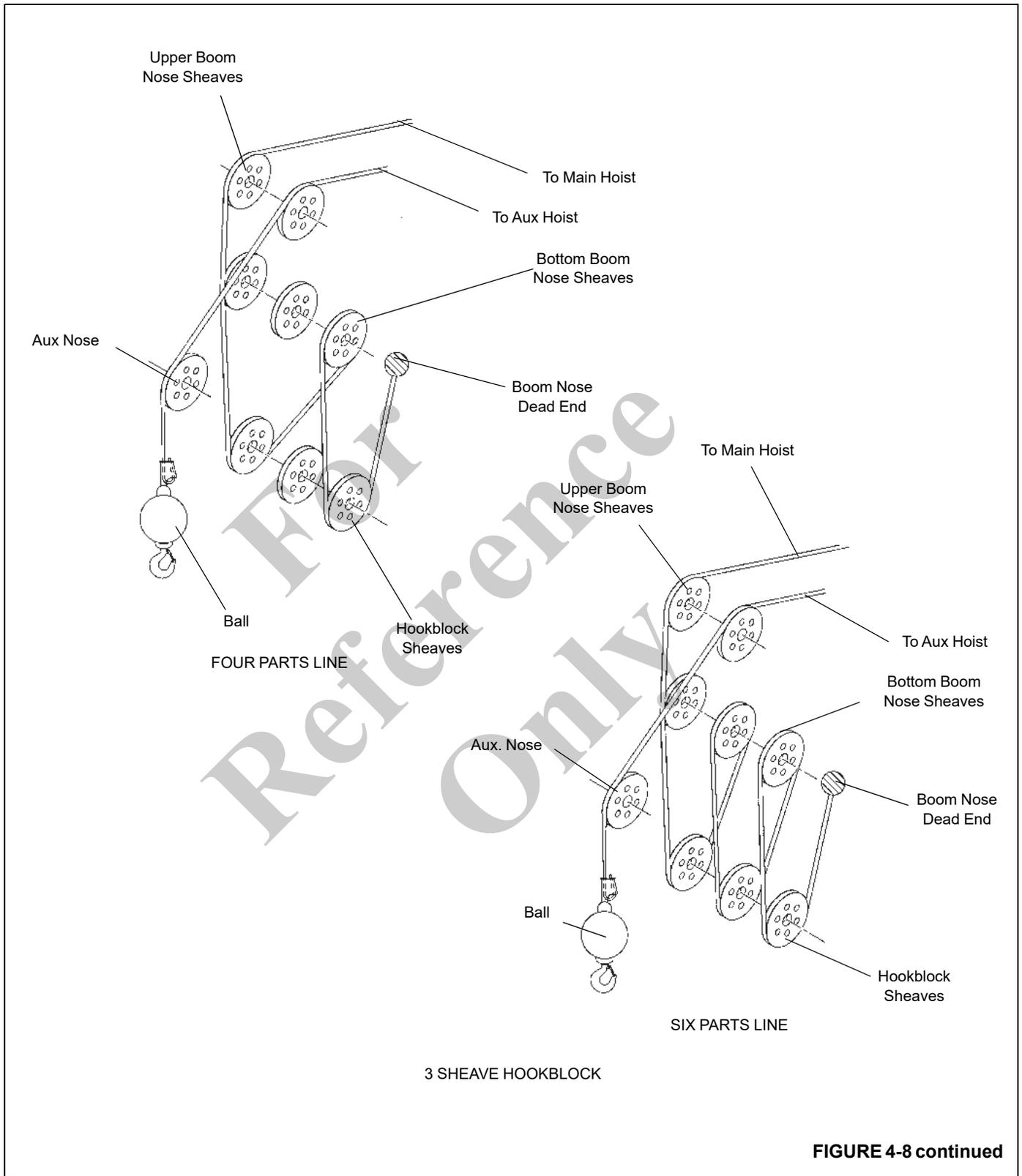


FIGURE 4-8 continued

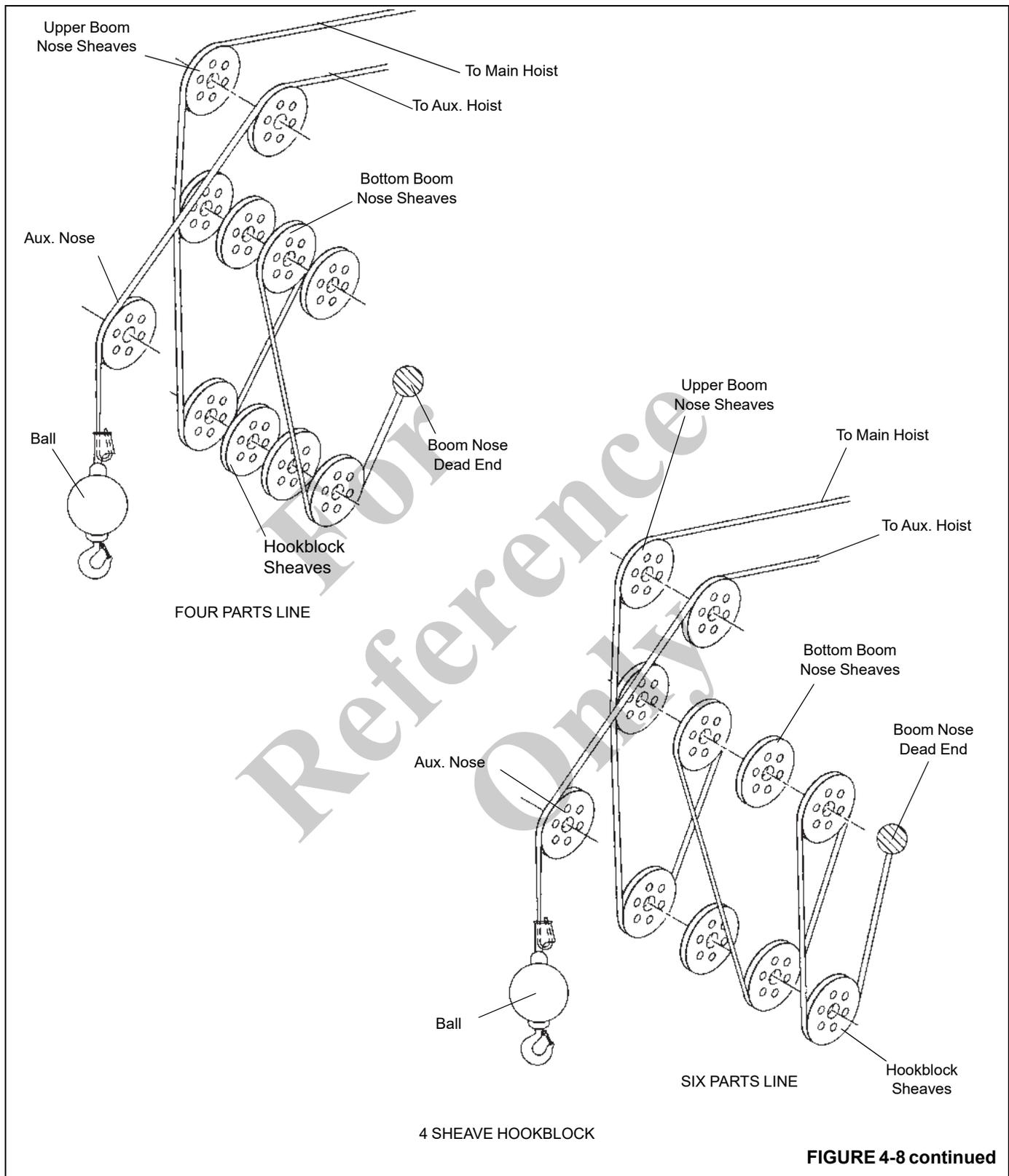


FIGURE 4-8 continued

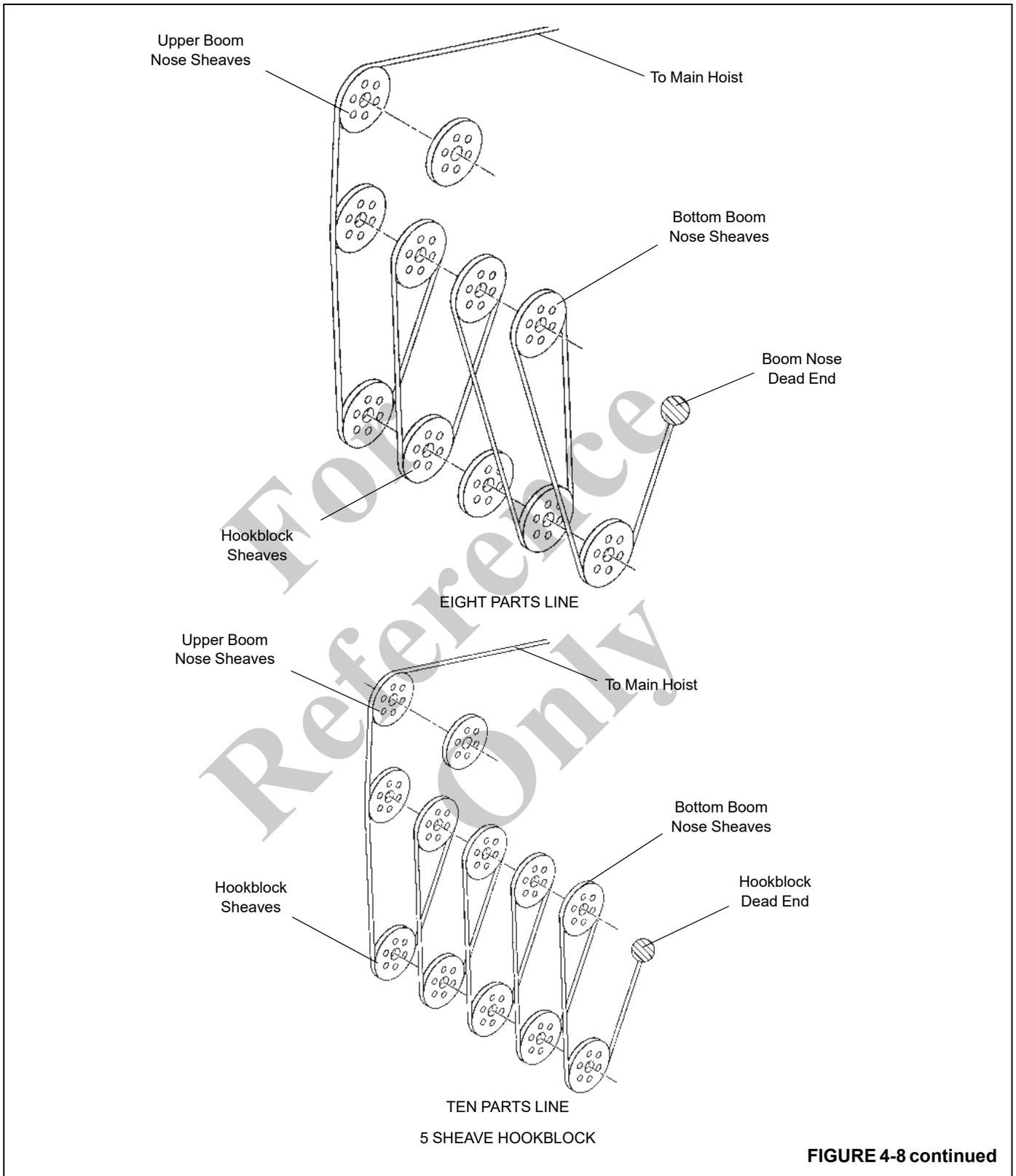


FIGURE 4-8 continued

ANTI TWO BLOCK (A2B) SWITCH

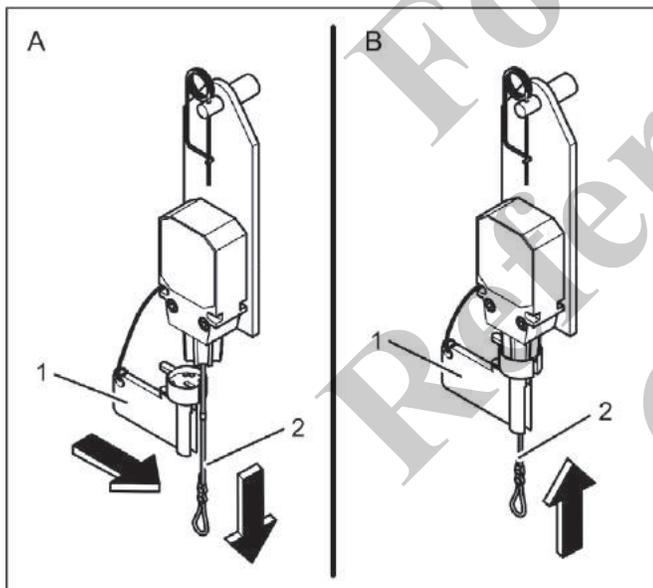
If a hoist rope has been reeved and two A2B switches are installed, the unused A2B switch must be locked (disabled) to allow all crane operations.

Lock

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).



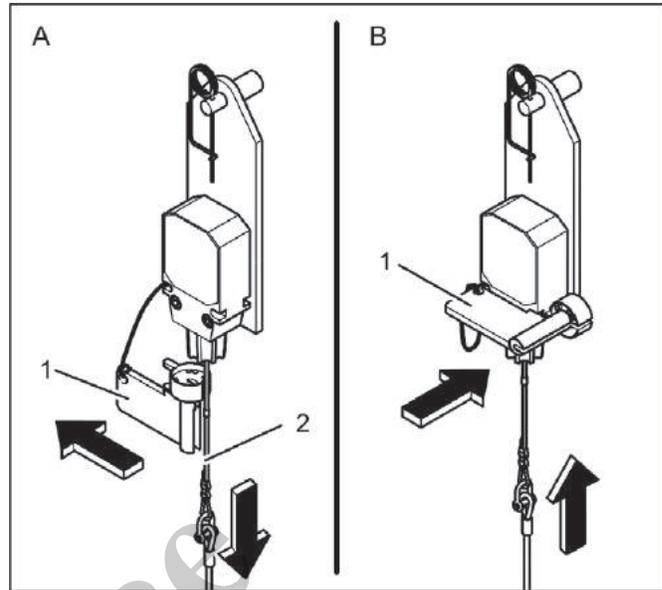
8684-1

FIGURE 4-9

Unlock

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 4-10

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 extension, 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 lattice extension and the distributor socket on the main boom. The main boom A2B switch weight must be disconnected and mounted on the extension or fly boom 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 extension, 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 extension 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 extension (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 main boom or lattice extension, the inspection procedure must be repeated for the A2B switch of the extension/top section.
6. Check display of main boom length agrees with actual boom length.
7. Check display of main boom angle agrees with actual boom angles.
8. Check display of the crane operating radius agrees with the actual radius.
9. Check load display by lifting a load of known weight. Load display accuracy must be within the tolerance range.

ERECTING AND STOWING THE BI-FOLD BOOM EXTENSION



DANGER

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

Lifting over the bi-fold extension base section is strictly prohibited, when the fly extension is either erected or folded along side of extension base section.

Erecting

1. Fully extend and set the outriggers.
2. Position the boom over the front.
3. If extended, fully retract all the boom sections and lower the boom to minimum elevation to permit ease of installation of pins and access to the boom nose.

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

4. Rig either the main hoist or optional auxiliary hoist cable for single part line with nothing but the wedge socket on the end of the cable.
5. Extend the boom enough to disengage the spring loaded boom stop block (Figure 4-11).
6. Pull down on the handle to disengage the spring loaded boom stop block. Place the handle in the retainer plate to lock. Fully retract the boom.

NOTE: When the boom retracts, the handle will be released allowing the stop block to re-engage when the boom is extended.

7. Remove the retainer clips from the attachment pins stowed in the base of the boom extension and insert the attachment pins through the attachment and anchor fittings on the right side of the boom nose. Install the retainer clips in the attachment pins.

CAUTION

If the boom extension fly section (stinger) is not to be erected, it should remain on the stowage brackets on the side of the boom.



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FIGURE 4-11

NOTE: If erecting the boom extension fly section with the boom extension base section, skip to step 12. If not erecting the boom extension fly section, perform steps 8 to 11.

8. Remove retainer clip from base to fly attachment pin and remove attachment pin from base section to fly section attachment fittings.
9. Stow the pin in the opposite attach fitting or the stowage lug.
10. Ensure the pin attaching the fly section to the boom base section rear stowage bracket (Figure 4-12), (Detail D) is in place.
11. At fly section sheave end (Figure 4-12), (Detail E) push in on the spring loaded latch hook to release latch, allowing the base to separate from the fly. Skip to step 14.
12. Remove the pin attaching the fly extension section to the boom base section rear storage bracket ((Figure 4-12), (Detail D). Ensure that the latch hook at the fly section sheave end (Figure 4-12), (Detail E) is latched.
13. Remove the lock hitch pin securing the extension base to the front stowage bracket (Figure 4-12), (Detail A). Stow lock hitch pin in lug provided.
14. Attach a length of rope to the extension base section tip to aid in the extension of the swingaway into place ahead of the boom nose.

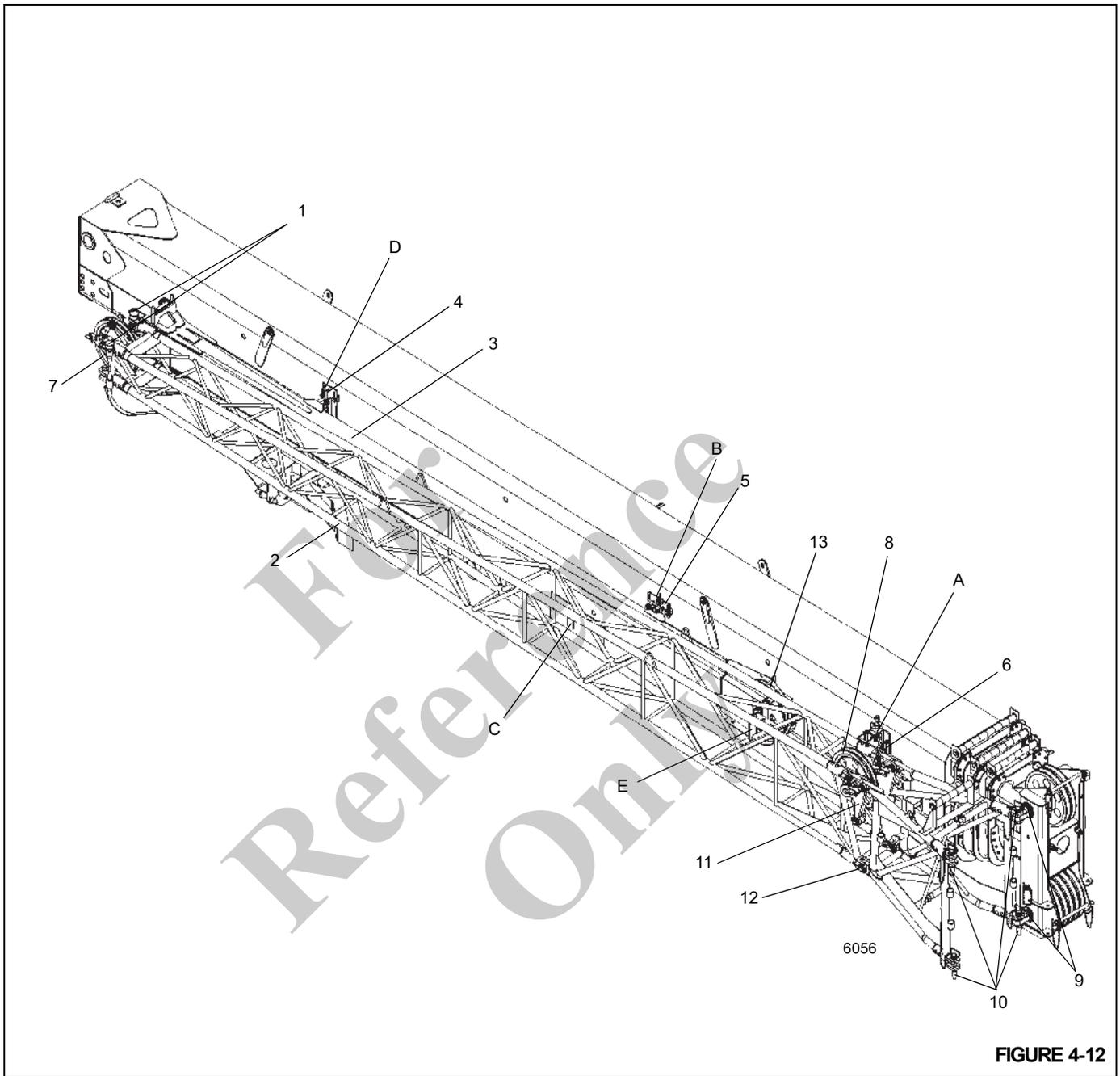
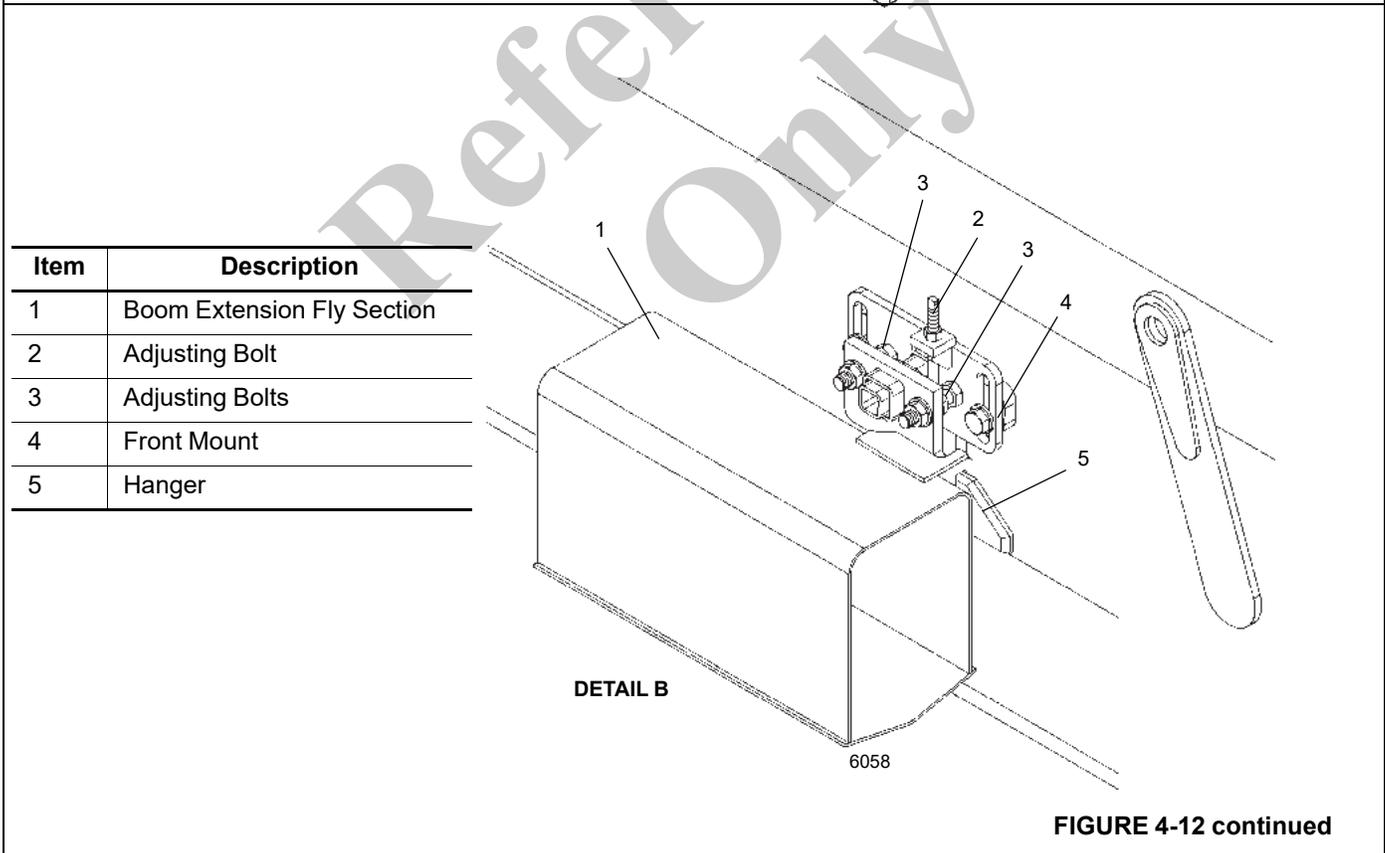
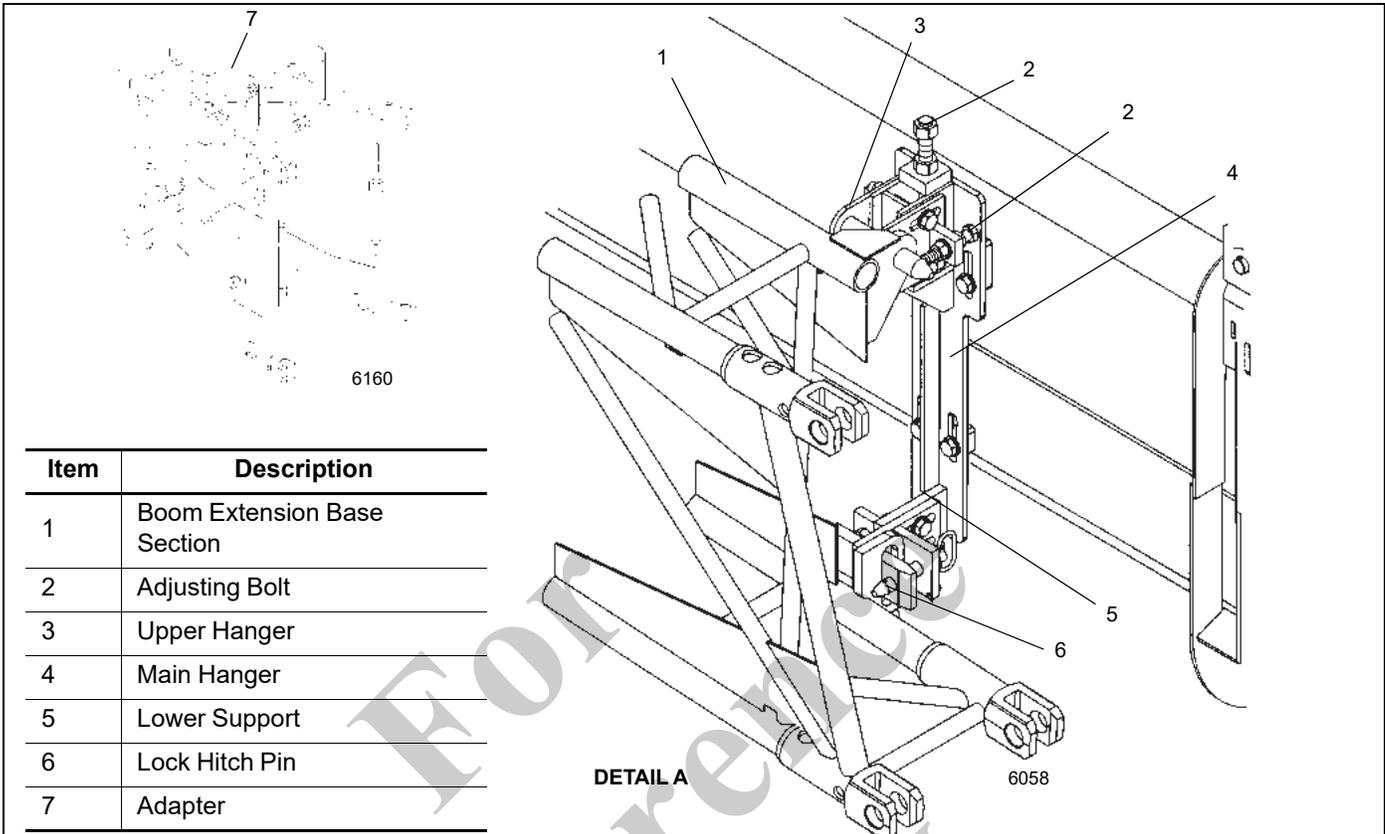


FIGURE 4-12

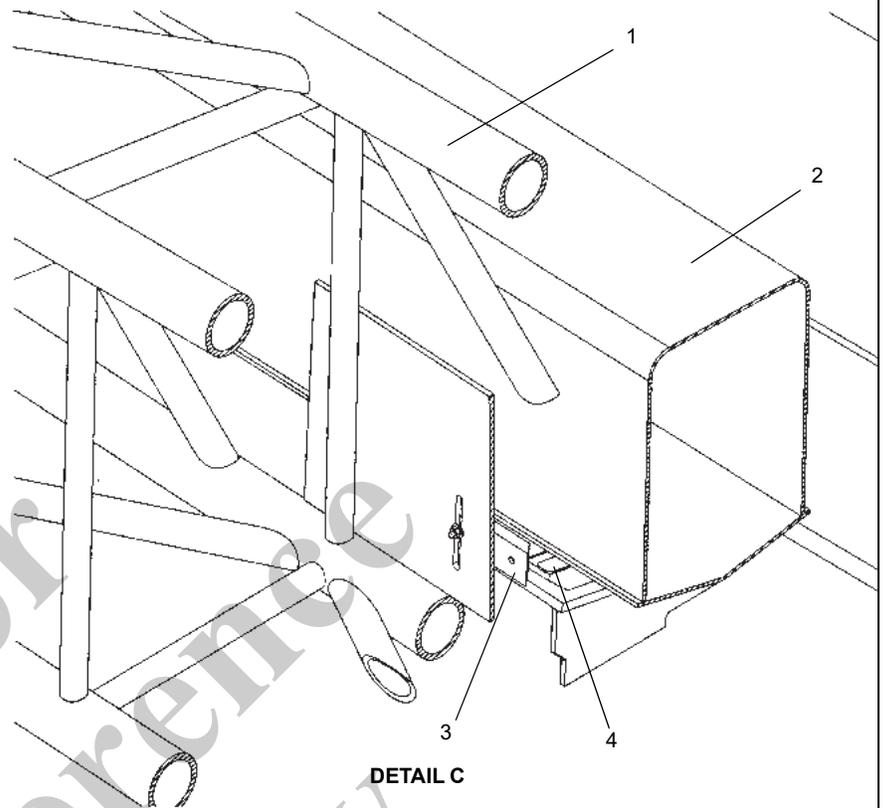
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Item	Description
1	Base To Fly Attachment Pins
2	Boom Extension Base Section
3	Boom Extension Fly Section
4	Fly Rear Stowage Bracket
5	Stinger Section Front Stowage Bracket
6	Front Stowage Bracket
7	Swingaway Base Sheave

Item	Description
8	Mast Assembly
9	Boom Nose To Boom Extension Attachment Anchor Fittings
10	Boom Nose To Boom Extension Attachment Pins
11	Offset Links
12	Offset Pivot Point
13	Stinger Sheave



Item	Description
1	Boom Extension Base Section
2	Boom Extension Fly Section
3	Shock Wear Pad and Shim
4	Ramp Wear Pad and Shim



Item	Description
1	Boom Extension Base Section
2	Boom Extension Fly Section
3	Fly Attachment Pin and Hitch Pin
4	Adjusting Bolts
5	Pin Stowage Lug
6	Upper Support
7	Lower Mount Ramp
8	Wear Pad

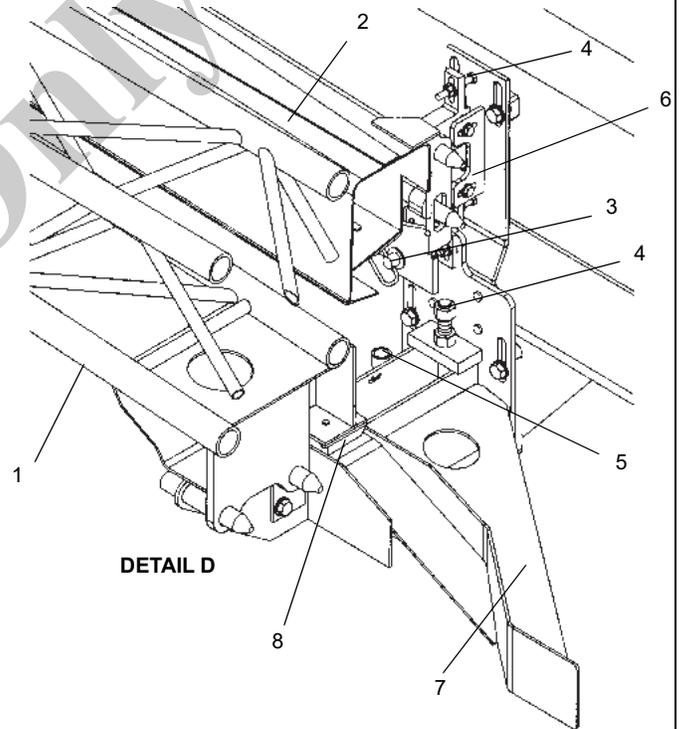
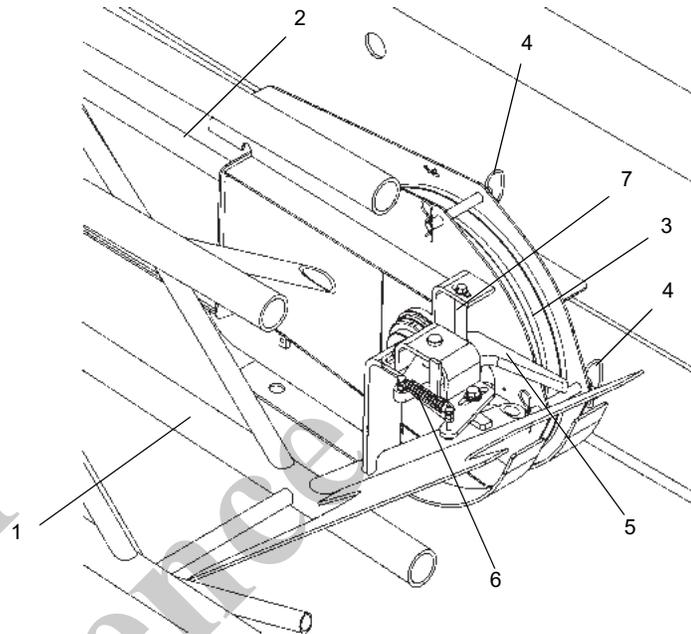


FIGURE 4-12 continued

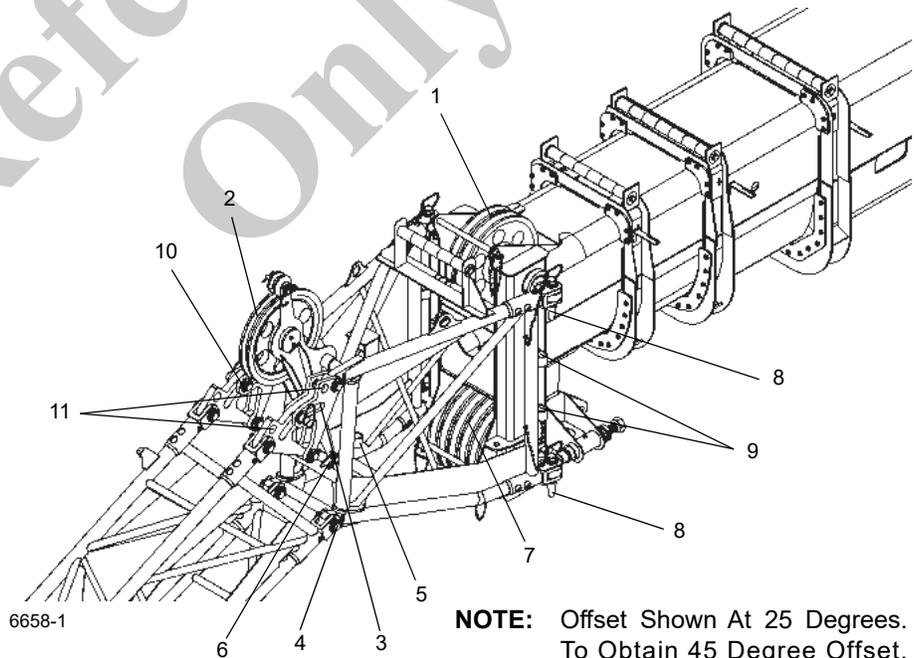
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Item	Description
1	Boom Extension Base Section
2	Boom Extension Fly Section
3	Fly Sheave
4	Cable Retainer Pins
5	Latch Hook
6	Spring
7	Latch Bar



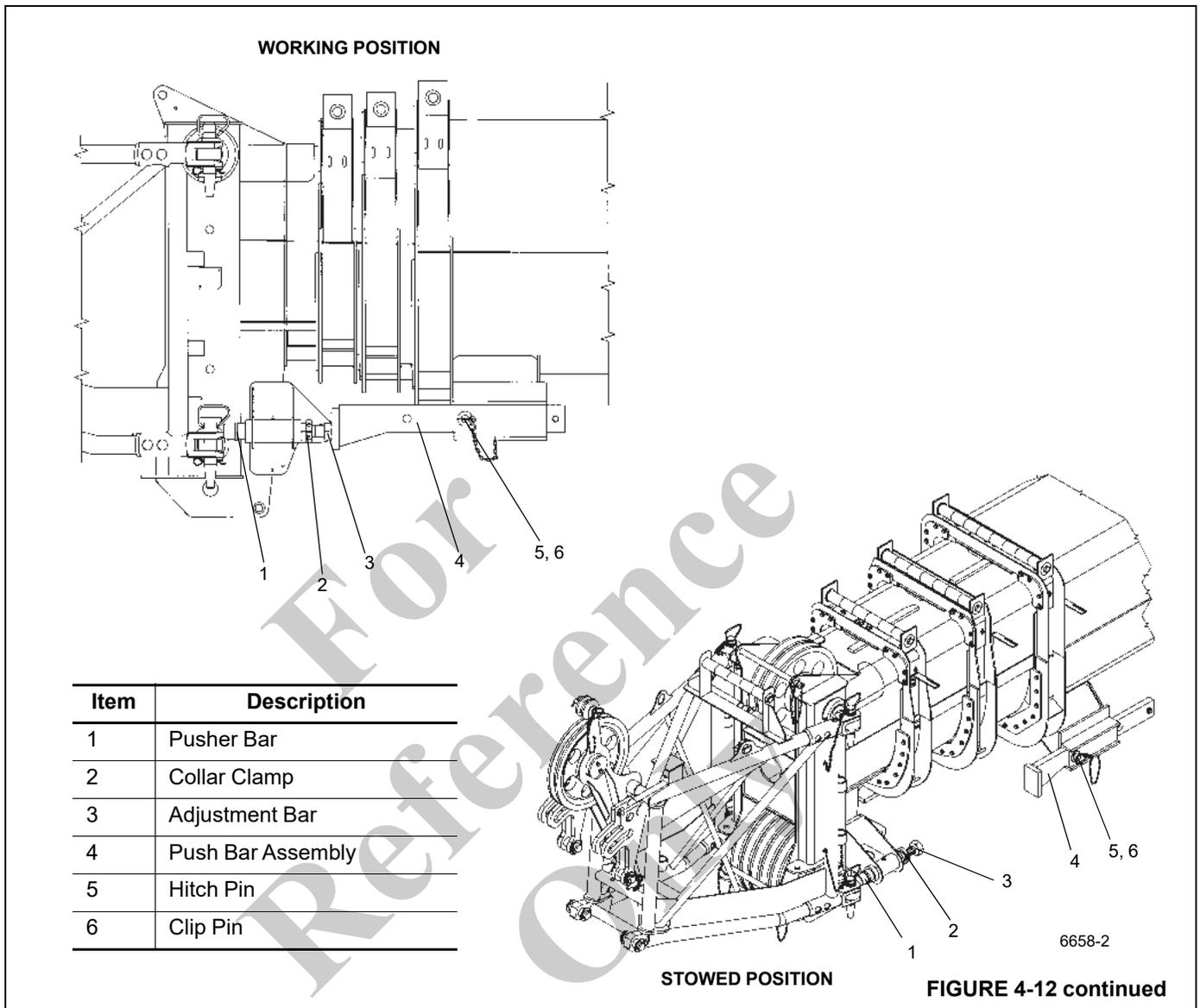
DETAIL E

Item	Description
1	Boom Nose Upper Sheaves
2	Mast Assembly
3	Offset Links
4	Offset Pivot Points
5	Offset Link Pins Stowage Lugs
6	Mast Assembly Pin
7	Boom Nose Lower Sheaves
8	Boom Extension Attachment Pins
9	Boom Extension Attachment Pins Stowage Lugs
10	Offset Link Pins
11	Zero Degree Offset Holes



NOTE: Offset Shown At 25 Degrees. To Obtain 45 Degree Offset, Remove Pins (Item 10) and Stow in Lug.

FIGURE 4-12 continued



CAUTION

If the fly section remains on the extension base, do not extend the extension assembly to far, as the nose of the extension fly section could contact the front stowage bracket and cause damage.

- 15. Raise the boom to horizontal and extend the boom just enough to clear the extension stowage lugs from the guide ramps and stowage pins on the front and rear stowage brackets.
- 16. Remove the hitch pin and clip pin securing the boom extension alignment device in the stowed position. Pull

the push bar assembly out to the working position and secure it in place with the hitch pin and clip pin.

DANGER

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

- 17. Slightly raise and/or lower the boom to help control the extension. Using the rope attached to the tip of the extension, swing the extension into place ahead of the boom nose, engaging the anchor fittings with the attachment fittings on the left side of the boom nose.

! DANGER

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

- 18. Install the attachment pin into the upper anchor and attachment fitting on the left side of the boom nose. Install retainer clip in attachment pin.

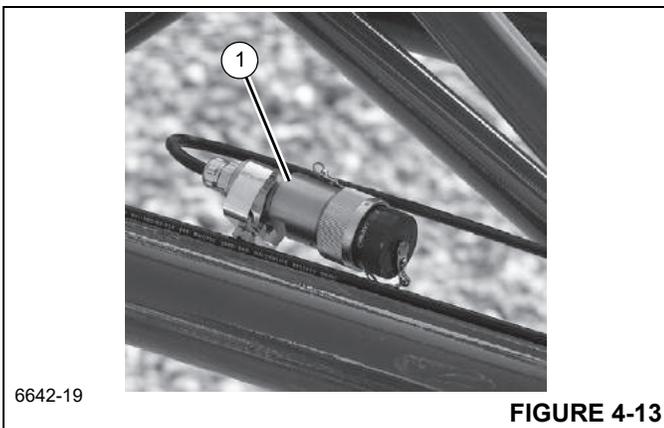
NOTE: If the boom extension alignment device does not properly align the anchor and attachment fittings to allow installation of the last attachment pin, refer to the Service Manual and adjust the boom extension alignment device.

- 19. Fully retract the boom until the bottom extension anchor fitting is against the boom extension alignment device and install the attachment pin in the lower anchor and attachment fittings on the left side of the boom nose. Install the retainer clip in the attachment pin.
- 20. Lower the boom and remove the rope from the tip of the extension base section.
- 21. Remove the hitch pin and clip pin securing the boom extension alignment device in the working position. Push the push bar assembly back to the stowed position and secure it in place with the hitch pin and clip pin.

! DANGER

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

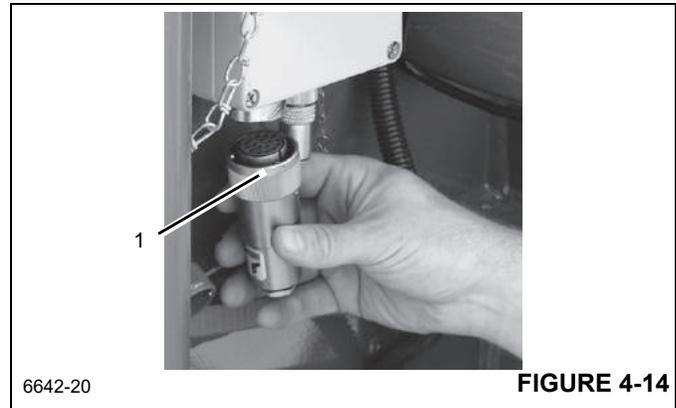
- 22. Connect RCL cables:
 - a. Remove RCL cable end connector (1) Figure 4-13 from extension and route through boom extension.



6642-19

FIGURE 4-13

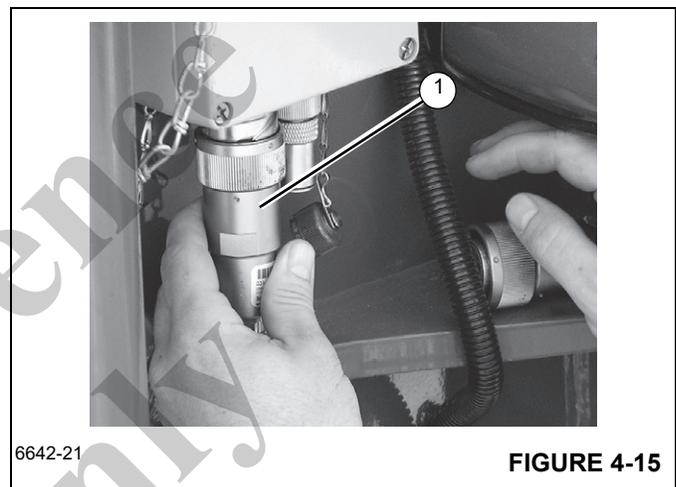
- b. Remove dummy plug (1) Figure 4-14 from junction box on boom nose.



6642-20

FIGURE 4-14

- c. Install cable end connector (1) Figure 4-15 from boom extension where dummy plug was removed.



6642-21

FIGURE 4-15

- 23. Erect the boom extension fly section as follows:
 - a. Attach a length of rope to the tip of the extension fly section to aid in swinging the fly into place ahead of the base section. Ensure that the right base to fly extension attachment pin is in place.
 - b. Position the boom to horizontal.
 - c. At the fly section sheave end (see detail E), push in on the spring loaded latch hook to release the latch allowing fly to separate from the base.

! DANGER

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

- d. Slightly raise and/or lower the boom to help control the extension fly. Using the rope attached to the tip of the fly section, swing the fly into place ahead of the extension base, engaging the anchor fittings with the attachment fittings on the left side of the base section.

- e. Install the attachment pin into the anchor and attachment fittings on the left side of the base section.
- f. Lower the boom and remove the rope from the tip of the extension.

NOTE: Refer to *Setting the Folding Swingaway Offset*, page 4-21 in to obtain a 25 or 45 degree offset with the swingaway.

- 24. Remove the cable retainer pins and clip pins from the tip of the extension base section or extension fly section.
- 25. Remove the mast assembly clip pin and pin from the stowed position on the extension and raise the mast assembly to an upright position. Install the pin and clip pin. Remove the cable retainer pin and clip pin from the mast.

NOTE: The hoist cable is not routed over the base extension sheave when using the fly extension.

- 26. Route the hoist cable over the mast sheave, the rollers on the adapter, the roller on the fly extension, and the sheave on the extension tip. Install the cable retainer pins and clip pins.

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

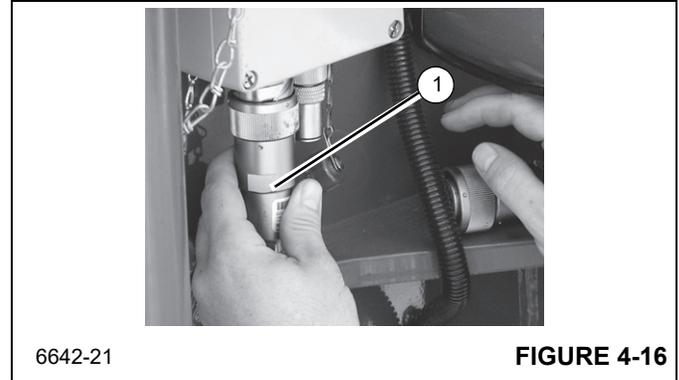
- 26. Rig the hoist cable.

Stowing the Swing-Away Boom Extension

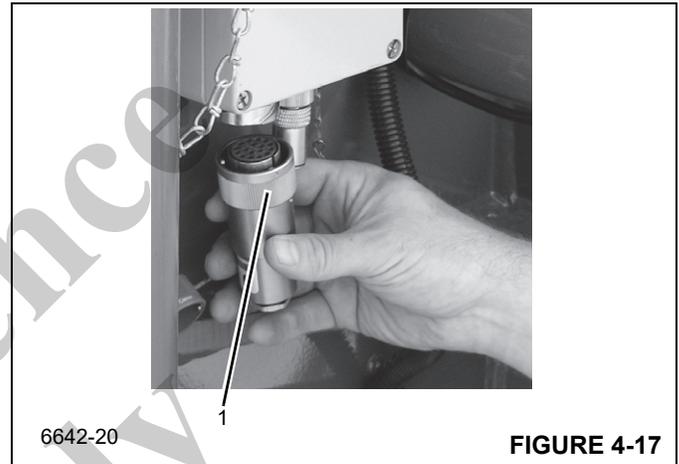
NOTE: The boom extension must be set at the zero (0) degree offset. Refer to *Setting the Folding Swingaway Offset*, page 4-21.

NOTE: If so equipped, the folding fly section must be stowed on the side of the base section.

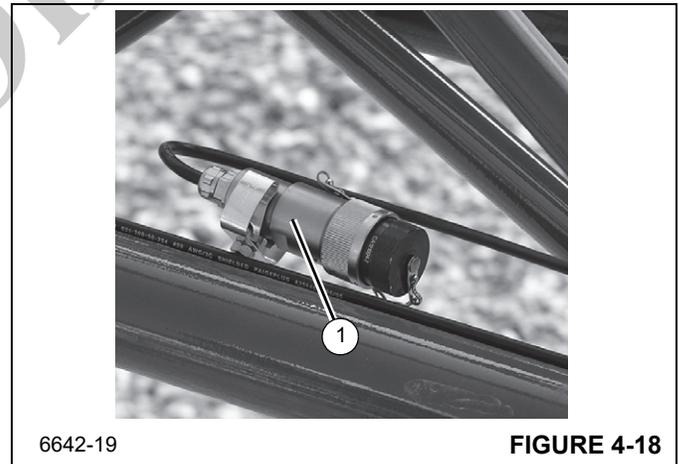
- 1. Fully retract the boom and swing it over the front.
- 2. Lower the boom to minimum elevation.
- 3. Remove the cable retainer pins and clip pins from the swingaway tip and mast assembly. Remove the hoist cable from the extension sheave and or mast. Install the cable retainer pins and clip pins.
- 4. Remove the mast assembly pin and clip pin securing the mast in the upright position. Lay the mast over to the stowed position and install the mast assembly pin and clip pin.
- 5. Disconnect RCL cable.
 - a. Remove connector (1, Figure 4-16) from junction box on boom nose.



b. Install dummy plug (1, Figure 4-17) on junction box.



c. Route cable through boom extension and stow connector (1, Figure 4-18).



- 6. If erected, stow the extension fly section as follows:
 - a. Attach a length of rope to the fly extension tip.
 - b. Raise the boom to horizontal.
 - c. Remove the retainer clip and attachment pin from the anchor and attach fittings on the left side of the base section and stow in the base section.

! **DANGER**

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

- d. Slightly raise and/or lower the boom to help control the extension fly. Using the rope attached to the tip of the fly section, swing the fly to the side of the base section.
 - e. Elevate the boom and push in on the fly section to engage the spring loaded latch hook (Detail E) on the base section. Ensure the latch hook is properly engaged.
 - f. Lower the boom and remove the rope from the fly section.
7. Remove the pin and clip pin securing the boom extension alignment device in the stowed position. Pull the alignment device out to the working position and secure it in place with the pin and clip pin.
 8. Lower the boom to minimum elevation.
 9. Attach a length of rope to the base extension tip.
 10. Raise the boom to horizontal.
 11. Remove the retainer clips and attach pins from the anchor and attachment fittings on the left side of the boom nose and stow them in the base of the base extension.
 12. Extend the boom enough so that the extension base and fly storage lugs will line up in front of the guide ramps and pins on the stowage brackets when the swingaway is positioned to the side of the boom.

! **DANGER**

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

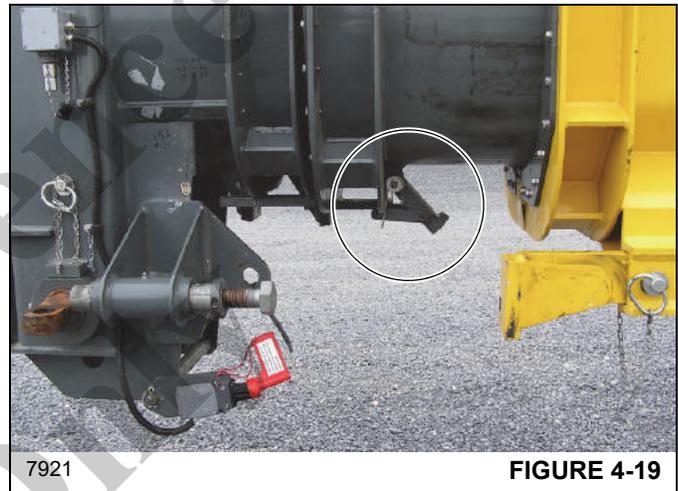
13. Raise and/or lower the boom to help control the swingaway and using the rope attached to the tip of the base extension, swing the base extension to the side of the boom.
14. Elevate the boom and push in on the extension to align the stowage lugs on the extension with the guide ramps and pins on the stowage brackets and fully retract the boom.

! **DANGER**

During disengagement of the stop block, extend the boom only enough to free the block. Extending the boom too far will cause the base extension to slide off the guide ramps and allow the extension to swing.

15. Lower the boom and extend the boom only enough to disengage the spring loaded boom stop block.
16. Pull down on the handle to disengage the spring loaded boom extension stop block (Figure 4-19). Place the handle in the retainer plate. Fully retract the boom.

NOTE: When the boom retracts, the handle will be released allowing the stop block to re-engage when the boom is extended.



17. Ensure that all the stowage lugs on the base and fly are fully engaged with the pins on the stowage brackets.

18. Insert lock hitch pin. Install the pin securing the extension base to the front stowage bracket (Figure 4-8), (Detail A). Ensure the lock hitch pin is pushed all the way in.

19. Install the pin attaching the fly section to the boom base section stowage bracket (Figure 4-12), (Detail D).

NOTE: If the extension fly section remained on the boom stowage brackets, perform steps 19 thru 22.

20. Remove retainer clip and attachment pin from the bushing on base section.
21. Insert the attachment pin into the base section to fly section attachment fittings and install the retainer pin.
22. Ensure the spring loaded latch hook is engaged on fly section sheave end (Figure 4-12), (Detail E).

23. Ensure the pin attaching the fly section to the boom base section stowage bracket (Figure 4-12), (Detail D) is in place.
24. Remove the retainer clips and attachment pins from the anchor and attach fittings on the right side of the boom nose and stow them in the base of the swingaway.
25. Remove the clip pin and pin securing the boom extension alignment device. Place the boom extension push bar assembly in the stowed position and secure it in place with the pin and clip pin.

**DANGER**

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

26. Extend the boom enough to engage the boom stop block.
27. Rig the boom nose and hoist cable as desired and operate the crane using normal operating procedures.

Setting the Folding Swingaway Offset**DANGER****Crushing Hazard!**

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

1. Extend and set the outriggers and swing the boom to over the front. Position the boom to above horizontal.
2. Block under the tip of the extension assembly section.
3. To set the offset from a lesser degree to higher degree perform the following procedures:

CAUTION**Possible Equipment Damage!**

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

- a. Slowly lower the boom until the pressure is relieved on the offset link pins.

NOTE: Make sure the mast is in the raised position.

- b. Remove the offset link clip pins and attach pins securing the offset links in the lesser degree offset position. If going to maximum offset stow them in the stowage lugs. If going to the intermediate (25 degree) offset install them in the offset links for that degree of offset.
 - c. Slowly elevate and telescope the boom at the same time so that the extension does not move off of the blocking until the offset links take the full weight of the extension.
 - d. Reeve the hoist cable as described under normal erecting procedures.
4. To set the offset from higher degree to lesser degree, perform the following procedures:

CAUTION

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

- a. Slowly lower the boom until the pressure is relieved from the offset links.
- b. Remove the offset link clip pins and attachment pins and lower the boom until the holes for the lesser degree offset position align in the offset links. Install the offset pins and clip pins.
- c. Slowly elevate and telescope the boom at the same time so that the extension does not move off of the blocking until the offset links take the full weight of the extension.
- d. Reeve the hoist cable as described under normal erecting procedures.

ERECTING AND STOWING THE BI-FOLD BOOM EXTENSION WITH THE 20 FT (6.1 m) INSERT**DANGER****Crushing Hazard!**

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

Erecting

1. Fully extend and set the outriggers.
2. Position the boom over the front.

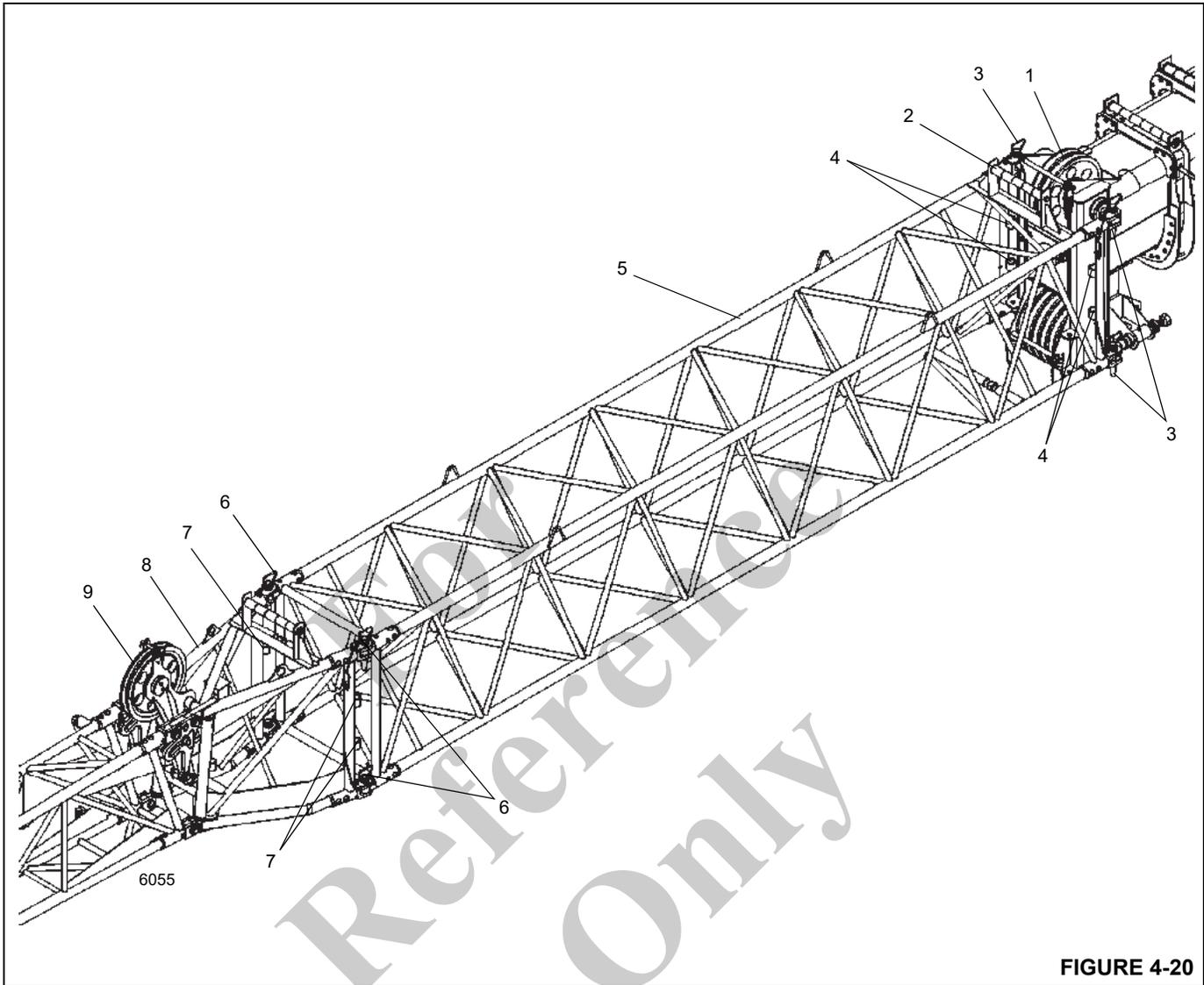


FIGURE 4-20

Item	Description
1	Boom Nose Upper Sheaves
2	Cable Roller
3	Insert Attachment Pins
4	Insert Attachment Pins Stowage Lugs
5	20 ft (6.1 m) Insert
6	Bi-Fold Extension Attachment Pins

Item	Description
7	Boom Nose Lower Sheaves
8	Boom Extension Attachment Pins
9	Bi-Fold Extension Attachment Pins Stowage Lugs
10	Offset Link Pins
11	Zero Degree Offset Holes

- If extended, fully retract all the boom sections and lower the boom to minimum elevation to permit ease of installation of pins and access to the boom nose.

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

- Attach the swingaway to the boom nose using steps 5 thru 21 of Erecting The Bi-Fold Boom Extension Assembly.
- Extend the boom as necessary to permit sufficient clearance for installation of the 20 ft (6.1 m) Extension Insert; then lower it until the tip of the bi-fold extension assembly is laying on the ground. Block up under the bi-fold extension, approximately 8 to 10 ft (2.4 to 3.0 m) ahead of the boom nose.
- Remove the four retainer clips and attachment pins that secure the bi-fold extension to the boom nose.
- Retract the boom leaving the bi-fold extension on the blocking.
- Using the main or auxiliary hoist cable, lift the Insert by the lifting lugs and position it at the base end of the bi-fold extension.
- Mate the Insert to the bi-fold extension and install the four attaching pins and retainer clips removed in step 6.
- With the hoist cable still attached to the Insert, lift the assembled unit and move the blocking, erected in step 5, to approximately 8 to 10 ft (2.4 to 3.0 m) ahead of the boom nose attach end of the Insert.

NOTE: Repeat steps 6 through steps 16 in a similar manner to install the second Insert if applicable.

- Lower the bi-fold and insert assembly onto the blocks and detach the hoist cable.
- Retract the boom and lower to minimum elevation.
- Rig the hoist cable for single part line with nothing but the wedge socket on the end of the cable.
- Extend the boom and mate the attachment lugs on the Insert with the anchor fittings on the boom nose. It may be necessary to raise or lower the boom slightly to mate the attach lugs.

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

- Remove the retainer clips from the four attachment pins stowed on the Insert and install them in the attachment

and anchor fittings on both sides of the boom nose. Install the retainer clips.

CAUTION

Possible Equipment Damage!

Do not attempt to swing the boom extension around to the right side of the insert. This could result in damage to the insert.

- Slowly elevate the boom and remove the blocking from under the Insert and bi-fold extension.
- Refer to steps 22 thru 26 of Erecting The Boom Extension to erect the fly section, to set the offset, and rig the hoist cable.

Stowing

NOTE: If equipped, the folding fly section must be stowed on the side of the base section.

- If the fly section is erected, refer to steps 1 thru 5 of Stowing The Bi-Fold Boom Extension.
- Extend the boom approximately 4 to 5 ft (1.22 to 1.52 m). Lower the boom until the sheave is on the ground.
- Block up under the insert approximately 8 to 10 ft (2.4 to 3.0 m) forward of the boom nose.
- Remove the retainer clips from the four pins in the attachment and anchor fittings and remove the attachment pins. Stow the pins in the holders on the insert.
- Retract the boom disengaging the anchor fittings on the boom nose from the attaching lugs on the insert.
- Attach a hook to the hoist cable.
- Attach the hoist cable hook to the lifting lugs on the insert. Lift the assembly and reposition the blocking approximately 2.4 to 3 m (8 to 10 ft) forward of the insert to swingaway attachment points.
- While supporting the insert with the hoist cable, remove the retainer clips from the four pins attaching the insert to the swingaway. Remove the four pins.
- Remove the insert and position it to one side of the crane.
- Position the boom and extend it to engage the boom nose with the swingaway. Install the four attachment pins and retainer clips removed in step 8.
- Stow the swingaway on the side of the main boom using steps 6 thru 26 of *Stowing the Swing-Away Boom Extension*, page 4-19.

FIXED COUNTERWEIGHT

Description

The fixed counterweight assembly (Figure 4-21) is pinned to the rear of the superstructure and weighs about 14,400 lb (6540 kg). For cranes without an auxiliary hoist, an additional 1478 lb (672 kg) counterweight is bolted to the hoist mounting area instead of the auxiliary hoist.

Maintenance



DANGER Crushing Hazard!

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

Ensure the counterweight pin assemblies are installed properly and are secure in their catches.

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

Removal

1. Fully extend and set the outriggers.
2. Rotate the superstructure so the counterweight is over the front of the carrier to gain additional clearance.

NOTE: The counterweight weighs approximately 13,007 lb (5900 kg).

3. Lower and fully retract the boom.

NOTE: Use of a forklift to install or remove the counterweight is not recommended. Damage or misalignment of the counterweight can result if a fork-lift is used for installation or removal.

4. Attach an adequate lifting device to the counterweight.
5. Adjust the four counterweight leveling bolts to provide maximum clearance of the counterweight from the superstructure.
6. Take up any slack on the lifting device and raise the counterweight just enough to remove any pressure on the left and right counterweight pin assemblies.
7. Remove the pins from the superstructure frame lugs and the counterweight. To remove each pin, push pin in and

turn it so its roll pin disengages from the related catch on the counterweight.

8. Lower the counterweight enough to clear the superstructure. Remove the counterweight from the crane and replace the retainer pins in mounting lugs.
9. Rotate the superstructure to the normal travel position.

Installation

1. Fully extend and set the outriggers.
2. Rotate the superstructure so the counterweight will be over the front of the carrier to gain additional clearance.

CAUTION

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

NOTE: The counterweight assembly weighs approximately 14,400 lb (6540 kg).

Use of a forklift to install or remove the counterweight is not recommended; damage or misalignment of the counterweight can result.

3. Attach an adequate lifting device to the counterweight and lift the counterweight into place on the superstructure, aligning the mounting holes on the counterweight to the holes in the superstructure.
4. Secure the counterweight to the superstructure with the two pins. Secure the pin by pushing it in and turning it so the roll pin engages the related catch on the counterweight. Release the pin so its spring can hold the pin in place.
5. Remove the lifting device from the counterweight.
6. Using the four counterweight leveling bolts, level the counterweight and eliminate any relative movement between the counterweight and turntable. Maximum height of counterweight shall not exceed 0.24 in (6 mm) out of level with the turntable bearing when measured from either counterweight outer edge.

Counterweight Plate

The counterweight has a removable counterweight plate attached to its rear wall with capscrews, flat washers and nuts. This plate weighs 870 lb (395 kg). Use appropriate caution and safety equipment in removing and installing this plate.

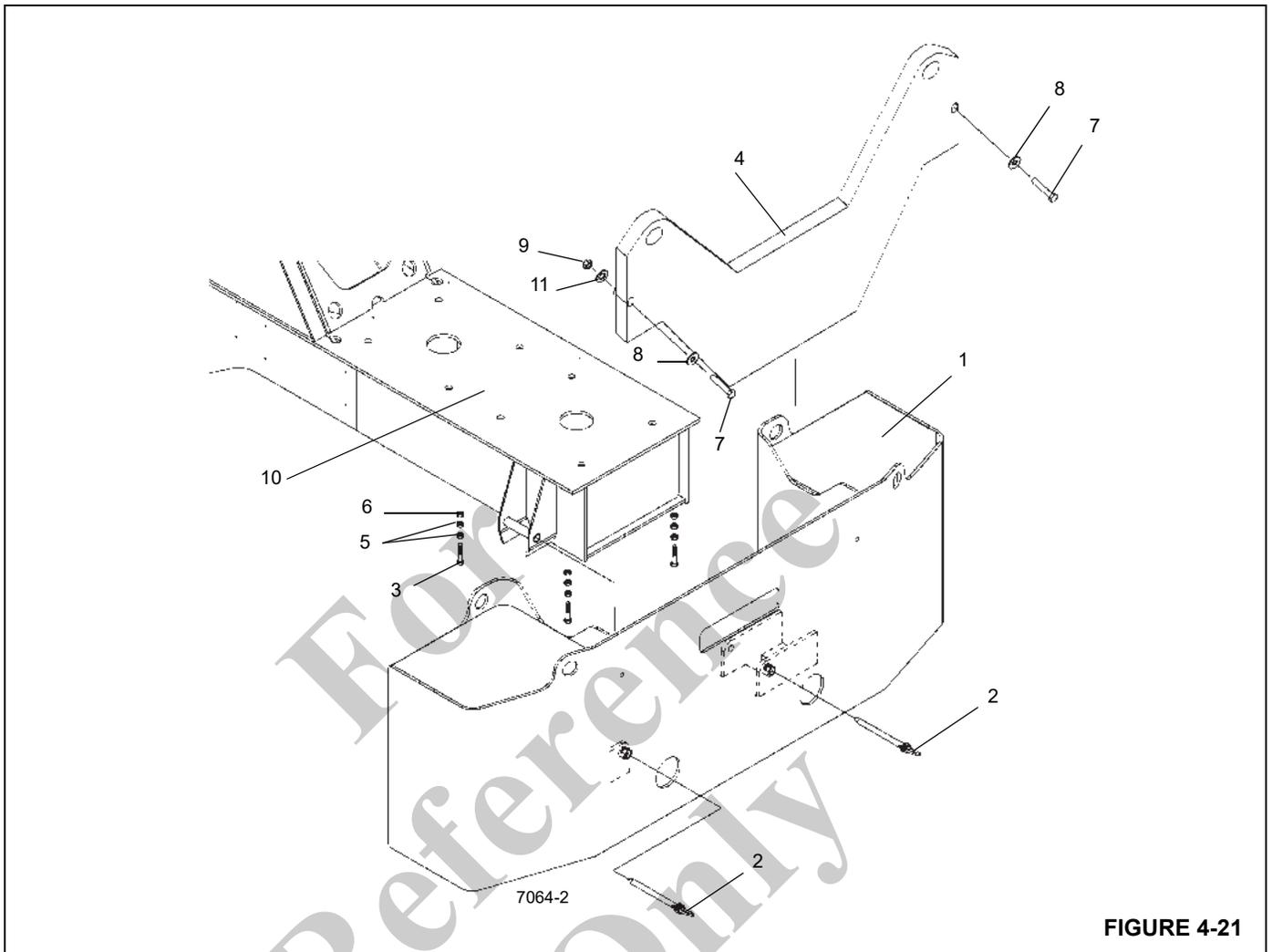


FIGURE 4-21

Item	Description
1	Fixed Counterweight
2	Pin Assembly
3	Capscrew
4	Counterweight Plate
5	Flatwasher

Item	Description
6	Locknut
7	Capscrew
8	Flatwasher
9	Locknut
10	Turntable

REMOVABLE COUNTERWEIGHT (OPTIONAL)



DANGER

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

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

NOTE: The removable counterweight consists of one standard box. The following procedures are applicable for removal and installation of any or all pieces.

Removal

1. Position the crane on a firm level surface. Fully extend and set the outriggers.
2. Rotate the superstructure to align the counterweight with the support weld on the front outrigger box. Engaging the pin type turntable lock will aid alignment.

NOTE: It may be necessary to jog the counterweight removal control valve switches to remove the weight of the counterweight from the upper attach pins.

3. Using the counterweight removal control valve switches (Figure 4-22), raise the counterweight cylinders to relieve weight on the upper attach pins.

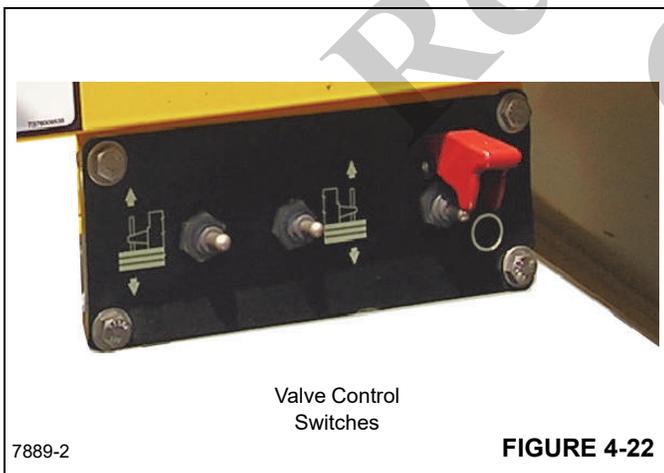


FIGURE 4-22

4. Push in, turn, and remove the upper attach pins from the superstructure frame lugs and the counterweight.
5. Stow the upper attach pins in the bushings on the side of the superstructure.

6. Using the counterweight removal control valve switches, slowly lower the counterweight onto the carrier stowage area.
7. Remove the attach pins from the counterweight lugs and cylinder ends. Raise the cylinders and stow the attach pins in cylinder and insert retainer clip pins.



DANGER

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

NOTE: The counterweight weighs approximately 14,860 lb (6740 kg).

8. Remove counterweight from the support weld on the front outrigger box before moving crane.
9. Using the crane's boom and hoist or other crane, lift the counterweight from the carrier deck to the auxiliary transport vehicle.

Installation

1. Position the crane on a firm level surface. Fully extend and set the outriggers.
2. Select the proper without counterweight operating code on the RCL.

NOTE: The counterweight weighs approximately 6740 kg (14,860 lb).

3. Using the crane's boom and hoist or other crane, lift the counterweight from the auxiliary transport vehicle and position the counterweight.
4. Rotate and align the rear of the superstructure above the removable counterweight setting on the support weld on the front outrigger box. Engaging the pin type turntable lock will aid alignment.

5. Using the counterweight removal control valve switches (Figure 4-22) and (Figure 4-23) located on either side of the turntable, lower the counterweight cylinders. Pin the cylinders to the counterweight using the attach pins in the cylinders. Insert the retaining pins in the attach pins.
6. Using the control switches, raise the counterweight up under the superstructure frame.

NOTE: It may be necessary to jog the counterweight removal control valve switches to install the upper attach pins.

7. Remove the upper attach pins from the stowage bushings and install them into the upper counterweight and superstructure frame lugs.
8. Push in on the pins and turn to lock pin in the notch.

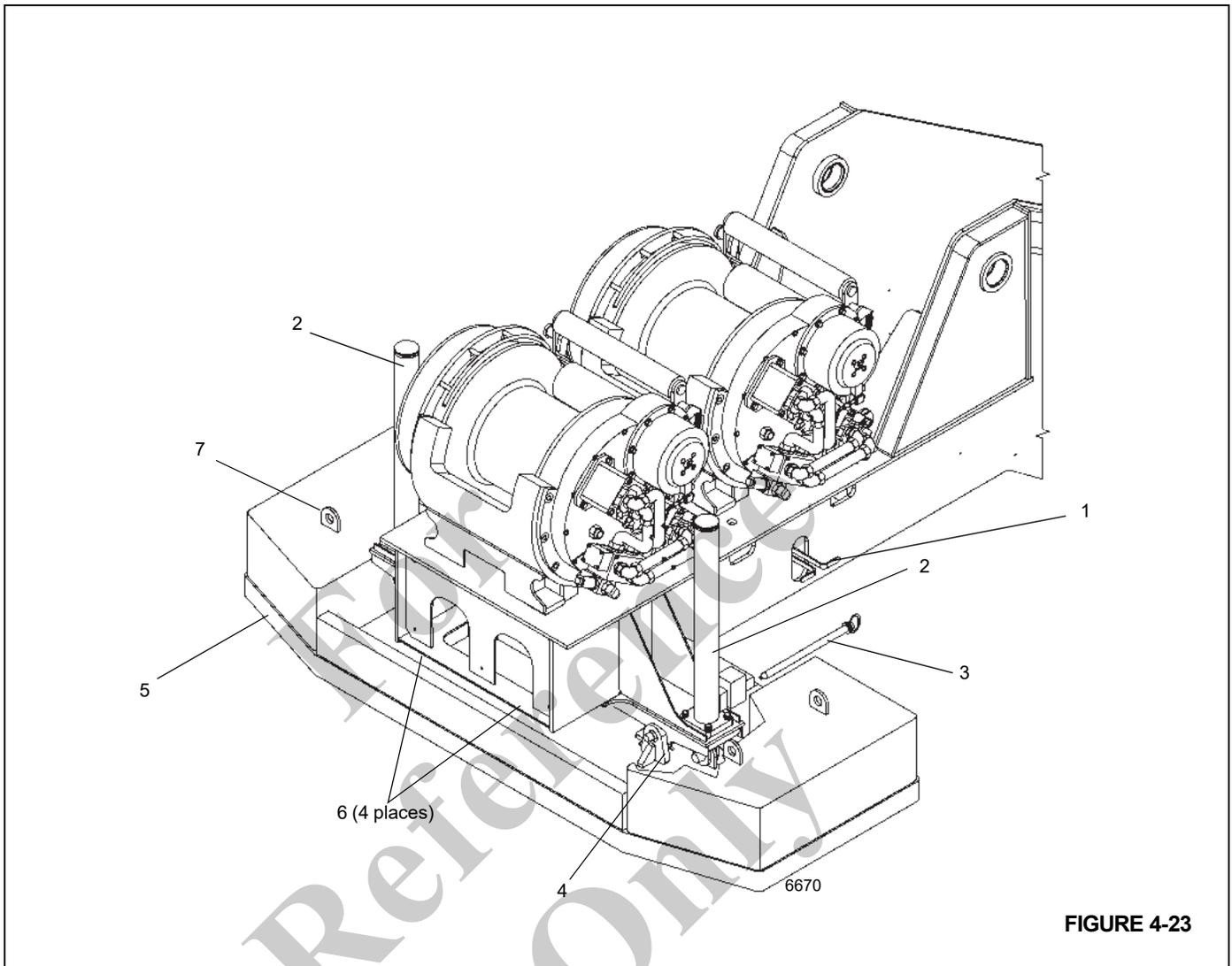


FIGURE 4-23

Item	Description
1	Valve Control Levers
2	Removal Cylinders
3	Cylinder Attach Pins
4	Counterweight Attach Pins
5	6740 kg (14,860 lb) Counterweight
6	Leveling Bolts (4 places)
7	Counterweight Lifting Lugs (4 places)

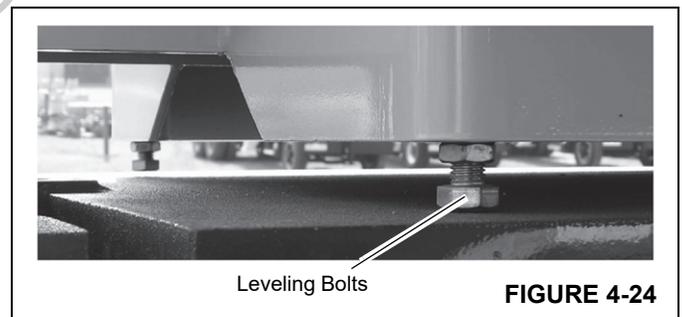


FIGURE 4-24

- Adjust the four counterweight leveling bolts (Figure 4-24) to eliminate any relative movement between the counterweight and the turntable.

The crane is now ready for operation with the counterweight installed.

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Reference
Only*

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SECTION 5 MAINTENANCE AND LUBRICATION

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GENERAL

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

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 Manitowoc 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 Manitowoc 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.

LUBRICANTS AND LUBRICATION INTERVALS

The service intervals specified are for normal operation where moderate ambient temperature, humidity, and atmospheric conditions prevail. In areas of extreme conditions, the service periods and lubrication specifications should be altered to meet existing conditions.

NOTE: All fluids and lubricants may be purchased by contacting an authorized Manitowoc distributor or Manitowoc Crane Care Parts Department.

Standard Lubricants

Standard lubricants are used on all Manitowoc cranes unless the crane is ordered with a cold weather package. These standard lubricants are effective in ambient temperatures down to -9°C (15°F). Refer to TABLE 5-1: for a list of the recommended standard lubricants.

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.

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

Lubricant/Fluid	Grove Spec.	Recommended Lubricant		
		Type	Grade	Classification
Axle Gear Oil	6829012964	Century Unigear Semi-synthetic Texaco Multigear SS Chevron DELO	80W-90	
Tier 3 Engine Oil	6829003483	Exxon XD-3 Conoco Fleet Supreme	15W-40	CI-4
Tier 4 Engine Oil	6829104182	Conoco Fleet Supreme EC Mobil Delvac 1300 Super	15W-40	CJ-4
Hydraulic/Transmission Oil	6829006444	Kendall Hyken 052 Exxon Torque Fluid 56 Esso Torque Fluid 56 BP-Eldoran UTH & Trak-Tran 9 BP- Blend- 7367	10W-20	Must Meet John Deere Std. JDM J20c
		Exxon Mobil 424 Phillip 66 PowerTran XP	ISO 46/68	
Hoist Gear/Swing Drive Oil	6829100213	Mobil: Mobilfluid 629 Texaco: Meropa 150		AGMA No. 4 EP
Grease, Multipurpose	6829003477	Citgo Lithoplex MP# 2 Texaco Starplex Moly # 2 Phillips 66 Philube M Mobil Mobilgrese XHP 222 Special Chemtool Inc, Lube-A-Boom	NLGI 2	
Open Gear Lube	6829102971	Fuchs Ceplattyn 300 Spray	NLGI 1-2	
Antifreeze Coolant	6829101130	Old World Industries, Inc. Fleet Charge SCA Caterpillar DEAC Fleetguard Complete EG	Mix 50/50	
Supplemental Coolant Additive (SCA)	6829012858	Fleetguard DCA4 Fleetguard DCA2 Penray Pencool 3000		

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.

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 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:

Down to -29°C (-20°F) Package

- Battery heater
- Fuel 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 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
 - Arctic fuel

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

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

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

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

Surface Protection for Cylinder Rods

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

It is recommended that all exposed cylinder rods be protected using Boeshield® T-9 Premium Metal Protectant. Manitowoc 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 rod

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 in 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.

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

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

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

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

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

Unless otherwise indicated, items not equipped with grease fittings, such as linkages, pins, levers, etc., should be lubricated with oil once a week. Motor oil, applied sparingly, will provide the necessary lubrication and help prevent the formation of rust. An Anti-Seize compound may be used if rust has not formed, otherwise the component must be cleaned first.

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

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

CraneLUBE

Manitowoc highly recommends the use of CraneLUBE lubricants to increase your crane's reliability and performance. Contact your Grove Distributor for information about the Grove 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 quickserv.cummins.com and login with a current username 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 of the locations the engine will need to be started. After positioning areas of the unit for lubrication the engine must be turned off and the moved areas stable before approaching.



DANGER

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.

For
Reference
Only

Steering and Suspension						
Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
1	Steer Cylinder Pivot Pins	Figure 5-1	EP-MPG Extreme Pressure Multipurpose Grease 6829003477	Until grease extrudes	500 hours or 3 months	8 grease fittings
2	Upper and Lower King Pins	Figure 5-1	EP-MPG Extreme Pressure Multipurpose Grease 6829003477	Until grease extrudes	500 hours or 3 months	8 grease fittings
3	Fifth Wheel Pivots	Figure 5-1	EP-MPG Extreme Pressure Multipurpose Grease 6829003477	Until grease extrudes	500 hours or 3 months	2 grease fittings
4	Lockout Cylinder Pivot Pins	Figure 5-1	EP-MPG Extreme Pressure Multipurpose Grease 6829003477	Until grease extrudes	500 hours or 3 months	4 grease fittings

Reference Only!

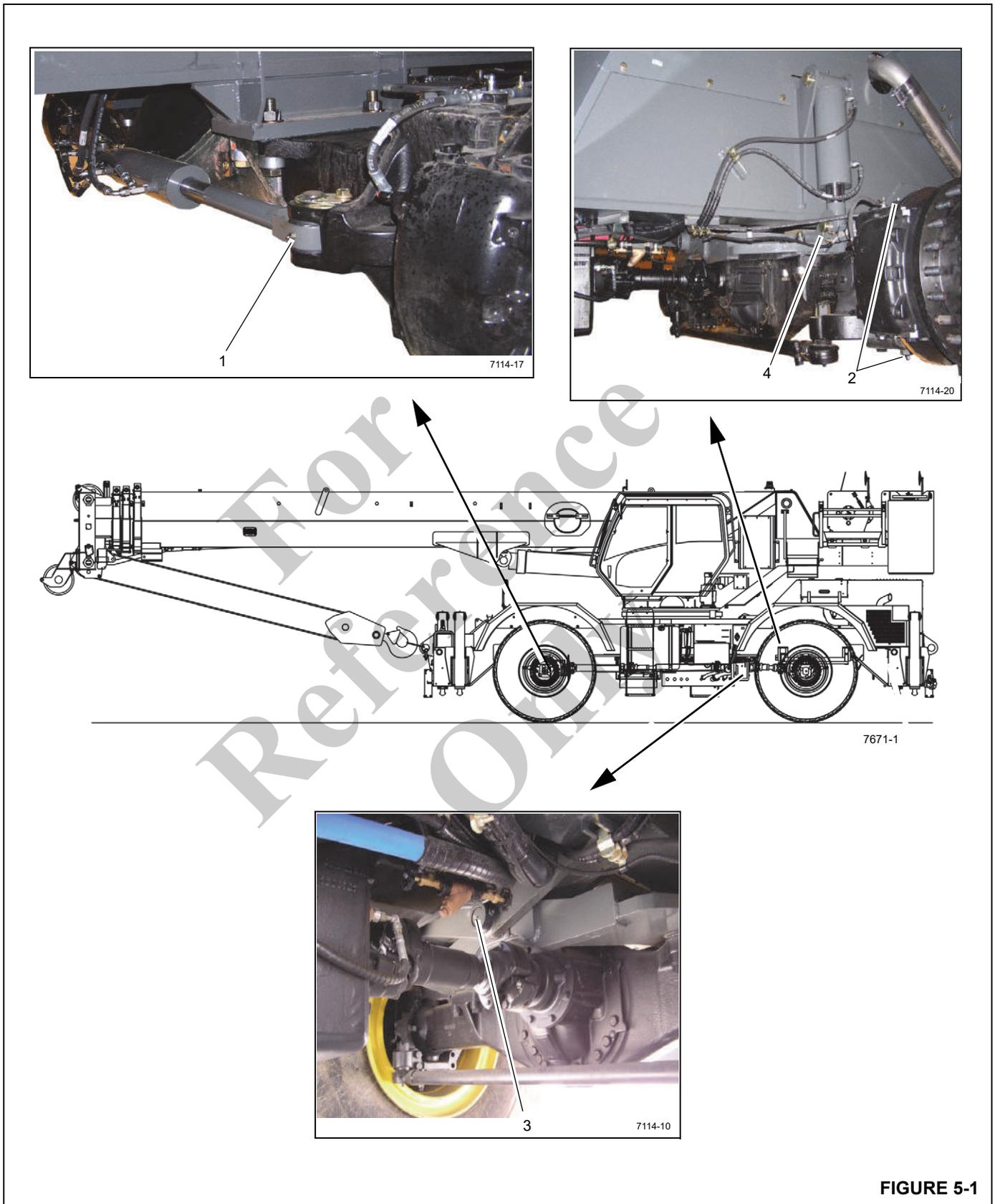
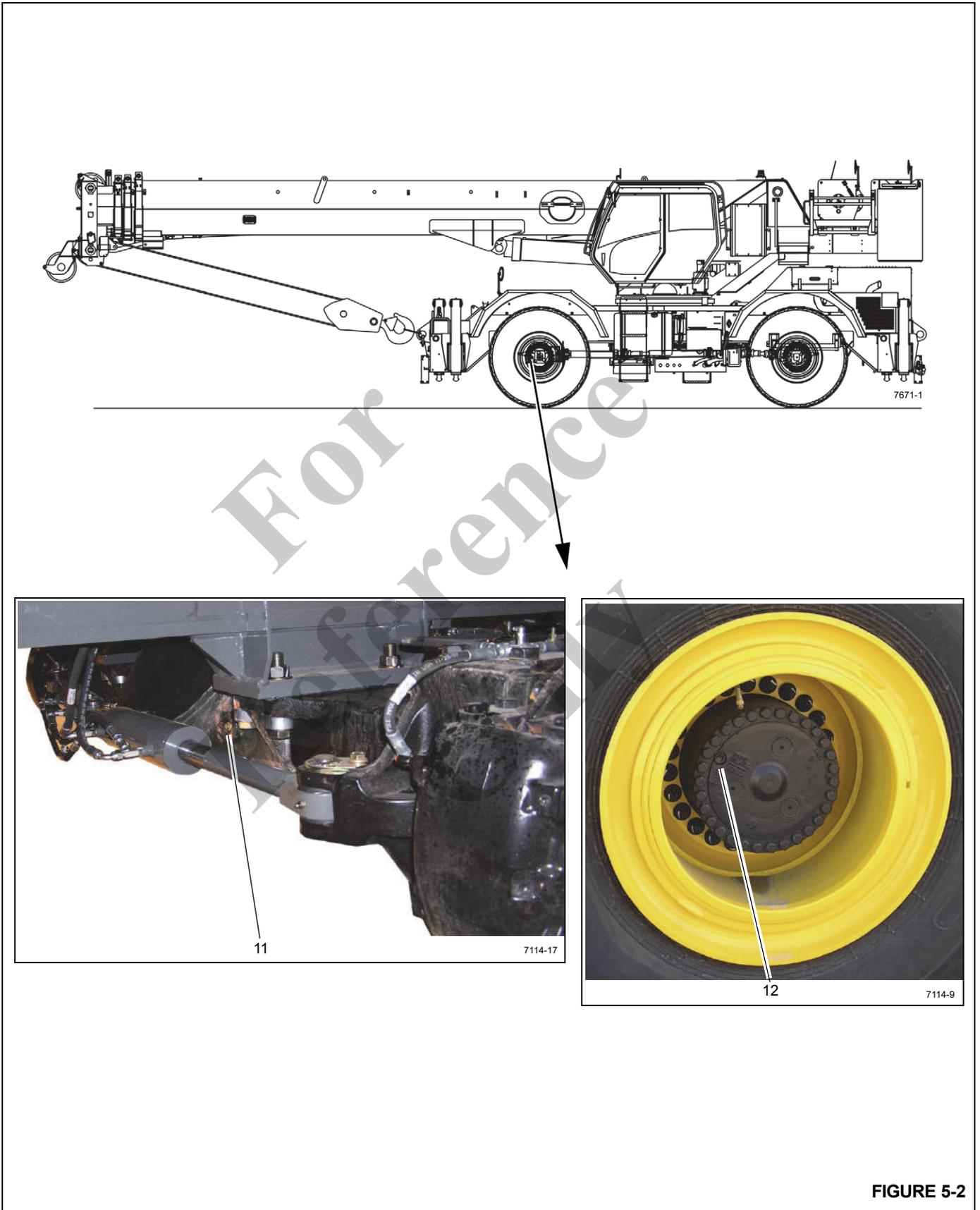


FIGURE 5-1

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
Axles						
11	Differentials	Figure 5-2	GL-5 Extended Service Interval Gear Lubricant 6829012964	48 pt (22.7 l)	<ul style="list-style-type: none"> • Check level every 500 hours or 3 months • Drain and fill every 4000 hours or 2 years 	Fill to bottom of hole in housing on the steer cylinder side
<p>NOTE: Lube level close enough to the hole to be seen or touched is not sufficient. It must be level with the hole. When checking lube level, also check and clean housing breathers.</p> <p>CAUTION: Use of non-approved lubricant may damage components and/or invalidate published lubricant intervals.</p> <p>CAUTION: If the makeup amount is substantially more than 0.5 pt (0.23 l), check for leaks.</p>						
12	Planetary Hubs and Wheel Bearings	Figure 5-2	GL-5 Extended Service Interval Gear Lubricant 6829012964	8 pt (3.7 l)	<ul style="list-style-type: none"> • Check level every 500 hours or 3 months • Drain and fill every 4000 hours or 2 years 	Fill to the bottom of the level hole in the housing with the fill plug and the oil level mark horizontal.
<p>CAUTION: Use of non-approved lubricant may damage components and/or invalidate published lubricant intervals.</p>						

For Reference Only



Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
Drive Train						
20a 20b	a. Engine Crankcase b. Filter	Figure 5-3	EO-15W/40 Engine Oil SAE 15W-40 T3 Engine - 6829003483 T4 Engine - 6829104182	20 qt (18.9 l)	<ul style="list-style-type: none"> Check level every 10 hours or daily Drain, fill and replace filter every 500 hours 	<ul style="list-style-type: none"> Through fill cap to FULL mark on dipstick Filter located on left side of frame beneath radiator
21a 21b	a. Transmission, Torque Converter, Dipstick b. Filter	Figure 5-3	HYDO Hydraulic Oil 6829006444	40 qt (37.8 l)	<ul style="list-style-type: none"> Check level every 10 hours or daily Drain and refill every 1000 hours or 6 months Change transmission filter after first 50 and 100 hours of service, then every 500 hours thereafter 	Through fill pipe to FULL mark on dipstick
<p>NOTE:</p> <ul style="list-style-type: none"> Check fluid level with engine running at low idle and the oil at 180 to 200 ° F (82 to 93° C). Do not attempt an oil level check with cold oil. To bring the oil temperature to this range, it is necessary to either work the crane or stall the converter. Converter stall should be accomplished by engaging shift lever in forward high range with the brakes applied and then accelerating the engine to half or three-quarter throttle. Hold the stall until the required converter temperature is reached and stabilized. <p>Do not operate the converter at stall condition for longer than 30 seconds at one time. Shift to neutral for 15 seconds and repeat the procedure until the desired temperature is reached. Excessive temperature, i.e., 250° F (120° C) maximum will cause damage to transmission clutches, fluid, converter and seals.</p> <ul style="list-style-type: none"> Drain and fill with the oil at 150 to 200 ° F (65 to 93° C). Transmission filters are located on the outside left hand frame in the area of the hydraulic oil cooler inside left hand engine cover. To add fluid: <ol style="list-style-type: none"> Fill to FULL mark on dipstick Run engine at low idle to prime torque converter and lines Check oil level with engine running at low idle and oil at 180 to 200° F (82 to 93° C). Add oil to bring oil level to FULL mark on dipstick. 						
22	Engine Cooling System and SCA Levels	Figure 5-3	AFC 50/50 50/50 Blended Fully Formulated Antifreeze Coolant 6829101130 SCA 6829012858	40 qt (37.8 l)	<ul style="list-style-type: none"> Check coolant level every 10 hours or daily Check SCA levels every 500 hours Check coolant for contamination every 1000 hours 	See <i>Service Manual</i>
<p>NOTE: Radiator Fill Procedure: Open the petcock or loosen plug to allow trapped air to bleed. Slowly fill the system with specified coolant/antifreeze. Fill to the bottom of the surge tank filler neck. A fill rate exceeding 3 gpm (12 l/min) can give a false reading. Close the petcock or secure air bleed plug. Wait one minute and re-check the coolant/antifreeze level. Refill as necessary. Run engine through two thermal cycles and re-check the antifreeze/coolant level. Refill as necessary.</p>						
23	Coolant Strainer (Cab Heater)	Figure 5-3	---	---	Clean strainer screen after first 100 hours and every 2000 hours or 12 months intervals thereafter.	Close shutoff valves. Unscrew hex plug to clean filter.

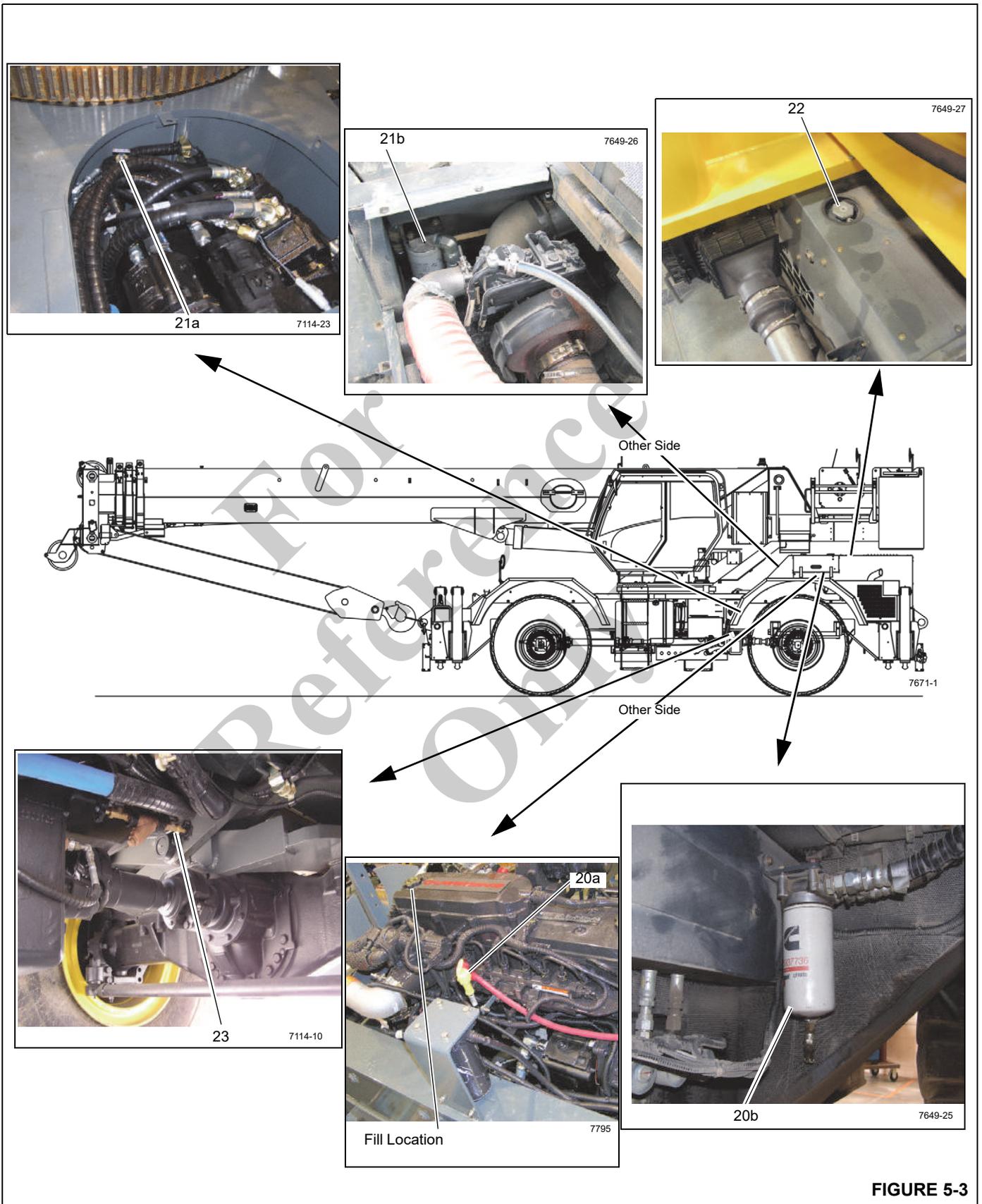
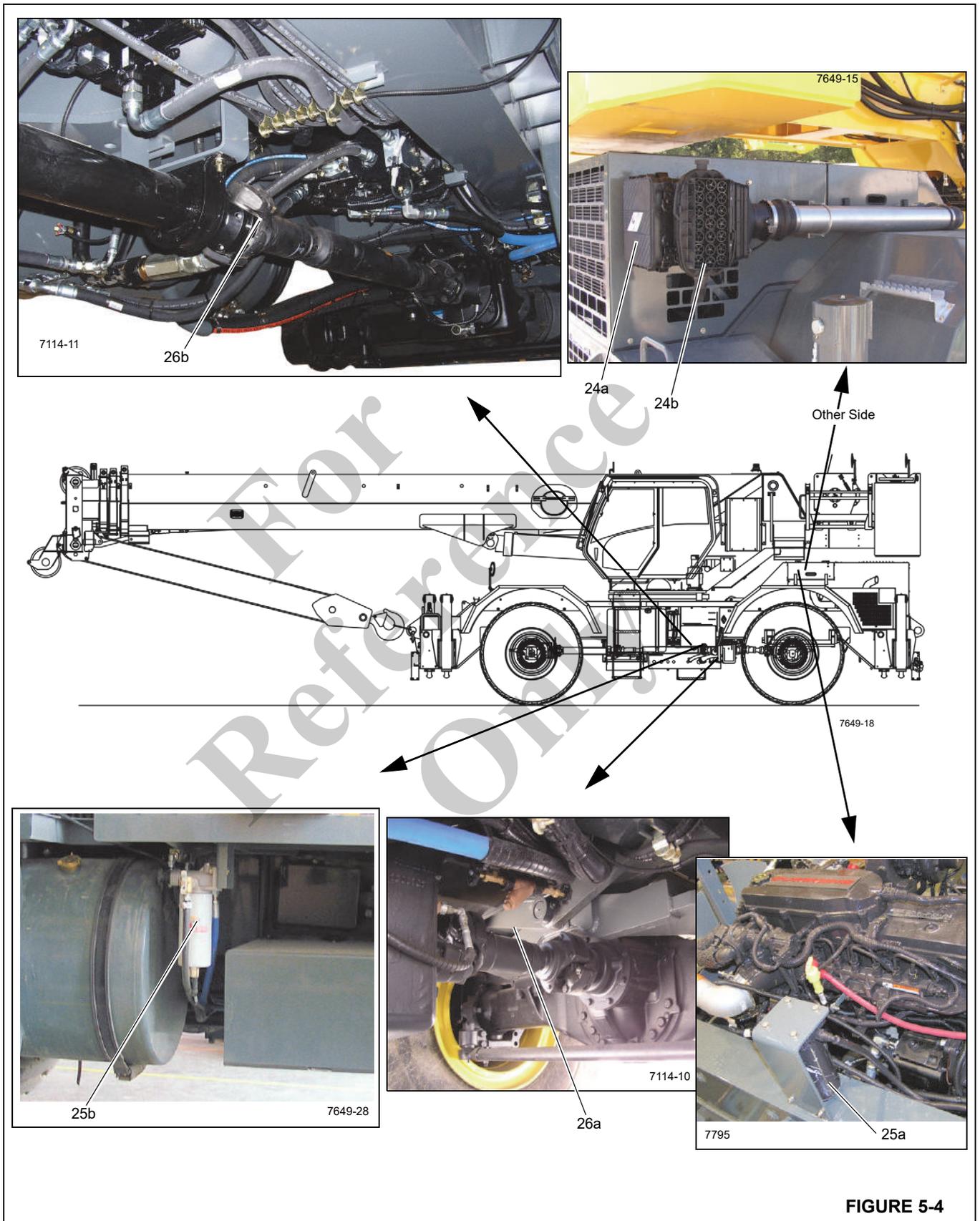


FIGURE 5-3

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
Drive Train (continued)						
24a	Air Cleaner Filters	Figure 5-4	---	---	<ul style="list-style-type: none"> Replace primary filter element when indicator shows red (25 in of H₂O). Replace secondary filter every third time primary filter is replaced. In severe dust conditions the pre-cleaner may need to be serviced. 	Right hand side of engine hood.
24b	Pre-cleaner					
25a	a. Fuel Filter	Figure 5-4	---	---	<ul style="list-style-type: none"> Change filter every 500 hours or 6 months. Drain water trap every 10 hours or daily. 	<ul style="list-style-type: none"> Fuel filter is located on the intake manifold of engine. Water Separator is located near oil cooler.
25b	b. Water Separator					
NOTE: During replacement of the water separator, take note of the direction of the arrow. The arrow must point towards the fuel filter						
26a 26b	Driveline - Slip Joints	Figure 5-4	EP-MPG Extreme Pressure Multipurpose Grease 6829003477	Until grease extrudes	500 hours or 3 months	2 grease fittings



Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
Turntable						
40	Turntable Gear Box	Figure 5-5	AGMA No. 4 Extreme Pressure Gear Lubricant 6829100213	5.25 qt (4.9 l)	<ul style="list-style-type: none"> • Check and fill every 50 hours • Drain and fill after first 250 hours and every 500 hours or 12 months thereafter. 	Fill to max level on level plug.
41a	Turntable Gear and Drive Pinion	Figure 5-5	EP-OGL Open Gear Lubricant 6829102971	Coat all teeth	500 hours or 6 months	Spray on
41b	Turntable Swivel Lock Pin	Not shown	EP-OGL Open Gear Lubricant 6829102971	Coat pin	500 hours or 6 months	Spray on
42	Turntable Bearing	Figure 5-5	EP-MPG Extreme Pressure Multipurpose Grease 6829003477	Until grease extrudes the whole circumference of the bearing	500 hours or 6 months	2 grease fittings at the front of the turntable.
NOTE: Rotate the turntable 90° and apply grease to fittings. Continue rotating 90° and grease the fittings until the whole bearing is greased.						

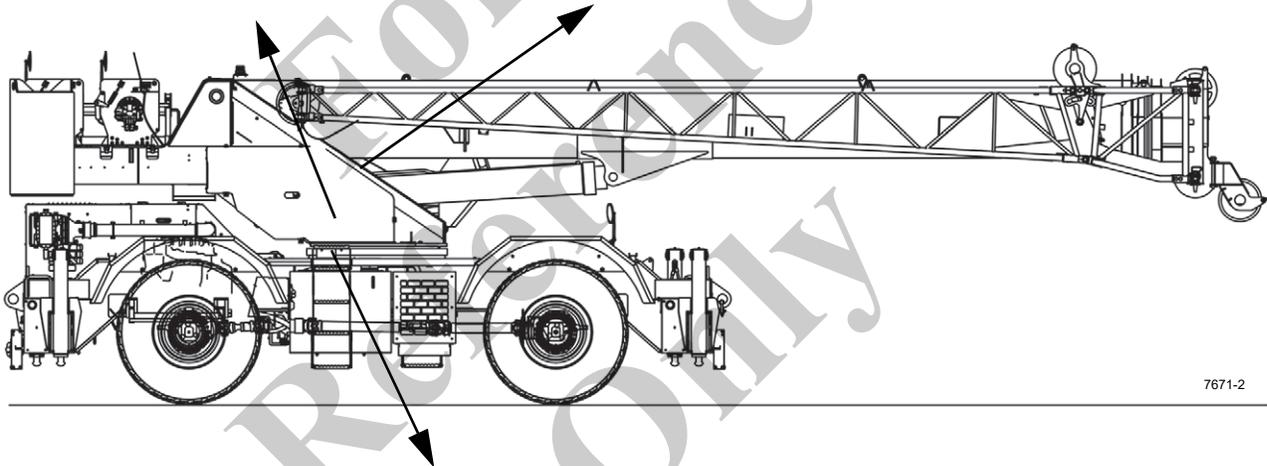
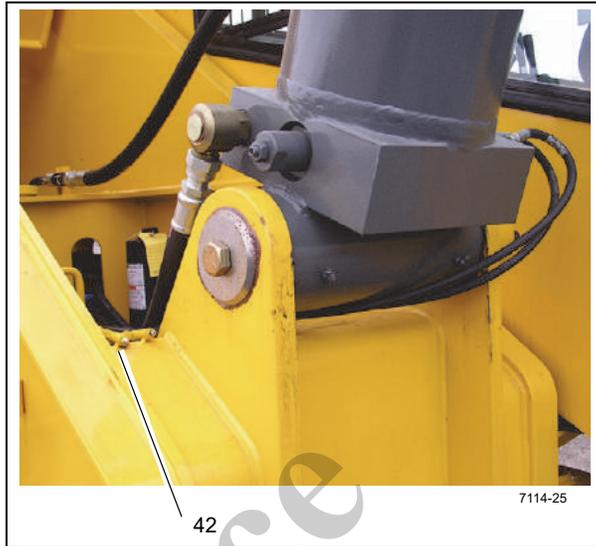
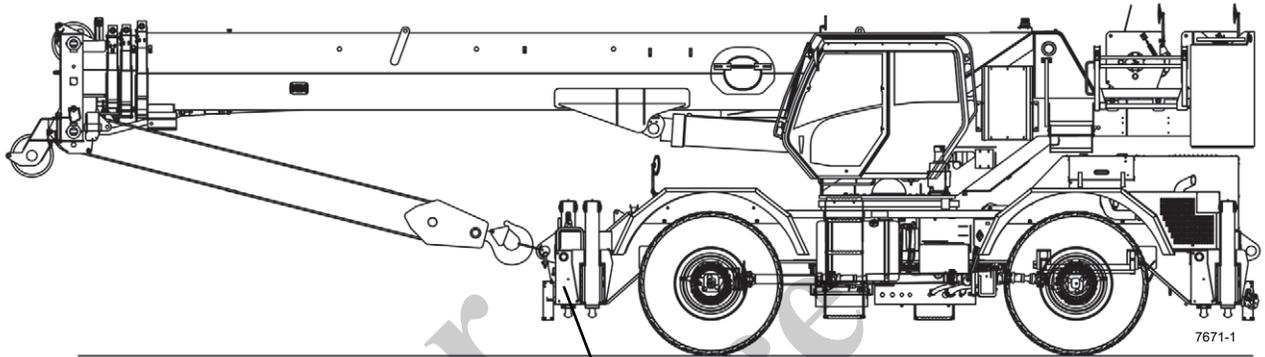


FIGURE 5-5

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
Outriggers						
50	Outrigger Beams	Figure 5-6	EP-MPG Extreme Pressure Multipurpose Grease 6829003477	---	50 hours or 1 week	Brush lubricant on bottom of outrigger beams
51	Jack Cylinder Support Tubes	Figure 5-6	EP-MPG Extreme Pressure Multipurpose Grease 6829003477	---	50 hours or 1 week	Brush lubricant on ID of jack cylinder support tubes (4) places and wear bands before installing jack cylinders
52	Jack Cylinder Barrels	Figure 5-6	EP-MPG Extreme Pressure Multipurpose Grease 6829003477	---	50 hours or 1 week	Brush on

For Reference Only



For Reference

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
Boom						
60	Upper Lift Cylinder Pin	Figure 5-7	EP-MPG Extreme Pressure Multipurpose Grease 6829003477	Until greases extrudes	500 hours or 3 months	2 grease fittings
61	Lower Lift Cylinder Pin	Figure 5-7		Until greases extrudes	500 hours or 3 months	2 grease fittings
70	Hook Block Swivel Bearing	Figure 5-7		Until grease extrudes	250 hours or 3 months	1 grease fitting
71	Hook Block Sheaves	Figure 5-7		Until grease extrudes	250 hours or 3 months	4 grease fittings - 60 Tons 3 grease fittings - 40 Tons
72	Telescope Cylinder Wear Pads	Figure 5-7		Thoroughly coat	Every boom teardown or 125 hours/3 months	<ul style="list-style-type: none"> • 2 places by brush • Extend boom for access through holes
73	Side Wear Pads	Figure 5-7		Thoroughly coat all areas the wear pad moves on	250 hours or 3 months	2 places by brush; with boom in extended position
NOTE: Lubricate items more frequently than interval indicated in table if environmental conditions and/or operating conditions necessitate.						
74	Boom Section Rear Upper Wear Pads	Figure 5-7	EP-MPG Extreme Pressure Multipurpose Grease 6829003477	Thoroughly coat all areas the wear pad moves on	50 hours or 1 week	<ul style="list-style-type: none"> • 6 places • Extend boom, aligning grease fittings with holes in side of each boom section
NOTE: Lubricate items more frequently than interval indicated in table if environmental conditions and/or operating conditions necessitate.						

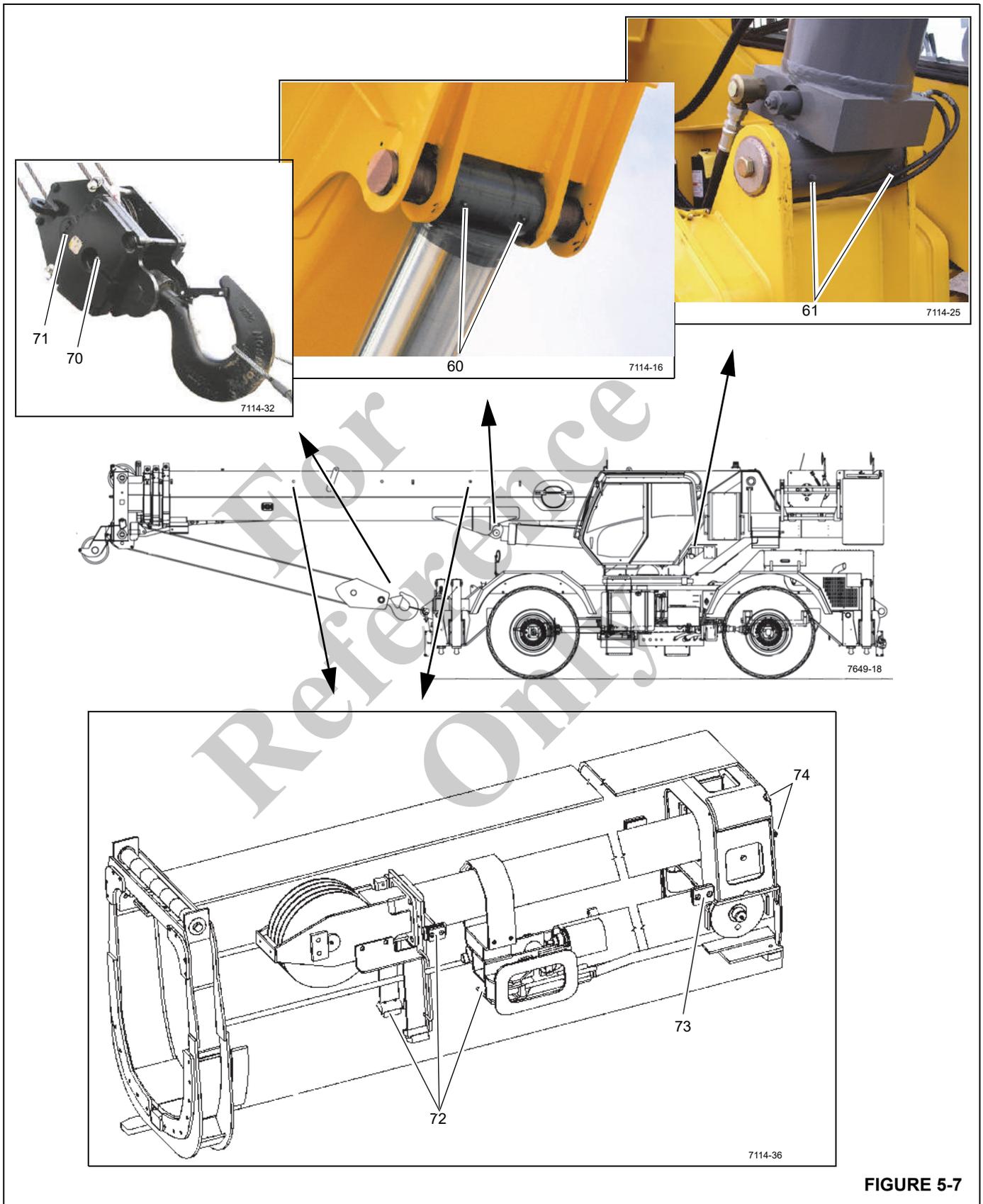


FIGURE 5-7

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
Boom (continued)						
75	Boom Section Front Wear Pads	Figure 5-8	EP-MPG Extreme Pressure Multipurpose Grease 6829003477	Thoroughly coat all areas the wear pad moves on	50 hours or 1 week	Brush grease on the outside of sections 1, 2, & 3 in the area that the front wear pads move on
NOTE: Lubricate items more frequently than interval indicated in table if environmental conditions and/or operating conditions necessitate.						
76	Extend Cable Sheaves	Figure 5-8	EP-MPG Extreme Pressure Multipurpose Grease 6829003477	Until grease extrudes	250 hours or 3 months	1 grease fitting Extend boom for access through holes
NOTE: Lubricate items more frequently than interval indicated in table if environmental conditions and/or operating conditions necessitate.						
77	Retract Cable Sheaves	Figure 5-8	EP-MPG Extreme Pressure Multipurpose Grease 6829003477	Until grease extrudes	250 hours or 3 months	2 grease fittings
78	Boom Pivot Shaft	Figure 5-8		Until grease extrudes	250 hours or 3 months	2 grease fittings
79	Boom Extension Sheave	Figure 5-8		Until grease extrudes	250 hours or 3 months	1 grease fitting
81	Upper Boom Nose Sheave	Figure 5-8		Until grease extrudes	250 hours or 3 months	2 grease fittings (1) per sheave
82	Lower Boom Nose Sheave	Figure 5-8		Until grease extrudes	250 hours or 3 months	5 grease fittings
83	Auxiliary Boom Nose Sheave	Figure 5-8		Until grease extrudes	250 hours or 3 months	1 grease fitting

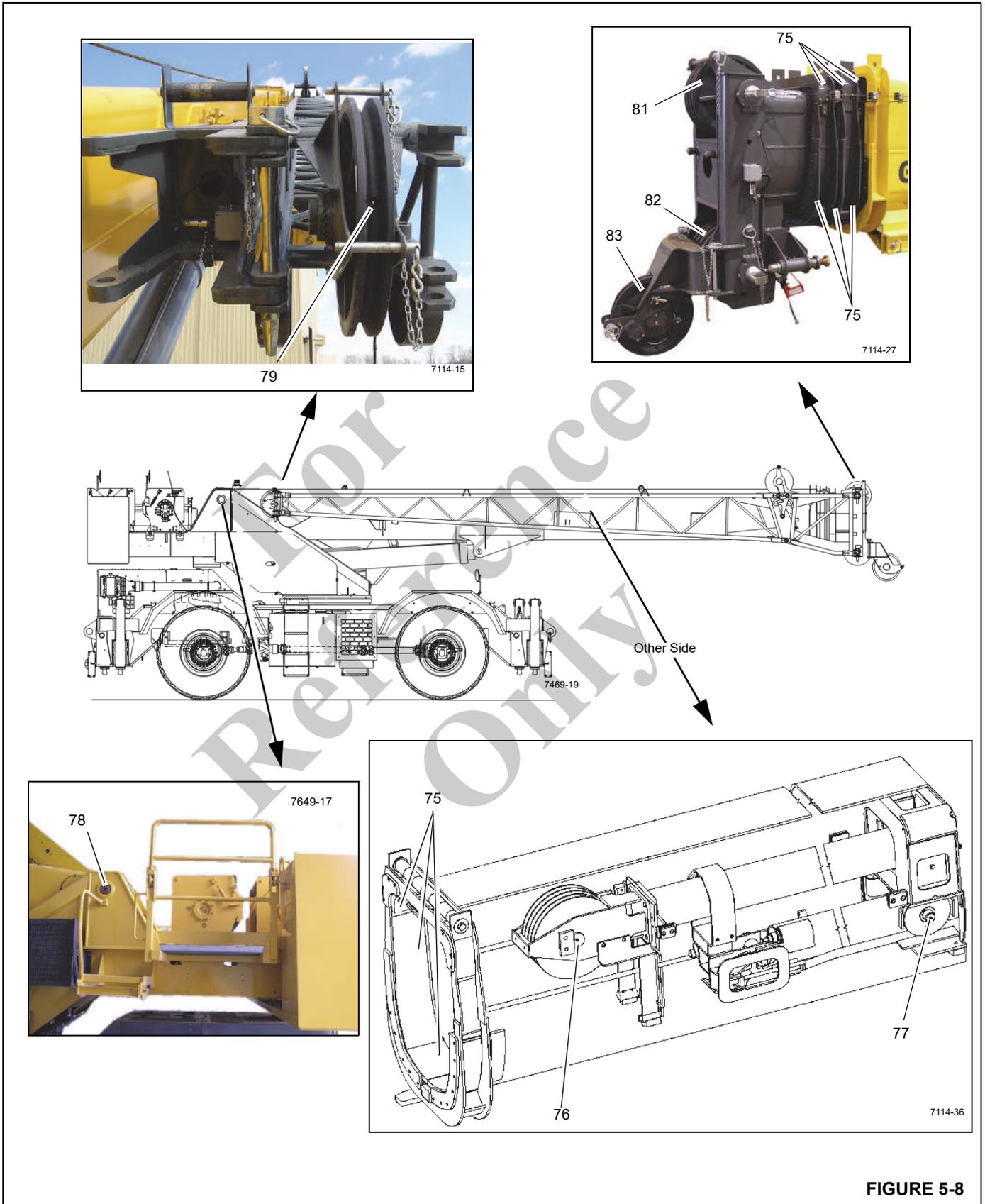
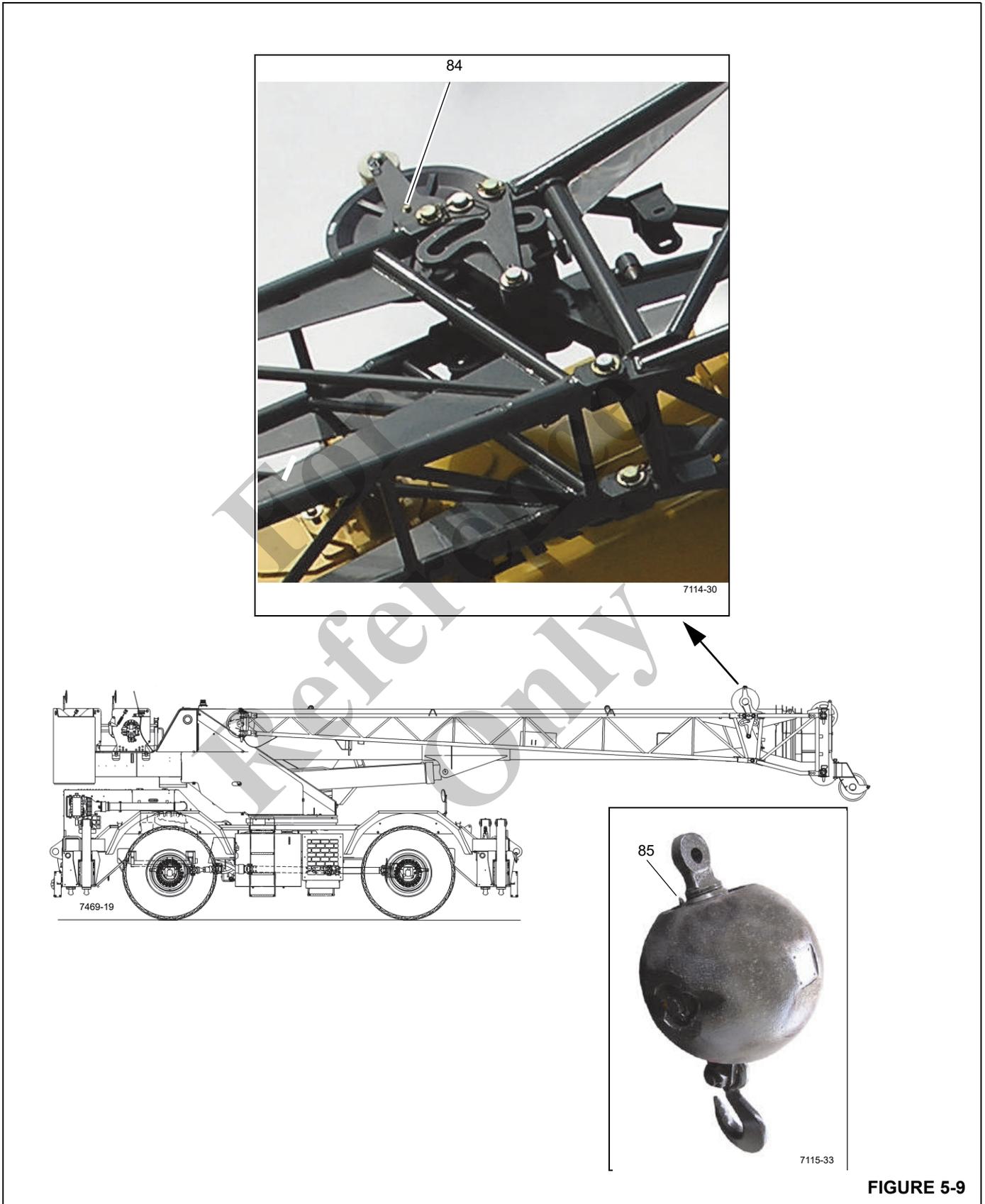


FIGURE 5-8

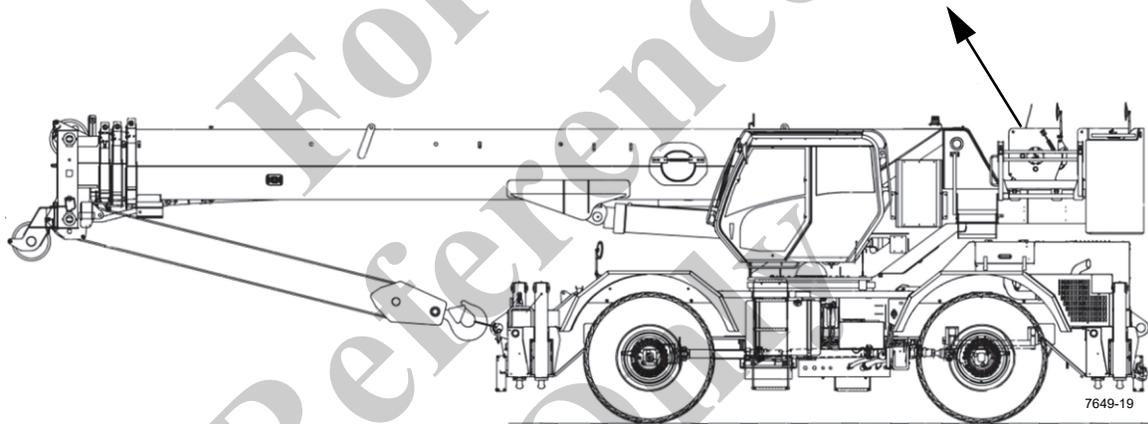
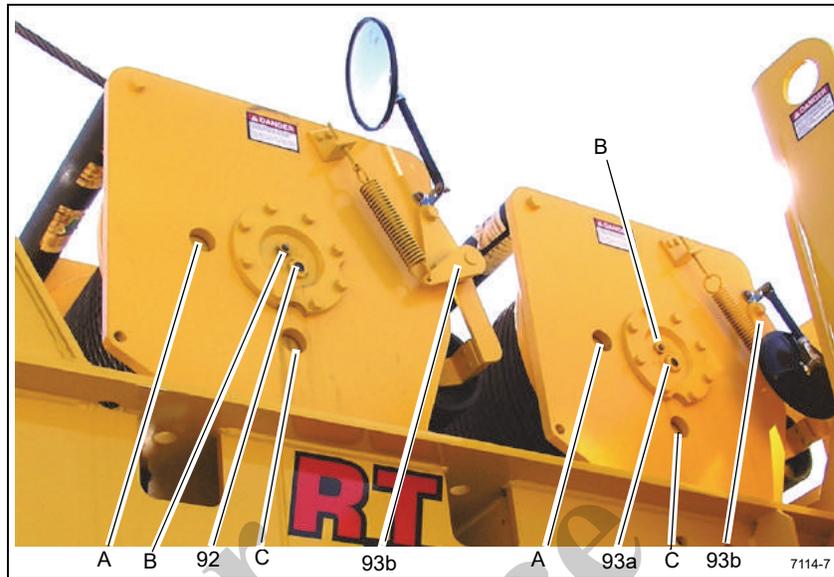
Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
Boom (continued)						
84	Mast Sheave	Figure 5-9	EP-MPG Extreme Pressure Multipurpose Grease 6829003477	Until grease extrudes	500 hours or 12 months	1 grease fitting
85	Overhaul Ball	Figure 5-9		Until grease extrudes	250 hours or 3 months	1 grease fitting

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Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
Hoist						
92	Main Hoist	Figure 5-10	AGMA Extreme Pressure Gear Lubricant 6829100213	15.5 qt (14.7 l)	<ul style="list-style-type: none"> • Check and fill every 50 hours or weekly • Drain and fill every 1000 hours or 12 months 	Oil must be visible in the sight glass (see note)
93a	Auxiliary Hoist	Figure 5-10	AGMA Extreme Pressure Gear Lubricant 6829100213	15.5 qt (14.7 l)	<ul style="list-style-type: none"> • Check and fill every 50 hours or weekly • Drain and fill every 1000 hours or 12 months 	Oil must be visible in the sight glass (see note)
<p>NOTE: Line up the Fill/Drain Plug with the upper cutout hole (A). Let hoist sit idle for 20 minutes for an accurate reading. Ensure hoist is level and oil is within 21°C ±11°C (70°F ±20°F). If oil level is not visible in sight glass, the hoist may be underfilled. Oil escaping from vent plug (B) is an indication the hoist may be overfilled. If hoist is over filled, move the Fill/Drain Plug to the lower cutout hole (C) and drain until oil level falls within the sight glass.</p>						
93b	Cable Follower (Arms)	Figure 5-10	EP-MPG Extreme Pressure Multipurpose Grease 6829003477	Thoroughly coat	250 hours or 3 months	Spray on
<p>NOTE: Lubricate more frequently than interval indicated if environmental and/or operating conditions necessitate.</p>						

Reference Only



Reference

FIGURE 5-10

Item	Lube Point Description	Figure No.	Approved Lubricant	Lube Capacity	Lube Interval	Application
Hydraulic						
100	Hydraulic Tank	Figure 5-11	HYDO Hydraulic Oil 6829006444	150 gal (568 l)	Check fluid level every 10 hours or daily.	<ul style="list-style-type: none"> Use sight gauge on side of tank, with boom down and all outrigger cylinders retracted. Drain and refill as necessary
NOTE:						
<ul style="list-style-type: none"> 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. Air borne and ingested contaminants can significantly reduce the life of oil and the condition of hydraulic oil filters and tank breathers. 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. The inspections should be for air borne 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 the indicator reaches the red zone or indicates a by-pass condition, the hydraulic oil must be sampled. The hydraulic tank breather should also be inspected to assure that it is not restricting air flow into and out of the reservoir. To inspect hydraulic oil, fill a small glass container with a sample of reservoir oil and another glass container with fresh oil. Let the samples stand, undisturbed, for one to two hours and then compare the samples. If the 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. The hydraulic oil shall meet or exceed ISO 4406 class 17/14 cleanliness level. Refill volumes could possibly exceed tank capacity due to oil draining from the lines. 						
101	Hydraulic Filter	Figure 5-11	HYDO Hydraulic Oil 6829006444	---	Change filter when the indicator is red	---
102	Diesel Particulate Filter	Figure 5-12	---	---	See Engine Owner's Manual	---

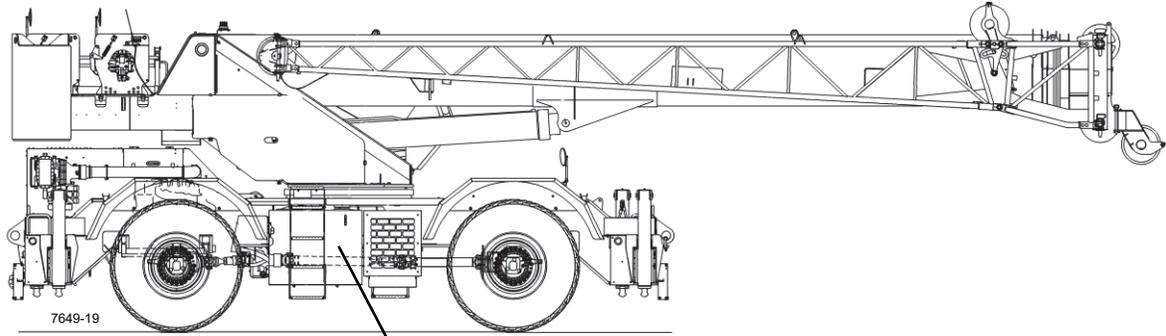


FIGURE 5-11

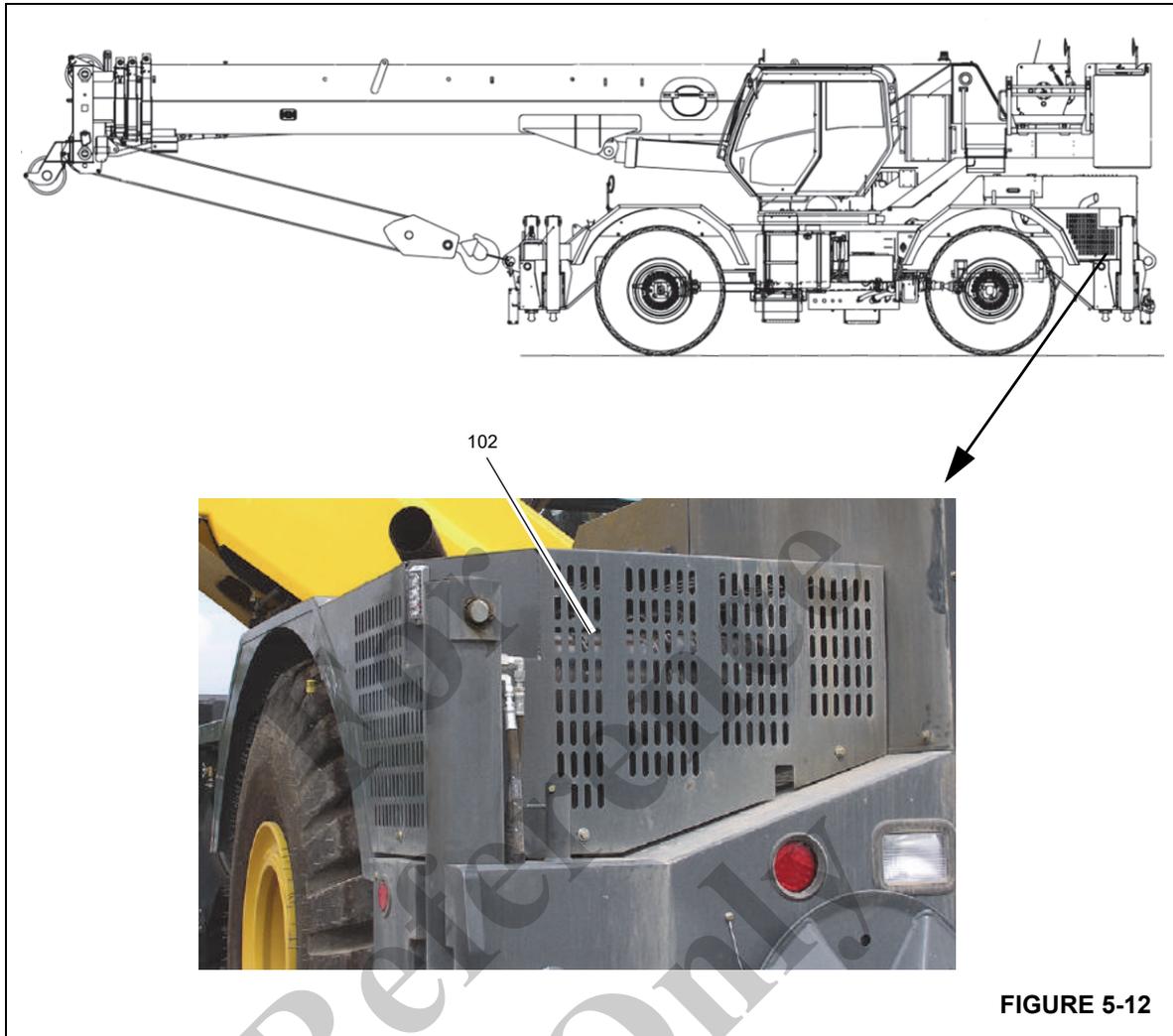


FIGURE 5-12

CARWELL® RUST INHIBITOR

Protecting Cranes From Rusting

Manitowoc Crane Group's 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 a rust inhibitor called Carwell® T32 (CP-90). While a rust inhibitor cannot guarantee that a machine will never rust, this product will help protect against corrosion on Grove cranes that are treated with this product.

Carwell is a treatment, not a coating. It contains no silicones, solvents, CFCs or anything that would be classified as hazardous under OSHA Regulation 29CFR 19 10.1200. The product is a liquid blend of petroleum derivatives, rust inhibitors, water-repelling and water-displacing agents.

Special equipment is used to spray a light film onto the entire undercarriage and various other areas of each new crane prior to shipment. When applied the product has a red tint to allow applicators to view coverage during application. This red tint will turn clear on its own 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 initially 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 the surfaces of the crane that are easily seen have the biggest impact on the appearance of the crane, particular attention should be given to the undercarriage of the crane to minimize the harmful effects of corrosion.

Exercise special care and increase the frequency of cleaning if the 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, Manitowoc Crane Care recommends washing the crane at least monthly to remove all foreign matter. More frequent changeling 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 will 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 in the vicinity of electrical controls, panels, wiring, sensors, hydraulic hoses and fittings, or anything that can be damaged by high pressure cleaning/spraying.

- Rinse the 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 prior to 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 the crane to dry thoroughly. You can accelerate drying by using compressed air to remove excess water.

NOTE: Polishing and waxing (using an automotive-type wax) is recommended to maintain the original paint finish.

Inspection and Repair

- Immediately following cleaning, Manitowoc Crane Care 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.
- All identified spots and/or areas that have been scratched through to the 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: Manitowoc Crane Care recommends that a qualified body repairman 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:
- Sand to remove the scratch and feather outward from the mark to blend the repair into the original surface. Body putty may be applied as necessary to hide the defect; then sand smooth.
- Cover all bare metal with a primer that is compatible with the original paint finish
- and allow to dry thoroughly.
- Prepare the surface prior to applying the finish coat of paint.
- Apply a finish coat paint using accepted blending techniques. Use of original paint colors is recommended to insure 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 the effects of corrosion and enable you to do the repair at a later time 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 upon the environment in which a crane is used and/or stored, the initial factory application of Carwell® T32 (CP-90) should help inhibit corrosion for up to approximately 12 months.

It is recommended that 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 of treatment, the product needs to be fogged on the unit.
- Use of pressure pots to apply the treatment to the unit being processed is recommended.
- Carwell treatment is available in 16 ounce spray bottles from Manitowoc Crane Care (order part number 8898904099).
- After application of the treatment is complete, wash or clean film residue from lights, windshield, grab handles, ladders/steps and all access areas to crane, as necessary.

Please contact Manitowoc Crane Care should you have any questions.

Areas of Application

Refer to Figure 5-13 and Figure 5-14.

- The underside of the unit will have full coverage of the rust inhibitor. These are the only areas that a full coat of the rust inhibitor is acceptable on the 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, headache ball pins/ hook block pins and fasteners.
- All hardware, clips, pins, hose connections not painted will have treatment applied.



7650-75

Figure 5-13

Item	Description
1	Pivot Shaft
2	Boom Extension Pins, Clips
3	Boom Nose Pins, Clips
4	Hook Block/Headache Ball
5	Boom Extension Hanger Hardware
6	Hose Connections inside turntable
7	All Hardware, Clips, Pins, Hose Connections not painted O/R Pins, Clips
8	Turntable Bearing Fasteners
9	O/R Hose Connections
10	Hookblock Tiedown Cable

Item	Description
11	O/R Pins, Clips
12	O/R Beam Wear Pad Adjustment Hardware
13	Entire underside of unit
14	Powertrain Hardware Inside Compartment
15	Valve Bank
16	Hoist Hose Connections
17	Tension Spring
18	Wire Rope
19	Counterweight Mounting Hardware
20	Counterweight Pins
21	Hose Connections
22	Mirror Mounting Hardware

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