

# National Crane NBT60

## Operator Manual



Grove

Manitowoc

National Crane

Potain





## **WARNING**

### **California Proposition 65**

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

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

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

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

### **California Spark Arrestor**

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

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The original language of this publication is English.

# OPERATOR MANUAL

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

## NBT60 Crane

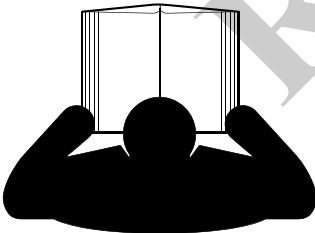
This Manual is divided into the following sections:

<b>SECTION 1</b>	<b>INTRODUCTION</b>
<b>SECTION 2</b>	<b>SAFETY PRECAUTIONS</b>
<b>SECTION 3</b>	<b>CONTROLS AND OPERATING PROCEDURES</b>
<b>SECTION 4</b>	<b>SET-UP</b>
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<b>SECTION 6</b>	<b>MAINTENANCE CHECKLIST</b>
<b>SECTION 7</b>	<b>RATED CAPACITY LIMITER</b>

### NOTICE

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

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

	<p><b>⚠ DANGER</b></p> <p><b>An untrained operator subjects himself and others to death or serious injury. Do not operate this crane unless:</b></p> <ul style="list-style-type: none"><li>• You have been trained in the safe operation of this crane. National Crane is not responsible for qualifying personnel</li><li>• 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.</li><li>• You are sure that all safety signs, guards, and other safety features are in place and in proper condition.</li><li>• The Operator Manual and Load Chart are in the holder provided on crane.</li></ul>
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*For  
Reference  
Only*

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## SECTION 1 INTRODUCTION

### SECTIONS CONTENTS

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This manual has been compiled to assist you in properly operating and maintaining your Model NBT60 Series National Crane (Figure 1-1).

Before placing the crane in service, all operators and persons working around the crane must thoroughly read and understand the contents of this manual pertaining to **Safety, Operation and Maintenance**. Before moving a vehicle equipped with the crane, information relating to transporting the vehicle must be read and observed.

This manual must be retained with the crane for use by subsequent operating personnel.

For detailed information concerning the operation and maintenance of the RCL system installed on the crane, see Section 7 - Rated Capacity Limiter in this manual. 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); National Crane refers to these systems as a rated capacity limiter (RCL) throughout its *Operator and Service Manuals*.)

Information in this manual does not replace federal, state or local regulations, safety codes or insurance requirements.

The NBT60 has been designed for maximum performance with minimum maintenance. With proper care, years of trouble-free service can be expected.

Constant improvement and engineering progress makes it necessary that we reserve the right to make specification and equipment changes without notice.

National Crane 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.

### Supplemental Information

Supplemental Information regarding Safety and Operation, Specifications, Service and Maintenance, Installation, and parts for options such as remote controls, augers, varying control configurations, baskets, grapples, etc. are included in separate manuals.

Whenever a question arises regarding your National product or this publication, please consult your National Crane Distributor for the latest information. Your National Crane Distributor is equipped with the proper tools, necessary parts, and trained personnel to properly maintain and service your crane.

A Safety Compact Disc/USB flash drive which includes sections on Operation, Safety and Maintenance for National Crane operators and owners is supplied when the crane is purchased new. Additional copies are available from your local distributor.

### New Owner

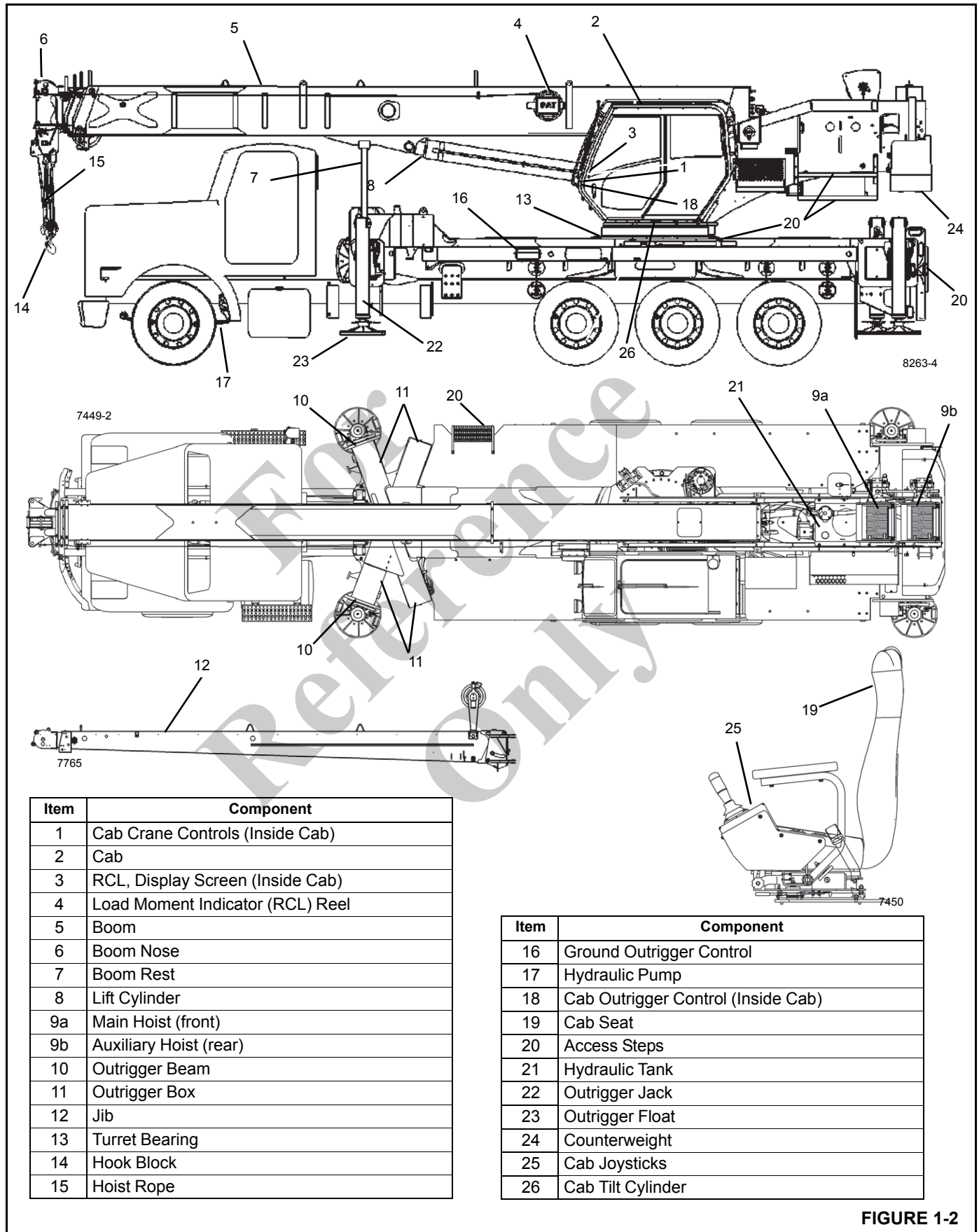
If you are the new owner of a National Crane, please register it with Manitowoc Crane Care so we have the ability to contact you if the need arises. Go to: [https://www.manitowoccranes.com/en/Parts\\_Services/ServiceAndSupport/ChangeOfOwnershipForm](https://www.manitowoccranes.com/en/Parts_Services/ServiceAndSupport/ChangeOfOwnershipForm) and complete the form.

### Basic Nomenclature

The nomenclature used to describe parts of a National Crane are described in Figure 1-2. This nomenclature is used throughout this manual.



For Reference Only



Item	Component
1	Cab Crane Controls (Inside Cab)
2	Cab
3	RCL, Display Screen (Inside Cab)
4	Load Moment Indicator (RCL) Reel
5	Boom
6	Boom Nose
7	Boom Rest
8	Lift Cylinder
9a	Main Hoist (front)
9b	Auxiliary Hoist (rear)
10	Outrigger Beam
11	Outrigger Box
12	Jib
13	Turret Bearing
14	Hook Block
15	Hoist Rope

Item	Component
16	Ground Outrigger Control
17	Hydraulic Pump
18	Cab Outrigger Control (Inside Cab)
19	Cab Seat
20	Access Steps
21	Hydraulic Tank
22	Outrigger Jack
23	Outrigger Float
24	Counterweight
25	Cab Joysticks
26	Cab Tilt Cylinder

FIGURE 1-2

## NOTICE TO OWNER/USER

IMMEDIATELY report all accidents, malfunctions, and equipment damages to your local National Crane distributor. Following any accident or damage to equipment, the local National Crane 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 National Crane Care. The crane must not be returned to service until it is thoroughly inspected for any evidence of damage. All damaged parts must be repaired or replaced as authorized by your local National Crane distributor or Manitowoc Crane Care.

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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 a **professional** and follow the **rules of safety**.

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

## ACCIDENTS

Following any accident or damage to equipment, the National Crane distributor must be immediately advised of the incident and consulted on necessary inspections and repairs. Should the distributor not be immediately available, contact should be made directly with Manitowoc 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 National Crane distributor and/or Manitowoc Crane Care.

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

### The Manitowoc Company, Inc.

1565 East Buchanan Trail  
Shady Grove, PA 17256-0021

Phone: 888-777-3378 (888-PSR.DEPT)

Fax: 717-593-5152

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

## OPERATOR INFORMATION

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

The *Operator Manual* supplied with and considered part of your crane must be read and completely understood by each



person responsible for assembly, disassembly, operation and maintenance of the crane.

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

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



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

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

If adjustments or repairs are necessary, the operator shall notify the next operator.

**OPERATOR QUALIFICATIONS**

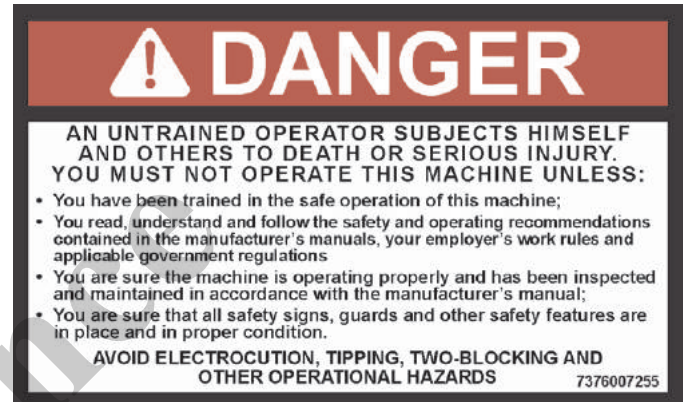
**Qualified person** is defined as one who by reason of knowledge, training and experience is thoroughly familiar with crane operations and the hazards involved. Such a person shall meet the operator qualifications specified in Occupational Safety and Health Administration (OSHA) Regulations (United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

Ensure that all personnel working around the crane are thoroughly familiar with safe operating practices. You must be thoroughly familiar with the location and content of all 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 cranes 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 machine unless:**

- You have been trained in the safe operation of this machine.
- You read, understand, and follow the safety and operating recommendations contained in the manufacturer's manuals, your employer's work rules, and applicable government regulations.
- You are sure the machine 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. 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.

National Crane remains committed to providing reliable products that enable users and operators to safely lift and position loads. National Crane 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 National Crane 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 (If Equipped)

Your crane may be 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 ensure 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 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); National Crane 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, headache ball, rigging, etc.) comes into physical contact with the boom (boom nose, sheaves, boom extension, etc.). Two-blocking can cause hoist lines (wire rope), rigging, reeving, and other components to become highly stressed and overloaded in which case the rope may fail allowing the load, block, etc. to free fall.

Two-blocking is more likely to occur when both the main and auxiliary hoist lines are reeved over the main boom nose and boom extension 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 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.

**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 judgements.



! **DANGER**

	<p style="text-align: center; font-weight: bold;">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; font-weight: bold;">POSITION CRANE ON FIRM SURFACE. EXTEND OUTRIGGERS AND LEVEL CRANE.</p>	<p style="text-align: center; font-weight: bold;">TO AVOID DEATH OR SERIOUS INJURY:</p> <p><b>NEVER</b> handle personnel with this machine unless the requirements of the applicable national, state and local regulations and safety codes are met.</p> <p><b>NEVER</b> use this crane for bungee jumping or any form of amusement or sport.</p> <p><b>NEVER</b> permit anyone to ride loads, hooks, slings or other rigging for any reason.</p> <p><b>NEVER</b> get on or off a moving crane.</p> <p><b>NEVER</b> allow anyone other than the operator to be on this crane while it is operating or traveling.</p>
	<p style="text-align: center; font-weight: bold;">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; font-weight: bold;">DO NOT PASS LOADS OR BOOM OVER GROUND PERSONNEL.</p>	<p style="text-align: center; font-weight: bold;">ELECTRONIC EQUIPMENT</p> <p>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.</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.

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**CRANE STABILITY/STRUCTURAL STRENGTH**

To avoid death or serious injury, ensure that the crane is on a firm surface with load and crane's configuration within

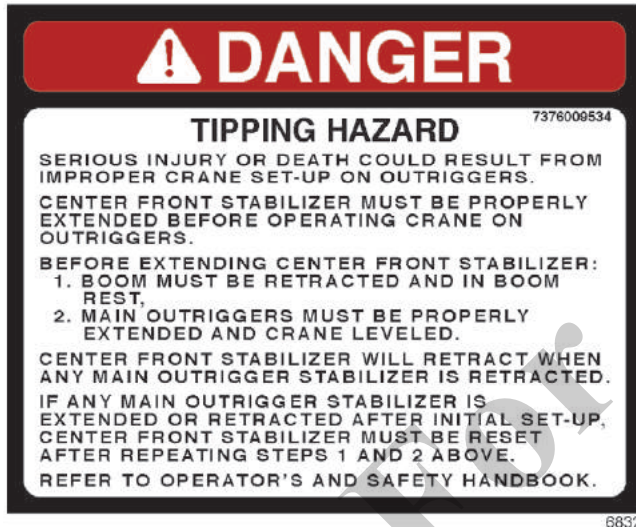
capacity as shown on the crane's *Load Chart* and notes.

Ensure 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.

Read and follow the following safety decal for cranes with center front stabilizers.



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.

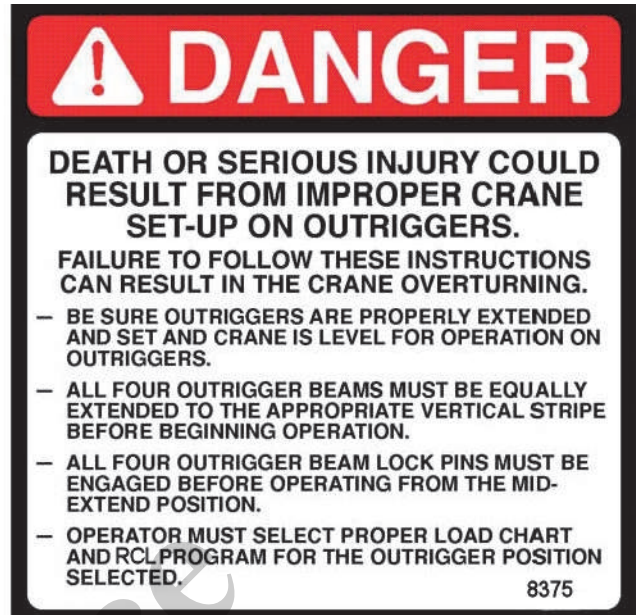
The operator must select the proper *Load Chart* and Rated Capacity Limiter (RCL) System program for the outrigger position selected.

Before swinging the superstructure over the side when the outriggers are retracted, check the *Load Chart* for backwards stability.

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

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

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. Be 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.

## 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 ensure 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. National Crane recommends that a lift not be made if the wind can cause a loss of control in handling the load.

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

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

Table 2-1 Beaufort Wind Scale

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

**Wind Speeds**

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

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

- a) If **V(z)** is ≤ 13.4 m/s (30 mph), then the **allowable** load is the published rated capacity from the Load Chart.
- b) If **V(z)** is > 13.4 m/s (30 mph) and is ≤ 20.1 m/s (45 mph), the **allowable** load is the published rated capacity multiplied by the Capacity Reduction Factor from Table 2-4 (metric) or (non-metric).

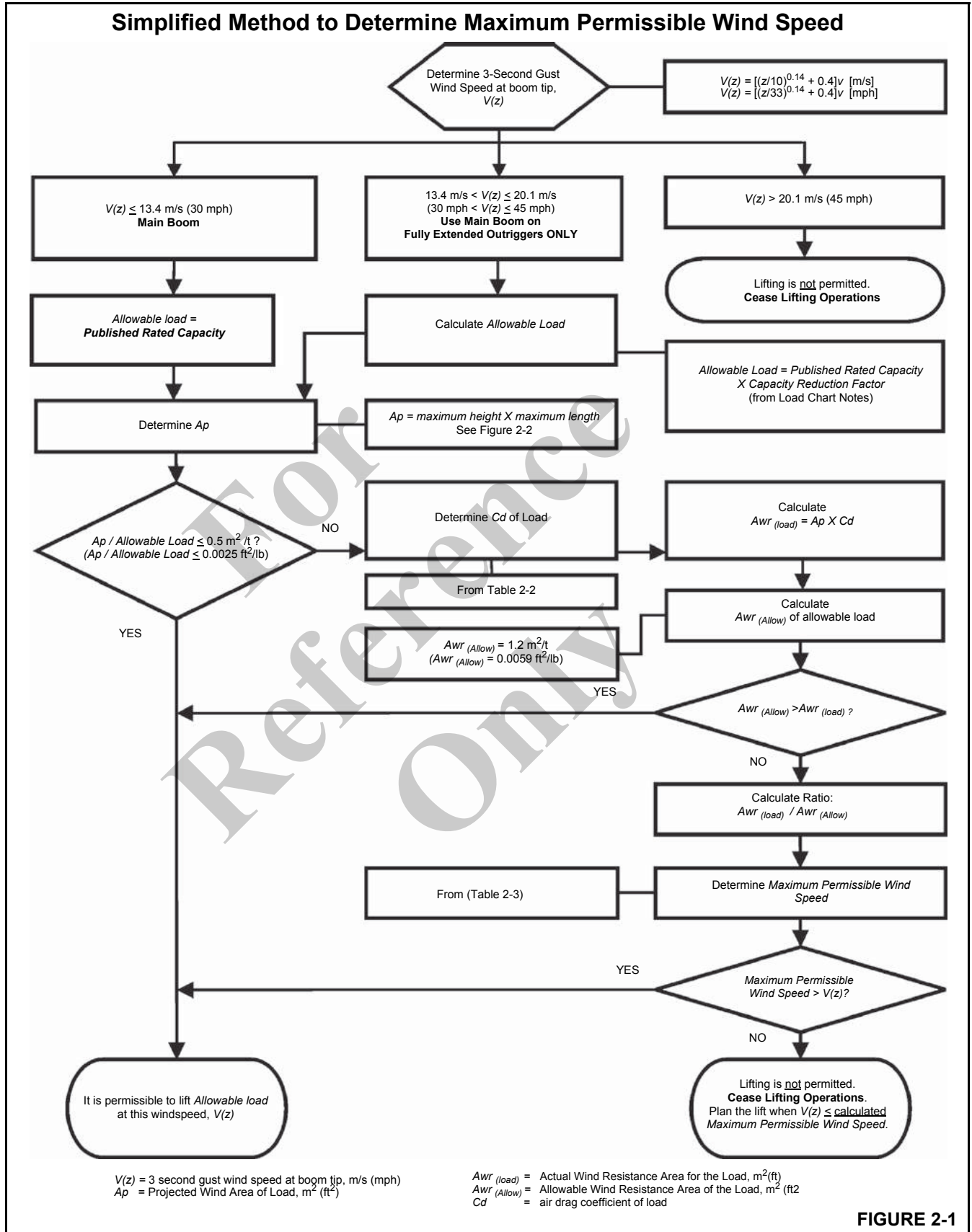
**NOTE:** This condition is limited to operation with the main boom on fully extended outriggers only.

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

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

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

For  
Reference  
Only



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

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

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

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

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

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

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

where:

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

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

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

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

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

then:

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

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

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

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

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

**Size and Shape of the load:**

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

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

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

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

where:

$Awr_{(load)}$  [ $m^2$ ] [ $ft^2$ ] - Wind resistant area of the load

$Ap$  [ $m^2$ ] [ $ft^2$ ] - projected wind area,

$Cd$  - wind drag coefficient.

$Ap$  is determined by using the calculation of maximum height x maximum length (see Figure 2-3).

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

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

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

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

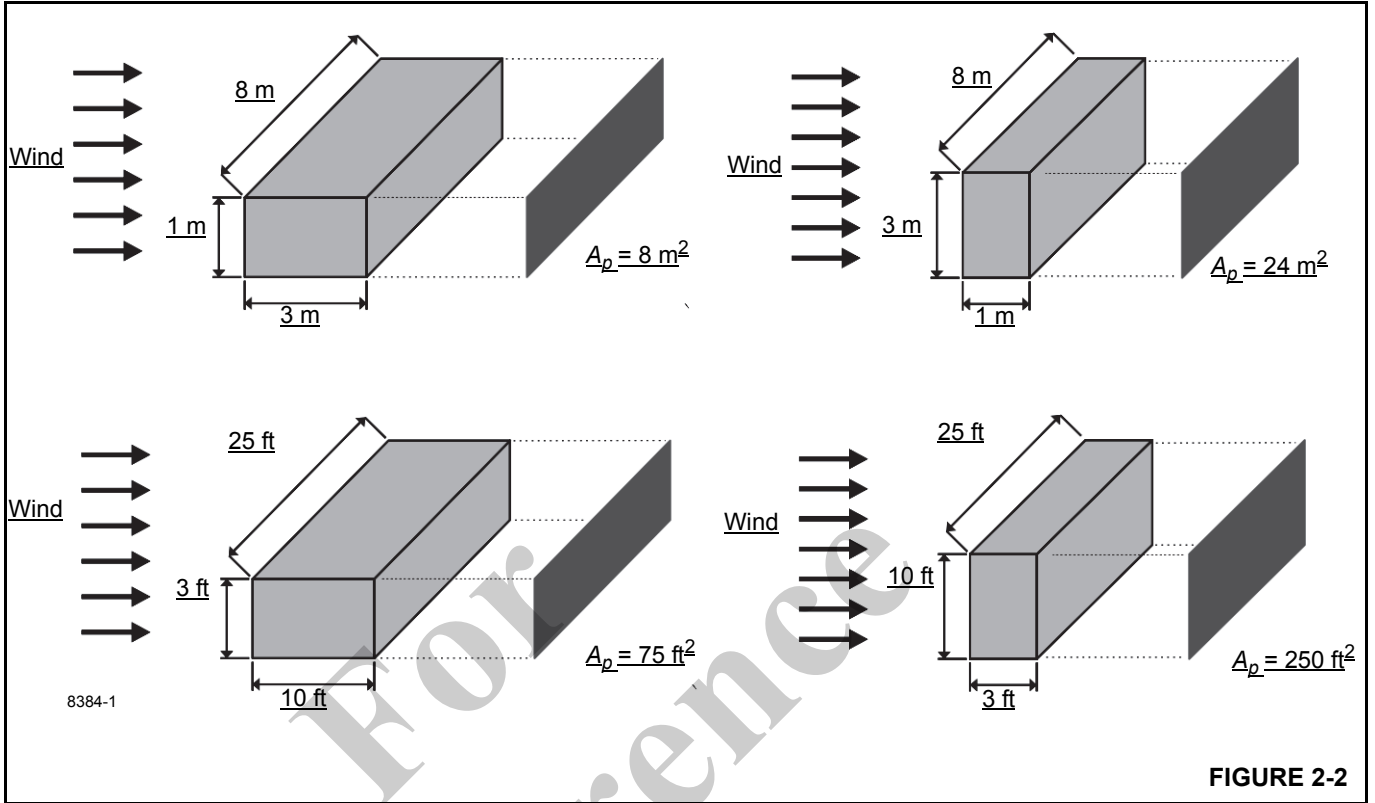
Non-metric, with  $m_{(load)}$  [lb] - Mass of the allowable load

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

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



Calculation of Projected Wind Area ( $A_p$ ):



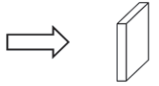

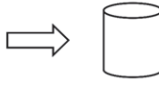
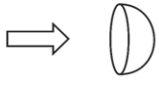
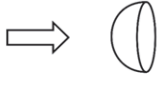
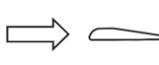

**Determining Wind Drag Coefficient ( $C_d$ )**

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

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

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

**Table 2-2 Wind Drag Coefficient**

Shape	$C_d$
	1.1 to 2.0
	0.3 to 0.4
	0.6 to 1.0
	0.8 to 1.2
	0.2 to 0.3
	0.05 to 0.1 Turbine Blade or Complete Rotor
	Approximately 1.6

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**Maximum Permissible Wind Speed**

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

**Table 2-3  $Awr$  Ratio and Permissible Wind Speed  $V(z)$  - 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 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 (8)			
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 (71)	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)	17,175 (41)	17,125 (54)	17,325 (60)	15,175 (64)	13,725 (67.5)	12,700 (70.5)	11,400 (72.5)
12			14,025 (35)	12,575 (45.5)	12,575 (53.5)	11,600 (59)	11,600 (63)	10,725 (66.5)	10,050 (69)
14				9,000 (35)	9,360 (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:

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

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

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

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

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

**Example and Sample Calculations (metric)**

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

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

**Example 1: Crane Configuration:**

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

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

The maximum allowable wind resistance area of load is

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

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

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

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

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

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

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

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

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

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

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

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

**Load example 1.1:**

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

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

wind resistance area of load can be estimated as

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

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

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

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

**Load example 1.2:**

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

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

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

the wind resistance area of load can be estimated as

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

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

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

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

**Load example 1.3a:**

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

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

the wind resistance area of load can be estimated as:

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

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

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

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

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

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

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

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

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

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

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

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

**Load example 1.3b:**

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

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

the wind resistance area of load can be estimated as

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

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



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

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

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

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

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

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)	18,250 (49.5)	19,100 (55)	18,550 (59.5)	17,350 (62.5)
55					14,300 (33.5)	15,150 (44)	16,000 (51)	16,400 (56)	15,800 (60)
60					11,050 (23.5)	12,700 (38)	13,550 (46.5)	13,950 (52.5)	14,100 (56.5)
65						9,000 (31.5)	11,550 (41.5)	11,950 (48.5)	12,300 (53.5)
70						9,010 (22.5)	9,920 (36)	10,250 (44)	10,650 (50)
75							8,510 (29.5)	8,890 (39.5)	9,250 (46)
80							7,260 (21)	7,690 (34.5)	8,050 (42.5)
85								6,620 (28.5)	7,010 (38)
90								5,630 (20)	6,100 (33)
95									5,240 (27)
100									4,480 (19.5)
Minimum boom angle (°) for indicated length (no load)									0
Maximum boom length (ft.) at 0° boom angle (no load)									110

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

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

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

FIGURE 2-4



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

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

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

Wind Speed $Vz > 30$ mph $\leq 45$ mph	Main Boom Length in Feet								
	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 in lb.,  $Awr_{(allow)} = 0.0059 \times$  calculated reduced capacity in lb.

Wind resistance area of load,  $Awr_{(load)} =$  projected wind area  $Ap \times$  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  $V(z) \leq 45$  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 ft<sup>2</sup>

For the allowable wind speed  $> 30$  mph and  $\leq 45$  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  $\leq 45$  mph** at this configuration:

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

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

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

**Load example 2.1:**

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

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

then the wind resistance area of load can be estimated as

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

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

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

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

**Load example 2.2:**

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

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

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

the wind resistance area of load can be estimated as

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

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

- Is the load to be lifted less than allowable load?  
18,000 lb  $\leq$  20,160 lb YES

- Is **Awr<sub>(load)</sub>** less than **Awr<sub>(allow)</sub>**?  
108 ft<sup>2</sup>  $\leq$  119 ft<sup>2</sup> YES

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

**Load example 2.3a:**

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

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

the wind resistance area of load can be estimated as:

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

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

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

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

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

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

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

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

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

**Load example 2.3b:**

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

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

the wind resistance area of load can be estimated as:

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

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

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

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

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

From Table 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 be sure 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, ensure 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.

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

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

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

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. Ensure the crane's capacity is not exceeded when this occurs.

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

Never push or pull with the crane boom.

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

Using only one hoist at a time when lifting loads is recommended. See "Tilt-Up Panel Lifting" on page 2-21 for additional lifting instructions.

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

## Counterweight

On cranes equipped with removable counterweights, ensure 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 JUNE2017 "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 National Crane 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.

## 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 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.
- Ensure 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.

## Tilt-Up Panel Lifting

Requirements and recommendations regarding operation and use of National Cranes are stated on decals and in the Operator and Safety Handbook and other manuals 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 instructions in the Operator and Safety Handbook, 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.
- 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 ensure 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.

Ensure 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.

## PILE DRIVING AND EXTRACTING

Pile driving and extracting are applications approved by National Crane, provided all equipment is operated within factory guidelines. The following operating requirements must be used during pile driving and extracting with a National 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 National Crane 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 National Crane, 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 ensure all wear pads remain in place. Cranes which utilize pinned boom sections shall be inspected daily to ensure 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 ensure 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 29CFR1926.1400].**

**To avoid death or serious injury, National Crane 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.**

**NOTE:** For detailed guidelines on operating near power lines, refer to the current edition of OSHA

29CFR1926.1408 and ASME B30.5 American National Standard.



**WARNING  
Electrocution Hazard!**

National cranes are not equipped with all features required to operate within OSHA 29CFR1926.1408, 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.

**THIS CRANE IS NOT INSULATED.**

**7937**

**80037260**

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

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

This crane is **not insulated**. Always consider all parts of the load and the crane, including the wire rope, hoist cable, 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, wire 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.

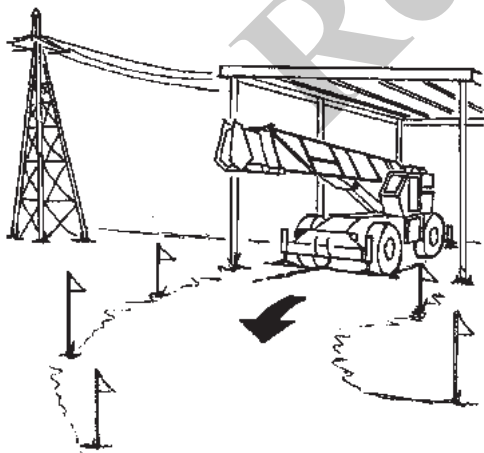
## Set-Up and Operation

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, proximity warning devices, or mechanical limit stops does not assure that electrical contact will not occur. Even if codes or regulations require the use of such devices, failure to follow the rules listed here may result in serious injury or death. You should be aware that such devices have limitations and you should follow the rules and precautions outlined in this 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 work station. **Don't panic.**
2. Immediately warn personnel in the vicinity to stay away.
3. Attempt to move the crane away from the contacted power source using the crane's controls which are likely to remain functional.
4. Stay in the crane until the power company has been contacted and the power source has been de-energized. **No one** must attempt to come close to the crane or load until the power has been turned off.

Only as a last resort should an operator attempt to leave the crane upon contacting a power source. If it is absolutely necessary to leave the operator'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 National Crane distributor must be immediately advised of the incident and consulted on necessary inspections and repairs. Thoroughly inspect the 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 National Crane 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 packed with insulating material (e.g. wooden planks).



#### WARNING

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

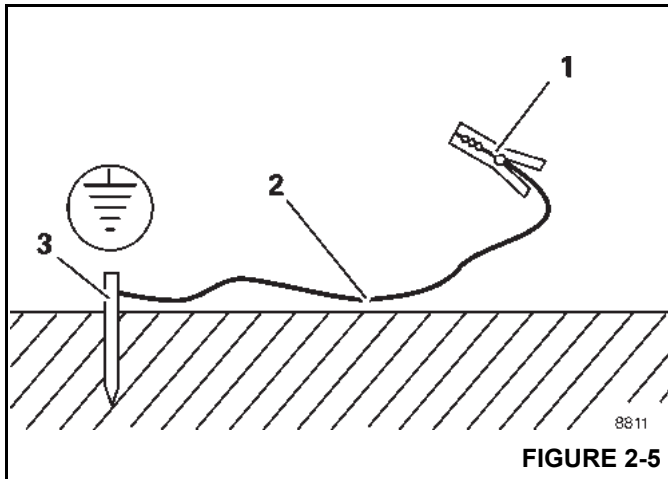
Ground the crane before you start to work with it

- 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 2-5) (length of approximately 2.0 m (6.6 ft)) at least 1.5 m (5 ft) into the ground.
2. Moisten the soil around the metal rod (3) for better conductivity.
3. Clamp an insulated cable (2) to the metal rod (3), cross-section of at least 16 mm<sup>2</sup> (0.025 inches<sup>2</sup>).

4. Connect the free end of the cable with a clamp (1) to a good electrically conductive location on the frame.



### WARNING

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

Ensure 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 publishes the American National Standard entitled, *Personnel Lifting Systems*, ASME B30.23-2016:

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 830 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 National 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's 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 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:
  - On cranes equipped with a boom mounted personnel platform, use only a platform approved by National Crane.
  - 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.

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, 0700-2900
- or -
- online at: [www.asme.org/kb/standards](http://www.asme.org/kb/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 National 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 ensure that routine maintenance and lubrication are being dutifully performed. **Never** operate a damaged or poorly maintained crane.

National Crane continues to recommend that cranes be properly maintained, regularly inspected and repaired as necessary. National Crane reminds crane owners to ensure that all safety decals are in place and legible. National Crane 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 *Manitowoc Crane Care Maintenance and Inspection Manual*. Any questions regarding procedures and specifications should be directed to your National Crane distributor.

## Service and Repairs



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 National Crane 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.**

Any modification, alteration, or change to a crane which affects its original design and is not authorized and approved by National Crane is **strictly prohibited**. All replacement parts must be National Crane approved. 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 and move the hydraulic controls in both directions several times.
- 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 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.

Ensure all lug nuts are properly torqued.

Ensure pneumatic tires are inflated to the proper pressure. 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 ensure that crane surfaces such as wear pads, sheaves, etc have not been damaged in a manner that can then damage the synthetic hoist rope.

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.

### Wire Rope

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

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

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

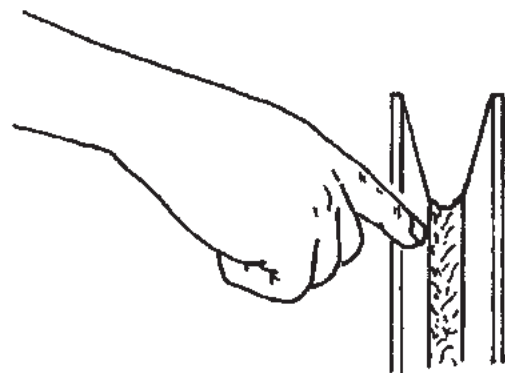
When installing a new rope:

- Keep all parts of your body and clothing away from rotating hoist drums and all rotating sheaves.
- Never handle the 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 insure tight, even spooling onto the hoist drum.
- Operate the new rope - first through several cycles at light load and then through several cycles at intermediate load to allow the rope to adjust to operating conditions.

When using a wedge socket:

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

## Sheaves



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

Ensure 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. Ensure 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 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 wire 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.
- 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.
- 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.

## Engine

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.

## 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 ensure 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.

Ensure the crane is adequately secured to the transporting vehicle.

Do not use the dead end lug on the boom nose for tying down the boom during transport. Damage to the lug and boom can result from usage as a tie down point.

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

Either the hook block may be reeved over the main boom nose or the headache ball may be reeved over the main boom nose or auxiliary boom nose; the other must be removed. If the hook block or headache 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 and avoid contact with surrounding components. 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. If equipped with boom rest, lower the boom into the boom rest and engage the turntable swing lock pin and/or 360 degree swing lock.

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

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.

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

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

Keep Clear of revolving tires.

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

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

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

When driving the crane, ensure the cab is level, 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, ensure they will carry a load greater than the crane's weight.

If it is necessary to take the 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, ensure that the hoist access platform hand rail and step are in the travel configuration.

Slopes:

- 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 ensure you do not slip and/or fall off the crane. Falling from any elevation could result in serious injury or death.

Never exit or enter the crane cab or deck by any other means than the access system(s) provided (i.e., steps and grab handles). Use the recommended hand-holds 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 Manitowoc Crane Care.

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 hand-holds, access steps,

or walking/working surfaces could cause a slipping accident. A shoe that is not clean might slip off a control pedal during operation.

Do not 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.
- Ensure 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 (e.g. RCL).
- Check all braking (e.g. wheel, hoist, and swing brakes) and holding devices before operation.

You must ensure that the outriggers and stabilizers 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 machine controls.

Make sure 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.

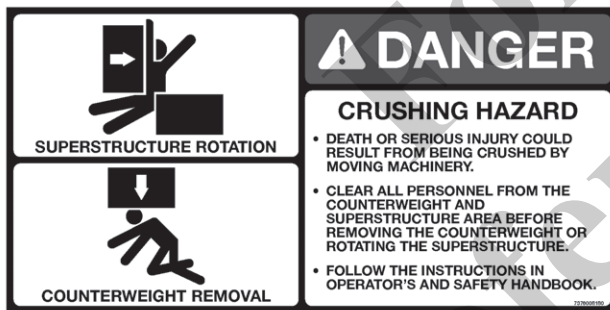
Carbon monoxide fumes from the engine exhaust can cause suffocation in an enclosed area. Good ventilation is very important when operating the crane.

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.

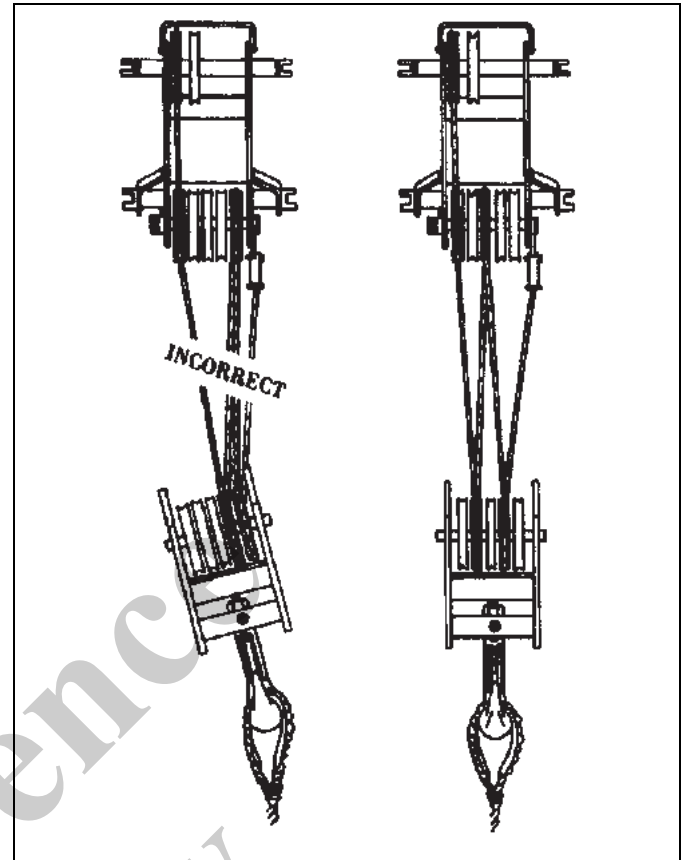
You must always be aware of everything around the crane while lifting or traveling. If you are unable to clearly see in the direction of motion, you must post a look out or signal person before moving the crane or making a lift. Sound the horn to warn personnel.

Operate the equipment from the operator's control station. 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.

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



## Lifting

**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 rope or hoist. **No less than three wraps** of rope should remain on the hoist drum. When slings, ties, hooks, etc., are used, make certain they are correctly positioned and secured before raising or lowering the loads.

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

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

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

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

Ensure that all slings, ties, and hooks are correctly placed and secured before raising or lowering the load.

Be 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. Be sure the hoist brake is working correctly before continuing the lift.

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

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.

**Lift one load at a time.** Do not lift two or more separately rigged loads at one time, even if the loads are within the crane's rated capacity.

Never leave the crane with a load suspended. Should it become necessary to leave the crane, lower the load to the ground and stop the engine before leaving the 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, ensure *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. Ensure weight of load is within 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.

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

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

## Hand Signals

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

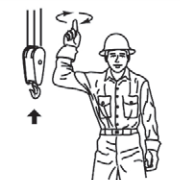


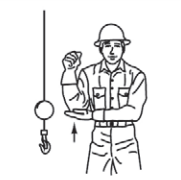

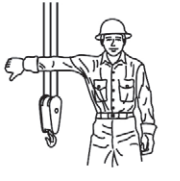

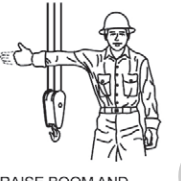
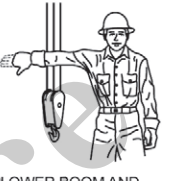
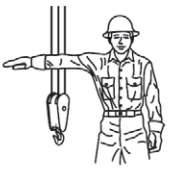

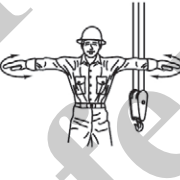
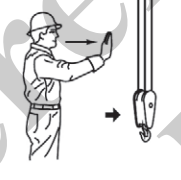

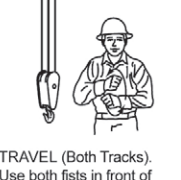





- Working in the vicinity of power lines.
- The crane operator cannot clearly see the load at all times.
- Moving the crane in an area or direction in which the operator cannot clearly see the path of travel.

At all times use standardized hand signals (Figure 2-6) - 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.

<b>STANDARD HAND SIGNALS FOR CONTROLLING CRANE OPERATIONS</b>				
Complies with ASME B30.5-2011				
				
<b>HOIST.</b> With forearm vertical, forefinger pointing up, move hand in small horizontal circle.	<b>LOWER.</b> With arm extended downward, forefinger pointing down, move hand in small horizontal circle.	<b>USE MAIN HOIST.</b> Tap fist on head; then use regular signals.	<b>USE WHIPLINE (Auxiliary Hoist).</b> Tap elbow with one hand; then use regular signals.	<b>RAISE BOOM.</b> Arm extended, fingers closed, thumb pointing upward.
				
<b>LOWER BOOM.</b> Arm extended, fingers closed, thumb pointing downward.	<b>MOVE SLOWLY.</b> Use one hand to give any motion signal and place other hand motionless in front of hand giving the motion signal (hoist slowly shown as an example).	<b>RAISE BOOM AND LOWER LOAD.</b> With arm extended, thumb pointing up, flex fingers in and out as long as load movement is desired.	<b>LOWER BOOM AND RAISE LOAD.</b> With arm extended, thumb pointing down, flex fingers in and out as long as load movement is desired.	<b>SWING.</b> Arm extended, point with finger in direction of swing of boom.
				
<b>STOP.</b> Arm extended, palm down, move arm back and forth horizontally.	<b>EMERGENCY STOP.</b> Both arms extended, palms down, move arms back and forth horizontally.	<b>TRAVEL.</b> Arm extended forward, hand open and slightly raised, make pushing motion in direction of travel.	<b>DOG EVERYTHING.</b> Clasp hands in front of body.	<b>TRAVEL (Both Tracks).</b> Use both fists in front of body, making a circular motion about each other, indicating direction of travel, forward or backward. (For land cranes only.)
				
<b>TRAVEL (One Track).</b> Lock the track on side indicated by raised fist. Travel opposite track in direction indicated by circular motion of other fist, rotated vertically in front of body. (For land cranes only.)	<b>EXTEND BOOM (Telescoping Booms).</b> Both fists in front of body with thumbs pointing outward.	<b>RETRACT BOOM (Telescoping Boom).</b> Both fists in front of body with thumbs pointing toward each other.	<b>EXTEND BOOM (Telescoping Boom).</b> One Hand Signal. One fist in front of chest with thumb pointing outward.	<b>RETRACT BOOM (Telescoping Boom).</b> One Hand Signal. One fist in front of chest, thumb pointing outward and heel of fist tapping chest.

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**FIGURE 2-6**

## 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 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 all the pins from both front and rear stowage brackets 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



### WARNING

#### Tipping Hazard!

When parking the crane and leaving it unattended follow the instructions for the Controls and Operating Procedures 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.

The Controls and Operating Procedures section 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, National Crane 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 in erection mode, 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 extensions 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 and/or 360 degree swing lock.
- Place controls in neutral position.
- Shut down the engine and remove the ignition key.
- 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 ample time for hydraulic oil to warm up.

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

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

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

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

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

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

## TEMPERATURE EFFECTS ON HYDRAULIC CYLINDERS

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

The change in the length of a cylinder is proportional to the extended length of the cylinder and to the change in temperature of the oil in the cylinder. For example, a cylinder extended 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 2-8]. A cylinder extended 1.5 m (5 ft) in which the oil cools 15.5°C (60°F) would only retract approximately 38 mm (1 1/2 in). The rate at which the oil cools depends on many factors and will be more noticeable with a larger difference in oil temperature verses the ambient temperature.

Thermal contraction coupled with improper lubrication or improper wear pad adjustments may, under certain conditions, cause a “stick-slip” condition in the boom. This “stick-slip” condition could result in the load not moving smoothly. Proper boom lubrication and wear pad adjustment is important to permit the boom sections to slide freely. Slow movement of the boom may be undetected by the operator unless a load is suspended for a long period of time. To minimize the effects of thermal contraction or “Stick-slip” it is recommended that the telescope control lever is activated periodically in the extend position to mitigate the effects of cooling oil.

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

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

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

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

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

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

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

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

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

**MODEL SPECIFIC INFORMATION**

On cranes equipped with a boom mounted personnel platform, use only a platform approved by Manitowoc.

**OVERLOAD INSPECTION**

This information supplements the Rated Capacity Limiter (RCL) manual supplied with each National crane.

When the RCL system has acknowledged an overload on your crane, you must carry out specified inspections on the crane.

These inspections apply only to overloads up to 50%. For overloads of 50% or higher, crane operation must be stopped immediately and Crane Care must be contacted for corrective action.



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

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

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

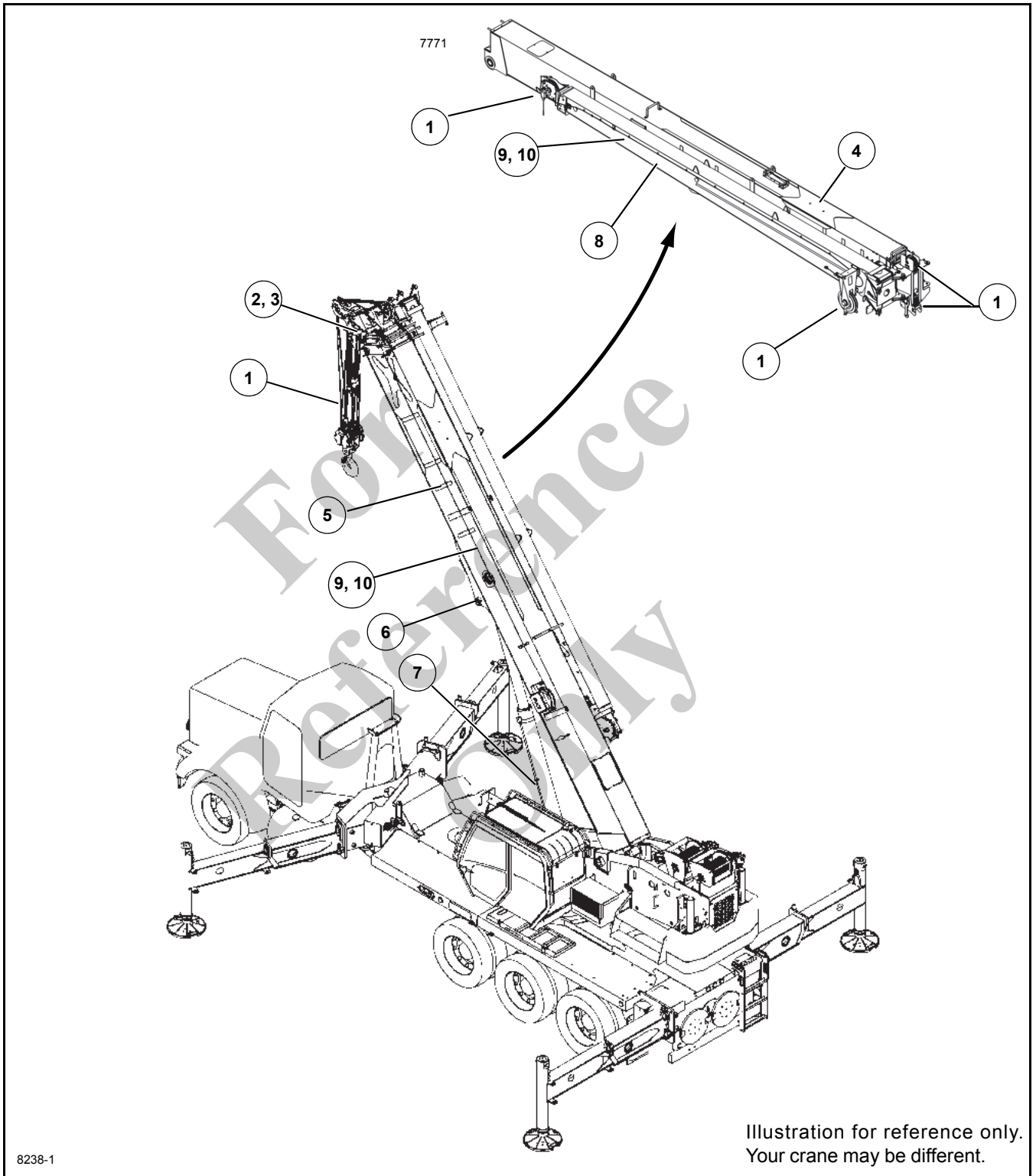
- Perform the inspections outlined in this publication for overloads up to 50%.
  - Stop operating the crane and contact Manitowoc Crane Care immediately for overloads of 50% and higher.
- 

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

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

For  
Reference  
Only

Boom Inspection



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

<b>Overload less than 25%</b>			
1	Sheaves, Rope Guides	Inspect all for damage.	
2	Collar-Wear Pads, Pad Retainers	Inspect for damage.	
<b>Overload from 25% to 49%</b>			
1	Sheaves, Rope Guides	Inspect all for damage.	
2	Collar-Wear Pads, Pad Retainers	Inspect all for damage.	
3	Collar-welds	Inspect all for damage.	
4	Pinning Areas	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	Jib Section	Inspect for bent or twisted section. Check for straightness.	
9	Welds	Inspect for cracks.	
10	Paint	Inspect for cracked paint which could indicate twisted, stretched, or compressed members.	



Superstructure Inspection

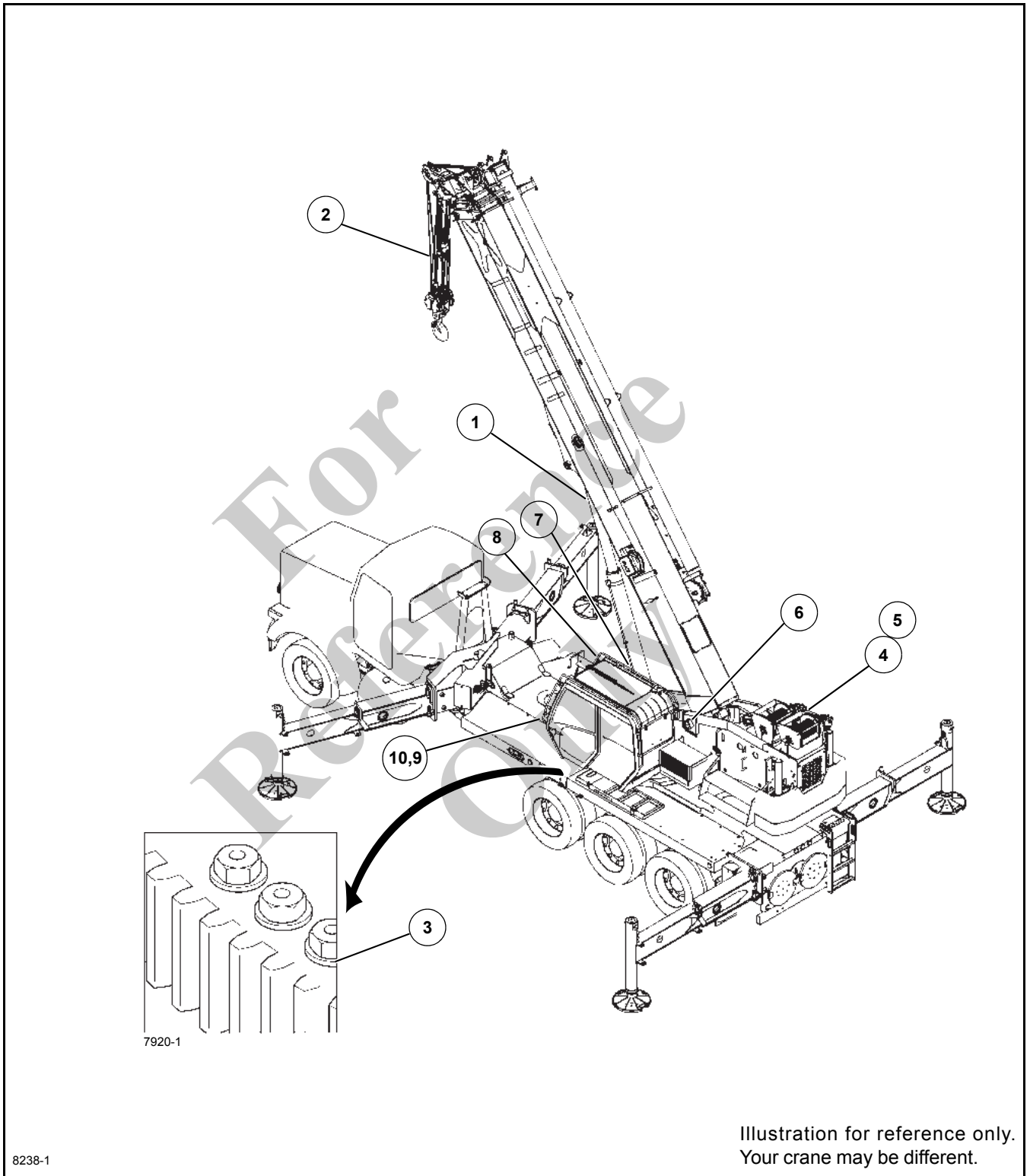


Illustration for reference only.  
Your crane may be different.

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

<b>Overload less than 25%</b>			
1	Lift Cylinder	Inspect for leaks.	
2	Rope	Inspect all for damage.	See topic in Introduction section of Service Manual.
3	Turntable Bearing	Check bolts for proper torque.	See topic in Swing section of Service Manual.
<b>Overload from 25% to 49%</b>			
1	Lift Cylinder	Inspect for leaks.	
2	Rope	Inspect all for damage.	See topic in Introduction section of Service Manual.
3	Turntable Bearing	Check bolts for proper torque.	See topic in Swing 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	Turret Area	Inspect for deformation, cracked welds.	
9	Welds	Inspect for cracks.	
10	Paint	Inspect for cracked paint which could indicate twisted, stretched, or compressed members.	

Carrier Inspection

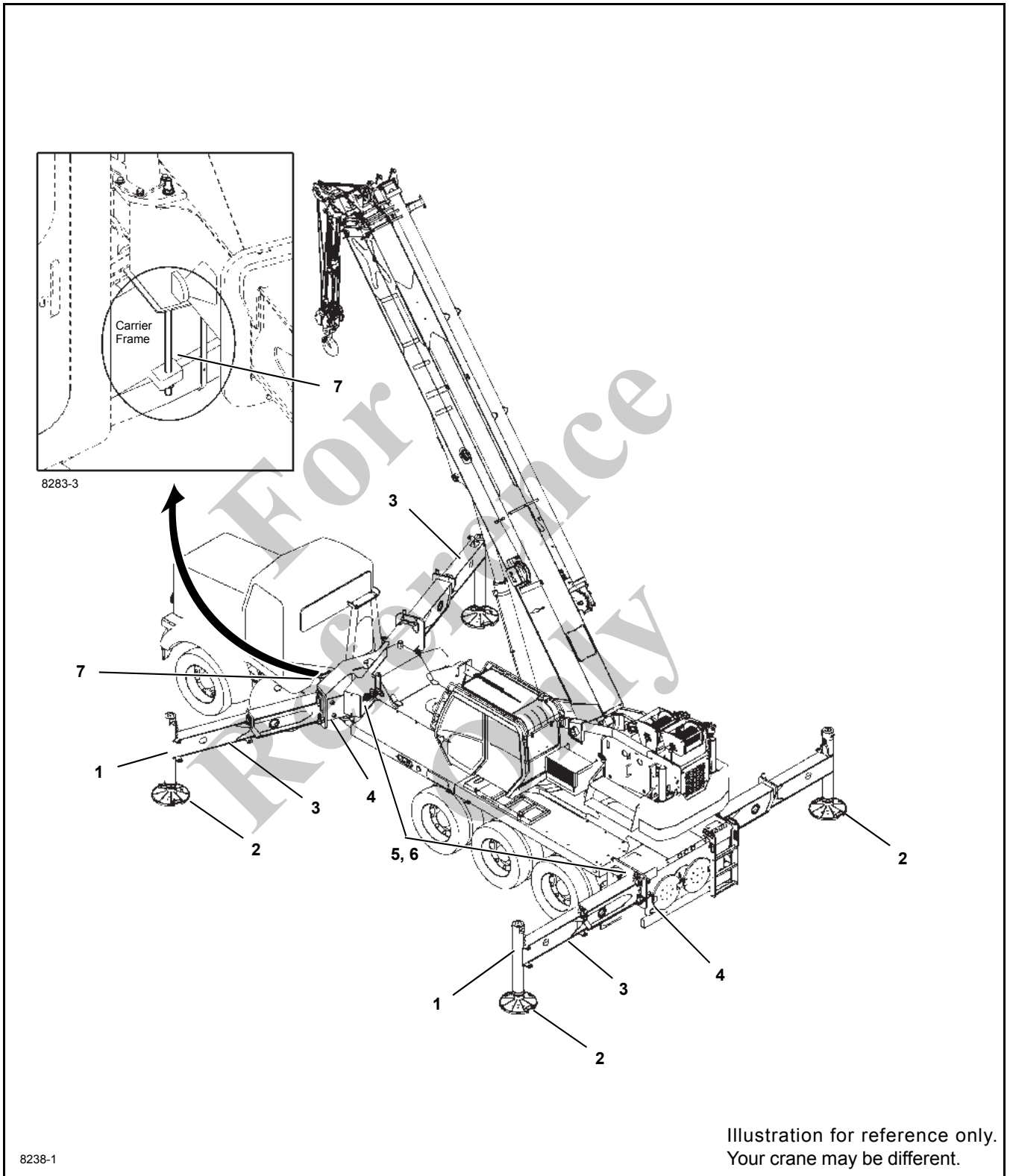


Illustration for reference only.  
Your crane may be different.

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

<b>Overload less than 25%</b>			
1	Jack Cylinders	Inspect for leaks.	
2	Outrigger Pads	Inspect for deformation and cracked welds.	
<b>Overload from 25% to 49%</b>			
1	Jack Cylinders	Inspect for leaks.	
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.	
7	Mounting Studs	Check bolts for proper torque.	

Reference Only

**SECTION 3**  
**CONTROLS AND OPERATING PROCEDURES**

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This section contains information on the controls and operating procedures to include:

- Truck Cab Controls
- Outrigger Controls
- Crane Controls
- Operating Procedures
- Hoist System Operation
- Work Site Location
- Load Chart
- Lifting the Load
- Shutdown and Preparation for Travel

## CRANE THEORY OF OPERATION

### Crane Software Overview

The NBT60 is equipped with a CAN bus electronic system that controls the majority of the devices on the crane. This is a distributed system consisting of several electronic modules that all perform different functions based on the crane's software. These modules are all connected together with a twisted pair of wires that allows all the modules to talk on the same databus - the CAN bus - to provide the information about the state of all the devices on the crane. There is a main module, or "server" module that controls all the other secondary modules called "client" modules in the system. The software that describes how the crane should react to the various switches, sensors, joysticks and pedals is installed on the server module which then controls the client modules functions.

When a switch or a pedal is used, an "input" is sent to an electronic module which monitors any change in value. When the input has been received and the crane software logic allows for this to be communicated to the "output" device, the crane then responds to the operator's "input". For example, if the crane operator moves the swing left joystick to rotate the crane, the "input" from the joystick is read by the control modules but the crane server module knows that movement is not allowed unless the swing brake release switch is activated. So in this example, the swing left proportional output is not energized and there is no crane movement.

## JUMP STARTING THE CRANE

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.

All crane models, particularly those produced since 2000, have multiple computer systems (crane control, RCL, engine & 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.

### Charging

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.

### Getting Started

The NBT60 has several interlocks that must be satisfied before operating the crane. To operate the crane, the crane must be started from the crane cab key switch. Starting the truck from the truck cab will not allow the crane to operate. There are several interlocks that will prevent the crane cab key switch from turning on the ignition power circuit for the truck ignition:

- Lower ground level outrigger panel ESTOP switches must be released
- Crane Cab ESTOP switch must be released
- Truck ignition key switch must be off
- Hydraulic Suction Shut-off Valve is shut and must be opened.
- There is also an interlock that prevents the crane key switch from starting the truck engine:
  - PTO must be engaged

If unable to activate the crane cab key switch, first check the status of these items and then cycle the crane cab key switch and try again. These interlocks are designed to ensure that the crane performs as desired and allow for all the ESTOP switches to be available for use if needed.

## Crane Ignition and Control States

The NBT60 control system consists of many “states” which describe functions that can or cannot be performed while in that state. This allows for the crane to operate several ways when running the truck chassis, the crane, or radio remote control of the crane. These “states” can only be seen through the crane’s diagnostic software program.

### Ignition States

Since the crane and the truck chassis both have key switches, there is interlock logic to only allow one switch to be active at a time even if both switches are turned ON. The first switch to be turned to ignition is the controlling key switch. Here is a summary of the main states:

- State = 0 (No ignition switch active)
- State = 1 (Truck ignition switch active)
- State = 2 (Crane ignition switch active)

### Control States

To transition between State = 0 and 1 to State = 2 to 5, the Truck Key State must be inactive (0) and the crane cab key switch should be turned to the ON ignition position. In order to transition from Crane Ignition to Truck Ignition, the crane cab key switch must first be turned OFF and then the truck key switch can be turned to the ON ignition position. Both switches must be OFF before changing between states 1 and 2.

There are several Crane States, but the main states are listed below:

- Control State = 0 (Control OFF)
- Control State = 1 (Truck Control Active)
- Control State = 2 (Lower Control Active)
- Control State = 3 (Crane Cab Control Active)
- Control State = 4 (Radio Remote Control Active)

- Control State = 5 (Radio Remote Control Idle)

When the Crane key switch is turned ON and the truck engine is started, the crane is in Control State = 2. In this state, the outriggers can be operated using the ground level panels on either side of the crane and the hoists and single front outrigger (if equipped) can be operated using the standard handheld remote control.

The cab HVAC is functional to allow the crane to be heated and cooled while not using the crane functions.

To transition between Control State = 2 to Control State = 3, the crane power switch must be ON, the armrests must be in the down position, and the operator must be sitting on the cab seat to activate the safety switch. In this Control State 3, the lower outrigger stations and the standard remote control are inactive. The cab outrigger controller is active along with all crane functions.

To use the optional crane remote controller (if equipped), the crane must first be in the Control State =2 (Lower Control). The crane power switch and radio remote switch must both be OFF and the crane cab ignition switch must be ON. To enable remote control operation, turn on the remote power switch. Refer to *Crane Remote Control (optional)*, page 3-29 for more information on the crane remote controller operation. Similar to the Ignition States, both crane and remote power switches must be OFF to switch between states 3 and 4. The first switch turned on is the controlling state.

To use the optional crane remote control:

- Crane cab key switch = ON
- Crane Power switch = OFF
- Remote Power switch = ON

In order to sync the remote with the crane, the Horn/Enable button must be depressed and the engine start button can be used,

## TRUCK CAB CONTROLS

The truck cab controls described here are those controls that are used in conjunction with the crane controls.

### Truck Cab Ignition Switch

Truck cab ignition switch must be OFF in order for crane cab ignition switch to be operable.

### Power Take Off (PTO)

#### Manual Shift Control

The PTO is engaged when the knob on the dash or floor is pulled out and disengaged when the knob is pushed in. The

truck gear shift lever must be in neutral and the clutch depressed whenever the knob is moved.

#### ***Air Shift Control***

The PTO is engaged when the switch is moved to apply air to PTO and disengaged when switch is in off position. The truck gear shift lever must be in neutral and clutch depressed when switch is moved. The transmission selector lever must be returned to "N" for stationary vehicle operation. The power take-off may be disengaged while in any transmission range provided that the load has first been removed from the PTO.

#### ***Electric Shift Control***

Full torque electric shift PTO's are controlled by a switch. To operate, disengage the clutch, shift to fourth or fifth gear, and then move the switch down to engage the PTO or up to disengage the PTO. Return the gear shift to neutral and engage the clutch.

#### ***Power Shift Control***

If the vehicle is equipped with an automatic transmission, the power take-off must be engaged with the engine at idle. See transmission manufacturer's instructions for special procedures.

#### **Park Brake**

The truck brake must be firmly set before leaving cab to begin operation. If the ground surface is icy or slick or is sloped, you may be required to help immobilize the truck with wheel chocks.

#### **Engine Speed Governor**

Some diesel engines are equipped with a variable speed governor which overrides the engine speed governor. If equipped, two knobs in the cab select between crane operation and normal driving operation.

#### **Neutral Start/Safety Switch**

The truck must be equipped with a neutral/start safety switch on truck transmission. Check occasionally to ensure it is working correctly and repair if it is not.

#### **OUTRIGGER CONTROLS**

The outriggers can be operated from three locations, including a controller located (Figure 3-2) on the crane cab console and two ground station control panels located on the left and right sides of the carrier decking. Each controller contains the control buttons for extending and retracting the outrigger beams, for raising and lowering the outrigger jack cylinders and for raising and lowering the single front outrigger (SFO), if equipped.



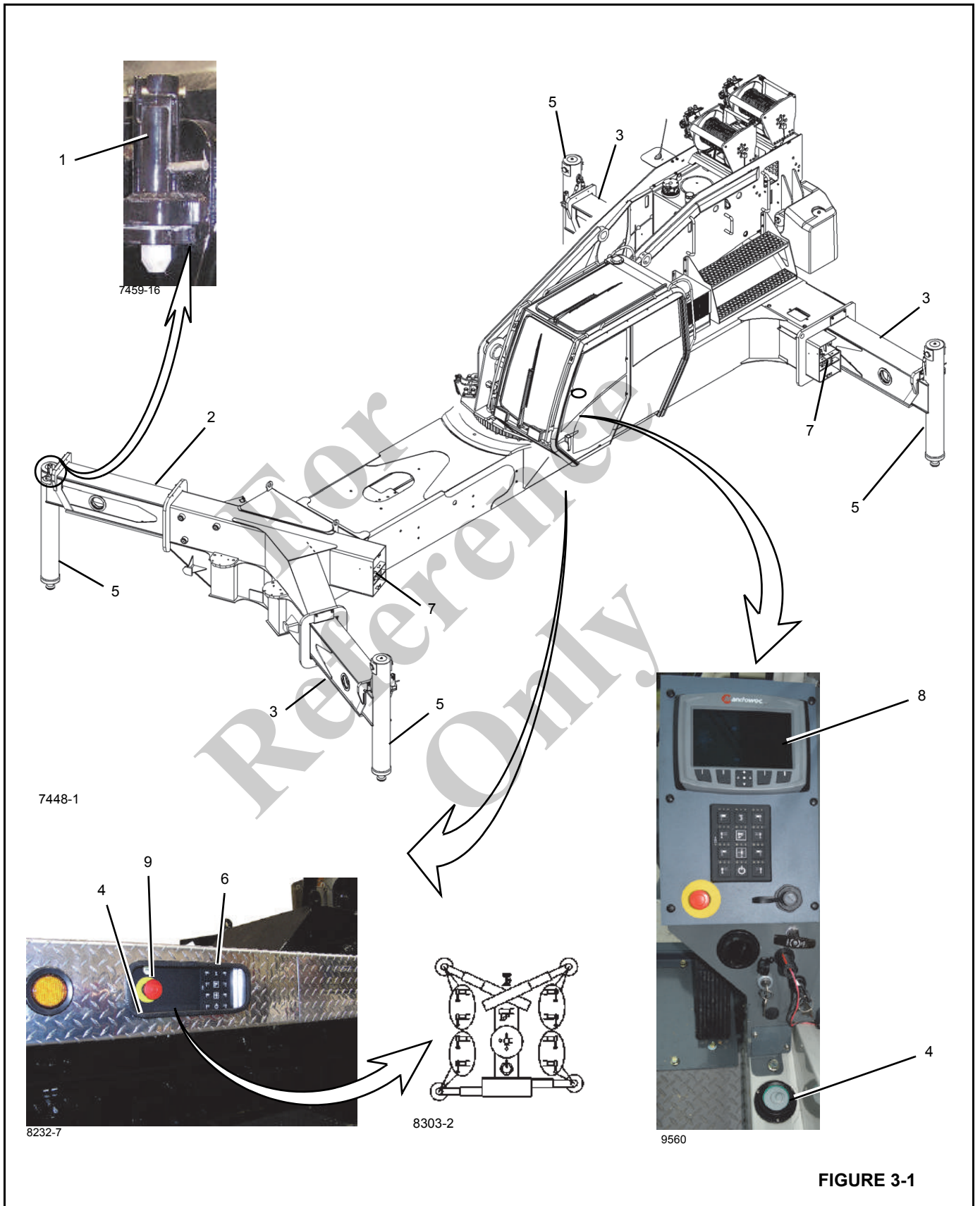


FIGURE 3-1

Item	Description	Item	Description
1	Outrigger Midspan Selector Pin	6	Ground Station Outrigger Controls
2	Outrigger Beam Assy Long	7	Outrigger Extend/Retract Cylinder
3	Outrigger Beam Assy Short	8	Console Panel
4	Level Indicator	9	Emergency Stop Switch
5	Outrigger Jack Cylinder		

### Cab Outrigger Control Panel

The cab outrigger control panel (Figure 3-1) is located on the superstructure cab front console panel (8) and is used to control the outriggers from inside the cab. The control panel contains a touch pad with control buttons and indicators for extending and retracting the outrigger beams, for raising and lowering the outrigger jack cylinders and for raising and lowering the single front outrigger (SFO) - if equipped. The station contains a level indicator and an emergency stop switch. All outrigger functions can be controlled from the cab control panel.

**NOTE:** The operator must be in the crane cab seat with left armrest lowered and crane power switch (16, Figure 3-3) ON for the crane cab outrigger controls to operate.

**NOTE:** Make sure tilting cab is in the lowered position before leveling crane.

### Ground Station Outrigger Control Panel

The ground station control panels are located on the left and right sides of the carrier decking (Figure 3-1). Each control station has a touch pad with LED indicators, control buttons for extending and retracting the outrigger beams, for raising and lowering the outrigger jack cylinders and for raising and lowering the single front outrigger (SFO) - if equipped. Each station contains a level indicator and an emergency stop switch.

**NOTE:** Outrigger beam functions can be controlled only from the side the ground station control panel is located.

### Outrigger Control Operation

There is a outrigger control panel located on each side of the crane, as shown in Figure 3-1 and Figure 3-2. The following details apply to both control panels as indicated.

- The panel on the right side operates the outrigger beams for right side only.

**NOTE:** The red LED's for left side beams will be illuminated at right work station when operating right side ground station control and when cab outrigger controls are disabled.

- The panel on the left side operates the outrigger beams for left side only.

**NOTE:** The red LED's for right side beams will be illuminated at left work station when operating left side ground station control and when cab outrigger controls are disabled.

- The jacks may be operated from either the left or right side of the crane.
- Each control panel contains a control button for raising and lowering the single front outrigger (SFO) - if equipped.
- Each control panel contains an emergency stop switch.
- Each control station contains a bubble level for leveling crane.

CAB OUTRIGGER CONTROL

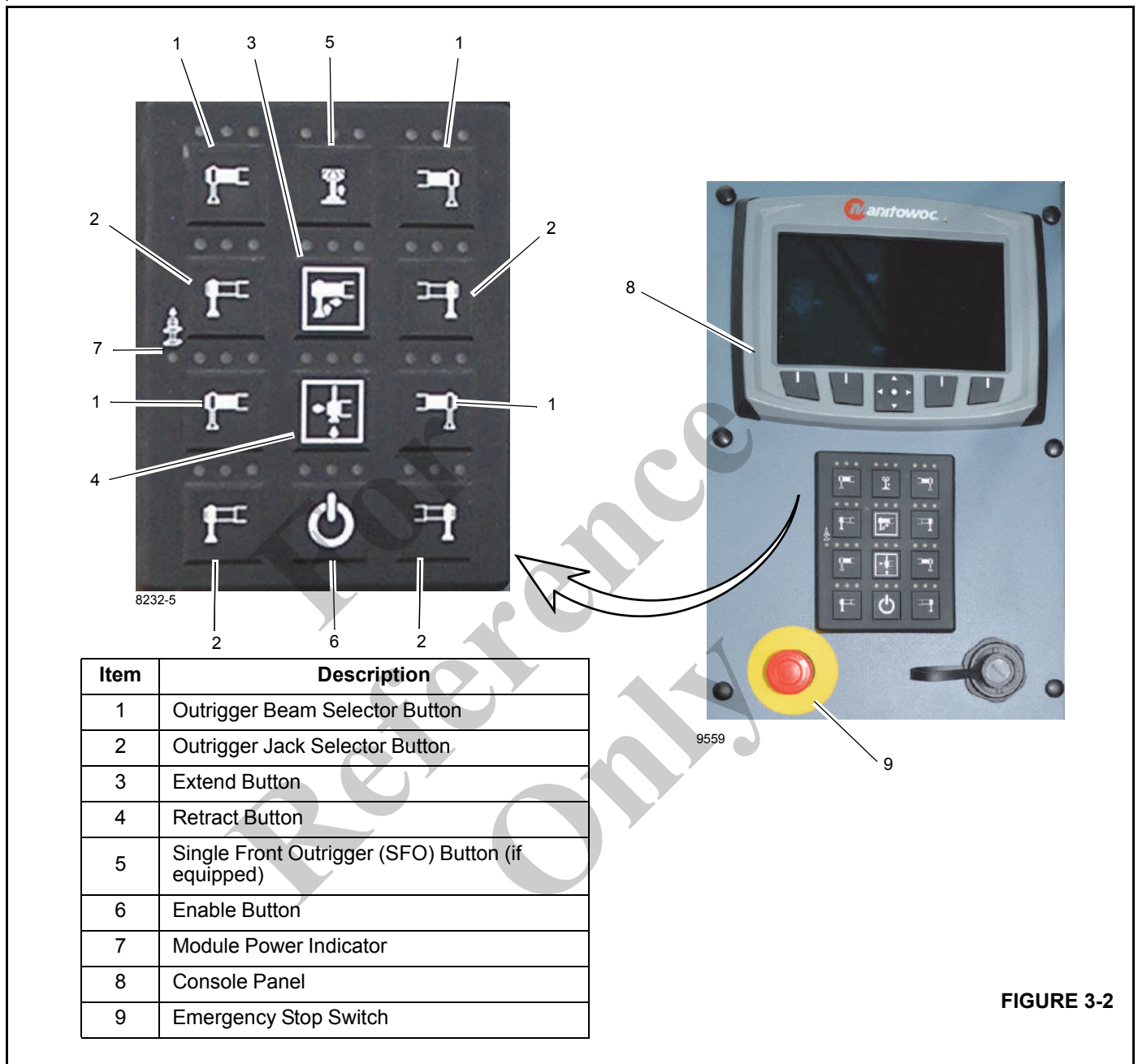


FIGURE 3-2

**Outrigger Selector Buttons**

There are four outrigger beam selector buttons (1) located on each outrigger control panel (Figure 3-2).

There are four outrigger jack selector buttons (2) located on each outrigger control panel (Figure 3-2).

Pre-selection of a button or a combination of buttons (one or more beams or one or more jacks) may be selected within 5 seconds before pressing next function. The enable button will activate the selected functions.

**NOTE:** A blue LED will illuminate for 5 seconds indicating a switch has been selected. A red LED will illuminate if a button selection is unavailable.

**NOTE:** Extension beam and jack cannot be combined to operate simultaneously.

**Enable Switch**

The enable button (6) is located on each outrigger control panel (Figure 3-2) and is used in conjunction with the

3

pre-selection of outrigger selector buttons (1, 2) to control the outrigger functions.

Pre-selection of a button or a combination of buttons (one or more beams or one or more jacks) may be selected within 5 seconds before pressing the enable button to activate all selected functions. A blue LED will illuminate for 5 seconds indicating the button has been selected. A red LED will illuminate if a selection is unavailable.

Press the extend or retract button while holding the enable switch to complete the operation.

**NOTE:** Extension beam and jack cannot be operated simultaneously.

### **Extend Button**

The extend button (3) is located on the outrigger control panel (Figure 3-2) and is used in conjunction with the enable buttons (6) to control both the outrigger beams or the jacks functions.

### **Retract Button**

The retract button (4) is located on the outrigger control panel (Figure 3-2) and is used in conjunction with the enable buttons (6) to control both the outrigger beams or the jacks functions.

### **LED Indicators**

LED indicators display the status of the control button being selected (Figure 3-2) on the outrigger control panel. A LED will illuminate for 5 seconds after a button has been selected.

- Blue indicates active selection
- Green indicates pre-selection is enabled
- Red indicates inactive selection (For example: trying to pre-select and enable an outrigger beam and jack to operate at the same time)
- The red LED's for left side beams will be illuminated at right work station when operating right side ground station control and when cab outrigger controls are disabled.

The panel on the left side operates the outrigger beams for left side only.

- The red LED's for right side beams will be illuminated at left work station when operating left side ground station control and when cab outrigger controls are disabled.

### **Module Power**

The module power indicator (7) is located on each outrigger control panel and indicates the outrigger control station panel (Figure 3-2) is activated when a green LED illuminates. The control station can not be activated if the crane is performing another function. (For example: operating the boom.)

### **Outrigger Beam Selector Button**

The outrigger beam selector buttons (1, Figure 3-2) are used to operate the front or rear outrigger beams. Both sides can be operated from the cab outrigger control panel.

**NOTE:** The following details apply to both ground station control panels as indicated.

The ground control outrigger beam selector buttons (1, Figure 3-2) are used to operate the front or rear outrigger beam only on the side of the crane the ground control is located.

- The panel on the right side operates the outrigger beams for right side only.
- The red LED's for left side beams will be illuminated at right work station when operating right side ground station control and when cab outrigger controls are disabled.  
The panel on the left side operates the outrigger beams for left side only.
- The red LED's for right side beams will be illuminated at left work station when operating left side ground station control and when cab outrigger controls are disabled.

### **Outrigger Jack Selector Button**

Use the outrigger jack selector buttons (2, Figure 3-2) to indicate which jack you desire to operate.

### **Single Front Outrigger Button (SFO) - if equipped**

The single front outrigger (SFO) button (5, Figure 3-2) is located on the outrigger control panel (if equipped).

### **Outrigger Selector Valve**

After pushing the desired selector buttons, the enable button, and either the extend or retract button energizes the control solenoid to allow hydraulic fluid to flow through the control solenoid valve and the individual solenoid valves and moves the selected component in the desired direction. In addition, when the buttons are pushed, a signal is sent to the engine ECM to increase the engine speed above idle for operation of the outriggers.

### **Emergency Stop Switch**

There is an emergency stop switch (9, Figure 3-2) located at each outrigger control on each side of the carrier and inside the cab on the front console (9, Figure 3-3). Pressing an emergency stop switch shuts down the engine.

**NOTE:** Only use the emergency stop switch in the case of an emergency to shut down the engine; do not use the emergency stop switch regularly as a means of turning off the crane.

**Crane Level Indicators**

A bubble level indicator (Figure 3-1) is located on the right interior wall of the cab and on each ground station outrigger control panels located on the lower frame decking. The

indicator provides the operator with a visual indication for determining the levelness of the crane.

**NOTE:** To ensure a true reading always make sure the cab tilt is completely lowered.

For  
Reference  
Only

CRANE CONTROLS



<b>Item</b>	<b>Description</b>	<b>Item</b>	<b>Description</b>
1	Outrigger Control Pad	13	Program/Diagnostic Connector
2	Swing Brake Pedal	14	Crane Level
3	Boom Telescope Pedal (Optional)	15	Truck Engine Hi/Low Switch
4	Foot Throttle Pedal	16	Crane Function Power Switch
5	Display Panel Assembly	17	Remote Power Switch (Optional)
6	RCL Bypass Switch	18	Work Light Switch
7	Reserved	20	Skylight Wiper Switch
8	Reserved	21	Windshield Wiper Switch
9	Emergency Stop Switch	22	A/C Heater Function Switch
10	A/C Heater Vent	23	A/C Heater Temperature Control
11	Ignition Switch	24	A/C Heater Fan Speed
12	Receptacle (12v)		

For Reference Only

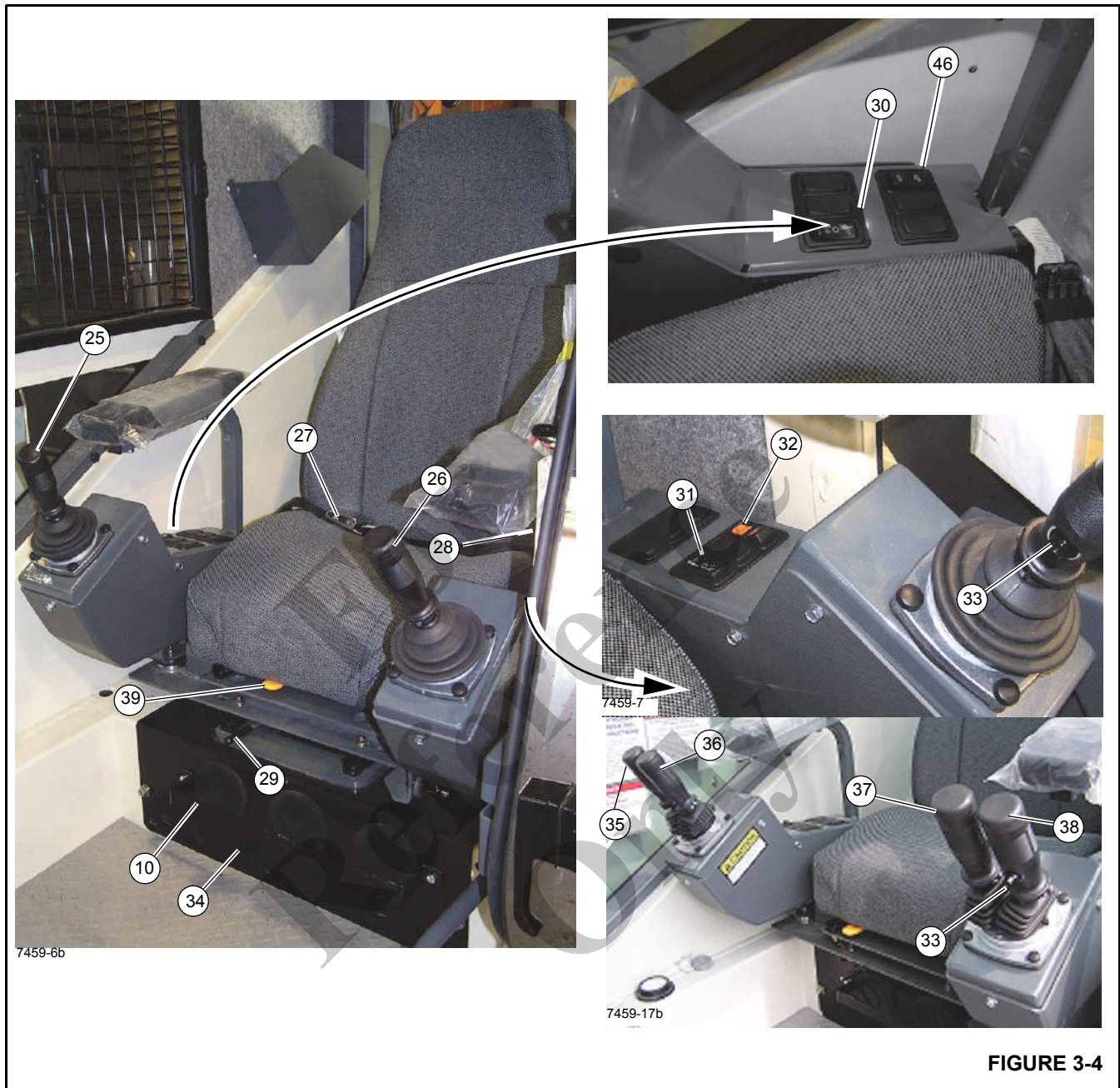


FIGURE 3-4

Item	Description
25	Dual Axis Controller- Boom Lift/Main Hoist
26	Dual Axis Controller- Swing/Tele/ Aux Hoist
27	Seat Belt
28	Seat Back Adjustment
29	Seat/Controls Assembly Slide Adjustment Lever
30	Main Hoist Speed Switch-HI/OFF/LOW
31	Auxiliary Hoist Speed Switch-HI/OFF/LOW

Item	Description
32	Swing Brake Control Switch
33	Swing Horn Button
34	AC/Heater Climate Control Unit
35	Single Axis Controller-Boom Lift Lever
36	Single Axis Controller- Main Hoist Lever
37	Single Axis Controller-Boom Telescope/ Auxiliary Hoist Lever
38	Single Axis Controller-Swing Control Lever



Item	Description
39	Seat (only) Slide Adjustment Lever
40a	360° Swing Lock Pedal
40b	360° Swing Lock Assembly
41	Swing Lock Control Handle
42	Swing Lock Pin
43	Buzzer Alarm
44	PC1 Interface Connector
45	Fuse Panel
46	Cab Tilt Switch

The crane controls are located in the crane cab and are used for all crane functions. See (Figure 3-3 and Figure 3-4) for crane cab item number (#) identification. For best control response, run the engine at governed RPM when operating the crane.

**NOTE:** The operator must be in the crane cab seat with left armrest lowered and crane power switch ON for the crane controls to operate.

### Swing Brake Pedal

#### CAUTION

Do not actuate the Swing Control Lever while the Swing Brake is engaged, as the turret may push through the brake. Damage to the swing brake can occur.

The swing brake pedal (2, Figure 3-3) is located on the left side of the crane cab floor. The swing brake pedal is used to actuate the swing brake to slow or stop swing motion. Pressing the pedal down applies brake to the turret and prevents rotation; releasing the pedal allows the turret to rotate freely. 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.

### Boom Telescope Pedal (Standard with Aux Hoist)

The crane is equipped with the boom telescope pedal only when the auxiliary hoist option is included. The telescope foot pedal (3, Figure 3-3) is located on the crane cab floor and is used to extend and retract the boom. Pushing down at the top of the pedal extends the boom out; pushing down at the bottom of the pedal retracts the boom in.

### Foot Throttle Pedal

The foot throttle (4, Figure 3-3) is located on the crane cab floor and is used to control the engine speed. It is used to control engine RPM which increases or decreases proportionately with the amount of foot pressure applied to the pedal. Depress the foot throttle to accelerate the engine speed and release to return to idle. The pedal is electrically connected to the superstructure control module which sends the signal to the engine ECM via the J1939 data link.

### Display Panel

The display panel (5, Figure 3-3) is for the Rated capacity Limiter (RCL), see operating instructions and screen displays in this manual.

The RCL provides the crane operator with the information required for the crane to perform safely within its design parameters. The RCL displays information on length and angle of boom, working radius, rated load, and total weight being lifted.

The RCL continuously monitors these parameters and provides the operator with an updated readout of the crane status. If a rated capacity condition is approached, the RCL warns the operator with an alarm and locks out the crane functions.

#### DANGER

The RCL only aids the operator when properly programmed with the proper load chart and crane configuration. To prevent injury or death to personnel, be sure the RCL is programmed before crane operation.

### RCL Bypass Switch

There are two RCL Bypass (Override) Switches (6, Figure 3-3) located in the crane cab.

The switch located on the front control panel is a momentary type switch. Turn the key to the On position (right) to disengage the RCL controls. Releasing the key allows the RCL controls to re-engage.

The RCL bypass switch (6, Figure 3-3) located behind the cab seat, below the fuse relay panel, is an off/on switch and will bypass the overloaded controls until the switch is turned to the OFF position.

The RCL will be bypassed only as long as the switches are in the ON position.

Turning the key switch to the ON position re-engages the boom down, telescope out and hoist up controls. These functions were disabled when an overload condition was sensed by the Rated Capacity Limiter (RCL). It is important to read and understand the RCL Override information before

using the RCL bypass on/off switch. For detailed information concerning the operation and maintenance of the RCL system installed on the crane, see Section 7 - Rated Capacity Limiter in this manual.

### Minimum Wrap Indicator

The minimum wrap indicator notifies the operator when there are 3 wraps of wire or synthetic hoist rope left on the hoist drum. When the minimum wrap of the last layer is reached, the icon on the RCL console display panel will show solid. This feature does not lock out the hoist down function. Both main and auxiliary hoists use this indicator.

### Emergency Stop Switch

The crane emergency stop switches (9, Figure 3-1, Figure 3-2 and Figure 3-3) are located on the cab console and at the outrigger control panels. Push the red button in to shut down the engine, rotate the knob and pull out to resume normal operation.

**NOTE:** Only use the emergency stop switch in the case of an emergency to shut down the engine; do not use the emergency stop switch regularly as a means of turning off the crane.

### AC/Heater Vent

The cab has air conditioner and heating vents (10, Figure 3-3), located on the control panel, behind the panel, under the seat and at head level.

### Crane Ignition Switch

The crane ignition switch (11, Figure 3-3) is located on the crane cab console and controls the truck engine and crane cab power. The ignition switch has four positions. ACCY activates power to the accessory functions without power to engine, OFF shuts down engine and cab power, ON activates truck engine ignition as well as all cab power, and START is truck engine start.

### 12V Receptacle

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

### Diagnostic Connector

The diagnostic connectors (13, Figure 3-3) located on the front control panel and the fuse relay panel behind the cab seat, are for downloading console display software. The USB connections located on the fuse relay panel behind the cab seat (Figure 3-3) are for downloading software and diagnostic troubleshooting. They are used for servicing the RCL and the crane electrical system.

A laptop computer with a USB connector and the appropriate electrical system software is required. Contact Manitowoc Crane Care to obtain the appropriate diagnostic cables.

### PC1 Interface Connector

The PC1 interface connector (44, Figure 3-3) located on the fuse relay panel behind the cab seat is for Can bus diagnostics.

### Buzzer Alarm

The buzzer alarm is located on the fuse relay panel behind the cab seat (43, Figure 3-4).

### Engine Hi/Low Switch

The truck engine Hi/Low Switch (15, Figure 3-3) is located on the right overhead console.

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

This is an increment/decrement style switch, press and release the (+) or (-) side of the switch to increase or decrease idle speed incrementally.

Press and hold the switch in either the Hi or Low direction and the engine will ramp to maximum rpm or minimum rpm.

### Crane Function Power Switch

The crane function power switch (16, Figure 3-3) is located on the right overhead console. The switch has two positions: OFF takes all power from the joy stick controllers on the arm rest, the outrigger control panel inside the cab and from the swing brake unlock (assuring the brake stays locked). The OFF position prevents inadvertent operation of these functions and assures the swing brake is set when the crane is not powered. The ON position will provide power to the joy stick controllers, outrigger controls inside the cab and the swing brake.

### Remote Power Switch (Optional)

The radio remote switch (17, Figure 3-3) is used to enable the radio remote controls. The crane function power switch, and truck ignition must all be OFF before the crane can be operated with a radio remote control. The crane ignition switch must be in the ON position.

### Work Light Switch

The work light switch (18, Figure 3-3) is a two position rocker switch, ON and OFF, located on the right overhead console. It turns the cab outside working lights on or off.

## Skylight Wiper Switch

The skylight wiper switch (20, Figure 3-3) is located in the overhead console. This is a Hi/Low toggle type switch with 6 intermittent positions, intermittent timing is 2-15 seconds.

## Windshield Wiper/Washer Switch

The windshield wiper/washer switch (21, Figure 3-3) is located in the overhead console. This is a Hi/Low, rocker/toggle switch with 6 intermittent speed positions, ranging from 2 to 15 seconds and 2 constant low high speeds. Position 7 is low speed and position 8 is high speed. The wiper/washer timing is 3 seconds. The windshield washer is activated by depressing the top of the rocker on the windshield wiper switch.

## Air Conditioning/Heater Controls

**Function Switch** (22, Figure 3-3) allows operator to select either the heater or air conditioner.

**Temperature Control** (23, Figure 3-3) controls the temperature for both the heater and air conditioner.

**Fan Speed Control** (24, Figure 3-3) controls the fan for both heater and air conditioner.

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

The boom lift and main hoist (lift/main) control lever (25, Figure 3-3) is located on the right armrest.

The lever when positioned to the left raises the boom. Positioning the lever to the right lowers the boom.

Pushing the lever forward will let out the hoist rope and pulling the lever back reels the rope in.

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

## Dual Axis Controller (Swing/Tele/Aux Hoist)

### CAUTION

Do not actuate the Swing Control Lever while the Swing Brake is engaged, as the turret may push through the brake. Damage to the swing brake can occur.

The swing and telescope or auxiliary hoist (swing/tele or swing/aux) control lever (26, Figure 3-4) 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.

**Swing/Telescope** — Move the lever left to swing left (counterclockwise). Move the lever right to swing right (clockwise). Positioning the lever forward telescopes the boom out and pulling the lever back telescopes the boom in.

**Swing/Auxiliary Hoist** — If equipped with an auxiliary hoist, positioning the lever forward lets out hoist rope. Pulling the lever back reels the cable in. Moving the lever in a diagonal direction actuates the two functions simultaneously.

## Seat Back Adjustment

To adjust the back of the seat, press the adjustment knob (28, Figure 3-4) and then adjust the seat as needed.

## Seat Slide Adjustment Lever

Moving the seat slide adjustment lever (39, Figure 3-4) will slide the seat (only) either forward or backward.

## Seat/Controls Assembly Slide Adjustment Lever

Moving the seat/controls assembly slide adjustment lever (29, Figure 3-4) will slide the seat/controls assembly either forward or backward.

## Main Hoist Speed

The main hoist speed selector switch (30, Figure 3-4) is located on the right seat armrest. It is a three position switch (HI-OFF-LOW), placarded as *rabbit* (fast) hoist motor speed and *turtle* (slow) hoist motor speed. The center switch position turns off the hoist controller.

## Aux Hoist Speed

The auxiliary hoist speed selector switch (31, Figure 3-4) is located on the left seat armrest. It is a three position switch (HI-OFF-LOW), placarded as *rabbit* (fast) hoist motor speed and *turtle* (slow) hoist motor speed. The center switch position turns off the hoist controller.

## Swing Brake Control Switch

The swing brake control switch (32, Figure 3-4) is located on the left seat armrest and is a two position switch, press forward to lock the swing brake, press and slide the back half of the switch (1, Figure 3-5) to unlock the swing brake.

The back half of the switch (1, Figure 3-5) is designed with a locking mechanism to secure the swing brake in the locked position and prevent accidental movement of the cab and superstructure.

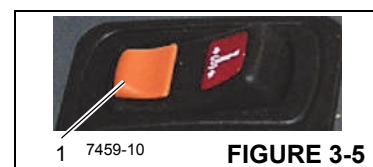


FIGURE 3-5

## Swing Brake Indicator

When the swing brake is locked, the swing brake indicator icon will be displayed on the crane cab console display panel.

## Swing Horn Button

The swing horn button (33, Figure 3-4) is located on the cab seat left joystick. This horn is used by the operator to provide a warning that the superstructure is rotating.

## Single Axis Controller (Boom Lift/Hoist)

The boom lift control level (35, Figure 3-4) and the main hoist control lever (36, Figure 3-4) are located on the right armrest.

Push the boom lift lever (35) forward to lower the boom, pull back to raise the boom.

Push the main hoist lever (36) forward to play out loadline, pull the lever back to take up loadline.

## Single Axis Controller (Swing/Boom Tele)

### CAUTION

Do not actuate the Swing Control Lever while the Swing Brake is engaged, as the turret may push through the brake. Damage to the swing brake can occur.

The swing control lever (38, Figure 3-4) and the telescope or auxiliary hoist control lever (37, Figure 3-4) are located on the left armrest.

Push the swing lever (38) forward to rotate the superstructure clockwise, pull the swing lever back to rotate the superstructure counterclockwise.

Push the telescope lever (37) forward to extend the boom, pull the lever back to retract the boom. If equipped with an auxiliary hoist, this lever (37) operates the auxiliary hoist lever and the telescope pedal (3, Figure 3-3) controls the boom telescoping function.

## Cab Tilt Switch

The cab tilt switch button (46, Figure 3-4) is located on the right seat armrest. It is a three position, momentary spring centered to off rocker switch. It has two positions, Up and Down, allowing the cab to be positioned either up or down for easy viewing of an elevated boom or load. Pressing the rear of the switch tilts the cab upward and pressing the front of the switch tilts the cab downward.

**NOTE:** The cab tilt feature and the cab must be completely down before travel.

## SWING LOCK

The swing lock is used to lock the superstructure from rotating. It consists of 360° positive swing lock and swing lock control pin.

### 360° Positive Swing Lock

The 360° Swing Lock Pedal (40a, Figure 3-3) is located on the left side of the crane cab floor. The pedal is used to activate the swing lock assembly (40b, Figure 3-6) to prevent the turret from turning at any position. To release the swing lock, pull up on the 360° Swing Lock Release Lever.

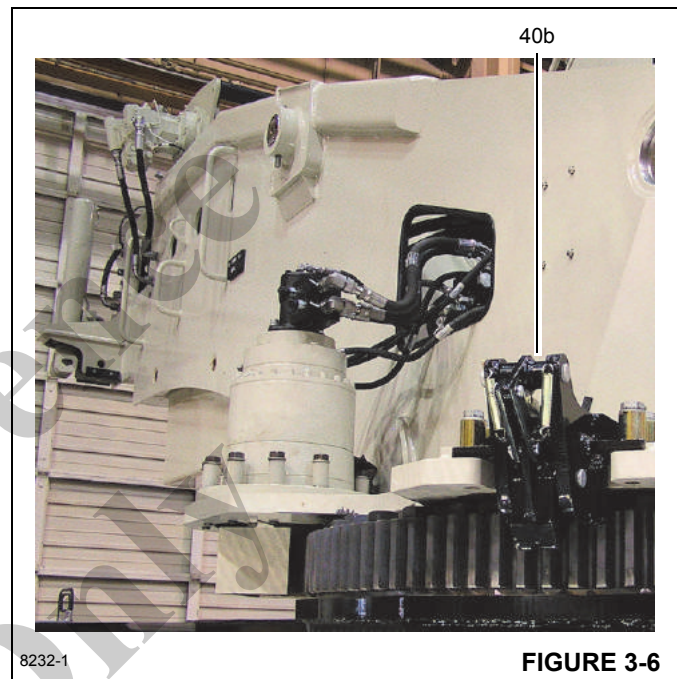


FIGURE 3-6

### Swing Lock Control (Pin Type)

The pin swing lock control cable handle (41, Figure 3-7) is located on the console of the cab. The purpose of the pin swing lock is to lock the superstructure in position directly over the front of the crane. With the superstructure positioned directly over the front and placed in the boom rest, push the control handle down and turn handle clockwise. The swing lock pin (42, Figure 3-7) located at the rear of the superstructure, will drop into a socket on the carrier frame, locking the superstructure in place. When the control handle is turned counterclockwise and pulled up, the pin is pulled out of the socket, unlocking the superstructure. Turn the handle on the cable clockwise to secure the superstructure in the unlocked position.

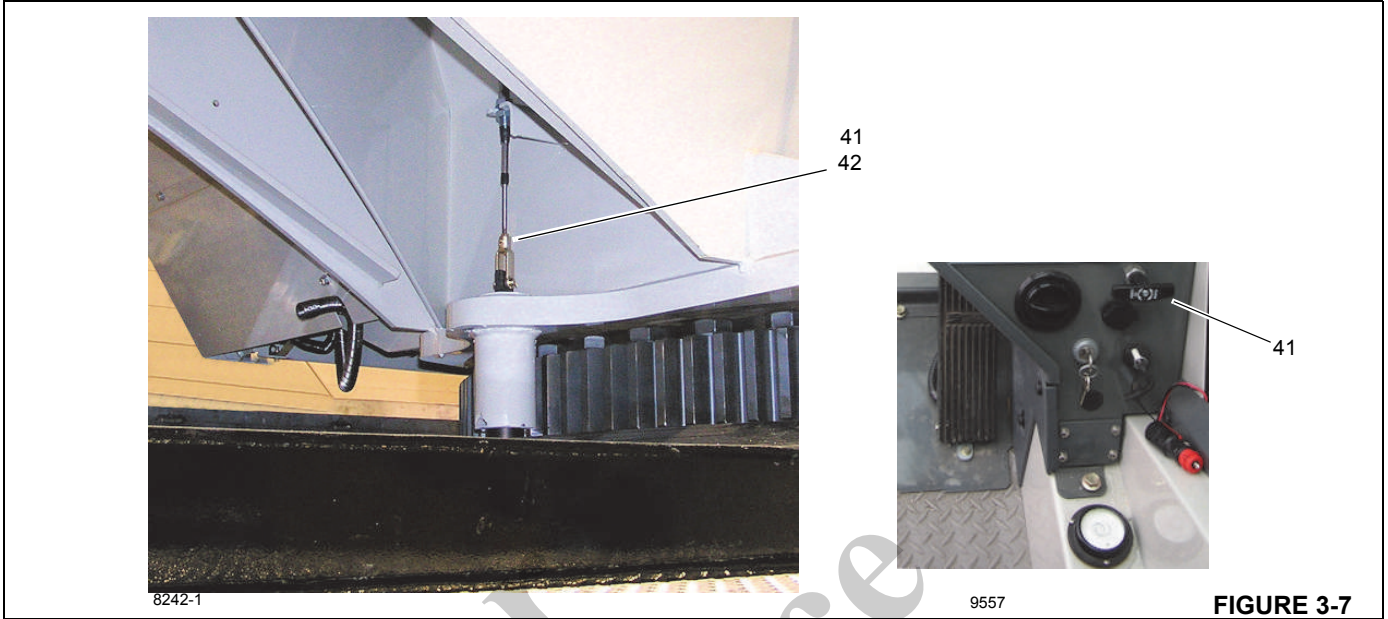


FIGURE 3-7

**Adjustable Swing Speed Valve**

The crane is equipped with an adjustable swing speed valve (1, Figure 3-8) that sets the maximum swing speed of the crane. Turn the valve knob clockwise to increase and counterclockwise to decrease speed.

control unit located under the cab seat. Controls (25, 26, 27, Figure 3-3) for the heater are located on the overhead control panel in the crane cab.

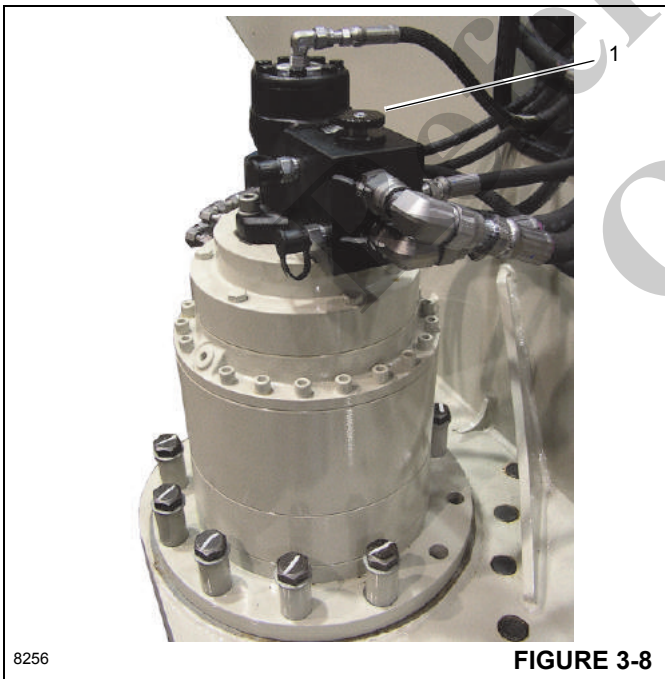


FIGURE 3-8

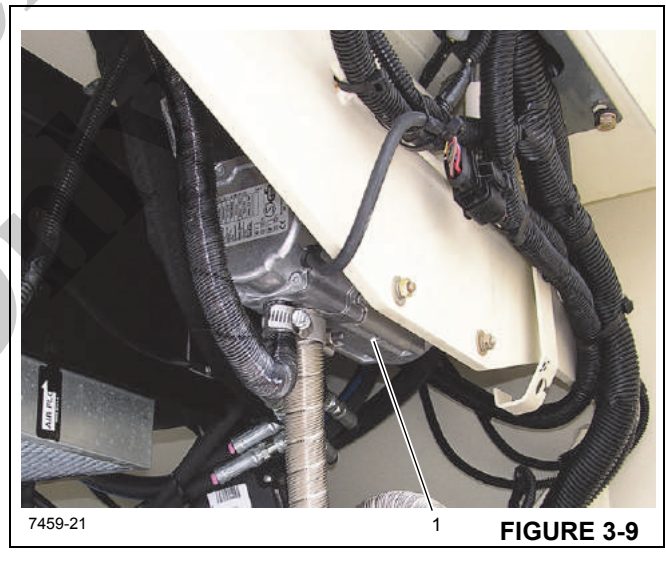


FIGURE 3-9

**WARNING**

**Explosion Hazard!**

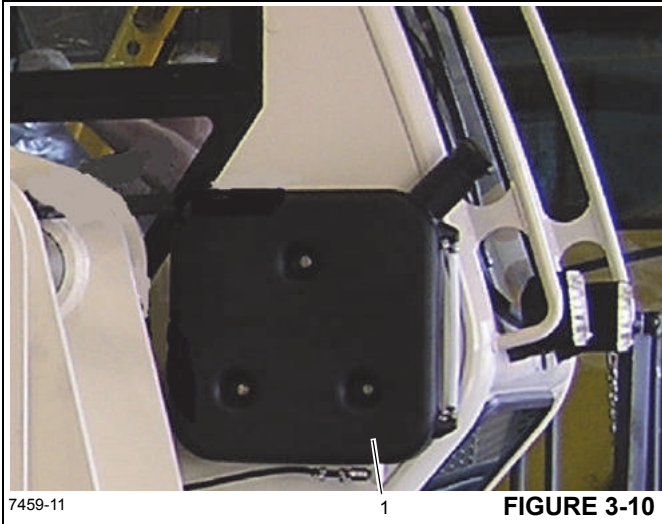
Do not mix gasoline with diesel fuel. Death or serious injury can occur due to explosion.

**HEATER**

The diesel powered supplemental heater (1, Figure 3-9) is located under the cab support frame and supplies heat to the crane cab. The heater controls the temperature of the crane cab by cycling coolant between the heater and the climate

**Heater Cold Weather Fuel Mixture**

At temperatures below -7°C (20°F), add a cold weather additive or mix kerosene with the diesel fuel at a 50/50 ratio, Add the mixture to the heater diesel fuel tank (1, Figure 3-10) located on the outside of the cab.

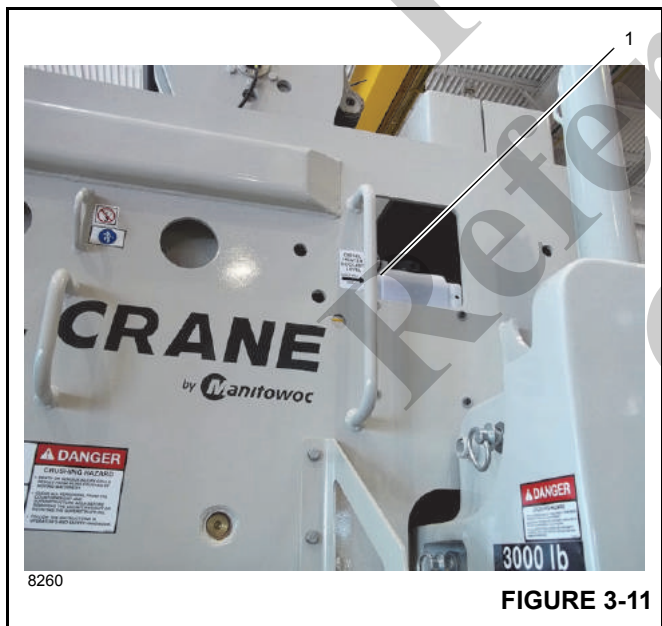


7459-11

FIGURE 3-10

**Heater Coolant**

The heater coolant bottle (1, Figure 3-11) is mounted to the turret frame. The coolant should contain a minimum 50/50 ratio mixture of water and antifreeze to prevent freezing or slushing.



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FIGURE 3-11

**OPERATING PROCEDURES**

You need to be familiar with the safety precautions outlined in the section titled *Safety Precautions*, page 2-1 before operating the crane.

**Equipment Familiarization**

All members of the crew should become familiar with the location and operation of the controls, the correct operating

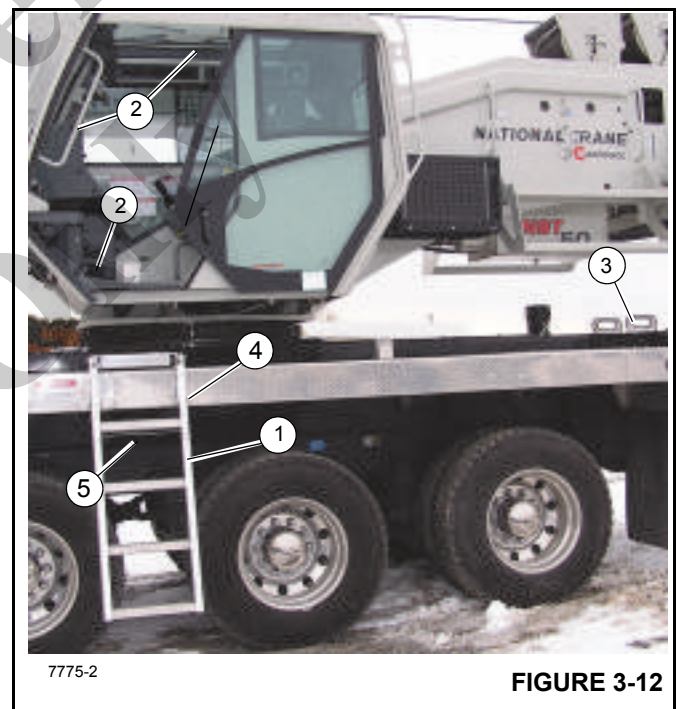
procedures, the maximum lifting capacities, and the Safety Precautions in Section 2 of this manual. Carefully follow the operating procedures outlined below and the information in the load charts located in the crane cab.

**Crane Cab Access**

To enter the crane cab use the ladder (1, Figure 3-12) stowed next to the cab on the carrier decking and position it as shown in Figure 3-12. The ladder is secured in position by latches (4). Climb the ladder and at the same time grasp the grab handles (2) in the cab doorway to enter the cab. Do not try to access the crane cab by other means. Release the ladder using handle (5) and lift and rotate to the stowed position.

To gain access to the rear of the crane and the hydraulic tank and hoist area of the superstructure insert ladder (3) into the frame decking.

Ladder (3) is stowed at the right rear of the crane and is also used to access the cab and superstructure area from the right side of the crane (left side is shown in Figure 3-12). Two sets of holes in the crane left side decking are provided to insert the ladder (3) in the same positions as shown in Figure 3-12.



7775-2

FIGURE 3-12

**Equipment Checks**

Prior to placing the crane in operation, do a complete walk-around visual inspection and look for structural damage, loose components, leaks, or other conditions that requires immediate correction for safe operation. The following checklist of items are suggested to ensure the crane is prepared for performing work operations. Check:

- For any unusual conditions such as pools of hydraulic fluid or lubricating oil under the chassis, any outrigger which may have crept down or up and any signs of damage or improper maintenance.
- The tires are inflated to the proper pressure.
- The level of the hydraulic reservoir oil.
- The operation of the “E-stop” and horn circuits.
- For missing and loose bolts.
- For damaged structural members and welds.
- All rope guides and cable keepers.
- All sheaves for free turning.
- The hoist rope for kinks, broken strands or other damage in accordance with instructions under the section *Hoist Rope Inspection And Maintenance*, page 6-3.
- To see that the hydraulic hoses and fittings are in good condition and show no signs of leaking. The hoses should be free from cuts and abrasions and there should be no evidence of binding. Any damage or leakage should be repaired immediately.
- The RCL and anti-two-block system for proper operation.
- The electrical wiring connecting the various parts of the system for physical damage.

**NOTE:** Consult the truck manufacturer’s manual for vehicle checks.

### Cold Weather Operation

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

Cranes should have appropriate hydraulic oil, lubricants, and other auxiliary items required for operation in very cold temperatures. Operate individual crane functions to ensure they are sufficiently warmed prior to performing a lift.

Operation of cranes at full rated capacities in temperatures between -9°C (15°F) and -40°C (-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.

#### Operation Below -40°C

For crane operation below -40°C, capacities shall be derated 3.67 percent of the rated load shown on the capacity charts for each degree below -40°C.

#### Operation Below -40°F

For crane operation below -40°F, capacities shall be derated 2 percent of the rated load shown on the capacity charts for each degree below -40°F.

### CRANE WARM-UP PROCEDURES

The following procedures detail the actions that must be taken to properly warm the different crane components before operating the crane.

**NOTE:** For temperatures below -9°C (15°F) refer to arctic lubricants and conditions in the Operator and Service Manuals.

Before starting the crane, ensure the appropriate lubricants are used to provide lubrication for the prevailing ambient temperatures in which the crane will operate in (a list of lubricants and their temperature ranges can be found in the Lubrication section of your crane’s *Operator Manual*, by contacting your local Manitowoc 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 Manitowoc 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 Manual and supplement before operating the crane at full load.

### Engine

**NOTE:** For National Crane engine warm-up procedures, refer to chassis manufacturer’s manual.

#### Warm-up Procedures for All Temperature Ranges:

1. Upon startup, allow the engine to idle for 3 to 5 minutes before operating with a load.
2. Cold Engine Startup: After allowing the engine to warm by idling it for 3 to 5 minutes, slowly increase the engine speed to provide adequate lubrication to the bearings and to allow the oil pressure to stabilize.

### Transmission

**NOTE:** For National Crane transmission warm-up procedures, refer to chassis manufacturer’s manual.

Operating the 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.

#### Alternate Warm-up Procedures for Truck Mount (TM/TMS) Cranes:

1. Setup the crane on outriggers.
2. Engage the transmission and allow crane to run at idle until the temperature of the transmission sump reaches normal operating temperature.

### Hoist

Performing a warm-up procedure is recommended at every startup and is 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 3-20).
2. After the 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 the crane on fully extended outriggers, with the boom fully retracted and near maximum lift angle with no load applied.
2. Rotate the superstructure at a speed of less than one RPM for at least one complete revolution in one direction, then rotate the superstructure at a speed of less than one RPM for at least one complete revolution in the opposite direction.

#### Warm-up Procedures for Temperatures Below -7°C (20°F):

1. Ensure the boom is fully retracted and near maximum lift angle with no load applied.
2. Rotate the superstructure at a speed of less than one-half RPM for at least two complete revolutions in one direction, then rotate the superstructure at a speed of less than one-half RPM for at least two complete revolutions in the opposite direction.

### Axles

**NOTE:** For National Crane axle warm-up procedures, refer to chassis manufacturer's manual.

### 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 the 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 there is any unusual sound coming from the crane's hydraulic pumps or motors, stop the 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 the 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 the crane's hydraulic oil cool by running the engine at idle with no functions actuated.

### Anti-two Block Check

#### DANGER

The following tests must be performed with caution to prevent damage to the crane or injury to personnel.

Check the Anti-two Block (A2B) alarm light and the audible alarm by lifting the A2B weight until the switch is activated. To check the anti-two block switch, do one of the following:

- manually lift the A2B switch weight.
- slowly raise the hoist rope.
- slowly extend (telescope) the boom.
- with the load block close to the A2B switch weight and the boom raised to an elevated boom angle, slowly lower the boom.

#### DANGER

If the light and audible alarm do not function and the hoist does not stop, the system is not working properly and must be corrected before operating the crane.



If the crane is equipped with a jib that is deployed and rigged for work, repeat the test procedure for the jib A2B block switch.

### RCL Check

Perform the following checks to verify proper RCL operation.

- Check that the display of the main boom length agrees with the actual boom length.
- Check that the display of the main boom angle agrees with the actual boom angles.
- Check that the display of the operating radius of the crane agrees with the actual radius.

Check the load display by lifting a load of known weight. The accuracy of the load indication shall be within the tolerance of SAE J159.

---

### DANGER

A deviation between displayed and actual values indicates a malfunction and a RCL service representative shall be called for repair and/or recalibration of RCL system.

---

### HOIST SYSTEM OPERATION

The hoist may have lifting capabilities greater than that of the crane limits. Therefore, care must be taken to ensure that the load lifted is within the crane rating. General rules for hoist operation are:

- Lower the hoist rope when extending the boom.
- Use the anti-two-block system only as an aid.
- Make sure the rope is not twisted or kinked and that it is properly seated in the hoist and in sheaves.
- Always have at least three full wraps of wire rope and eight wraps of synthetic rope on the hoist.
- Check the hoist brake when approaching the load limit of the hoist. Raise the load a few inches and return the control to neutral to check the brake.
- Do not drag the load with the hoist.
- Do not try to lift loads that are not free such as, frozen down material or poles.
- Keep tension on the rope to prevent it from becoming twisted, kinked, or improperly seated on the hoist.

### WORK SITE LOCATION

Select a location that is firm, level, and dry. Avoid uneven, rocky or muddy terrain, steep grade or locations with overhead obstructions. The outrigger jacks must be supported on a firm level surface at the fully retracted, mid-span, or fully extended positions. Avoid overhead power lines.

### Before Leaving the Truck Cab

- Position the truck so that the outriggers can be extended with no obstructions.
  - Position the truck transmission to neutral.
  - Set the truck park brake. Wheel chocks may also be required.
  - Engage the power takeoff.
  - Turn the truck cab ignition switch to OFF.
- 

### DANGER

Truck must be in neutral with the park brake set before starting engine from crane cab to avoid sudden potential movement of truck.

---

### Stowing and Parking

---

### WARNING

#### Tipping Hazard!

Never park the crane near holes, or on rocky or extremely soft surfaces. This may cause the crane to overturn. Failure to comply with these instructions may cause death or serious injury.

---

When parking the crane, it should be placed in the smallest, most stable operational configuration that the job site practically allows by doing the following steps:

1. Park the crane on a stable surface.
2. Remove the load from the hook.
3. Stow the swingaway jib, if erected.
4. Fully retract the boom and position it in the normal travel position, then perform the following and proceed to Step 6:
  - a. Engage the swing brake and/or swing lock pin.
  - b. Retract all outrigger jack cylinders and outrigger beams.

5. If it is not practical to fully retract the boom and place it in the travel position, then perform the following and proceed to Step 6:
  - a. Make the crane as stable as possible, including, boom angle, superstructure orientation, jib angle, etc. In high winds, the boom and jibs should be lowered or secured.
  - b. Engage the swing brake and/or swing lock pin.
6. Apply the parking brake.
7. Put all operating controls in the neutral position.
8. Position the Crane Function switch to OFF.
9. Shut down the engine following the proper procedures specified in this manual and the applicable engine manual.
10. Remove the keys.

---

### CAUTION

To avoid possible engine fault codes and undesirable operation, ensure the keyswitch has been off 2 minutes before disconnecting batteries. Disconnect batteries if crane will be inactive for over 24 hours.

11. Disconnect batteries, if crane will be inactive for over 24 hours.
12. Close and lock all windows, covers, and doors.

---

### Unattended Crane



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.

### Before Making the Lift

- Set the outriggers as described in the section titled *Outrigger Setup*, page 4-1.
- Program the RCL.

- Check all controls for proper operation. If any abnormal operations are detected, the condition must be corrected before continuing.
- Check the work area for electric power lines.

### LOAD CHART

Your crane is designed to provide satisfactory service if it is not loaded in excess of the maximum rated loads specified in the load chart. Overloading can create safety hazards, cause structural damage, and shorten the service life of the crane. You must understand how to use the load charts located in the crane cab. Make sure the load, the working area, and the crane configuration are within the load limit specified in the load chart.

**NOTE:** Load handling devices (hook blocks and slings) are considered part of the load.

### Using the Load Chart

The load chart is stored in a pocket in the crane cab. The load chart contains lifting capacities of the crane in all allowable lifting configurations.

The following list is a definition of terms needed when using the load chart.

- **Load Radius** - The horizontal distance from the centerline of rotation, before loading, to the center of the vertical load line or block. This distance is slightly greater with an unloaded boom due to deflection.
- **Loaded Boom Angle** - The loaded boom angle is the angle between the first section boom and the horizontal with the load. The loaded boom angle combined with the boom length approximates the operating radius.
- **Working Area** - The area measured in a circular arc above the center line of rotation to the suspended load.
- **Freely Suspended Load** - The load hanging free with no direct external force applied except by the loadline.
- **Side Load** - Horizontal side force applied to the lifted load either on the ground or in the air.
- **Boom Length** - The length from boom pivot pin to the boom nose. Decals on either side of the boom shows when specific boom lengths are reached.
- **Range Diagram** - The range diagram (Figure 3-14) shows the operating radius and height of the unloaded boom nose at all boom lengths and angles. It should be used as a guide to position unloaded load line and to determine to approximate height to which the load can be lifted.
- **Structural Limit Line** - Is contained in the range diagram (Figure 3-14). It shows the lowest angle the

unloaded boom can be placed at for all boom lengths. Below this line the crane is structurally overloaded.

The load chart contains the lifting capacities of the crane in all allowable lifting configurations. The information is presented in several parts, which include three different outrigger spans (fully retracted, mid-span, and fully extended), one outrigger span when lifting “over-rear”, and three counterweight configurations. Each part contains the load chart, range diagram, and hoist data sheet. In the examples shown here, the information for the outriggers fully extended is used.

**NOTE:** The load charts shown in this manual are examples only. See the load charts attached to the crane for actual values.

- The load chart (Figure 3-17) is used to determine the weight limit of the load based on the load radius and boom angle. All lifting devices must be included when determining the weight of the load.
- The range diagram (Figure 3-14) shows the operating radius and the height from horizontal of the unloaded boom.
- The hoist data chart (Figure 3-15) shows hoist capacity and multipart line reeving. The correct reeving for all loads listed in the load chart is also shown.

Before you can determine the crane configuration you need to know:

- the weight of the load to be lifted.
- the lifting devices needed.
- the height of the lift.
- the horizontal distance from the center of rotation (load radius) to where the load is to be placed.

To determine the safe operating parameters you need to:

1. Determine the weight of the load to be lifted.
2. Approximate the load radius. This is the horizontal distance from crane center of rotation to where the payload is to be placed.
3. Determine the lifting devices and hook block reeving using the hoist data chart.
4. Calculate the combined weight of the lifting devices and the load to be lifted.
5. Determine the boom angle and length from the range diagram using the height and load radius of the lift.
6. In the load chart, take the load radius and boom angle/length column over to the weight column and check the weight. If the weight is between two values, use the lower value.

## LIFTING THE LOAD

The following general guidelines outline the proper procedure for making a lift after the crane has been properly set up.

1. Position the crane in the work area and set the outriggers. See *Outrigger Setup*, page 4-1.
2. Program the RCL. Use the load chart to estimate the values.
3. Position the boom nose over the load. Do not try and drag the load with the boom or hoist.
4. Perform the lift. Use light variable movements of the controls when moving the load to avoid sudden stops.
5. Retract and lower the boom after the lift is complete.

## SHUT DOWN AND PREPARATION FOR ROAD TRAVEL

---

### CAUTION

Disengage the hydraulic pumps for extended traveling, cold weather starting, or engine checks.

Check cold tire pressure prior to extended travel. Refer to tire inflation decal on crane.

---



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### CAUTION

#### Machine Damage Hazard!

Do not travel with an empty hook in a position where it can swing freely. Either remove the hook block and/or headache ball from the hoist rope and stow securely or make sure the hook block or headache ball is properly secured to the tie down provided for that purpose.

Fully retract the outrigger jacks and properly store the floats.

---

1. Ensure the swingaway, if so equipped, is properly stowed and secured or removed from crane.
- 

### WARNING

Do not travel with swingaway extended to prevent damage to equipment.

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

---

2. Retract and place the boom in boom rest.
3. Engage the mechanical travel lock at each outrigger beam.

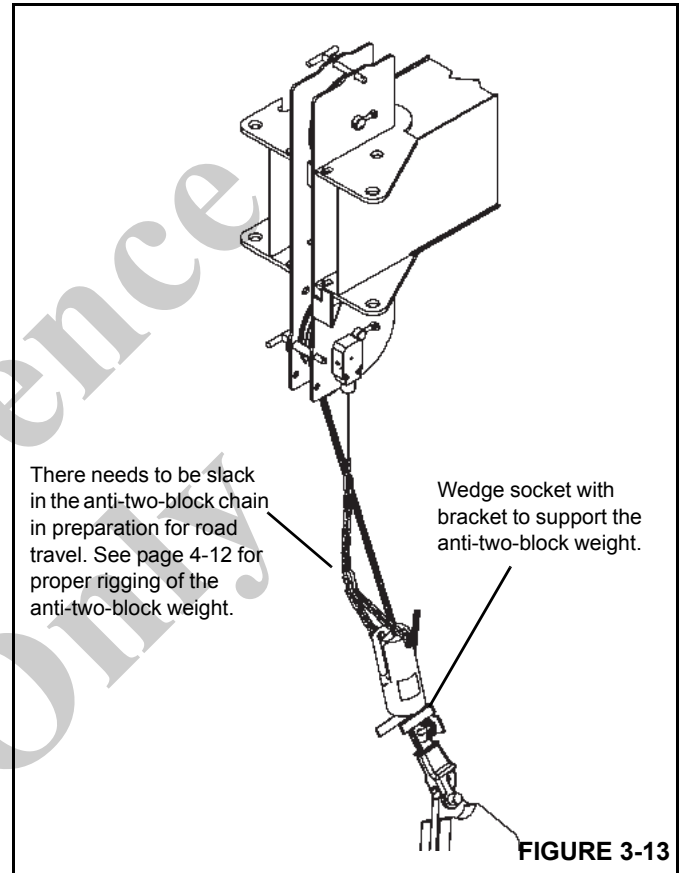
4. Engage the swing brake.
5. Engage the swing lock.
6. Lower the cab tilt completely down.
7. Secure the hook block/headache ball and A2B weight:
  - Either the hook block may be reeved over the main boom nose or the headache ball may be reeved over the main boom nose or auxiliary boom nose. The other must be removed and stowed securely before travelling. If the hook block or headache ball remains reeved on the boom, it must be secured at the tie down on the carrier provided for that purpose.
  - Slowly hoist up until there is a slight tension on the hoist rope. It may be necessary to override the A2B function to tension the cable.
  - The A2B weight needs to be resting on the wedge socket so that there is slack in the anti-two-block chain.

**NOTE:** There needs to be enough slack in the A2B chain so that the A2B switch does not switch between open and close positions during travel.

If the chain is too tight, road bounce causes the A2B switch to open and close numerous times and this can damage the switch.

8. Ensure the single front outrigger (SFO) is fully retracted (if equipped).
9. Ensure the outrigger beams and jacks are fully retracted.
10. Remove the outrigger jack pads and place on the stowage brackets.
11. Engage the mechanical travel lock at each outrigger beam.

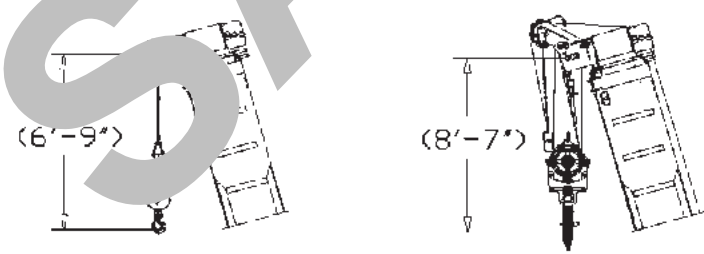
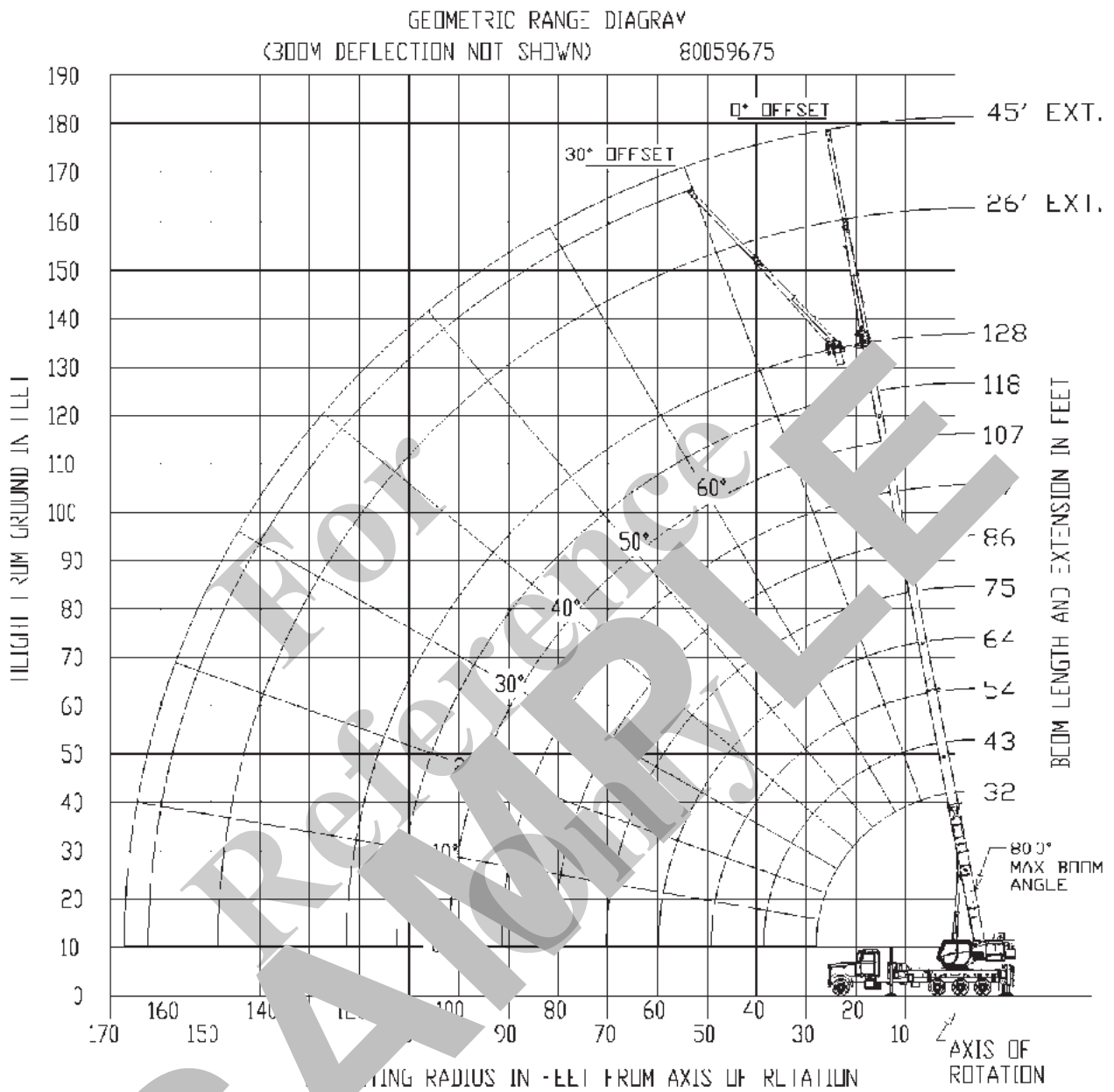
12. Turn off the ignition and all other switches in the crane cab.
13. Close and/or secure all windows and doors.
14. Exit the cab, lock the door, and stow the access ladder.
15. Secure any loads or lifting devices on truck bed or body.
16. Ensure tires are properly inflated.
17. Disengage the Power Take Off (PTO) and start truck from the truck cab.
18. Release the park brake before moving truck.



**CAUTION**

Outrigger beams must be pinned for travel.

If not pinned, outrigger beams may drift out during travel.



DIMENSIONS ARE FOR LARGEST FURNISHED HOOK BLOCK & HEADACHE BALL, WITH ANTI-TWO BLOCK ACTIVATED.

\*THIS DRAWING SHOWS THE PHYSICAL REACH OF THE MACHINE. ALWAYS REFER TO LOAD CHART TO SEE WHICH PORTIONS OF THIS DIAGRAM ARE VALID FOR THE SPECIFIC MACHINE CONFIGURATION AND WHERE THE LOADS ARE STRUCTURALLY OR STABILITY LIMITED.

FIGURE 3-14

8302-1

WEIGHT REDUCTIONS FOR LOAD HANDLING DEVICES

AUXILIARY BOOM NOSE	76 lb
HOOKBLOCKS and HEADACHE BALLS:	
60 ton, 5 sheave (14" sheave) (CE)	1112 lb+
40 ton, 3 sheave (12" sheave)	600 lb+
20 ton, 1 sheave	410 lb+
7 ton overhaul ball	171 lb+

+Refer to rating plate for actual weight

When lifting over boom extension, deduct total weight of all load handling devices reeved over main boom nose directly from boom extension capacity.

**NOTE:** All load handling devices and boom attachments are considered part of the load and suitable allowances **MUST BE MADE** for their combined weights. Weights for Manitowoc furnished equipment

LINE PULLS AND REEVING INFORMATION

HOISTS	CABLE SPECS.	PERMISSIBLE LINE PULLS	NOMINAL CABLE LENGTH
Main Standard	5/8" (16 mm) Dyform 34 LR Rotation Resistant (Non-rotating) Min. Breaking Strength 56,420	11,280 lb	500 ft.
Main & Aux Optional	5/8" (16 mm) 6x19 Class II EIPS, WRC Min. Breaking Strength 56,420 lb	11,280 lb*	500 ft.

The approximate weight of wire rope is 1.0 lb/ft.

\* With certain boom and hoist combinations, the allowable line pull may be limited by hoist performance. See Hoist Performance table for lift planning to ensure adequate hoist capacity on drum rope layer required.

Parts of line	1	2	3	4	5	6	7	8	9	10	11
Max. boom length (ft.) at max. elevation with stated rigging and load block at ground level	173 (incl. 45')	128	114	99	72	60	51	44	38	34	31.7
Low speed lift (lb)	11250	22500	33750	45000	56250	67500	78750	90000	101250	112500	120000
High speed lift (lb)	5000	10000	15000	20000	25000	30000	35000	40000	45000	50000	55000

HOIST PERFORMANCE

Wire Rope Layer	Hoist Line Pulls		Drum Rope Capacity (ft.)	
	Two Speed Hoist			
	Low	High	Layer	Total
	Available lb*	Available lb*		
1	15,000	7,516	82	82
2	13,529	6,765	92	174
3	12,299	6,150	101	275
4	11,275	5,637	110	385
5	10,407	5,204	119	504

\*Max. lifting capacity: Dyform 34 LR and 6x19 class = 11,280 lb

FIGURE 3-15

8302-2

**STANDARD REMOTE CONTROL**

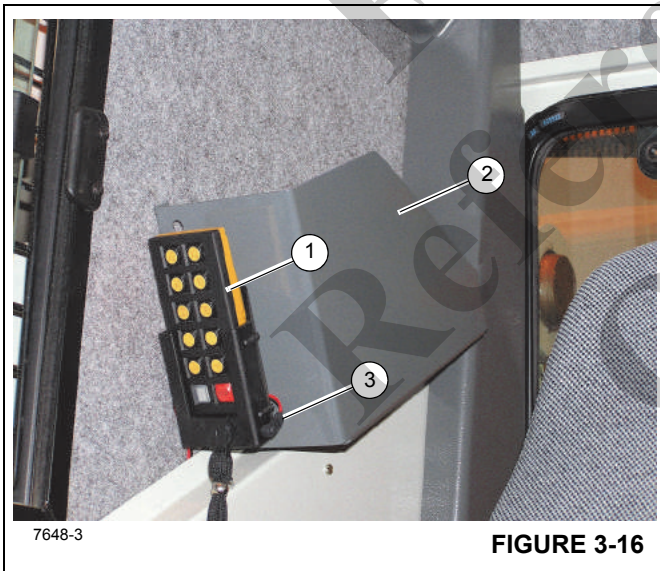
The National Crane model NBT60 is equipped with a standard hand held radio remote control. An optional remote control and remote receiver are available and is mounted on the right side of the crane turret. The standard remote control is designed for use in setup and tear down of the crane at the job site.

If your crane is equipped with the optional Full Crane Remote Control (Figure 3-19), [large dark blue remote control supplied with a waist strap], see the Radio Remote Options manual for operating instructions.

The standard Remote Control (1, Figure 3-16) is a palm size remote control and is shipped with each crane as standard equipment. This remote control (Front Bumper Remote) has limited functions as described in the following information; it does not allow full remote control of the crane.

The standard remote control (1, Figure 3-16) operates the main hoist up/down, aux hoist up/down and single front outrigger (if equipped).

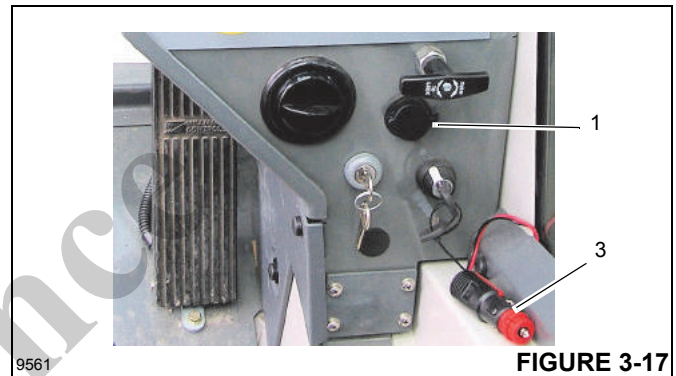
The standard Remote (1, Figure 3-16) and its storage bracket are secured to the load chart binder bracket (2).



**Batteries**

If the standard remote control is not used for a long period, it is recommended, if using rechargeable batteries, that they be charged before using the remote control.

When the standard Remote Control (1) is in the stowed position as shown in Figure 3-16 the remote control power cord (3, Figure 3-16) should be plugged into the remote control stow bracket and the other end into the 12V receptacle (1, Figure 3-17) on the cab control panel. This will keep the two AA rechargeable batteries used, to power the Remote Control, charged.



Access the batteries by removing the battery compartment screw on the back of the Remote Control.

When the 'L' flashes on the Remote Control Display (1, Figure 3-18) the batteries are low and should be replaced immediately.

**CAUTION**

Do not store the battery in your pocket. Metal objects can short the battery and cause burns.

**CAUTION**

Rechargeable batteries (NiMH or NiCd) must be fully charged before first use! Never attempt to charge standard non-rechargeable batteries!

Operation

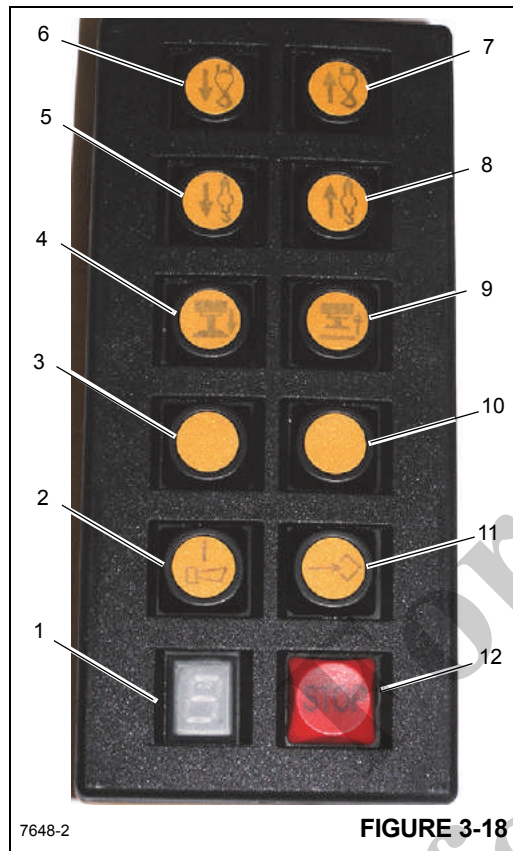


FIGURE 3-18

Item	Description
1	Display - Channel Number Codes
2	ON/Horn
3	Blank
4	Single Front Outrigger (SFO) (if equipped) - Extend
5	Auxiliary Hoist Down

Item	Description
6	Main Hoist Down
7	Main Hoist Up
8	Auxiliary Hoist Up
9	Single Front Outrigger (if equipped) - Retract
10	Blank
11	Frequency Change
12	Stop/Off

The remote control operates only when the crane is running and the "Crane Power" switch is turned OFF, the boom length is less than 10ft extended, and the boom angle is less than 10 degrees.

To use this remote, the ON/Horn button must be pressed to turn on the remote and a second time to activate the remote. The crane horn will sound as confirmation that the remote is now active. The remote can now be used to control the hoist(s) and front outrigger.

To activate a function press and hold the button that corresponds to the desired movement until you desire the function to stop.

For each button press and hold, the crane will allow for several seconds of continuous movement. To move the function more, press and hold the button again.

When finished with the remote, press the red STOP button. This will only turn off the remote; it will not shut off the crane.

If the remote is left turned on for more than 5 minutes, the remote will shut itself off.

If any interference is present in the area and the remote does not function properly, the radio's channel can be changed. This is done by pressing and holding the ON/Horn button while momentarily pressing the Frequency Change button.

Once finished using this remote, it can be stored and charged in the 12V charging base located in the crane cab on the load chart manual holder (1, Figure 3-20).



CRANE REMOTE CONTROL (OPTIONAL)

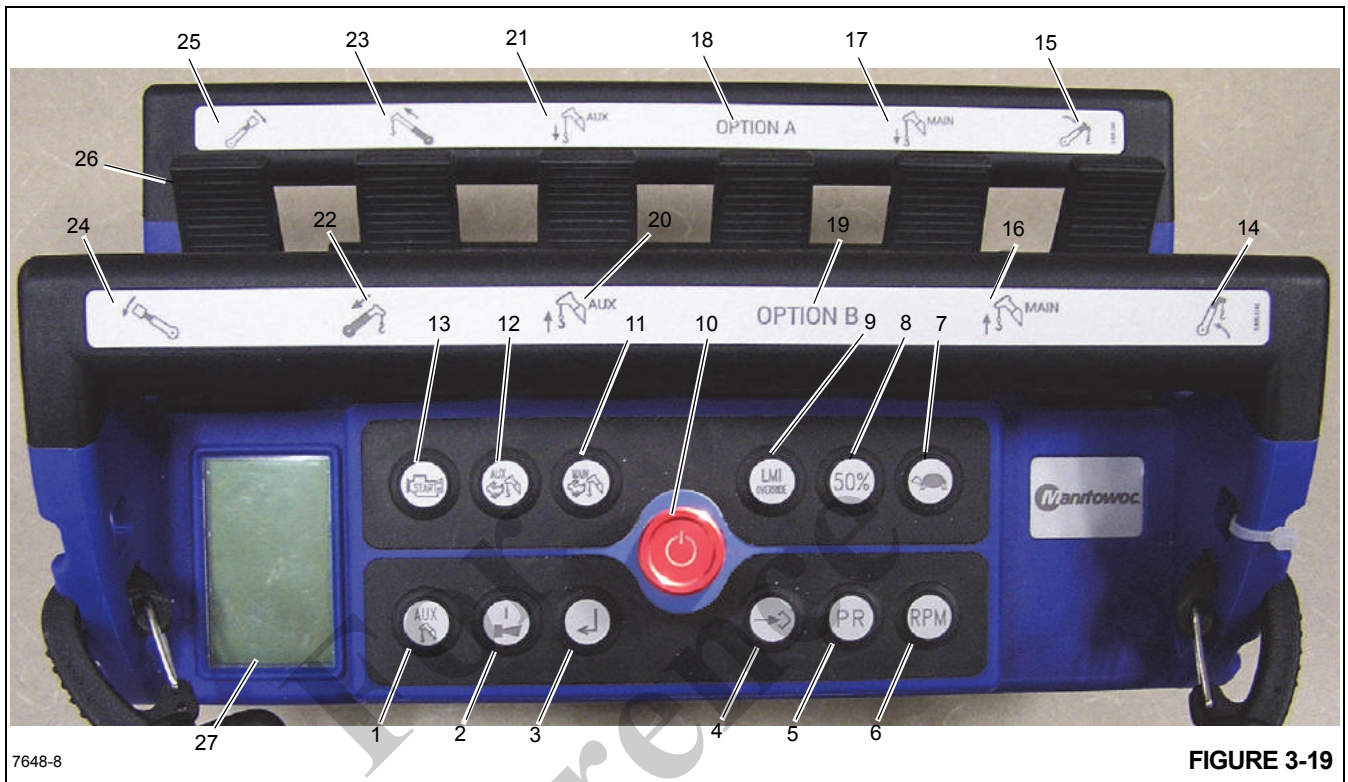


FIGURE 3-19

The optional Crane Remote Control (Figure 3-19) will allow full remote control of the crane. The standard Remote Control is disabled when using the optional Crane Remote Control.

Refer to the Crane Remote Control Operator Manual for operating instructions for this optional remote control.

The Crane Remote Control allows the operator to operate the following functions:

Item	Description
1	Auxiliary Hoist Enable (Disabled is Default)
2	On/Horn Button
3	Toggle Crane RCL Screen
4	Remote Frequency Change
5	Not Used
6	RPM + (Default is RPM -)
7	Turtle Mode (Default is Normal)
8	50% (Default is 100%)
9	RCL Override
10	E-Stop

Item	Description
11	Main Hoist High Speed
12	Auxiliary Hoist High Speed
13	Engine Start
14	Boom Up
15	Boom Down
16	Main Hoist Up
17	Main Hoist Down
18	Option B
19	Option A
20	Auxiliary Hoist Up
21	Auxiliary Hoist Down
22	Boom Retract
23	Boom Extend
24	Swing Counterclockwise
25	Swing Clockwise
26	Joystick Lever (6 levers, two position)
27	LCD Screen

The LCD Screen (27, Figure 3-19 and Figure 3-20) on the display is used to communicate signal strength, battery level, wireless channel, remote status, and the configuration of the crane based upon which buttons are depressed. RCL information is also displayed to the operator and can be toggled by pressing the Toggle Crane RCL Screen button (3). The following RCL information is available to the operator on the LCD screen:

- Screen #1: Actual Load, Maximum Load, Capacity Percentage
- Screen #2: Radius
- Screen #3: Boom Length
- Screen #4: Boom Angle
- Screen #5: Tip Height
- Screen #6: Reeving Configuration

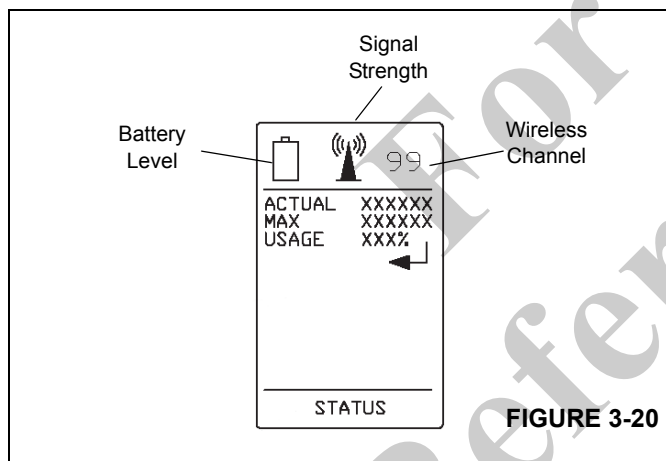


FIGURE 3-20

The Crane Remote can only be used when the crane cab ignition key is in the ON position, the Crane Power switch is OFF, and the Remote Power switch is ON.

When the Crane Remote Control is active, the Front Bumper Remote control will not function. Likewise, when the Front Bumper Remote is active, the Crane Remote control will not function.

### Crane Remote Control Activation

To use this remote, the red STOP button (10, Figure 3-19) must be pressed to turn on the transmitter.

1. Press the ON/Horn button (2) to activate the remote. The crane horn will sound as confirmation that the remote is now active.
2. Press and hold the Engine Start button (13) to start the crane. The remote can now be used to control the crane.
3. Move the joystick (26) that corresponds to the desired movement to activate desired function.

4. Press the red STOP button (10) when finished with the remote. This will shut off the crane.

**NOTE:** To turn the crane controls back on with the remote after pressing the red stop button, the remote control will need to be reactivated by performing step 1 to step 4.

5. Turn off the crane power switch in the crane cab to deactivate the remote control. If the remote is left turned ON for more than 60 minutes, the remote will time out and shut itself off.

If any interference is present in the area and the remote does not function properly, the radio's channel can be changed. This is done by pressing and holding the ON/Horn button (2) while momentarily pressing the Frequency Change button (4).

When finished using the Crane Remote, the remote power switch should be turned OFF and the crane cab ignition key should be turned to the OFF position. The remote controller can be stored in the crane cab or the truck cab.

### DANGER

Be sure to turn off the remote by pressing the red stop button to de-activate the controls in order to prevent crane from functioning if the controller switches are inadvertently depressed or bumped during storage. Failure to comply with these instructions may cause death or serious injury.

Use of rechargeable batteries or standard AA batteries is acceptable; however, the batteries can not be charged in the remote itself.

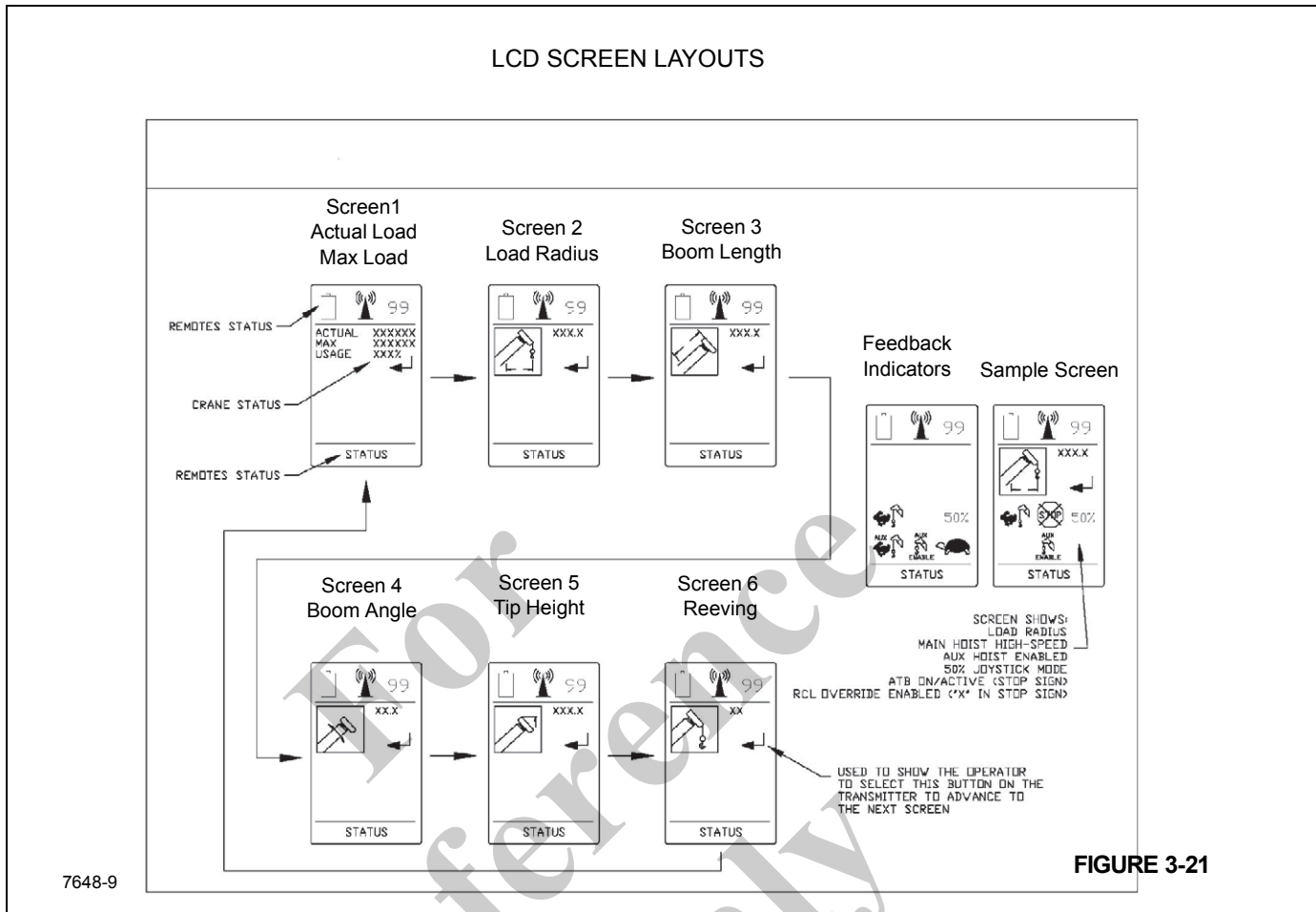


FIGURE 3-21

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Only*

## SECTION 4 SET-UP

### SECTION CONTENTS

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--	---

This section contains information on how to perform the following tasks:

- Set the outriggers
- Erect the jib
- Stow the jib
- Remove the jib
- Use multi-part reeving
- Install the hoist rope
- Install the anti-two-block weight
- Install a wedge socket
- Mount/stow the removable counterweight



**DANGER**

Do not operate outriggers unless they are visible to either the operator or a designated signal person to avoid crushing injury.

### OUTRIGGER SETUP

#### 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. 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). To ensure a true reading always make sure the cab tilt is completely lowered.

Raise and level the crane using the outriggers; refer to *Setting the Outriggers*, page 4-2.

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 4-2.

#### 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. Position 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 a miracle pointer level, carpenter level, or similar type device on a machined surface such as the turntable bearing or bearing mounting surfaces.
4. Using the outriggers, level the crane as indicated on the leveling device used in step 3.
5. Ensure the cab tilt is completely lowered (if equipped).
6. Using the bubble level indicator mounting screws, adjust the bubble level indicator to show level.

## Site Selection

The outrigger floats must be on a firm solid surface that is level. The surface must keep the crane stable and not allow the outrigger jack float to sink or slide. Avoid areas that are:

- uneven
- rocky
- muddy

## Setting the Outriggers

The outrigger setup procedure is as follows:

1. Disengage the mechanical travel lock (1, Figure 4-1) that secures each outrigger beam in the fully retracted position during travel.

**NOTE:** To ensure a true reading always make sure the cab tilt is completely lowered.



FIGURE 4-1

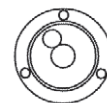
2. On the outrigger control panel, select the desired outrigger beam with the extension switch and press the extend/switch to extend the outrigger beams.
3. Set all four outrigger beams to:
  - a. the fully retracted position. Does not require the outrigger beams to be extended.
  - b. the midpoint position. Engage the manual midspan over-center locks (2, Figure 4-1) for the midpoint position.
  - c. the fully extended position.

## DANGER

All four outriggers must either be fully retracted, at the midpoint, or fully extended, and the RCL set to the correct position. Failure to do so creates a tipping hazard.

**NOTE:** The RCL will automatically preselect the outrigger position based on inputs from the four outrigger beam extension monitoring sensors.

4. Remove the front outrigger floats from the carrying brackets and place the floats under the outrigger jack.
5. Secure the front outrigger floats to the outrigger jacks with the pins and clips.
6. Select the desired jack with the jack selector switch and press the extend switch to extend the jack.
7. Extend all four jacks until the truck tires are about four inches off the ground.
8. Adjust the jacks until the bubble in the level indicator is in the center of the bulls eye. Do not allow the tires to touch the ground.
9. Using the level indicator, adjust the jacks until the bubble is in the center of the bulls eye. Do not allow the tires to touch the ground. 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 4-1.



Not Level



FIGURE 4-2

10. Lower the single front outrigger (SFO) - (optional-if equipped) only after all other outriggers are set. Press the SFO switch to activate and the extend switch to extend. Hold the extend switch for two seconds after the outrigger contacts the ground. The SFO (if equipped) is automatically set at the correct ground pressure.

11. Verify that the RCL has preselected the outrigger position mode correctly.

**JIB SAFETY INFORMATION**

1. Ensure the proper jib mode is selected in the RCL.
2. The anti-two block (A2B) switch weight and cord must be attached to the jib when deployed.
3. Use caution when lifting the load with the main boom when the jib is pinned on the tip of the main boom.
4. Operate with the jib by radius when main boom is fully extended. If necessary, increase boom angle to maintain loaded radius.

When radius is between points listed on capacity chart, the load shown at the next longer radius shall be used.

5. Operate with the jib by boom angle when main boom is not fully extended. Do not exceed rated jib capacities at any reduced boom lengths.

When angle is between points listed on capacity chart, the load shown at next lower boom angle shall be used.

6. Ensure jib is stowed correctly (Figure 4-3):
  - a. Removal of right side attachment pins (6), without proper installation of stow pin (1) and Jib swing pin (5), may allow jib to fall off.
  - b. Extending boom with the jib stowed and failure to remove right side attachment pins (6), will damage crane upon extension.
7. Only swing jib into working or stowed position when boom is horizontal, stow pins (1, Figure 4-3) and jib swing pin (5) are removed and right side attachment pins (6) are in place. The jib could swing uncontrollably if boom is not horizontal.
8. Tag line must be used in these procedures to control the movement of the jib.
9. Crane shall be fully set up according to proper set-up procedures outlined previously when stowing or unstowing jib.
10. Operate boom and turn functions very slowly and carefully when using jib since extension can increase boom length by 50%.
11. Area where jib swings around must be clear of obstructions, personnel and power lines when stowing and unstowing jib.

12. Use safety glasses when installing pins with hammer.
13. Do not extend/retract boom unless boom is horizontal when stow pin (1, Figure 4-3) and jib swing pin (5) are removed during stowing or unstowing procedures.
14. Always put spring clips in pins to ensure that they will stay in place.
15. When the jib is stowed, the boom can not be fully retracted if a boom tip attachment option is installed.

Also, on manually extendable jib options:

1. Jib retaining pin (9, Figure 4-3) must always be installed when operating.
2. All swing around (stow and unstowing) operations shall be done with jib retracted and pinned.
3. Extendable section may slide out of 1<sup>st</sup> jib when jib retaining pin (9, Figure 4-3) is removed. Keep personnel clear of area.

**ERECTING AND STOWING THE JIB**

**General Warnings**



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

---



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

---

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

---



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

---

## ! CAUTION

- Boom tip attachment can contact jib in stowed position when boom is fully retracted.
- Contact can cause damage to boom extension system and jib stow system.
- Boom must be left extended .5 ft (.2 m) to prevent contact.
- Boom attachment must be removed for retracted boom lifting operations.

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## JIB OPERATION

### Jib Deployment Procedure

1. Using boom telescope function, fully retract boom.
2. Using lift function, lower boom so that attachment pins (6 and 7, Figure 4-3) are easily accessible from the ground.

**NOTE:** When lowering the boom below horizontal, two persons may be required. With the telescope control in neutral, the boom may slide out when below horizontal.

3. Remove cable keeper pins from boom sheave case and jib. Remove hook block. Remove loadline from boom sheave case and place in an area to minimize possible damage. Keep slight tension on loadline to avoid bird caging of loadline on hoist drum.
4. Install right side attachment pins (6, Figure 4-3) in upper and lower jib lugs, secure with retainer spring clips. These pins are used as a pivot point to swing jib into the deployed position.
5. Locate the stowed position of attachment pins (7, Figure 4-3). If in jib attachment holes or boom sheave case jib holes, remove pins from storage location.
6. Remove jib swing pin (5, Figure 4-3) from top ear of jib.
7. Remove stow pin (1, Figure 4-3) and stow in hook bracket (3), secure with spring clip.
8. Attach tag line to sheave case end of jib.
9. Using the lift function, raise the boom to the horizontal position.

## ! CAUTION

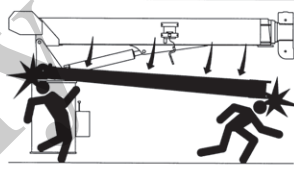
Use caution during this step. The jib is free to swing away from the boom upon boom extension.

10. Using telescope function, slowly extend boom approximately 30 cm (12 in). This procedure will pull the jib out of the hook bracket (3, Figure 4-3).
11. Using tag line, swing jib into deployed position.
12. Install upper left attachment pin (7, Figure 4-3) and spring clip. A slight mallet strike may be necessary to install pins. Always use proper eye protection during this step.

## ! DANGER

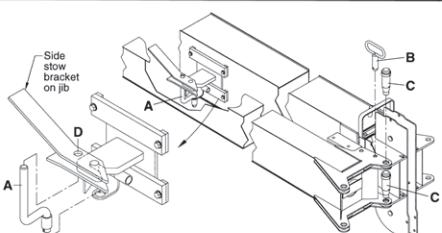
To prevent serious injury or death, always wear personal protective equipment; i.e., a hard hat, eye protection, gloves and metatarsal boots.

### ! DANGER



**A FREE FALLING JIB WILL RESULT IN DEATH OR SERIOUS INJURY**

Before operating the crane check that jib is properly secured. You must follow proper jib erection and stowing procedures. See crane manufacturer's manual.



- Before removing pins (C) when stowing jib, boom must be level and fully retracted, and stow pin (A) must be properly located in the side stow bracket through hole (D).
- Do not extend boom after removing jib swing pin (B) until boom is in level position.
- When stowing or erecting jib, boom must be in level position.

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13. Use the alignment jack (10, Figure 4-3) to align lower left side attachment pin (7, Figure 4-3).



- a. Remove the jack handle (8, Figure 4-4) from the boom stowage bracket and check that the jack release valve is closed.
  - b. Extend the alignment jack (10, Figure 4-3) so that the lower left pin holes (7, Figure 4-3) are aligned.
  - c. Install the lower left side attachment pin (7, Figure 4-3) and spring clip.
  - d. Open the jack release valve and retract the jack (10, Figure 4-3).
14. Using hoist function, un-spool enough loadline to reeve loadline over jib sheave case. Keep slight tension on loadline to avoid bird caging of loadline on hoist drum.
- NOTE:** The hoist cable must be routed over the mast assembly and under the roller on the mast for all configurations.
15. Route loadline over jib sheave and install keeper. Install line block to end of loadline.
  16. Remove A2B switch and weight/chain assembly and install on jib tip, see Figure 4-6. Be certain to use the keeper provided with A2B switch.
  17. Disconnect A2B cord going to boom A2B switch and attach to quick coupler on jib A2B wire on rear of jib between the upper and lower jib lugs.
  18. Install jib swing pin (5, Figure 4-3) and spring clip into jib lugs.
  19. For manually extendable jib, pull jib retaining pin (9, Figure 4-3), and extend second section out by pulling on sheave case. The second section jib, as it extends, will hit a mechanical stop that allows for jib retaining pin (9, Figure 4-3) installation. Install pin (9) and spring clip.
  20. Make A2B cord connections as required.

For  
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Only

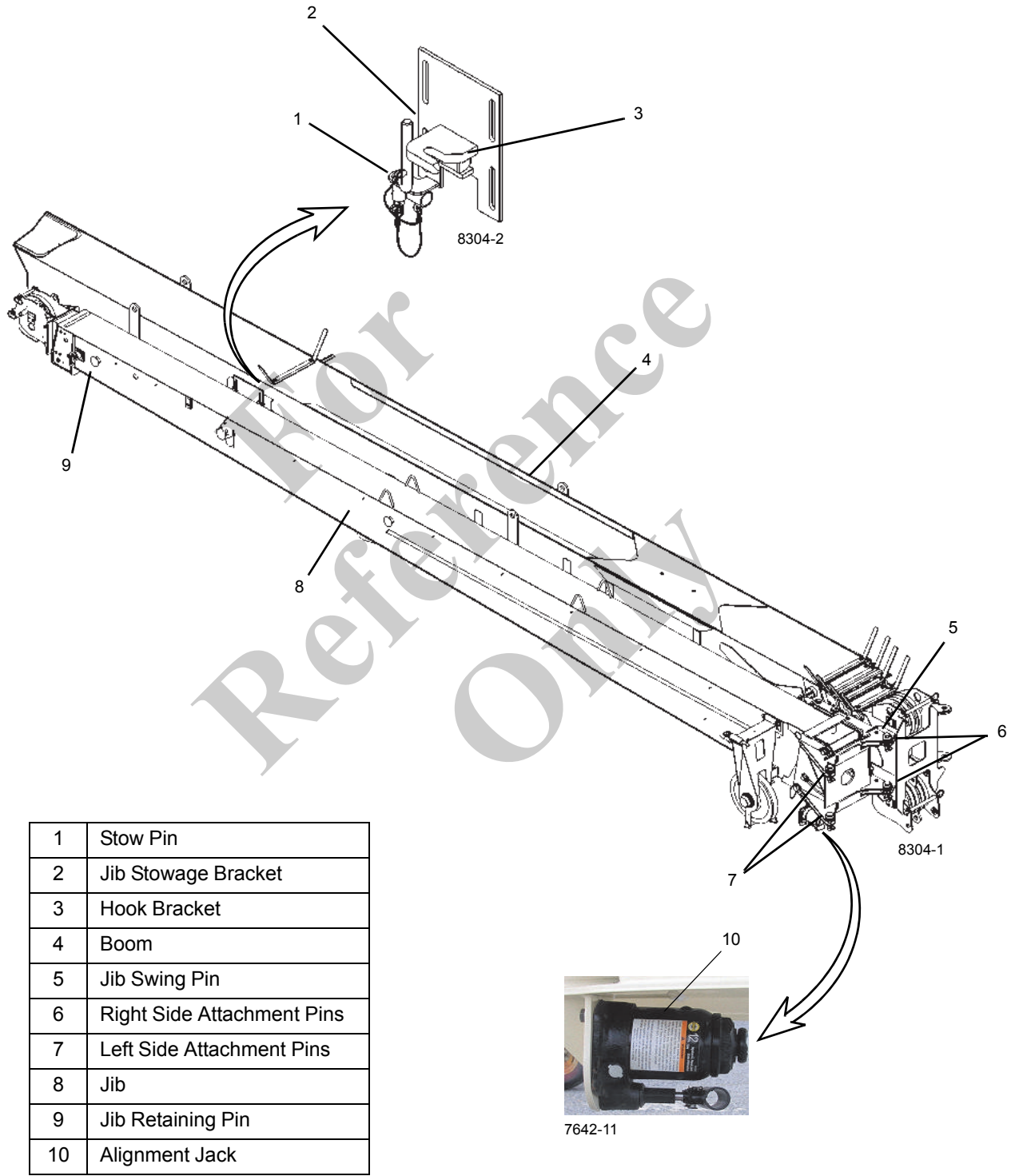


FIGURE 4-3

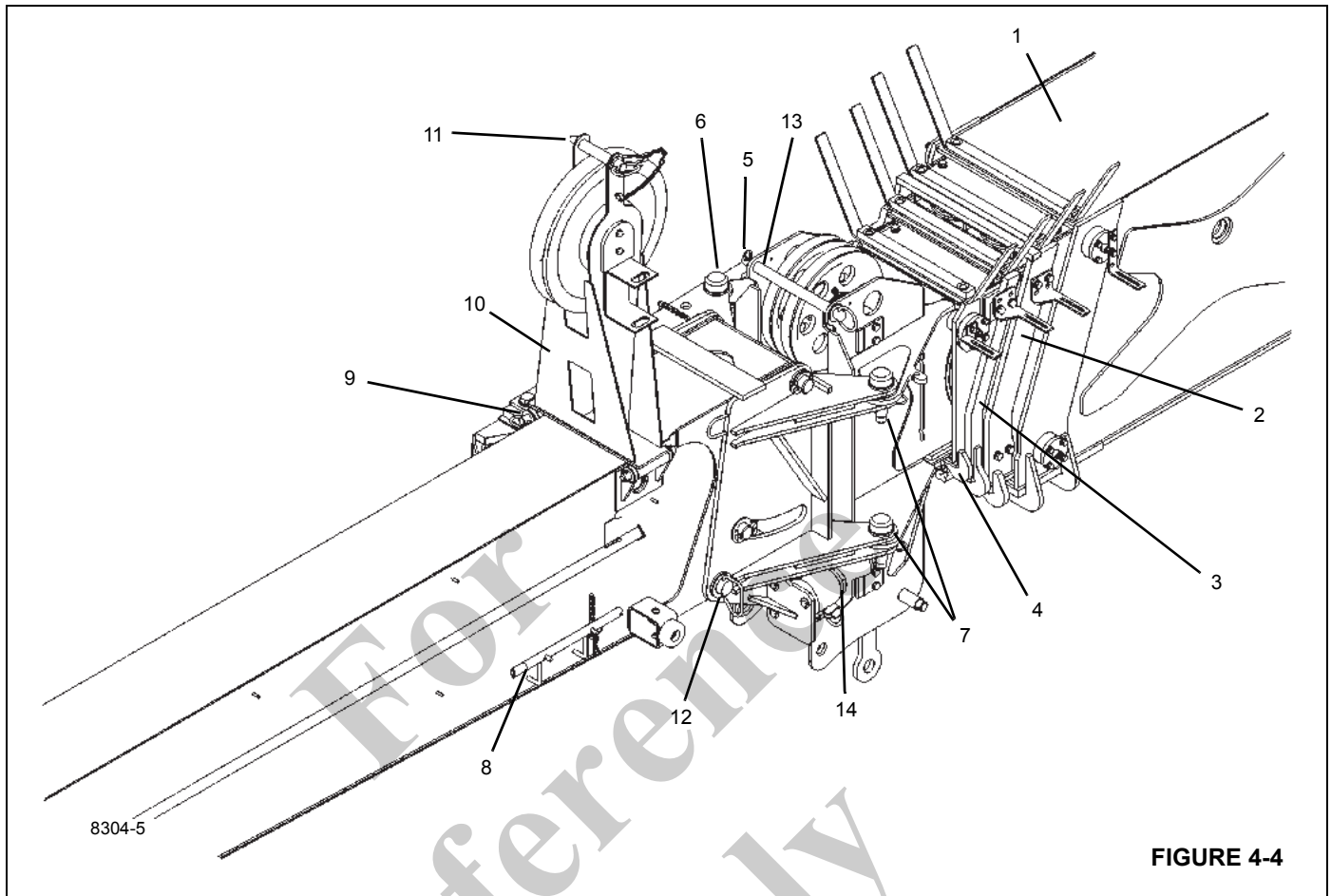


FIGURE 4-4

Item	Description
1	Boom Base Section
2	Tele 1
3	Tele 2
4	Tele 3
5	Jib Swing Pin
6	Right Side Attachment Pins
7	Left Side Attachment Pins
8	Jack Handle
9	Mast Assembly Stowage Pin
10	Mast Assembly
11	Mast Assembly Cable Retainer
12	Offset Pin
13	Upper Sheave Cable Retainer
14	Alignment Jack

**NOTE:** The hoist cable must be routed over the mast assembly and under the roller on the mast for all configurations.

**Stowing Procedure**

**NOTE:** Depending on the length of the jib being used; the crane can be equipped with either a two section or one section jib. Certain stowing instructions may only apply to one or the other and will be noted so.

## DANGER

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

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

- Side stow bracket completely engaged into stow hook with stow pin (1, Figure 4-3) properly in place.
- Both pins (6, Figure 4-3) in upper and lower jib holes properly in place through mating holes on boom tip.

1. Using lift function, lower boom so that right side attachment pins (6 and 7, Figure 4-3) are easily accessible from the ground.

**NOTE:** When lowering the boom below horizontal, two persons may be required. With the telescope control in neutral, the boom may slide out when below horizontal.

2. Two section jib - For manually extendable jibs, pull jib retaining pin (9, Figure 4-3) and fully retract extendable 2<sup>nd</sup> section into the 1<sup>st</sup>. Retraction of 2<sup>nd</sup> section may be facilitated by attaching loadline wedge socket to jib nose. Slowly activate the hoist up function until the 2<sup>nd</sup> section is fully retracted.
3. Two section jib - Reinstall jib retaining pin (9, Figure 4-3) through the 1<sup>st</sup> and 2<sup>nd</sup> section jib assembly and install spring clip.
4. Remove loadline from jib sheave case. Place loadline in area to avoid possible damage from stow procedure.
5. Disconnect A2B wire connector at rear of the jib. Reconnect A2B switch connector on boom tip. Move weight/chain assembly to boom tip see Figure 4-6.
6. Attach tag line to sheave case end of jib.
7. Remove spring clips from left side attachment pins (7, Figure 4-3 and Figure 4-4) on both upper and lower jib lugs.
8. Remove jib swing pin (5, Figure 4-3) from the boom nose.
9. Remove left side attachment pins (7, Figure 4-3 and Figure 4-4) from upper and lower jib lugs. Do not remove right side attachment pins (6) at this time. The right side attachment pins (6) will be used as a pivot point to swing jib into stowed position. A slight hammer strike may be necessary to remove pins.

## CAUTION

Always use proper eye protection during this step.

10. Raise the boom to the horizontal position.
11. Extend boom approximately 0.3 m (1 ft).
12. Using tag line attached to jib sheave case, slowly swing jib into stowed position (parallel with Tele 1 boom), the right side attachment pins (6, Figure 4-3) are the jib pivot points during this operation.

## CAUTION

Use caution when swinging jib to avoid unnecessary impact with Tele 1 boom.

13. Install jib swing pin (5, Figure 4-3) with spring clip through jib ear and boom sheave case holes. This pin will keep the jib assembly in line (parallel) with the Tele 1 boom.

**NOTE:** Jib swing pin (5, Figure 4-3) does not retain the jib in its stowed position on the Tele 1 boom.

14. Using boom telescope function, slowly retract boom.

The jib stowage bracket (2, Figure 4-3) on the side of the jib will engage the hook bracket (3) on the side of the Tele 1 boom; first lifting the jib and then engaging the jib stowage bracket (2) and the hook bracket (3) completely upon full retraction of the boom.

Ensure boom is fully retracted.

15. Install stow pin (1, Figure 4-3) with spring clip into the jib stowage bracket (2) on the jib. Complete engagement of stow brackets and proper installation of stow pin (1) is critical for secure jib stow attachment.
16. Remove right side attachment pins (6, Figure 4-3) from upper and lower jib lugs. A slight hammer strike may be necessary to remove pins.

## CAUTION

Always use proper eye protection during this step.

17. Reinstall loadline over boom sheave case.

**NOTE:** When the jib is stowed on side of crane, always leave the ram and handle sleeve of the alignment jack pushed all the way in to reduce exposure to rusting.

## Jib Removal

**NOTE:** The hoist cable must be routed over the mast assembly and under the roller on the mast for all configurations.

To remove the jib, proceed as follows:

1. Using boom telescope function, fully retract boom.
  2. Using lift function, lower boom so that attachment pins (6 and 7, Figure 4-3) are easily accessible from the ground.
- NOTE:** When lowering the boom below horizontal, two persons may be required. With the telescope control in neutral, the boom may slide out when below horizontal.
3. Install right side attachment pins (6, Figure 4-3) in upper and lower jib lugs, secure with retainer spring clips. These pins are used as a pivot point to swing jib into the deployed position.
  4. Locate the stowed position of attachment pins (7, Figure 4-3). If in jib attachment holes or boom sheave case jib holes, remove pins from storage location.
  5. Remove jib swing pin (5, Figure 4-3) from top ear of jib.
  6. Remove stow pin (1, Figure 4-3) and stow in hook bracket (3), secure with spring clip.
  7. Attach tag line to sheave case end of jib.
  8. Using the lift function, raise the boom to the horizontal position.

 **CAUTION**

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

9. Using telescope function, slowly extend boom approximately one foot. This procedure will pull the jib out of the hook bracket (3, Figure 4-3).
10. Support and raise the jib at its balance point, then remove right side attachment pins (6, Figure 4-3) in upper and lower jib lugs. Jib is now free of boom.
11. To install, proceed in reverse order of removal.

**JIB MAINTENANCE**

1. Lubricate as outlined in the section titled *Lubrication Procedure and Charts*, page 5-1.
2. Check for free rotation of jib sheave daily when using jib.

**Setting the Offset**

**CAUTION**

The mast assembly (10, Figure 4-4) must be positioned on top of the base section before attempting to offset the swingaway to 30 degrees. Failure to do so can cause damage to the mast and/or swingaway adapter.

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

**CAUTION**

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

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

**Setting the Offset Mast**

**NOTE:** The hoist cable must be routed over the mast assembly and under the roller on the mast for all configurations.

**CAUTION**

The mast assembly (10, Figure 4-4) must be positioned on top of the base section before attempting to offset the swingaway to 30 degrees. Failure to do so can cause damage to the mast and/or swingaway adapter.

1. Extend and set the outriggers.
2. Swing the boom over rear of truck chassis.

**CAUTION**

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

3. Deploy the jib as outlined in (*JIB Operation*, page 4-4).
4. Remove the pin (3, Figure 4-5) from the mast stowage bracket (4).
5. Swing the mast (1 Figure 4-5) from the stowed position to the top of the jib boom (2).

---

**CAUTION**

Use caution to avoid pinch points while positioning mast.

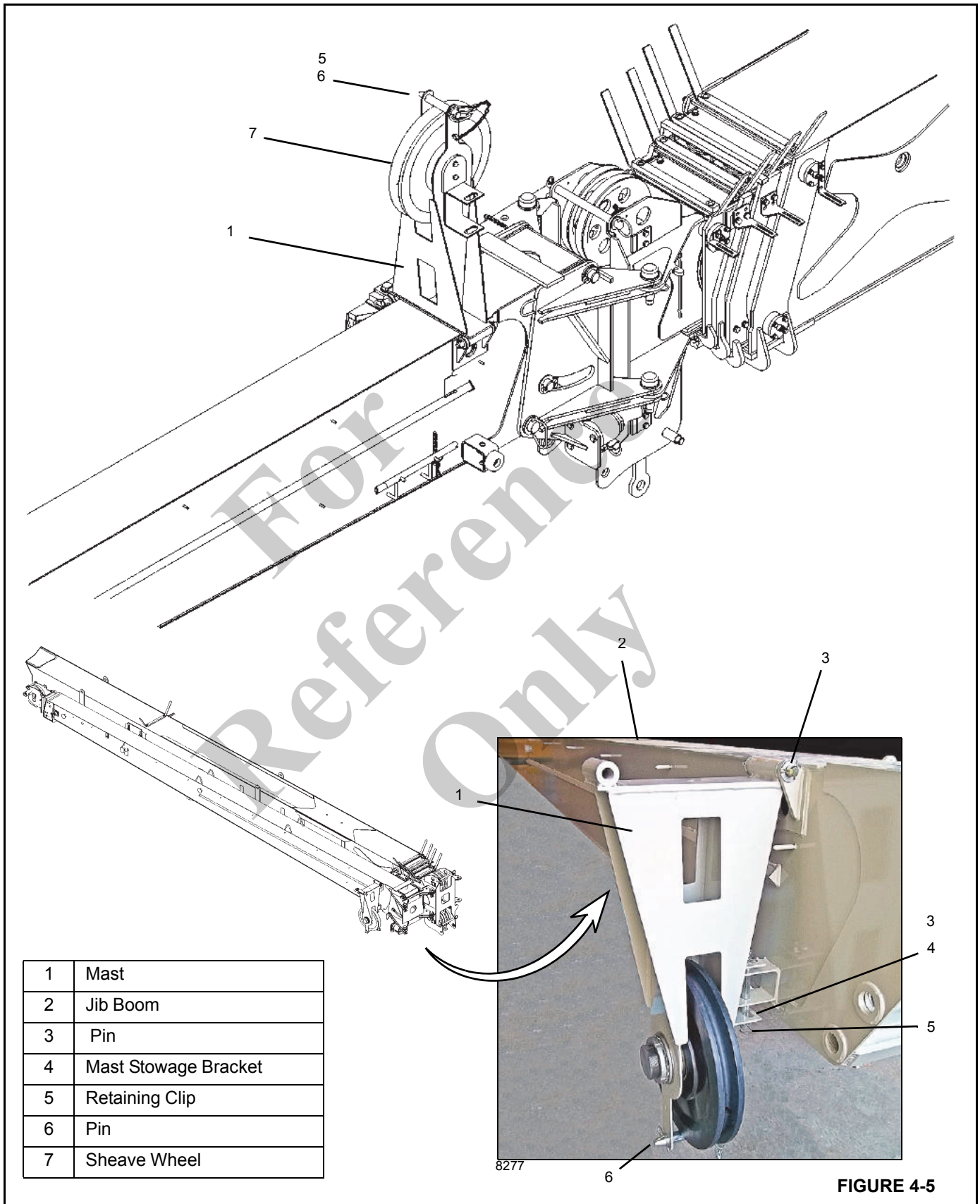
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6. Install pin (3) that was removed from the stowage bracket (4) to secure the mast to the jib boom.

**NOTE:** The hoist cable must be routed between the mast assembly and the roller on the mast for all configurations.

7. Install the retaining clip (5) to secure pin to mast.
8. Route hoist rope in groove in sheave wheel and secure with retaining pin (6).

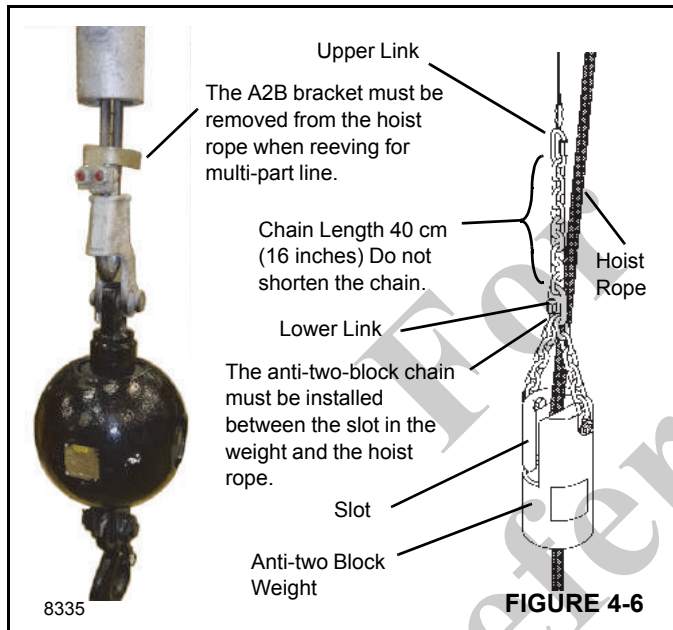
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## Anti-Two-Block Weight Installation

To prevent the hoist rope from slipping out of the A2B weight, rig the weight as shown in Figure 4-6.

**NOTE:** The A2B bracket shown in Figure 4-6 must be removed from the hoist rope when changing between a single part line and multiple part line to allow the hoist rope and wedge socket to be reeved through the sheaves on the boom nose and the hookblock. Re-install the bracket and clamp to the cable before performing a lift.



## MULTI-PART LINE REEVING

Multi-part line reeving enables greater loads to be lifted than can be lifted with single part line. However, loads are limited by the stability and structural integrity of the crane. The load must be within the limits contained in the load chart.

### Using Multiple Part Lines



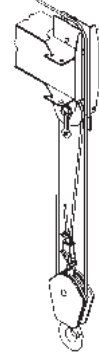

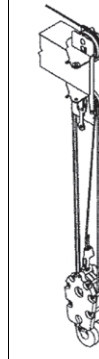
The hoist data chart provides information for pull limitations on the hoist with various multi-part reevings. These ratings are based on providing the proper operating safety factor on the cable supplied with the crane. Therefore, any replacement rope must meet the cable specification in this manual.

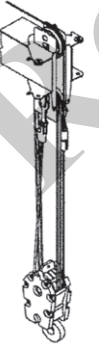
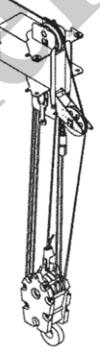




**NOTE:** The A2B bracket shown in Figure 4-6 must be removed from the hoist rope when changing between a single part line and multiple part line to allow the hoist rope and wedge socket to be reeved through the sheaves on the boom nose and the hookblock. Re-install the bracket and clamp to the cable before performing a lift.

### Lifting the Rated Load

The NBT60 is rated to lift 54.4 metric ton 54,431 kg [120,000 lb (60 ton)] at a 2.44 m (8 ft) radius with all booms retracted with a 11 part block. To make this lift the crane must be equipped with 16 mm (0.625 in) diameter wire rope with a rated breaking strength of 25,089 nm (56,400 lb). This rope is required to have the appropriate 5:1 safety factor.



1 Part Line	2 Part Line	3 Part Line	4 Part Line	5 Part Line
				
<b>Maximum Pull</b> Normal Speed 11,250 lbs 191 fpm High Speed 5,000 Lbs 383 fpm	<b>Maximum Pull</b> Normal Speed 22,500 Lbs 95 fpm High Speed 10,000 Lbs 191 fpm	<b>Maximum Pull</b> Normal Speed 33,750 Lbs 63 fpm High Speed 15,000 Lbs 127 fpm	<b>Maximum Pull</b> Normal Speed 45,000 Lbs 47 fpm High Speed 20,000 Lbs 95 fpm	<b>Maximum Pull</b> Normal Speed 56,250 Lbs 38 fpm High Speed 25,000 Lbs 76 fpm
The hook block must be sized to the number of line parts. For example, do not use a six part line hook block on a three part line reeving. Contact your National Crane Distributor or Manitowoc Crane Care to order the proper hook block.				

6 Part Line	7 Part Line	8 Part Line	9 Part Line	10 Part Line	11 Part Line
					
<b>Maximum Pull</b> Normal Speed 67,500 Lbs 31 fpm High Speed 30,000 Lbs 63 fpm	<b>Maximum Pull</b> Normal Speed 78,750 Lbs 27 fpm High Speed 35,000 Lbs 54 fpm	<b>Maximum Pull</b> Normal Speed 90,000 Lbs 23 fpm High Speed 40,000 Lbs 47 fpm	<b>Maximum Pull</b> Normal Speed 101,250 Lbs 21 fpm High Speed 45,000 Lbs 42 fpm	<b>Maximum Pull</b> Normal Speed 112,500 Lbs 19 fpm High Speed 50,000 Lbs 38 fpm	<b>Maximum Pull</b> Normal Speed 120,000 Lbs 17 fpm High Speed 55,000 Lbs 35 fpm
The hook block must be sized to the number of line parts. For example, do not use a six part line hook block on a three part line reeving. Contact your National Crane Distributor or Manitowoc Crane Care to order the proper hook block.					

## INSTALLING CABLE ON THE HOIST

### CAUTION

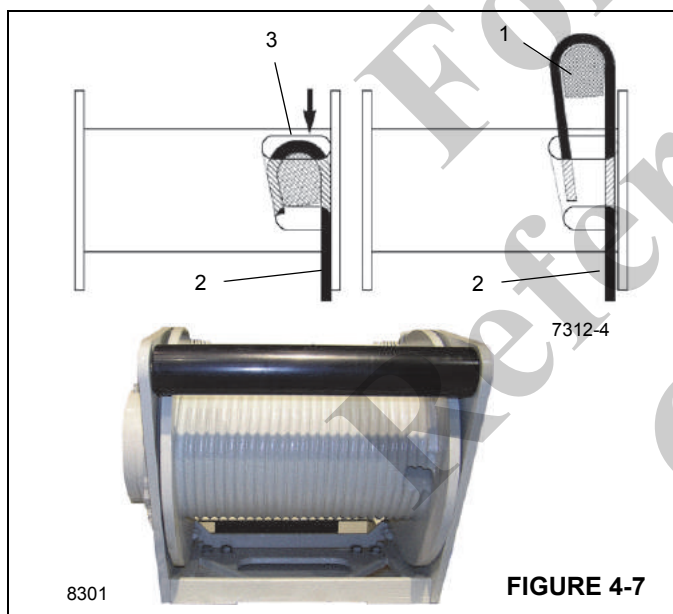
If cable is wound from the storage drum, the reel should be rotated in the same direction as the hoist.

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

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

1. Position the cable over the boom nose sheave and route to the hoist drum.
2. Position the hoist drum with the cable anchor slot on top.
3. Insert the cable through the slot and position around the anchor wedge (1) Figure 4-7.

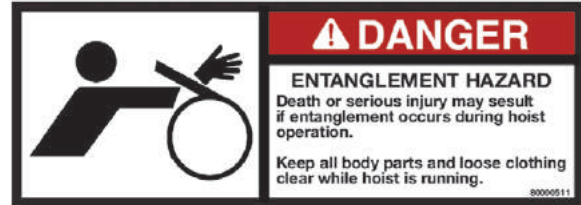
**NOTE:** The end of the cable should be even with the bottom of the slot for the anchor wedge.



**FIGURE 4-7**

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.



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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.

### WEDGE SOCKETS

To install a wedge socket:

- Make sure the wedge socket is the proper size for the cable.
- Do not mix components of different wedge socket manufacturers.
- The wedge socket must meet the requirements of the wedge socket and hoist rope manufacturers.

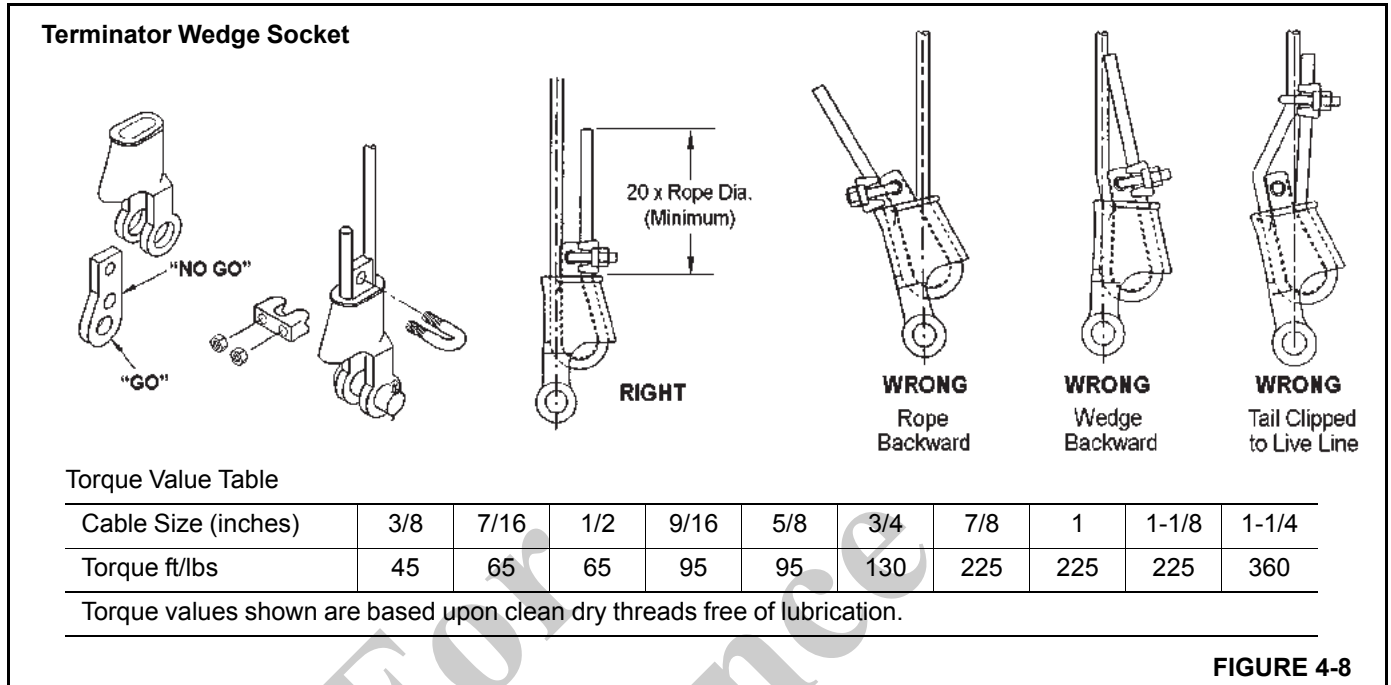
State and local laws may vary and require different attachment methods depending upon work conditions. The user is responsible for alternate attachment methods.

### Terminator Wedge Installation

The NBT60 is shipped with a terminator wedge socket which is National Crane's preferred type of socket (Figure 4-8). Other wedge socket types are discussed under *Wedge Socket Installation*, page 4-15.

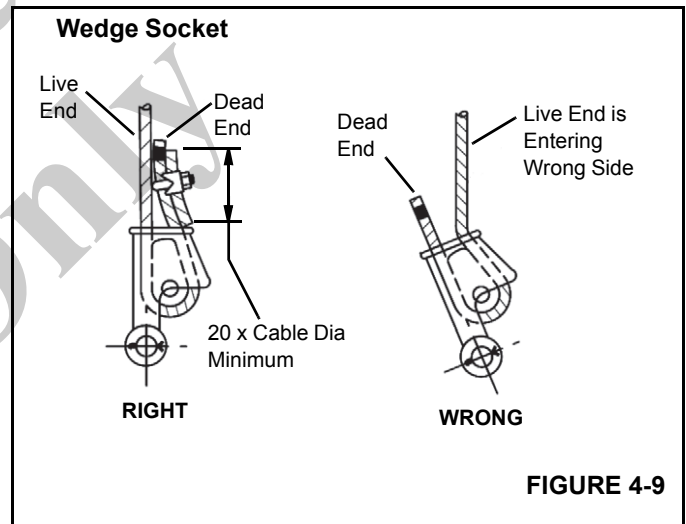
To attach a terminator wedge (Figure 4-8), use the following procedure:

1. Match the socket, wedge, and clip to hoist rope size.
  - The hoist rope must pass through the "go" hole in the wedge.
  - It must not pass through the "no go" hole in the wedge.
2. Align the live end of rope with center line of pin.
3. Secure dead end section of rope.
4. Tighten nuts on clip to recommended torque (Figure 4-8).
5. Do not attach dead end to live end or install wedge backwards.
6. Use a mallet to seat Wedge and Rope as deep into socket as possible before applying first load.



**Wedge Socket Installation**

1. Inspect the wedge and socket. Remove any rough edges and burrs.
2. The end of the 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. Do not weld on size 6X37 rope. 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. Refer to SECTION 1 - INTRODUCTION in the Service Manual for hoist rope procedures.
3. Make sure the live-end (Figure 4-9) of the rope is directly in line with the lugs 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 the hoist rope into the socket, form a loop in the rope, and route the rope back through the socket allowing the dead-end (Figure 4-9) 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 hoist rope by using the crane's hoist to first apply a light load to the live-end.

6. After final pin connections are made, increase the loads gradually until the wedge is properly seated.
7. The hoist rope and wedge must be properly secured inside the socket before placing the crane into lifting service. It is the wedge that secures the hoist rope inside the socket. The dead-end treatment is used to restrain the wedge from becoming dislodged from the socket should the rope suddenly become unloaded due to the headache ball or hook block striking the ground, etc.

Sketches A through F (Figure 4-10) illustrate various ANSI approved methods for treating the dead-ends of hoist 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 A2B system and other components during use of the crane.

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

When using method A, place a hoist 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 table titled Hoist Rope Clip Torque Values (Table 4-1).

Other sources for information with which crane users should be familiar and follow is provided by the American Society of Mechanical Engineers, American National Standard, ASME

B30.5, latest revised. ASME (formerly ANSI) B30.5 applies to cableways, cranes, derricks, hoists, hooks, jacks, and slings. It states, in section 5-1.7.3, "(c) Swagged, compressed, or wedge socket fittings shall be applied as recommended by the rope, crane or fitting manufacturer." Wire ropes are addressed in ASME B30.5, section 5-1.7.2, ROPES, it states, in pertinent part, "(a) The ropes shall be of a construction recommended by the rope or crane manufacturer, or person qualified for that service." Additional information is published by the Wire Rope Technical Board in the Wire Rope Users Manual, latest revised edition.

Table 4-1

Wire Rope Clip Torque Values			
Clip Sizes		Torque	
mm	Inches	Nm	lb-ft
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

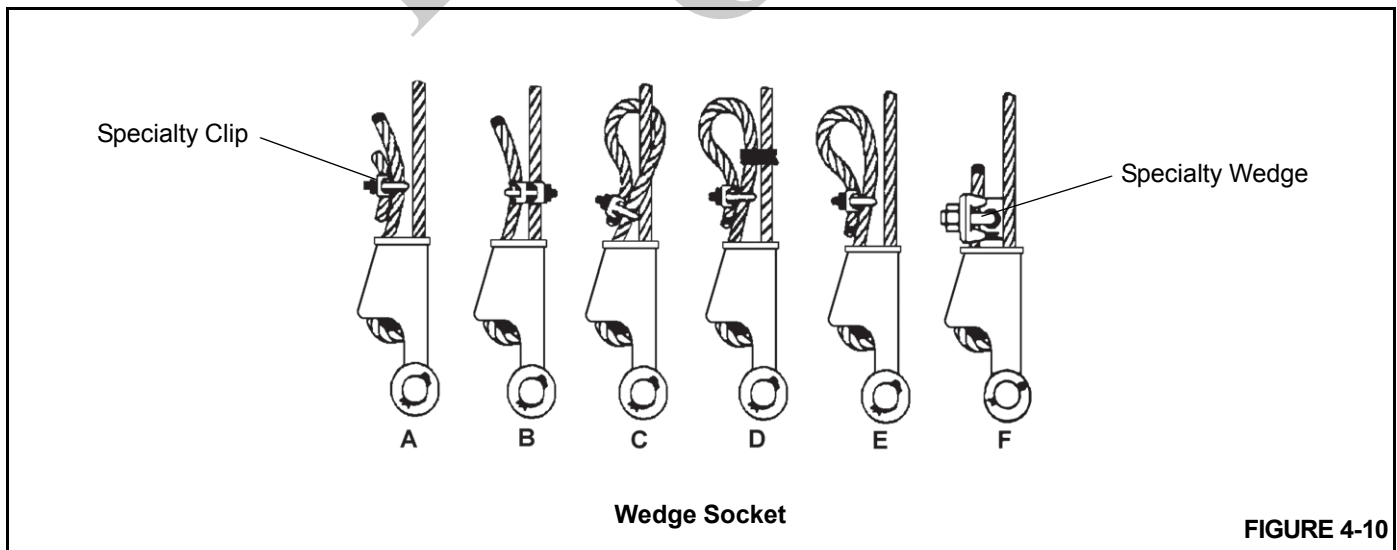


FIGURE 4-10

REMOVABLE COUNTERWEIGHT



**DANGER**

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

The NBT60 is equipped with a two section Removable Counterweight. Each cast section weighs 1360 kg (3000 lb). The following procedures are applicable for mounting and stowing the top section or both sections.

Refer to Figure 4-12 for an illustration of the components that make up the Removable Counterweight.

**Mounting the Counterweight**

1. Position crane on a firm, level surface.
2. Fully extend and set the outriggers, then level the crane (see *Setting the Outriggers*, page 4-2).
3. Set display in Operator's Console to the RCL Operating Mode Screen (Figure 4-11) (see *Section 7, Rated Capacity Limiter*).

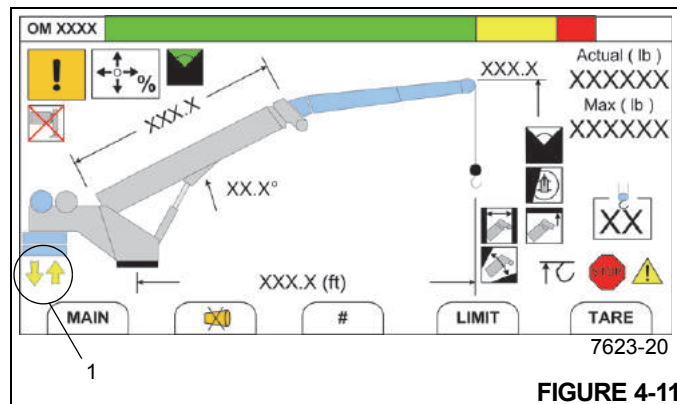


FIGURE 4-11

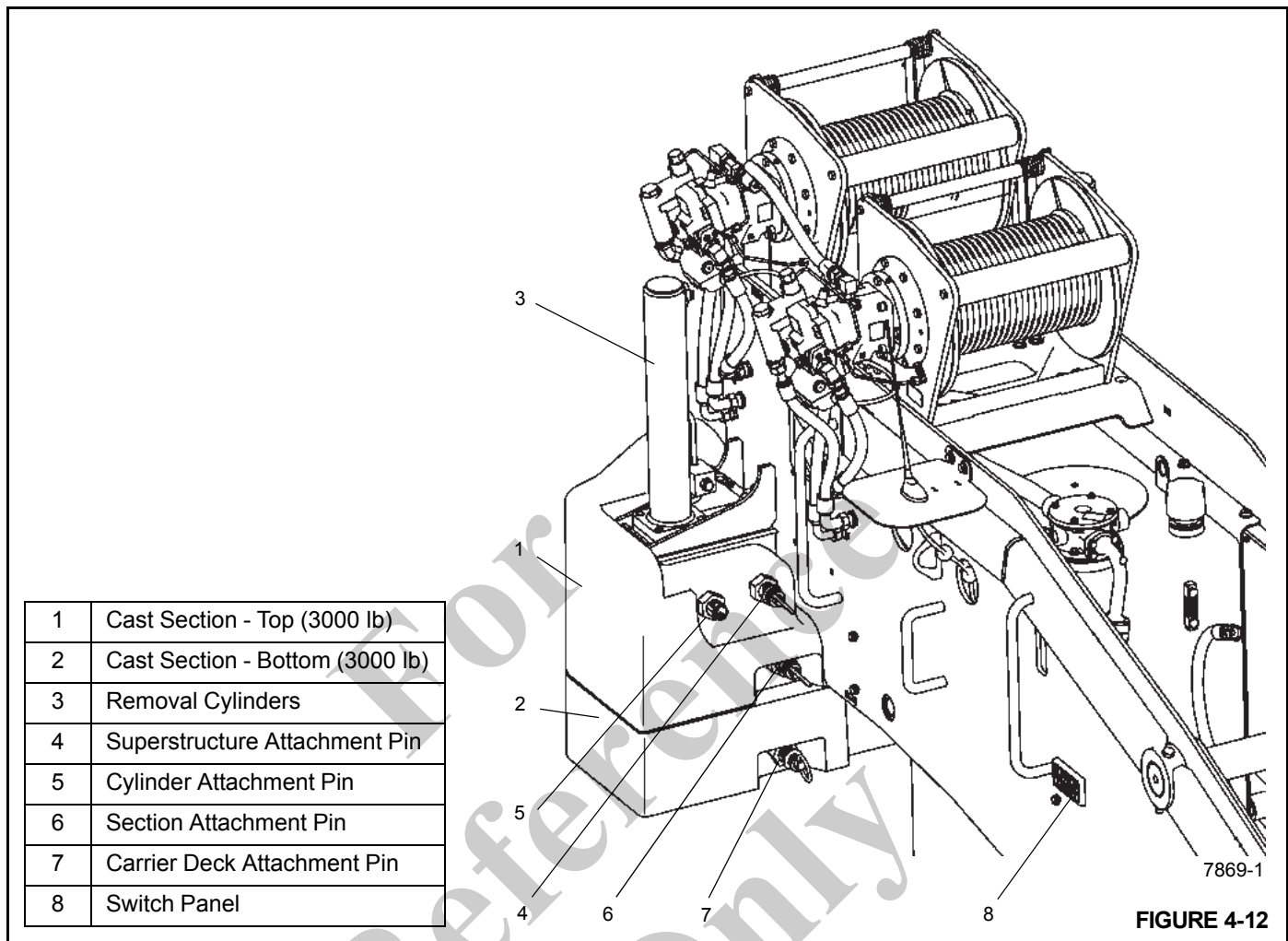
4. While watching the display, rotate superstructure until Counterweight Removal Slew Position Indicator (yellow arrows) (1, Figure 4-11) appears in the display, which indicates the rear of the superstructure is nearly directly above the Removable Counterweight stowed on the carrier deck.

Ensure vertical alignment of superstructure to counterweight by leaving the cab and performing a visual inspection. If necessary, return to cab and rotate superstructure until alignment is achieved.

5. Retract left and right pins (5, Figure 4-12) from top of Removable Counterweight.
6. Remove left and right pins (4, Figure 4-12) from top of Removable Counterweight.
7. Remove left and right pins (7, Figure 4-12) that secure counterweight to carrier deck.

If crane is equipped with top and bottom counterweight sections (1, 2, Figure 4-12) and only the top section is to be loaded, only remove the left and right pins (6, Figure 4-12) which secure the top and bottom sections together; do not remove pins (7, Figure 4-12) that secure bottom counterweight to carrier deck.

Reference Only



8. Using Counterweight Switch Panel (Figure 4-13) located on either side of turntable, lower the Counterweight Removal Cylinders by doing the following:

**NOTE:** The Counterweight Switch Panels will only function if the Crane Function Power Switch is turned off, an armrest is in the up position, or there is no one sitting in the crane cab operator's seat. A green LED (6, Figure 4-13) on the left side of the Counterweight Switch Panel will illuminate to indicate the panel is operational.

If a Counterweight Removal Cylinder Raise or Lower Button (4, 5, Figure 4-13) is pressed without first pressing and holding a Power Button (1, Figure 4-13), a red LED above that button will flash.

- a. Press and hold a Power Button.
- b. Press and hold the left and right Counterweight Removal Cylinder Lower Buttons.
- b. Press and hold the left and right Counterweight

- c. Release the left and right Counterweight Removal Cylinder Lower Buttons when cylinders are at the proper position to pin the counterweight to the cylinders.

If cylinders and counterweight do not vertically align, return to cab and swing superstructure until alignment is achieved.

**NOTE:** The cylinders can rotate axially when no counterweight is installed, causing the cylinder pin holes to not align with holes in counterweight. If this occurs, rotate cylinder rod using your hand or counterweight pin.

9. Attach Removable Counterweight to cylinders using pins (5, Figure 4-12).

10. Using Counterweight Switch Panel, fully raise Counterweight Removal Cylinders by doing the following:

- a. Press and hold a Power Button.  
Removal Cylinder Raise Buttons.

- c. Release the left and right Counterweight Removal Cylinder Raise Buttons when the cylinders are at the fully raised position.

**NOTE:** If top counterweight hits wear pads on the superstructure when raising, swing crane to re-align counterweight to mounting lugs, lower counterweight back down onto mounting lugs on carrier deck to realign counterweight on cylinder pins, then raise counterweight again.

- 11. Secure Removable Counterweight to left and right sides of superstructure using pins (4, Figure 4-12).

**NOTE:** It may be necessary to jog the cylinders up and down to install pins.

- 12. Slightly lower left and right cylinders to relieve the weight of the counterweight from the cylinder pins.

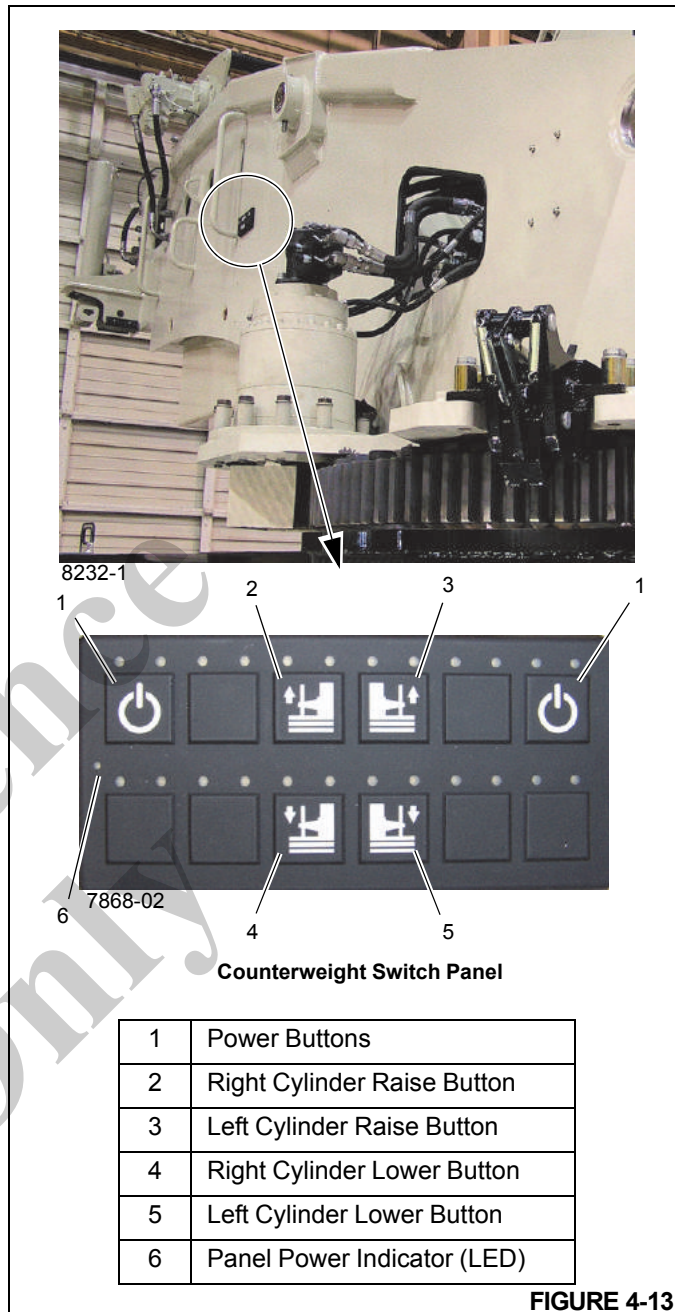


FIGURE 4-13

**Stowing the Counterweight**

1. Position crane on a firm, level surface.
2. Fully extend and set the outriggers, then level the crane (see *Setting the Outriggers*, page 4-2).
3. Set display in Operator’s Console to the RCL Operating Mode Screen (Figure 4-11) (see *Section 7, Rated Capacity Limiter*).
4. While watching the display, rotate superstructure until Counterweight Removal Slew Position Indicator (yellow arrows) (1, Figure 4-11) appears in the display, which

For Reference Only

indicates the rear of the superstructure is nearly directly above the counterweight stowage area on the carrier deck.

Ensure vertical alignment of counterweight to counterweight mounting lugs on the carrier deck or top counterweight section to bottom counterweight section by leaving the cab and performing a visual inspection. If necessary, return to cab and rotate superstructure until alignment is achieved.

5. Using Counterweight Switch Panel (Figure 4-13) located on either side of the turntable, slightly raise the Counterweight Removal Cylinders by doing the following:

**NOTE:** The Counterweight Switch Panels will only function if the Crane Function Power Switch is turned off, an armrest is in the up position, or there is no one sitting in the crane cab operator's seat. A green LED (6, Figure 4-13) on the left side of the Counterweight Switch Panel will illuminate to indicate the panel is operational.

If a Counterweight Removal Cylinder Raise or Lower Button (4, 5, Figure 4-13) is pressed without first pressing and holding a Power Button (1, Figure 4-13), a red LED above that button will flash.

- a. Press and hold a Power Button.
- b. Press and hold the left and right Counterweight Removal Cylinder Raise Buttons.
- c. Release the left and right Counterweight Removal Cylinder Raise Buttons when the cylinders are fully raised.

6. Remove pins (4, Figure 4-12) that secure Removable Counterweight to superstructure.

**NOTE:** It may be necessary to jog the cylinders up and down to remove pins.

7. Using Counterweight Switch Panel, fully lower Counterweight Removal Cylinders by doing the following:

- a. Press and hold a Power Button.
- b. Press and hold the left and right Counterweight Removal Cylinder Lower Buttons.
- c. Release the left and right Counterweight Removal Cylinder Lower Buttons when counterweight is in the fully lowered position.

If counterweight does not vertically align with mounting lugs or bottom counterweight section, raise cylinders, return to cab, and then swing superstructure until alignment is achieved.

8. Secure counterweight to carrier deck with pins (7, Figure 4-12).

If crane superstructure is loaded with only top counterweight section and bottom section is stowed on carrier deck, secure top section to bottom section with pins (6, Figure 4-12).

9. Remove pins (5, Figure 4-12) that secure Removable Counterweight to cylinders.

10. Fully raise cylinders, then stow pins in top counterweight section.



## SECTION 5 LUBRICATION PROCEDURE AND CHARTS

### SECTIONS CONTENTS

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### GENERAL

Following a designated lubrication procedure is important to ensure a maximum crane life. 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. This section does not include lubrication requirements for the truck chassis. Refer to truck service manual for this information.

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

### 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

Specific recommendations of brand and grade of lubricants are not made here due to regional availability, operating conditions, and the continual development of improved products. Where questions arise, contact your National Crane Distributor or Manitowoc Crane Care.

### Arctic Conditions Below -9°C (15°F)

In general, petroleum based fluids developed especially for low temperature service may be used with satisfactory results. However, certain fluids, such as halogenated hydrocarbons, nitro hydrocarbons, and phosphate ester hydraulic fluids, might not be compatible with hydraulic

system seals and wear bands. If you are in doubt about the suitability of a specific fluid, check with your authorized National Cranes distributor or Manitowoc Crane Care.

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

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

**Chassis Grease**

**CAUTION**

Do not use air pressure devices to apply chassis grease otherwise damage to sealed fittings may result.

Lubricating grease of proper consistency is to be applied periodically at relatively frequent intervals with grease guns through grease fittings. Minimum apparent viscosity of 300 SUS (Saybolt Universal Seconds) at 38°C (100°F) is recommended.

**CAUTION**

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

**Low Temperature Grease**

This special grease for low temperature remains plastic at -51° C (-60° F) with melting point of 138°C (280°F). The grease is a heavy duty extreme pressure type lubricant (Lubricate Low Temp or equal).

**Extreme Pressure Multipurpose Gear Lubricant (EPGL)**

This gear lubricant is compounded to achieve high load carrying capacity and meet the requirements of either API-GL-5 or MIL-L-2105C. Unless otherwise specified, SAE 80W-90 viscosity may be used for year round service. Low temperature usage is restricted as follows:

SAE Viscosity Number	Minimum Ambient Temperature C (F)	
75W	-40°C	(-40°F)
80W	-2°C	(-15°F)
85	-12°C	(+10°F)
90	-7°C	(+20°F)
140	+5°C	(+40°F)
250	+10°C	(+50°F)

**Open Gear Lubricant**

This is a special high-graphite adhesive lubricant that helps to eliminate fretting corrosion, is water resistant, and forms a dry lubrication film which does not attract dust. Lubricant meets NLGI Class 1-2 specifications.

**Low Temperature Grease**

This special grease for low temperature remains plastic at -60°F (-51°C) with melting point of 280°F (138°C). The grease is a heavy duty extreme pressure type lubricant (Lubricate Low Temp or equal).

**Antifreeze/Coolant (for Cab Heater)**

The standard antifreeze/coolant filled from the factory is intended to provide protection against freeze-up down to -36° C (-34° F) and boil-over up to 129° C (265° F) using a 15 psi pressure cap.

**Anti-wear Additives**

Excessive wear in the system may cause a loss in volumetric efficiency and cause shutdowns for maintenance. An efficient anti-wear oil protects the components against rusting, resists oxidation and helps prevent wear.

**Hydraulic Oil**

Oil in a hydraulic system serves as the power transmission medium, system lubricant and coolant. Selection of the proper oil is essential to ensure satisfactory system performance and life. The most important factors in selecting an oil for hydraulic service are viscosity and anti-wear additives.

**CAUTION**

Operation of the crane with incorrect hydraulic oil in sub freezing temperature below 0° C, (32° F) can cause damage to the extend cylinder.

**NOTE:** When operating the crane in temperatures -9°C (15°F) and below, follow the procedures in the section titled *Arctic Conditions Below -9°C (15°F)*, page 5-1.

**Standard Hydraulic Oil**

**Temperature Above -9°C (15°F)**

The factory fill standard hydraulic oil is SAE grade 10W-20 Hydraulic Oil. This fluid is acceptable for operating temperatures above -9°C (15°F).

**NOTE:** On units equipped with self-leveling platforms, low temperature service oils are necessary to provide proper boom functions at temperatures below -9°C (15°F).

**CAUTION**

Operation of the crane with incorrect hydraulic oil in sub freezing temperature below 0°C (32°F) can cause damage to the extend cylinder.

**Arctic Hydraulic Oil****Temperature Down to -9°C (15°F) to -29°C (-20°F)**

For colder operating conditions, the standard fluid may be replaced with a petroleum based fluid developed especially for colder environments.

**Temperature Down to -40°C (-40°F) and Below**

Petroleum based fluids developed especially for low temperature service may be used with satisfactory results. However, certain fluids, such as hydrogenated hydrocarbons, nitro hydrocarbons and phosphate ester hydraulic fluids might not be compatible with hydraulic system seals and wear bands. Arctic hydraulic oil is not recommended for service in ambient temperatures above 0°C (32°F).

If you are in doubt about the suitability of a specific fluid, check with your authorized National Crane distributor or Manitowoc Crane Care.

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

**Hydraulic Oil Inspection**

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 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, filter and breathers be inspected at least every three to six 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. For example, if 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 contaminant content is 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 the hydraulic oil, fill a small glass container with a sample of the reservoir oil and another glass container with

fresh oil. Let the samples stand, undisturbed, for one or two hours. 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 is due to air foaming, it will dissipate and the oil should closely match the fresh oil. Remember, replacement oil must meet ISO 17/14 or better cleanliness level and must meet John Deere Standard JDM J20C. Contact your National Crane distributor or Manitowoc Crane Care if you have any questions.

**LUBRICATION**

A regular frequency of lubrication must be established based on component operating time. The most efficient method of keeping track of lube requirements is to maintain a job log of crane usage.

** DANGER**

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

**CAUTION**

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

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 fill port.

Over lubrication of non-sealed fittings will not harm the fittings or components, but under lubrication shortens lifetime.

Worn grease fittings that do not hold a grease gun, or those that have a stuck check ball, must be replaced.

When wear pads or rotation bearings are lubricated, cycle the components and lubricate again to ensure complete lubrication of the entire wear area.

**CAUTION**

Lubrication intervals (page 5-8) are to be used only as a guide. Actual intervals should be formulated by the operator to correspond accordingly to conditions such as continuous duty cycles and/or hazardous environments.

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

Lubrication Chart

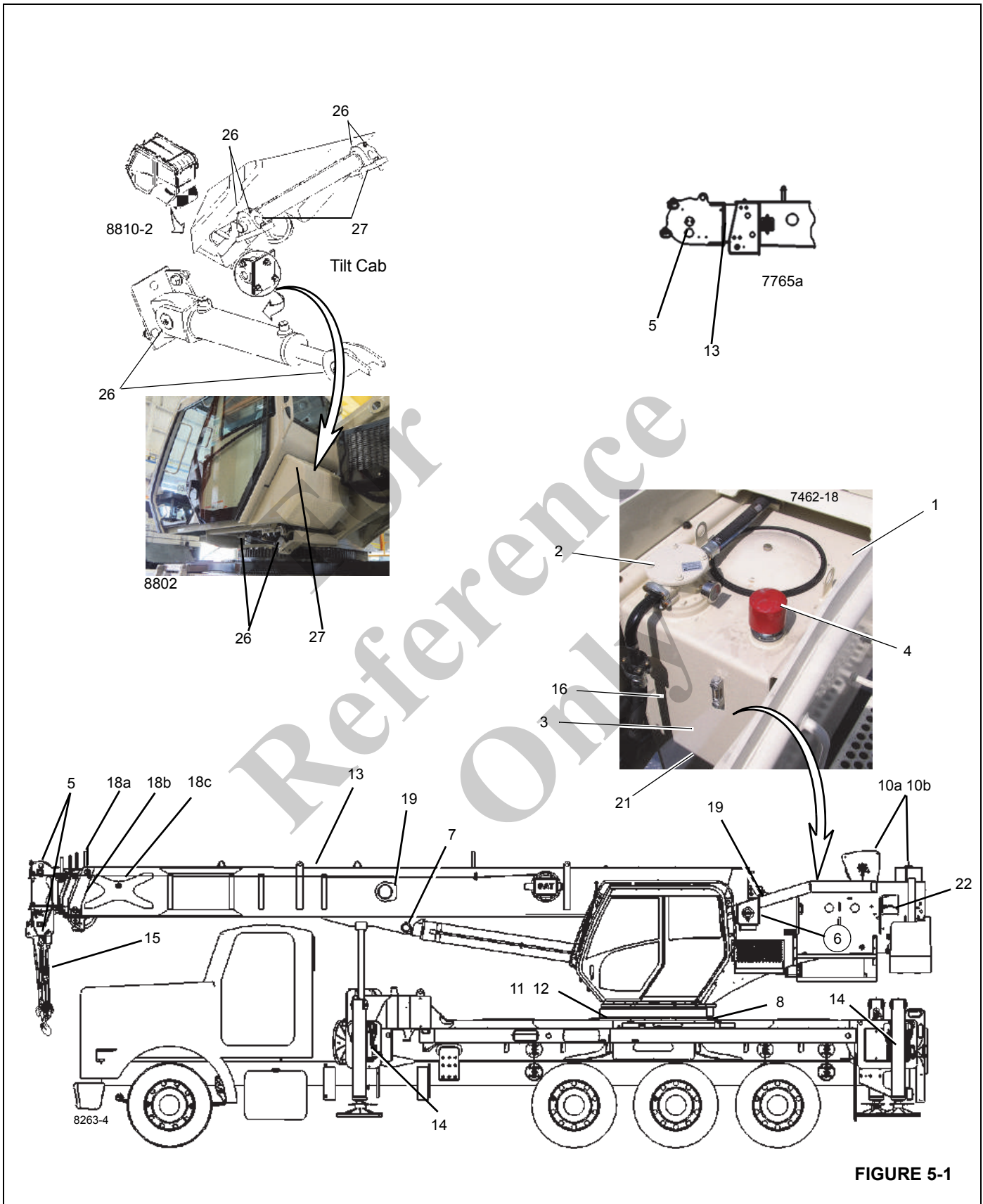


FIGURE 5-1

Symbol	Description	Manitowoc Lube Specification	
		Standard	Cold Weather -40°C (-40°F)
AFC	Antifreeze/Coolant (for Cab Heater)	6829101130	6829104212
EP-MPG	Extreme Pressure Multipurpose Grease	6829003477	6829104275
GL-5	GL-5 Gear Lubricant	6829012964	6829014058
HYDO	Hydraulic Oil	6829006444	6829006993
EP-OGL	Open Gear Lubricant, CEPLATTYN 300 Spray, NLGI Grade 1-2	6829102971	6829102971
AGMA EP-4	Extreme Pressure Gear Lubricant.	6829100213	6829103636
WRL	Wire Rope Lubricant	6829015236	6829010993
EO-20W-20	Engine Oil (Light non-EP Oil), Mil-L-46152	6829005570	-
TES 295	TES295 Compliant Fluid	-	6829101690

**NOTE:** Cold weather lubricants are not sufficient for temperatures below -40° C (-40° F). Use hydraulic tank heaters and insulate where appropriate.

For Reference Only

Item	Application	Recommended Lubricant	Procedure	Frequency
1	Hydraulic Oil Tank Reservoir	HYDO	Check, fill, change	Weekly, as required, Semi-Annually
2	Hydraulic Tank Oil Filter		Change or clean	After first 40 hours, Quarterly thereafter.
3	Hydraulic Tank Suction Filter (inside tank)		Change or clean	After first 40 hours, Quarterly thereafter.
4	Breather, Hydraulic Oil Reservoir		Clean	Monthly
5	Sheave Pins: boom (5 plcs), Jib (1 pl), Block (1 pl), Rooster Sheave (1 pl)	EP-MPG	Grease gun	Weekly
6	Boom Pivot Pin	EP-MPG	Grease gun	Monthly
7	Lift Cylinder Pin	EP-MPG	Grease gun	Monthly
8	Swing Bearing	EP-MPG	Grease gun	Weekly
10a	Hoist Gearbox	GL-5	Change/check and fill	Every 1000 hours or 6 months
10b	Hoist Brake	EO-20W-20 or TES295	Change/check and fill	Every 1000 hours or 6 months
11	Swing Drive Gearbox	GL-5	Change	After 100 operating hours
12	Swing Gear Teeth	EP-OGL	Spray Can	Monthly
13	Boom - Wear Pads (Inner, Side and Bottom)	LTG	See page 5-7	Monthly or as required
14	Outrigger Beams - Bottom, Sides	LTG	Brush or roller spray can	Monthly or as required
15	Wire Rope (loadline)	EP-OGL	Brush or spray	Semi-Annually
16	Diffuser Strainer, Hydraulic Oil Reservoir		Clean	Semi-Annually with oil change
17	Swing Motor Pinion Gear	EP-MPG	Grease Gun	Springly every 50 hours
18a	Extend Sheaves: Top of 2nd Section - 103 foot and 128 foot Booms	EP-MPG	Grease Gun	Weekly
18b	Extend Sheaves: Side of 4th Section 128 Foot Boom Each Side	EP-MPG	Grease Gun	Weekly
18c	Extend Sheaves: Telescope Cylinder	EP-MPG	Grease Gun	Weekly
19	Retract Sheaves: Fully retract the boom until the retract sheave grease fittings can be accessed from the rear of the booms or extend the booms until the grease fittings are visible through the access holes at the center of boom.	EP-MPG	Grease Gun	Weekly
20	Extension Cables (Not Shown)	WRL	Spray or Brush	Any time boom is disassembled or 5 years
21	Hydraulic Tank - Magnetic Plug (tank bottom)		Clean	When servicing hydraulic tank, item 1
22	Cab Heater Reservoir	AFC	Check/Fill/Drain	Weekly/as required/Semi-Annually
23	Hook Block Swivel Bearing	EP-MPG	Grease gun	Monthly
24	Hook Block Sheaves	EP-MPG	Grease gun	Monthly
25	Turntable Swing Lockpin	EP-MPG	Spray	Monthly
26	Cab Tilt Cylinder Pivot Pins - (If equipped with Cab Tilt)	EP-MPG	Grease gun	Every 500 hours or 3 months
27	Cab Pillow Block - (If equipped with Cab Tilt)	EP-MPG	Grease gun	Every 500 hours or 3 months

**NOTE:** Lubricate items more frequently than interval indicated in table if environmental conditions and/or operating conditions necessitate.

**Internal Cable Sheave Lubrication**



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

Lubrication of the extend and retract sheaves as follows:

1. Locate the fittings as listed in the table above.
2. Lubricate the sheave pins until a small amount of grease extrudes from the pin.

**Side and Bottom Boom Wear Pad Lubrication**



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

Recommended lubricant is EP-MPG grease.

1. Fully extend and set the outriggers.
2. Lower the boom to horizontal.
3. Extend the boom and apply grease to the sides and bottom of the Tele 2, Tele 3, Tele 4, and Tele 5 sections at contact areas with a brush or putty knife.
4. Raise the boom to 75° and retract the boom.
5. Extend and retract the boom several times until the grease is evenly spread.
6. Repeat as necessary.

**Top Boom Wear Pad Lubrication**



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

Recommended lubricant is EP-3MG grease.

1. Fully extend and set the outriggers.
2. Lower the boom to horizontal.
3. Remove access plate at top rear of the base section.
4. Extend the boom until wear pads are centered in access opening and apply grease to all wear pads and contact surfaces at the top of all boom sections with a grease gun or a brush.

5. Raise the boom to 75°.
6. Extend and retract the boom several times until the grease is evenly spread.
7. Repeat as necessary.

**Outrigger Beam Lubrication**



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

Recommended lubricant is EP-3MG grease.

1. Fully extend and set the outriggers. Refer to (Figure 5-2.)
2. Apply grease to all wear pads and contact surfaces at the side and bottom of all beam sections and lower surface of the jacks with a suitable brush or putty knife.
3. Extend and retract the outriggers several times until the grease is evenly spread.
4. Repeat as necessary.

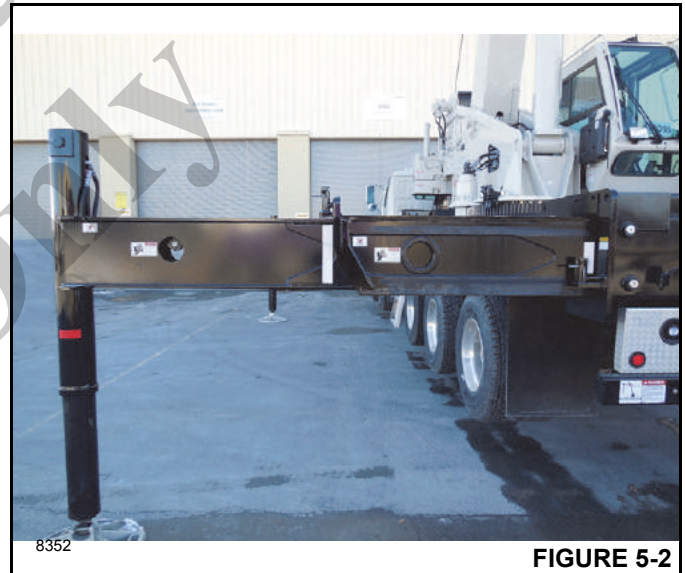


FIGURE 5-2

**Hoist Brake Oil**



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

**Check Hoist Brake Oil**

To check the hoist brake oil, remove the inspection plug (2, Figure 5-3) and visually inspect the oil level. The fluid should be level with the bottom of the inspection hole. If more fluid is needed, add through the brake oil vent and fill plug hole until oil is at the bottom level of the inspection hole (1).

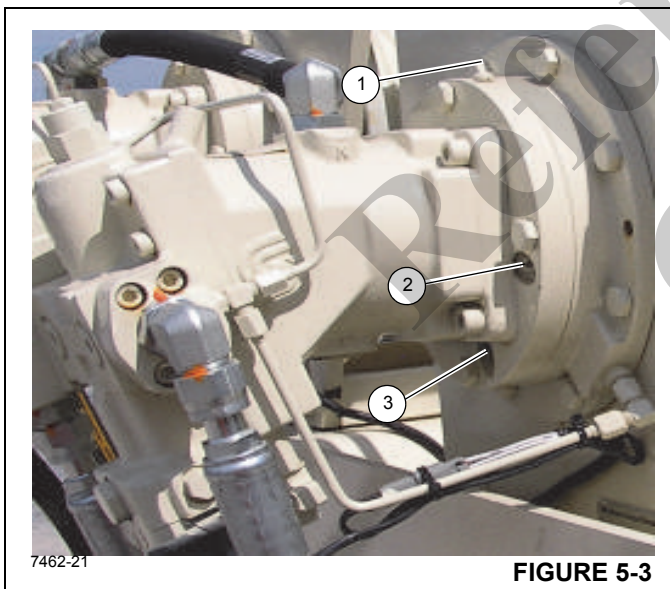
**Drain /Add New Hoist Brake Oil**

To drain and add new oil, remove the drain plug (3, Figure 5-3), inspection plug (2) and vent plug (1) and drain the hydraulic oil. Reinstall drain plug (3) and add fluid at the inspection hole (2), until oil is at the bottom level of the inspection hole. Install the inspection plug and the oil vent (1) and the inspection plug (2). See *Lubrication*, page 5-3. The hoist brake fill capacity is 0.23 liter (.25 quart).

**NOTE:** Hoist brake lubricants are satisfactory for operation in temperatures from -23° C to 66° C (-10° F to +150° F). For operation outside this range, contact Manitowoc Crane Care for recommendations.

**⚠ DANGER**

Do not use EP type gear lubes in the brake section. This may prevent proper operation and cause the load to fall resulting in serious injury or death.

**FIGURE 5-3****Hoist Gearbox Oil****Check hoist gearbox oil level:**

- Rotate the drum until the oil fill/level plug (1, Figure 5-4) is visible in the inspection hole.
- Remove the fill/level plug (1) and visually inspect the oil level. The oil should be level with the bottom of the

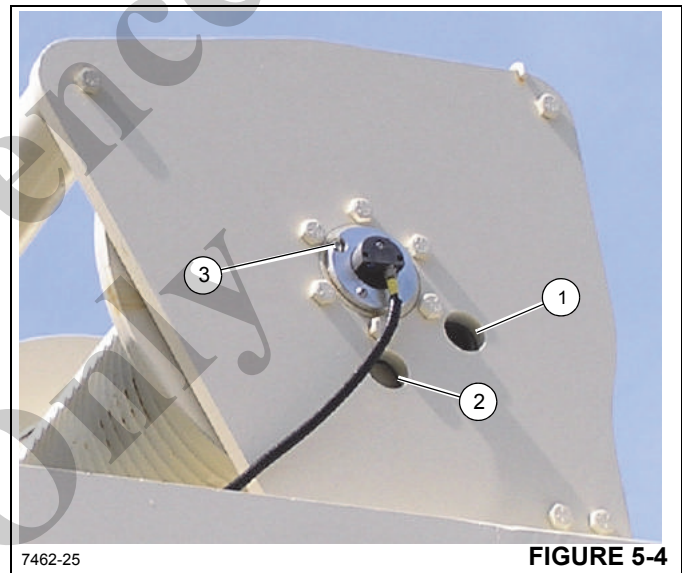
inspection hole. If more oil is needed, add and reinstall fill/level plug.

- To drain and add new oil, remove the vent plug (3, Figure 5-4). Remove the drain plug (2) with a hex head socket and then screw a 1" pipe into the drain plug hole (2) to allow the oil to drain. Drain hydraulic oil. Remove the 1" drain pipe and install drain plug (2).

**Fill hoist gearbox with oil.**

- To fill with oil, rotate the drum so the fill/level port (1, Figure 5-4) is visible through the upper hole. Install a 1" pipe with elbow into the fill hole (1) to assist in adding oil. Remove fill/level plug with a hex socket and fill gear box with 3.3 l (3.50 qt) of gear lube oil. See *Lubrication*, page 5-3.

**NOTE:** Hoist gear lubricants are satisfactory for operation in temperatures from -23° C to 66° C (-10° F to +150° F). For operation outside this range, contact Manitowoc Crane Care for recommendations.

**FIGURE 5-4****Swing Gearbox and Brake Oil****Check Swing Gearbox oil level:**

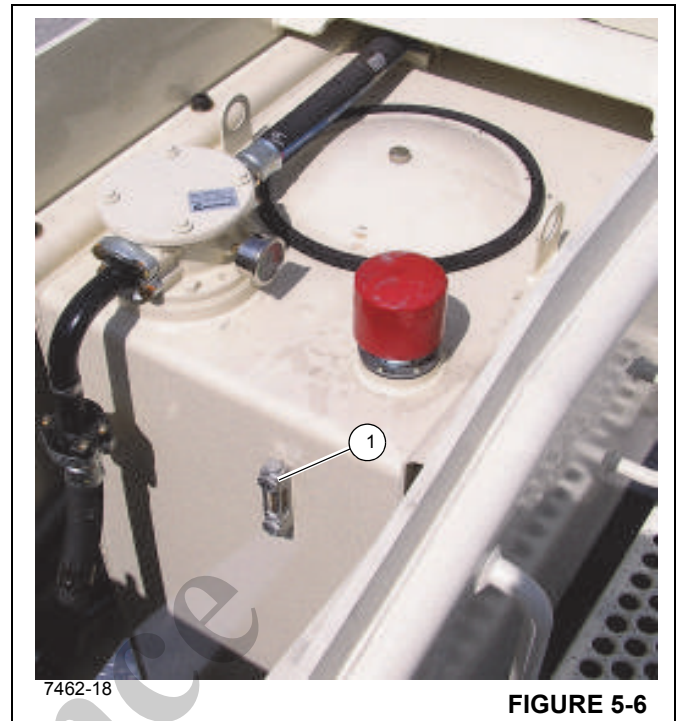
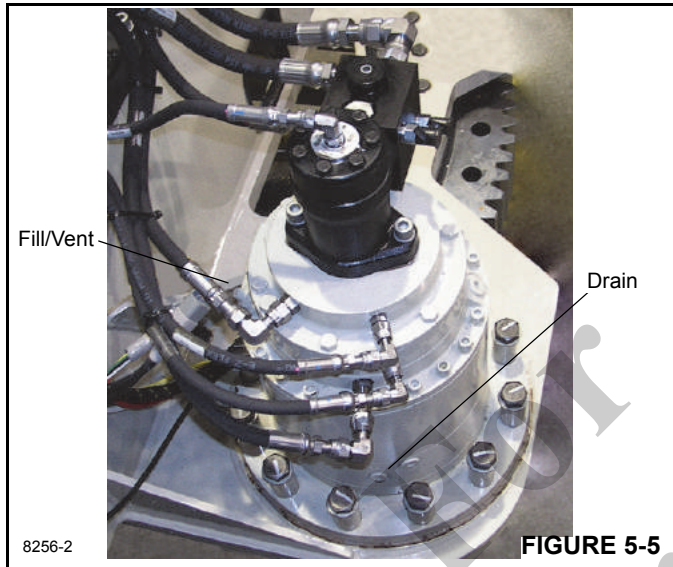
The oil in the gearbox and brake sections is recommended to be changed after first 50 hours of operation and every 1000 hours or 6 months of usage. Gearbox oil is drained by removing the drain plug and vent (See *Figure 5-3*).

1. Examine the used oil for signs of significant metal deposits and then dispose of it in a proper manner.
2. Replace the drain plug.
3. Fill the swing gearbox with the appropriate amount and type of oil and then replace plug and vent. See *Lubrication*, page 5-3 of this manual.



Gearbox oil level inspection is achieved by removing the gearbox fill/vent plug and visually inspecting the oil level. Maximum oil level is to be 1" below the port for this gearbox with 3.3 l (3.50 qt) of gear lube oil.

Gearbox lubricants are satisfactory for standard operation in temperatures from -23° C to 82° C (-10° F to +180° F). For operation outside this range, contact Manitowoc Crane Care for recommendations.



**Hydraulic Oil Reservoir Level**

The hydraulic oil reservoir has a sight gauge (1, Figure 5-6) located on the side of the reservoir. The oil in the hydraulic reservoir is sufficient when the level is between the High and Low marks on the sight gauge with the crane parked on a level surface in the transport position and the oil cold.

If the oil level is too low, add the recommended hydraulic oil until the oil level is even with the upper mark. If the oil level is high, drain oil until the oil level is even with the upper mark.

**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 crane operating temperatures will allow hydraulic oil to warm sufficiently to penetrate these cracks and if cranes are operated daily, protect the rods. Cranes 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 crane 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. cans that can be ordered through the Parts Department.

**NOTE:** Cylinder operation and inclement weather will remove the Boeshield protectant. Inspect cranes once a week and reapply Boeshield to unprotected rods.

## Wire Rope Lubrication

Wire rope is lubricated during manufacture and the lubricant applied does not last the life of the rope. The wire rope must be lubricated as part of a regularly scheduled maintenance program. The lubricant applied must be compatible with the original lubricant and not hinder visual inspection of the rope. Consult the rope manufacturer for proper lubricant. The sections of rope which are located over sheaves or otherwise hidden during inspection and maintenance procedures require special attention.

The object of rope lubrication is to reduce internal friction and to prevent corrosion. The type and amount of lubrication applied during manufacture depends on the rope size, type, and anticipated use. This lubrication provides the finished rope with protection for a reasonable time if the rope is stored under proper conditions. When the rope is put into service, periodic applications of a suitable rope lubricant are necessary. Characteristics of a good wire rope lubricant are that it should be:

- free from acids and alkalis.
- have sufficient adhesive strength to remain on the rope.
- of a viscosity capable of penetrating the interstices between wires and strands.
- not be soluble in the medium surrounding it under the actual operating conditions (example: Water).

- have a high film strength.
- resistant to oxidation.

Before applying lubrication, accumulations of dirt or other abrasive material should be removed from the rope. Clean with a stiff wire brush and solvent, compressed air, or live steam. Lubricate the rope immediately after the rope is cleaned. Techniques that can be used include:

- bath
- dripping
- pouring
- swabbing
- painting
- pressure spray

Whenever possible, the lubricant should be applied at the top of a bend in the rope, because at that point the strands are spread by bending and are more easily penetrated. There should be no load on the rope while it is being lubricated. The service life of wire rope is directly proportional to the effectiveness of the method used and amount of lubricant that reaches the working parts of the rope.

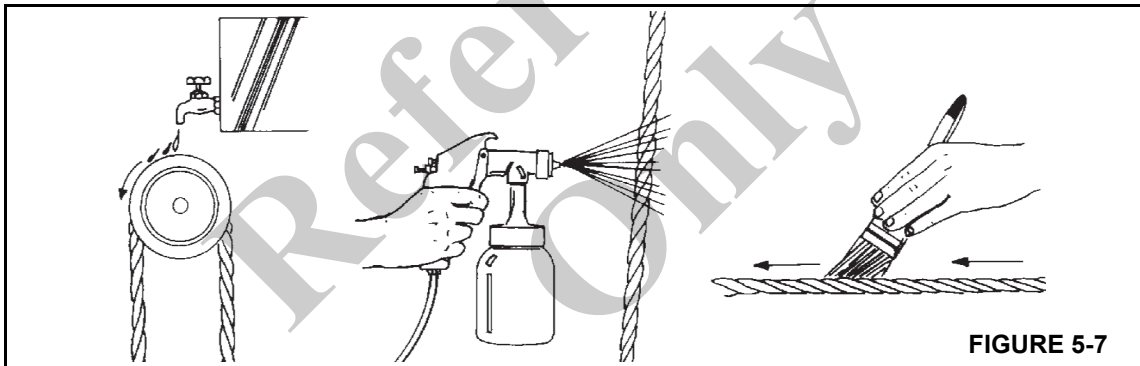


FIGURE 5-7

**CARWELL® RUST INHIBITOR**

**Protecting Cranes From Rusting**

National 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.

National cranes will be 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 National 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 29 CFR 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, National 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 National 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 National cranes, Manitowoc Crane Care recommends washing the crane at least monthly to remove all foreign matter. More frequent cleaning may be needed when operating in harsh environmental conditions. To clean the crane, follow these guidelines:

- High pressure water or steam is effective for cleaning the crane's undercarriage and wheel housings. Keeping these areas clean will not only help retard the effects of corrosion, but will also improve the ability to identify potential issues before they grow into larger problems.

<b>CAUTION</b>
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 of paint using accepted blending techniques. Use of original paint colors is recommended to ensure the best color match possible.

For scratches and marks in areas of low visibility:

- Consider touching up the spots with a brush technique to cover the bare metal. This will retard 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:** Crane must be completely dry before applying treatment.

- Do not allow product to puddle or build-up on weather stripping, rubber gaskets, etc. Crane should not have puddles or runs evident anywhere.
- To ensure proper coverage of treatment, the product needs to be fogged on the crane.
- Use of pressure pots to apply the treatment to the crane 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 5-8

- The underside of the crane 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 ends and fittings, swivel, pumps, axles, drivelines, 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 ends 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 ends 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.

For  
Reference  
Only



<b>Item</b>	<b>Description</b>
1	Counterweight Pins
2	Hoist Plumbing Connections
3	Tension Spring
4	Pivot Shaft
5	Valve bank, Hose Connections inside turntable
6	Wire Rope
7	Boom Nose Pins, Clips
8	All Hardware, Clips, Pins, Hose Connections not painted O/R Pins, Clips
9	Headache Ball/Hook block

<b>Item</b>	<b>Description</b>
10	Headache Ball/Hook Block Tiedown
11	Mirror Mounting Hardware
12	Powertrain Hardware
13	O/R Hose Connections
14	O/R Pins, Clips
15	Entire underside of crane
16	Turntable Bearing Fasteners
17	Outrigger Beam Hardware
18	Boom Extension Hardware (Optional)

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## SECTION 6 MAINTENANCE CHECKLIST

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### CRANE INSPECTION AND MAINTENANCE

Regularly scheduled inspection and maintenance intervals are required to keep the crane in peak operating condition. The following pages outline the inspection and maintenance intervals.

Refer to the Service Manual for complete instructions on performing maintenance on this crane.



**DANGER**

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

#### Inspections

The inspection intervals listed below are to be conducted on the crane to ensure safe and proper operation. If replacing a missing fastener or tightening a loose fastener, refer to the applicable torque chart in Section 1 of the Service Manual. Should a defect be found, a determination must be made as to whether the deficiency is a safety hazard or though not yet a safety hazard, needs to be monitored in the monthly inspections.

The inspections are separated into the following frequency classifications:

- Daily inspections - performed by the operator at the start of the day.
- Weekly inspections - performed by the operator.
- Monthly inspections - performed by maintenance personnel.
- Periodic inspections - performed by maintenance personnel at least every three months and includes all items listed under daily, weekly, and monthly inspections. Federal Laws through OSHA and ANSI B30.5 require that dated and signed records of these periodic inspections be kept. An inspection log book is available from National Crane.



**WARNING**

If any defect determined during the inspection is a safety hazard the crane must be removed from service and the defect corrected.

#### Daily Inspections/Pre-use

Check the following items:

1. Engine oil level.
2. Hydraulic oil level.
3. Radiator coolant level.

4. Loose parts or damage to structures or welds.
5. Operation of lights, safety equipment and gauges.
6. Condition of tires and suspension.
7. Condition of hoist rope and end attachment for corrosion, severe kinking, crushing, cutting, or slippage of cable clamps or wedge socket.
8. Loose parts or damage to cable hook blocks.
9. Position of cable with guides and on sheaves.
10. Free turning of sheaves.
11. Lubrication as specified by the Lubrication Chart.
12. Evidence of oil leaks from hoses, gearboxes, or swivel.
13. Hand and foot controls for malfunction or incorrect adjustment.
14. Truck parking brake operation.
15. Boom proportioning to insure that all boom sections extend and retract equally.
16. All securing hardware such as cotter pins, snap rings, hairpins, pin keepers, and capscrews for proper installations.
17. Proper condition and operation of RCL and anti-two block systems to include the anti-two block switch weight and chain at the boom tip (and jib tip if equipped), power cords, audible alarms, and indicator lights on the console.
18. Proper operation of the load hook safety latch.
19. Hooks and latches for excessive wear, cracks or damage from heat or chemicals.
20. Drain holes at rear of the first section of the boom are clear of all obstructions.
21. All fasteners retaining the cable retainers are in place and tight.
22. All safety covers for proper installation.
23. Boom lift and outrigger holding valves for proper operation.
24. Hoist brake for proper operation at hoist capacity load.
25. Control and drive mechanisms for excessive wear and/ or contamination from lubricants, water or other foreign matter.

**Weekly Inspections**

Check the following items:

1. Battery water level.
2. Tire pressure.
3. Lubrication as specified by the Lubrication Chart.

4. Torque the T-box mounting bolts during the first month of operation and periodic inspections thereafter.
5. Torque the swing bearing mounting bolts during the first month of operation and periodic inspections thereafter.
6. Torque the boom wear pad retaining bolts during first month of operation, and monthly thereafter.
7. Check to see that crane Operation Manual is with the crane. If the manual is missing, obtain the serial number of the crane and order an operation manual immediately.

**Monthly Inspections**

Check the following items:

1. All cylinders and valves for improper operation or signs of leaks.
2. Lubrication as specified by the Lubrication Chart.
3. Load hook for cracks or having more than 15 percent normal throat opening or 10 degree twist.
4. All structural members (boom, sub-base, frame, turret, and outriggers) for bends, cracks, or broken members.
5. All welds for breaks or cracks.
6. All pins for proper installation.
7. All control, safety, and capacity placards for readability and secure attachment.
8. Torque of cable clip bolts above wedge socket at end of loadline should be 95 ft-lb.
9. All boom wear pad retaining bolts.
10. Boom extension cables for proper tension or evidence of abnormal wear.
11. Sheaves and cable drums for wear and cracks.
12. Unwind the loadline and check according to cable maintenance procedure.

**Periodic/Annual Inspection**

Check the following items:

1. All items listed under daily, weekly, and monthly inspections.
2. Loose bolts and fasteners in all areas. Torque pin retainer bolts.
3. All pins, bearings, shafts, and gears for wear cracks or distortion to include all pivot, outriggers and sheave pins, and bearings.
4. Boom angle and boom length indicator for accuracy over full range.
5. Hydraulic systems for proper operating pressure.
6. Outrigger pads for excessive wear or cracks.

7. Cylinders for:
  - a. Damaged rods
  - b. Dented barrels
  - c. Drift from oil leaking by piston
  - d. Leaks at rod seals, welds, or holding valves.
8. PTO drive line system for proper alignment, lubrication and tightness.
9. Hydraulic hose and tubing for evidence of damage such as blistering, crushing, or abrasion.
10. Top and bottom wear pads for excessive wear.
11. Inspect all electrical wires and connections for worn, cut or deteriorated insulation and bare wire. Replace or repair wires as required.
12. Extend and retract cables, sheaves, pins, and bearings for wear or abrasion.
13. Main frame and jack mount bolts for proper torque (see Torque Chart).
14. Rotation bearing and gearbox mounting bolts for proper torque (see Torque Chart).
15. Missing or unreadable warning labels.
16. Missing or unusable/unsafe condition of steps, ladders, handrails, guards or seat.

**Special Boom Inspection**

If the boom has not been disassembled and inspected in the last five years or 3,000 hours of use, the boom is to be completely torn down to allow a thorough inspection of the extend and retract cables, sheaves, and pins.

**Stability**

Stability of crane throughout working area. Check the stability procedure in Installation Section of the Service Manual annually or when any changes are made to crane or truck.

**HOIST ROPE INSPECTION AND MAINTENANCE**

**▲ WARNING**

**Worn or Damaged Equipment Hazard!**

Never use a worn or damaged hoist rope. Death or serious injury could result from using worn or damaged hoist rope.

Rope should be inspected frequently/daily and periodically/ yearly in accordance with the following information excerpted from a National Consensus Standard as referenced by Federal Government Agencies. Recommended inspection intervals may vary from crane to crane and may vary based on environmental conditions, frequency of lifts, and exposure to shock loads. The inspection time intervals may also be predetermined by state and local regulatory agencies.

**NOTE:** Rope may be purchased through Manitowoc Crane Care.

Any deterioration observed in the rope should be noted in the equipment inspection log and an assessment concerning rope replacement should be made by a qualified person.

**Keeping Records**

A signed and dated report of the rope’s condition at each periodic inspection must be kept on file at all times. The report must cover all inspection points listed in this section. The information in the records can then be used to establish data which can be used to determine when a rope should be replaced.

It is recommended that the rope inspection program include reports on the examination of rope removed from service. This information can be used to establish a relationship between visual inspection and the rope’s actual internal condition at the time of removal from service.

**Environmental Conditions**

The life expectancy of rope may vary due to the degree of environmental hostility and other conditions to which these mechanical devices are subjected. Variation in temperature, continuous excessive moisture levels, exposure to corrosive chemicals or vapors or subjecting the rope to abrasive material may shorten normal rope life. Frequent/periodic inspections and maintenance of rope is recommended for preventing premature wear and to insure long-term satisfactory performance.

**NOTE:** Refer to *Wire Rope Lubrication*, page 5-10 for wire rope lubrication requirements.

**Dynamic Shock Loads**

Subjecting rope to abnormal loads beyond the endurance limit will shorten the rope life expectancy. Examples of this type of loading are listed below.

- High velocity movement, for example; hoisting or swinging of a load followed by abrupt stops.
- Suspending loads while traveling over irregular surfaces such as railroad tracks, potholes, and rough terrain.
- Lifting a load that is beyond the rated capacity of the lifting mechanism, such as overloading.

### Precautions and Recommendations During Inspection

- Always use safety glasses for eye protection.
- Wear protective clothing, gloves, and safety shoes as appropriate.
- Measure the rope's diameter across crowns of the strands when determining if rope has become damaged, refer to Figure 6-1.

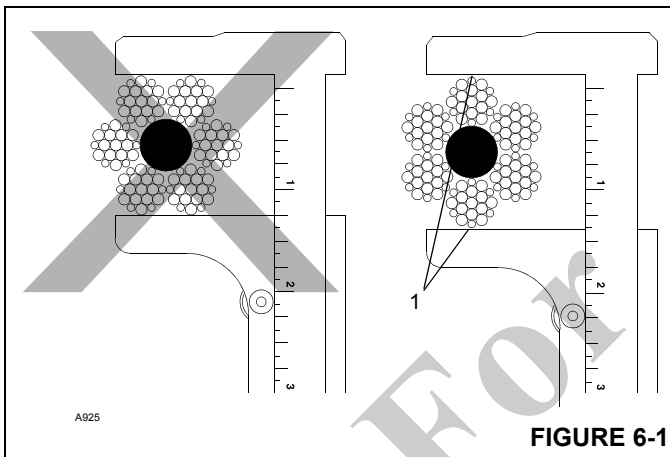


FIGURE 6-1

### Inspection

All hoist rope in service needs to be inspected on a daily, monthly, and quarterly basis. Cable which has been idle for a period of a month or more must be given a thorough inspection before it is placed in service. These inspections should cover all types of deterioration including:

- Distortion such as kinking, crushing, un-stranding, bird caging, main strand displacement or core protrusion.
- Loss of cable diameter in a short cable length or unevenness of outer strands indicates the cable needs to be replaced.
- Significant corrosion.
- Broken or cut strands.
- Number, distribution and type of visible broken wires.
- Core failure in rotation resistant ropes.
- Prior electrical contact with a power line or other electric arc damage.
- Significantly corroded, cracked, bent, or worn end connections.

Only inspect the outer surface of a cable. Never attempt to open the cable.

Pay particular attention to areas of the rope where wear and other damage is likely to occur:

- Pick-up Points: Sections of rope that are repeatedly stressed during each lift, such as those sections in contact with sheaves.
- End Attachments: The point where a fitting is attached to the wire rope or the point where the wire rope is attached to the hoist drum.
- Abuse Points: The point where the rope is subjected to abnormal scuffing and scraping.

### Daily Inspections

All cable in continuous service must be inspected at the beginning of each work day. Inspect the wedge socket and length of cable that is used in daily operation. The end should be inspected for abrasion, corrosion, broken wires, and loose or broken servings. Inspect the remainder of the cable length used for daily operations for points showing kinks, sharp bends, or any other evidences of damage or excessive wear.

### Monthly Inspections

Inspect the wedge socket and length of cable normally used in daily operations. Examine the rest of the cable for kinked, crushed or otherwise damaged points.

### Periodic Inspections

Rope should be inspected periodically/annually, or at a shorter time interval, if necessitated by environmental or other adverse conditions, and shall cover the entire length of the rope. Periodic inspection should include all previous items listed under Inspection, plus the following:

- Inspect for severely corroded or broken wires at end connections.
  - Reduction of rope diameter below nominal diameter.
- Inspect rope in areas subjected to rapid deterioration such as:
  - Sections in contact with saddles, equalizer sheaves, or other sheaves where rope travel is limited.
  - Sections of wire rope at or near terminal ends where corroded or broken wires may protrude.
  - Sections in contact with stationary surfaces where abrasion or chafing may take place as a result of equipment vibration.
- Inspect boom nose sheaves, hook block sheaves, jib/extension sheaves, auxiliary boom nose sheaves, and hoist drums for wear. Damaged sheaves or hoist drums can accelerate wear and cause rapid deterioration of the rope.

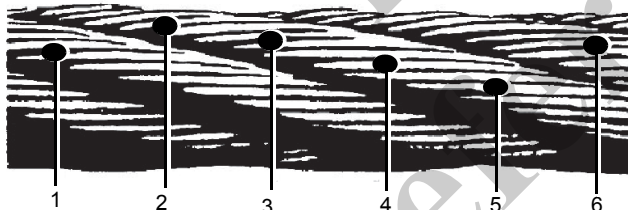
Inspect the wedge socket of the cable for greater wear than the rest of the cable. If the cable is in good condition, reverse

the cable on the drum so that the wear is equalized along the total length of the cable.

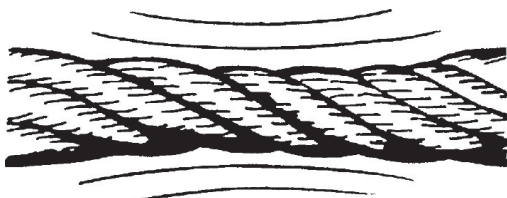
### Wire Rope Replacement

No precise rules can be given for determination of the exact time for replacement of wire rope since many variable factors are involved. Determination regarding continued use or replacement of wire rope depends largely upon the good judgement of an appointed and qualified person who evaluates the remaining strength in a used rope after allowance for any deterioration disclosed by inspection.

- 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 Manitowoc. 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:
- Six randomly distributed broken wires in one rope lay or three broken wires in one strand in one lay. The rope is unsafe for further use if there are either three broken wires in one strand (Breaks 2, 3, 4) or a total of six broken wires in all strands in any one lay.



- In rotation resistant ropes: two randomly distributed broken wires in six rope diameters or four randomly distributed broken wires in 30 rope diameters
- Wear of one-third the original diameter of outside individual wires. Worn rope, usually indicated by flat spots on the outer wires is unsafe for further use when less than two-thirds the thickness of the outer wire remains.
- Necking down of the rope indicates core failure.



- Kinking, crushing, bird caging, or any other damage resulting in distortion of the rope structure.
- Evidence of heat damage.
- Reductions from nominal diameter of more than 5%:

- .4 mm (0.0156 in) for rope diameters to 8 mm (0.313 in)
- .8 mm (0.031) for rope diameters 9.5 mm (0.375 in) to 0.50 in (12.7 mm)
- 1.2 mm (0.047 in) for rope diameters 14.3 mm (0.561 in) to 19.1 mm (0.75 in)
- 1.6 mm (0.063) for rope diameters 22.2 mm (0.875 in) to 28.6 mm (1.125 in).
- One outer wire broken at its point of contact with the core of the rope which has worked its way out of, and protrudes or loops out from the rope structure.
- Manitowoc recommends that for cable extended booms, a single damaged wire rope assembly shall require replacement of the complete set of extension cables.
- Manitowoc recommends that boom extension cables be replaced every seven (7) years.

### Care of Wire Rope

Handle wire rope with care to prevent damage to the individual wires which affect the overall strength and performance of the rope. Do not allow the formation of kinks, because this displaces the strands of wire from their original position and relation to each other causing severe bending and unequal tensions in the strands. This distortion and wire displacement cannot be corrected even under high tension and a permanent weak point remains in the rope. Displaced or raised wires indicate a previous kink, but does not show the damaged condition of the inner rope wires.

Never pull wire rope over a non-rotating support such as a spindle bar, a pin, or an inoperative sheave. This practice causes severe abrasion to the outer strand wires. A properly operating sheave or snatch block is essential to safety and long service life of the rope.

Do not use worn sheaves or sheaves with flat grooves because they do not provide sufficient support to prevent the distortion and flattening of the rope. Sheaves with nicked or broken flanges can cut or otherwise damage the rope.

An even distribution of rope coils over the hoist drum is essential to smooth operation. This prevents the rope from cutting down through or crushing other coils on the drum resulting in damage to and difficulty in unwinding the rope.

### REPLACEMENT ROPE

If the hoist rope needs to be replaced, care should be taken in selecting a suitable replacement cable. The cable strength requirements are shown on the crane load chart. The types of cable are optional with 6 x 25 and Dyform being the most common. A high strength, rotation resistant cable is preferred and is furnished as standard by National Cranes. This cable eliminates single part line load spin and prolongs

cable life. It also eliminates load block spin up when multi-part reeving is used.

<b>Standard</b>
14.3mm (9/16 in.) Dia. Wire cable: Rotation Resistant
18X25 Nominal Breaking Strength: 17,463 kg (19.25 Tons)
<b>Optional</b>
14.3mm (9/16 in.) Dia. Wire cable: 6X25 General Purpose
6X25 Nominal Breaking Strength: 15,241 kg (16.8 tons)

**CRANE ADJUSTMENTS AND REPAIRS**

Before adjustments and repairs are started on a crane, read and be familiar with the safety information outlined under “Safety Precautions” on page 2-1.

**Boom Extension Cable**

If a cable replacement is required for the boom extension system, the replacement cable must be obtained through the Manitowoc Crane Care. Cables are pre-stretched and have special connections for proper operation.

**NOTE:** Manitowoc Cranes recommends for cable extended booms, that boom extension cables be replaced every seven (7) years.

**Jib Jack Service and Maintenance**

Important: Use only a good grade hydraulic jack oil, transmission oil, or turbine oil. Avoid mixing types of oil. Do not use brake fluid, alcohol, glycerin, detergent motor oil, or dirty oil. Improper fluid can cause serious internal damage to the jack rendering it inoperative.

**Adding Oil to the Jib Jack**

To add oil to the jib jack, do the following:

1. Set the jack in an upright level position.
2. Lower the saddle and make sure the piston is fully depressed.
3. Remove the oil filler plug.
4. Fill until the oil is level with the filler plug hole.

**Changing the Jib Jack Oil**

For best performance and longest life, replace the oil at least once a year. To change oil, do the following:

1. Remove the filler plug.
2. Lay the jack on its side and drain the oil into a suitable drain pan. The oil will run slowly because air must enter as oil drains out.
3. Be careful to prevent dirt or foreign matter from entering the system.
4. Replace with proper oil as described above.

**Lubrication**

Add proper lubrication oil to all pivoting sections every three months.

**Rust Prevention**

Check the ram every three months for any sign of rust or corrosion. Clean as needed and wipe with an oil saturated cloth.

**NOTE:** When not in use, always leave the saddle and ram all the way down.

**HYDRAULIC SYSTEM**

**Oil Cooler**

The heat exchanger must be kept clean for efficient operation of the hydraulic cooler system. Wash the heat exchanger core frequently to eliminate oil film, road dirt, and other foreign object buildup on the heat exchanger fins.

Frequent inspection and tightening of hose clamp eliminates the possibility of end connection failure due to back pressure from a cold startup.

If the cooler system fails to provide adequate performance, reduced air or oil flow through the heat exchanger is the probable cause. Inspect the cooling fan for proper operation. Any obstructions to air flow should be corrected (cooler too close to other truck components, foreign matter in heat exchanger fins, etc.) All hydraulic lines should be periodically checked for obstructions, hose kinks or other flow restrictions.

**TIRE LOAD AND INFLATION TABLE**

Definite tire inflation pressures are established for each tire size depending upon the load imposed on the tires. For greater stability, riding comfort and prolonged tire life, tires should be inflated for the loads carried. The "Load and inflation Table" shown below indicates the proper inflation pressure.

**NOTE:** The values in the tables below are as published by the Tire and Rim Association 2005. Your vehicle may be equipped with other tire sizes or the same size tires rated differently. Always check the tire sidewalls to verify the maximum capacity and inflation. Inflation pressure and loading must not exceed the values shown on the wheel or rim.

**Tire and Load Inflation Tables**

Letters in parenthesis denote the load range for which the bold face loads are a maximum. International load index numbers are shown after the load range. The load range letters and corresponding ply rating are shown below.

**D = 8 ply • E = 10 ply • F = 12 ply • G = 14 ply**  
**H = 16 ply • J = 18 ply • L = 20 ply • M = 22 ply • N = 24 ply**

**Radial Ply Metric Tires for Trucks, Busses, and Trailers Used in Normal Highway Service**

Radial Ply Tires Mounted on 15° Drop Center Rims

Tire and Rim Association Standard

**TABLE TBM-2R**

		TIRE LOAD LIMITS (kg/lbs.) AT VARIOUS COLD INFLATION PRESSURES (kPa/psi)											
TIRE SIZE DESIGNATION	USAGE	450	480	520	550	590	620	660	690	720	760	790	830
		65	70	75	80	85	90	95	100	105	110	115	120
295/60R22.5	DUAL	1750 3860	1830 4040	1930 4245	2000 4410	2030 4480	2120 4665	2240 4940	2280 5025	2360 5195	2430 5355	2510 5535	2575(H) <sup>141</sup> 5675(H)
	SINGLE	1850 4080	1950 4300	2050 4515	2120 4675	2230 4925	2330 5125	2430 5355	2500 5520	2590 5710	2650 5840	2760 6085	2800(H) <sup>144</sup> 6175(H)
225/70R19.5	DUAL	<b>1180(D)</b> <sup>114</sup> <b>2600(D)</b> <sup>114</sup>	1230 2720	1300 2860	<b>1360(E)</b> <sup>119</sup> <b>3000(E)</b> <sup>119</sup>	1410 3115	1470 3245	<b>1550(F)</b> <sup>123</sup> <b>3415(F)</b> <sup>123</sup>	1580 3490	1640 3615	<b>1700(G)</b> <sup>126</sup> <b>3750(G)</b> <sup>126</sup>		
	SINGLE	<b>1250(D)</b> <sup>116</sup> <b>2755(D)</b> <sup>116</sup>	1310 2895	1380 3040	<b>1450(E)</b> <sup>121</sup> <b>3195(E)</b> <sup>121</sup>	1500 3315	1570 3450	<b>1650(F)</b> <sup>125</sup> <b>3640(F)</b> <sup>125</sup>	1690 3715	1740 3845	<b>1800(G)</b> <sup>128</sup> <b>3970(G)</b> <sup>128</sup>		
245/70R19.5	DUAL				1550 3415	1590 3515	1660 3655	<b>1750(F)</b> <sup>127</sup> <b>3860(F)</b> <sup>127</sup>	1790 3940	1850 4075	<b>1950(G)</b> <sup>131</sup> <b>4300(G)</b> <sup>131</sup>	1970 4345	<b>2060(H)</b> <sup>133</sup> <b>4540(H)</b> <sup>133</sup>
	SINGLE				1650 3640	1700 3740	1770 3890	<b>1850(F)</b> <sup>129</sup> <b>4080(F)</b> <sup>129</sup>	1900 4190	1970 4335	<b>2060(G)</b> <sup>133</sup> <b>4540(G)</b> <sup>133</sup>	2095 4620	<b>2180(H)</b> <sup>135</sup> <b>4805(H)</b> <sup>135</sup>
265/70R19.5	DUAL				1700 3750	1780 3930	1860 4095	1950 4300	2000 4405	2000 4415	<b>2120(G)</b> <sup>134</sup> <b>4675(G)</b> <sup>134</sup>		
	SINGLE				1800 3970	1900 4180	1970 4355	2060 4540	2130 4685	2200 4850	<b>2300(G)</b> <sup>137</sup> <b>5070(G)</b> <sup>137</sup>		
305/70R19.5	DUAL				2060 4540	2120 4670	2200 4860	2300 5070	2370 5230	2450 5410	<b>2575(H)</b> <sup>141</sup> <b>5675(H)</b> <sup>141</sup>	2620 5770	<b>2725(J)</b> <sup>143</sup> <b>6005(J)</b> <sup>143</sup>
	SINGLE				2240 4940	2330 5130	2420 5340	2500 5510	2610 5745	2700 5945	<b>2800(H)</b> <sup>144</sup> <b>6175(H)</b> <sup>144</sup>	2870 6340	<b>3000(J)</b> <sup>146</sup> <b>6610(J)</b> <sup>146</sup>

**Radial Ply Metric Tires for Trucks, Busses, and Trailers Used in Normal Highway Service**  
 Radial Ply Tires Mounted on 15° Drop Center Rims  
 Tire and Rim Association Standard

TABLE TBM-2R  
Continued

TIRE SIZE DESIGNATION	USAGE	TIRE LOAD LIMITS (kg/lbs.) AT VARIOUS COLD INFLATION PRESSURES (kPa/psi)											
		450 65	480 70	520 75	550 80	590 85	620 90	660 95	690 100	720 105	760 110	790 115	830 120
255/70R22.5	DUAL				1800 3970	1860 4110	1940 4275	2000 4410	2020 4455	2090 4610	2120(G) <sup>134</sup> 4675(G)	2230 4915	2300(H) <sup>137</sup> 5070(H)
	SINGLE				1900 4190	1980 4370	2060 4550	2120 4675	2220 4895	2300 5065	2360(G) <sup>138</sup> 5205(G)	2450 5400	2500(H) <sup>140</sup> 5510(H)
305/75R22.5	DUAL				2360 5205	2440 5375	2540 5595	2560 5840	2730 6025	2830 6235	3000(H) <sup>146</sup> 6610(H)	3010 6640	3150(J) <sup>148</sup> 6940(J)
	SINGLE				2575 5675	2680 5905	2790 6150	2900 6395	3000 6620	3110 6850	3250(H) <sup>149</sup> 7160(H)	3310 7300	3450(J) <sup>151</sup> 7610(J)
315/80R22.5	DUAL				2575 5675	2650 5840	2750 6070	2900(G) <sup>145</sup> 6395(G)	2970 6545	3070 6770	3150(H) <sup>148</sup> 6940(H)	3270 7210	3450(J) <sup>151</sup> 7610(J)
	SINGLE				2800 6175	2910 6415	3030 6670	3150(G) <sup>148</sup> 6940(G)	3260 7190	3370 7440	3450(H) <sup>151</sup> 7610(H)	3590 7920	3750(J) <sup>154</sup> 8270(J)
305/85R22.5	DUAL				2430 5355	2520 5550	2620 5780	2725 6005	2820 6215	2920 6435	3075(H) <sup>147</sup> 6780(H)	3110 6860	3250(J) <sup>149</sup> 7160(J)
	SINGLE				2650 5840	2770 6100	2880 6350	3000 6610	3100 6830	3210 7070	3350(H) <sup>150</sup> 7390(H)	3420 7540	3550(J) <sup>152</sup> 7830(J)

**Radial Ply Metric Tires for Trucks, Busses, and Trailers Used in Normal Highway Service**  
 Radial Ply Tires Mounted on 15° Drop Center Rims  
 Tire and Rim Association Standard

TABLE TBM-1R

TIRE SIZE DESIGNATION	USAGE	kPa psi	TIRE LOAD LIMIT AT VARIOUS COLD INFLATION PRESSURES										
			480 70	520 75	550 80	590 85	620 90	660 95	690 100	720 105	760 110	790 115	830 120
245/75R22.5 235/80R22.5	DUAL	kg lbs.	1430 3160	1500 3315	1600 3525	1640 3615	1710 3765	1800 3970	1840 4055	1900 4195	1950(G) <sup>131</sup> 4300(G)		
	SINGLE	kg lbs.	1570 3470	1650 3645	1750 3860	1800 3975	1880 4140	1950 4300	2020 4455	2090 4610	2120(G) <sup>134</sup> 4675(G)		
265/75R22.5 255/80R22.5	DUAL	kg lbs.	1600 3525	1680 3705	1750 3860	1830 4040	1910 4205	2000 4410	2050 4525	2130 4685	2180(G) <sup>135</sup> 4805(G)		
	SINGLE	kg lbs.	1760 3875	1850 4070	1950 4300	2010 4440	2100 4620	2180 4805	2260 4975	2340 5150	2360(G) <sup>138</sup> 5205(G)		
295/75R22.5 275/80R22.5	DUAL	kg lbs.	1860 4095	1950 4300	2060 4540	2130 4690	2220 4885	2300(F) <sup>137</sup> 5070(F)	2390 5260	2470 5440	2575(G) <sup>141</sup> 5675(G)	2630 5795	2725(H) <sup>143</sup> 6005(H)
	SINGLE	kg lbs.	2040 4500	2140 4725	2240 4940	2340 5155	2440 5370	2500(F) <sup>140</sup> 5510(F)	2620 5780	2710 5980	2800(G) <sup>144</sup> 6175(G)	2890 6370	3000(H) <sup>146</sup> 6610(H)
285/75R24.5 275/80R24.5	DUAL	kg lbs.	1870 4135	1970 4340	2060 4540	2150 4740	2240 4930	2360(F) <sup>138</sup> 5205(F)	2410 5310	2490 5495	2575(G) <sup>141</sup> 5675(G)	2660 5860	2800(H) <sup>144</sup> 6175(H)
	SINGLE	kg lbs.	2060 4545	2160 4770	2240 4940	2360 5210	2460 5420	2575(F) <sup>141</sup> 5675(F)	2650 5835	2740 6040	2800(G) <sup>144</sup> 6175(G)	2920 6440	3075(H) <sup>147</sup> 6780(H)



**Metric Wide Base Tires for Trucks, Busses, and Trailers Used in Normal Highway Service**  
 Tires Used as Singles Mounted on 15° Drop Center Rims  
 Tire and Rim Association Standard

TABLE MWB-1 Tire Load Limits at Various Cold Inflation Pressures

TIRE SIZE DESIGNATION	kPa psi	480 70	520 75	550 80	590 85	620 90	660 95	690 100	720 105	760 110	790 115	830 120
445/65R19.5	kg lbs.	3410 7540	3610 7930	3750 8270	3960 8680	4100 9040	4250 9370	4410 9730	4540 10100	4750(J) 10500(J) <sup>162</sup>		
385/65R22.5	kg lbs.	2880 6380	3060 6720	3150 6940	3350 7350	3470 7650	3650 8050	3740 8230	3850 8510	4000 8820	4100 9050	4250(J) 9370(J) <sup>158</sup>
425/65R22.5	kg lbs.	3430 7590	3640 7990	3750 8270	3980 8740	4130 9100	4250 9370	4440 9790	4580 10100	4750(J) 10500(J) <sup>162</sup>	4880 10700	5000(L) 11000(L) <sup>164</sup>
445/65R22.5	kg lbs.	3720 8230	3950 8660	4125 9090	4320 9480	4470 9870	4625(H) 10200(H) <sup>161</sup>	4820 10600	4960 11000	5150 11400	5290 11700	5600(L) 12300(L) <sup>168</sup>

**Radial Ply Tires for Trucks, Busses, and Trailers Used in Normal Highway Service**  
 Radial Ply Tires Mounted on 15° Drop Center Rims  
 Tire and Rim Association Standard

TABLE TTB-3R TIRE LOAD LIMITS (kg/lbs.) AT VARIOUS COLD INFLATION PRESSURES (kPa/psi)

TIRE SIZE DESIGNATION	USAGE	480 70	520 75	550 80	590 85	620 90	660 95	690 100	720 105	760 110	790 115	830 120
8R19.5	DUAL	1120 2460	1170 2570	1215(D) <sup>115</sup> 2680(D)	1260 2785	1310 2890	1360(E) <sup>119</sup> 3000(E)	1410 3100	1460 3200	1500(F) <sup>122</sup> 3305(F)		
	SINGLE	1150 2540	1220 2680	1285(D) <sup>117</sup> 2835(D)	1340 2955	1400 3075	1450(E) <sup>121</sup> 3195(E)	1500 3305	1550 3415	1600(F) <sup>124</sup> 3525(F)		
8R22.5	DUAL	1250 2750	1300 2870	1360(D) <sup>119</sup> 3000(D)	1410 3100	1460 3200	1500(E) <sup>122</sup> 3305(E)	1570 3455	1640 3605	1700(F) <sup>126</sup> 3750(F)		
	SINGLE	1290 2840	1360 2990	1450(D) <sup>121</sup> 3195(D)	1500 3305	1550 3415	1600(E) <sup>124</sup> 3525(E)	1670 3675	1740 3825	1800(F) <sup>128</sup> 3970(F)		
9R22.5	DUAL	1480 3270	1550 3410	1610 3550	1670 3690	1750(E) <sup>127</sup> 3860(E)	1820 4005	1890 4150	1950(F) <sup>131</sup> 4300(F)	2010 4425	2070 4550	2120(G) <sup>134</sup> 4675(G)
	SINGLE	1530 3370	1610 3560	1690 3730	1760 3890	1850(E) <sup>129</sup> 4080(E)	1920 4235	1990 4390	2060(F) <sup>133</sup> 4540(F)	2120 4675	2180 4810	2240(G) <sup>136</sup> 4940(G)
10R22.5	DUAL	1750 3860	1830 4045	1910 4230	2000(E) <sup>132</sup> 4410(E)	2080 4585	2160 4760	2240(F) <sup>136</sup> 4940(F)	2300 5075	2360 5210	2430(G) <sup>139</sup> 5355(G)	
	SINGLE	1850 4080	1940 4280	2030 4480	2120(E) <sup>134</sup> 4675(E)	2200 4850	2280 5025	2360(F) <sup>138</sup> 5205(F)	2430 5360	2500 5515	2575(G) <sup>141</sup> 5675(G)	
11R22.5	DUAL	1990 4380	2080 4580	2160 4760	2250 4950	2360(F) <sup>138</sup> 5205(F)	2460 5415	2560 5625	2650(G) <sup>142</sup> 5840(G)	2680 5895	2710 5950	2725(H) <sup>143</sup> 6005(H)
	SINGLE	2050 4530	2160 4770	2260 4990	2370 5220	2500(F) <sup>140</sup> 5510(F)	2600 5730	2700 5950	2800(G) <sup>144</sup> 6175(G)	2870 6320	2940 6465	3000(H) <sup>146</sup> 6610(H)
11R24.5	DUAL	2110 4660	2210 4870	2300 5070	2390 5260	2500(F) <sup>140</sup> 5510(F)	2580 5675	2660 5840	2725(G) <sup>143</sup> 6005(G)	2820 6205	2910 6405	3000(H) <sup>146</sup> 6610(H)
	SINGLE	2190 4820	2300 5070	2410 5310	2520 5550	2650(F) <sup>142</sup> 5840(F)	2770 6095	2890 6350	3000(G) <sup>146</sup> 6610(G)	3080 6790	3160 6970	3250(H) <sup>149</sup> 7160(H)
12R22.5	DUAL	2170 4780	2260 4990	2350 5190	2440 5390	2575(F) <sup>141</sup> 5675(F)	2630 5785	2680 5895	2725(G) <sup>143</sup> 6005(G)	2840 6265	2960 6525	3075(H) <sup>147</sup> 6780(H)
	SINGLE	2240 4940	2360 5200	2470 5450	2580 5690	2725(F) <sup>143</sup> 6005(F)	2820 6205	2910 6405	3000(G) <sup>146</sup> 6610(G)	3120 6870	3240 7130	3350(H) <sup>150</sup> 7390(H)
12R24.5	DUAL	2300 5080	2400 5300	2500 5520	2600 5730	2650(F) <sup>142</sup> 5840(F)	2770 6095	2890 6350	3000(G) <sup>146</sup> 6610(G)	3080 6790	3160 6970	3250(H) <sup>149</sup> 7160(H)
	SINGLE	2380 5240	2500 5520	2630 5790	2740 6040	2900(F) <sup>145</sup> 6395(F)	3020 6650	3140 6910	3250(G) <sup>149</sup> 7160(G)	3350 7380	3450 7600	3550(H) <sup>152</sup> 7830(H)

**SPECIFICATIONS**

**Hydraulic**

Hydraulic Pump .....	286 l/min (75.5 gpm) at 2200 rpm, Variable displacement, axial piston with load sense
Hydraulic Pump Displacement .....	130 cc/rev (7.93 in <sup>3</sup> /rev)
Pump Max Pressure .....	338 bar (4900 psi)
Load Sense Relief Valve.....	322 bar (4663 psi)
Pump Load Sense Margin .....	25 bar (363 psi)
Boom Up .....	182 l/min at 280 bar (48 gpm at 4061 psi)
Boom Down.....	72 l/min at 140 bar (19 gpm at 2031 psi)
Telescope Extend .....	189 l/min at 175 bar (50 gpm at 2538 psi)
Telescope Retract.....	57 l/min at 140 bar (15 gpm at 2031 psi)
Outrigger Extend .....	210 bar (3000 psi)
Outrigger Retract.....	80 bar (1200 psi)
Hoist System .....	132 l/min at 345 bar (35 gpm at 5000 psi)
Swing .....	102 l/min at 205 bar (27 gpm at 3000 psi)
Swing Park Brake .....	Hydraulic released disc, released at 17.2 bar (250 psi)
Cab Air Conditioner .....	8 gpm at 1450 psi
Reservoir Capacity .....	386 l (102 gal)
Reservoir Return Filter .....	5 micron
Reservoir Suction Filter .....	250 micron

**Air Conditioner**

Air Conditioner Hydraulic System.....	3500 (+/-100) psi
Minimum Evacuation Time .....	30 minutes
Refrigerant Charge Levels .....	2.0 pounds (+/- 0.5 Ounce)
Additional Pag Oil Required Above 6 ounces in Compressor	4.0 ounces

**Hoist System**

Wire Rope:	
Length .....	152 m (450 ft)
Diameter (Rotation Resistant) .....	16 mm (5/8 in)
Nominal Breaking Strength .....	25,592 kg (56,420 lb)
Synthetic Rope: Optional	
Length .....	157 m (450 ft)
Diameter .....	18 mm (.70 in)
Operating Pressure .....	345 bar (5000 psi)
Flow.....	132.5 l/min (35 gpm)
Gearbox Capacity.....	2.3 l (2.5 qt)
Brake Capacity .....	.236 l (1/4 qt)

Hoist Line Pull/Layer		
Layer	Low Speed kN (lb)	High Speed kN (lb)
1	67 (15,000)	33 (7,500)
2	60 (13,500)	30 (6,800)
3	55 (12,300)	27 (6,100)

Hoist Line Pull/Layer		
Layer	Low Speed kN (lb)	High Speed kN (lb)
4	50 (11,300)	25 (5,600)
5	46 (10,400)	23 (5,200)

Line Speed (no load at high engine idle speed)		
Layer	Low Speed m/min (ft/min)	High Speed m/min (ft/min)
1	45 (150)	90 (290)
2	50 (160)	100 (320)
3	55 (170)	110 (350)
4	60 (190)	120 (380)
5	65 (210)	130 (410)

**NBT60 Crane Operating Speeds**

(Performance based on full governed RPM and 37.8°C (100°F) hydraulic reservoir temperature.)

Rotation 360° .....	30 ± 5 sec (1.8 ± 0.2 rpm) Adjustment Knob Closed
Boom up 0° to 80° .....	27 ± 5 sec
Boom Down 0° to 0° .....	32 sec ± 5 sec
Boom Extend/Retract Five Section	
Extend (Angle 60°) .....	70 sec ± 10 sec
Retract (Angle 60°) .....	70 sec ± 10 sec
Outrigger Beam Extend .....	10 sec ± 3 sec
Outrigger Beam Retract .....	10 sec ± 3 sec
Outrigger Jack Extend .....	13 sec ± 3 sec
Outrigger Jack Retract .....	16 sec ± 3 sec

**Counterweight**

Weight - Top .....	1,360 kg (3,000 lb)
Weight - Bottom .....	1,360 kg (3,000 lb)
Weight - IPO (without auxiliary hoist option) .....	317.5 kg (700 lb)

**General**

Capacity NBT60 .....	60 tons (54.4 metric tons) at 2.4 m (8 ft) radius
Overall Length .....	12.10 m (39.7 ft), with 39.0 m (128 ft) Boom
Overall width .....	2591 mm (102 in)
Overall Height .....	4,020 mm (158.2 in)
Boom Length, 39 I (128 ft), 5 section .....	Retracted 9.7 m (32 ft), Extended 39.01 m (128 ft)
Boom Weight .....	6,812 kg (15,017 lb)
Jib Length - Optional .....	Retracted 7.9 m (26 ft), Extended 13.7 m (45 ft)
Jib Weight .....	828 kg (1,825 lb)
Jib Offset - Optional .....	0° and 30°
Gross Vehicle Weight - 4-axle minimum truck .....	39,009 kg (86,000 lbs)
Gross Vehicle Weight - heavy lift truck - Tandem/Tridem .....	106,000 kg (48,080 lbs)
Federal Bridge Law Compliant:	
Gross Vehicle Weight - 7-axle pusher 1 .....	3,629 kg (8,000 lbs)
Gross Vehicle Weight - 7-axle pusher 2 .....	3,629 kg (8,000 lbs)
Gross Vehicle Weight - 7-axle tag .....	3,629 kg (8,000 lbs)

*For  
Reference  
Only*

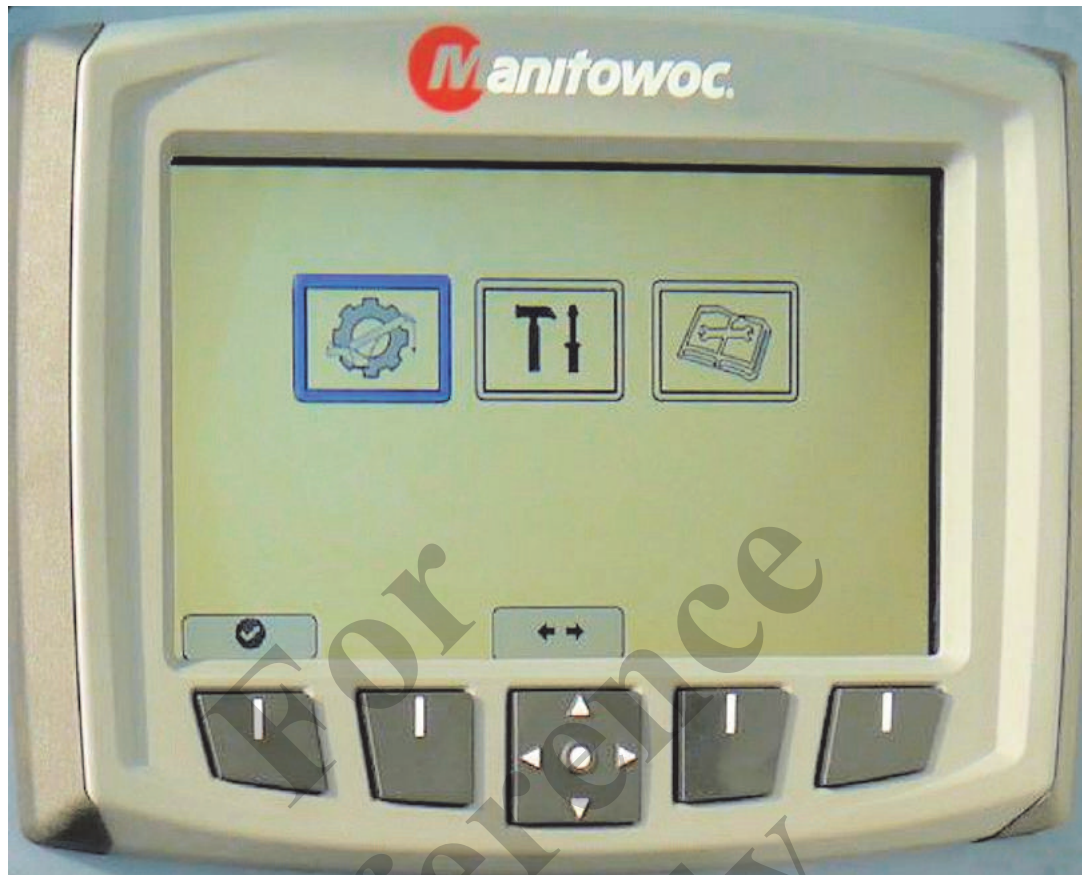
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**SECTION 7**  
**RATED CAPACITY LIMITER**

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For Reference Only



8798-6

FIGURE 7-1

## RCL SYSTEM DESCRIPTION

The Rated Capacity Limiter (RCL) is an operational aid that warns the operator of an impending dangerous overload condition that could result in death or injury to personnel and/or damage to equipment and property.

### WARNING

The RCL is not a substitute for good operator judgment, experience, and safe operating procedures. The responsibility for safe crane operation remains with the operator.

The RCL is not a scale and should not be relied upon solely to accurately weigh loads.

The Manitowoc RCL system consists of an operator's console, anti-two-block switch, length sensor, angle sensor, slew potentiometer, outrigger length sensors, and lift cylinder pressure transducers. The RCL has the crane load charts

loaded into the RCL module and are displayed on the screen as needed. When a load is picked, the RCL compares the actual conditions with the load chart. If an overload condition is sensed, audible and visual warnings are generated and the boom down, telescope out, and hoist up (main and auxiliary) controls are disabled. These are the functions that worsen the overload condition.

Components:

- RCL display on the operators console.
- Length/angle sensor with cable reel mounted on side of boom.
- Lift cylinder pressure transducers integral to lift cylinder hold valve.
- Anti-two-block switch (ATB) on the boom nose.
- Four outrigger length sensors (one on each outrigger beam).
- Slew sensor on the swivel.

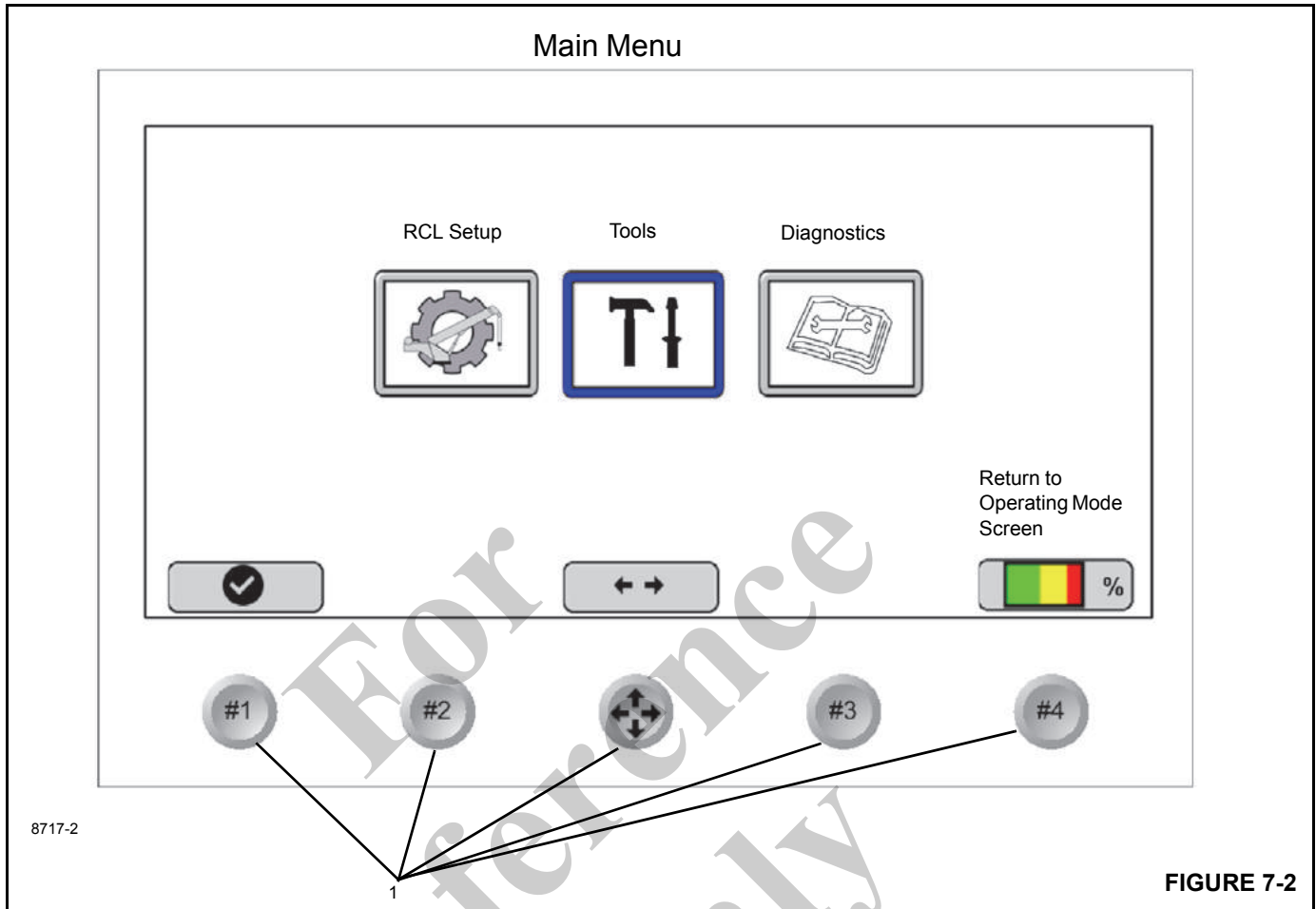


FIGURE 7-2

**RCL Display**

The **Main Menu** screen should display when:

- The display first powers up or
- If the 2-hour resume configuration timer has expired.


This screen should not display when:

- Crane was shut down while operating in Radio Remote Control State and was configured with a man-basket during first machine set-up-regardless of the above (2) conditions. In this case, the display should power up and display the last known operating mode screen (with basket).

The **Main Menu** screen (Figure 7-2) is divided into the following three major sections which are used to set-up, operate, calibrate and troubleshoot the Rated Capacity Limiter (RCL) system.

The RCL display will show available button functions based on the current screen and the current system status. An icon showing the available functions for each button will appear above each button.

Buttons 1-4 can be used to select/confirm a highlighted item, go back/escape, return to operating screen or go to a specific menu or function.










 The Directional button is used to highlight and select applicable choices and navigate to multiple screens.

Use the directional pad to highlight the desired function, then confirm selection by pressing button #1.

- **RCL Set-Up** — Highlight and press Select function key (Figure 7-2) to configure the RCL system. This screen includes configuration and establishing operational limits for the boom, outrigger, hoist, and reeving. The RCL Set-Up screen also includes the RCL operating mode screen, see page 7-4.
- **Tools** — Highlight and Select function key (Figure 7-2) to access the tools screen, see page 7-14. This screen includes RCL Setup and Sensor Calibration Screens and Measurement Display Information.
- **Diagnostic** — Highlight and press the Select function key #3 (Figure 7-2) to access the RCL diagnostic menu, see page 7-19. This menu

includes Machine Information and Warnings, Crane Electrical Fault Monitoring, Hour Meter, Load Chart Part Number, Calibration Chart Part Number and Module Input/Output screens with Software Versions and Real-Time Sensor information.

The **Main Menu** screen has *function keys* (Figure 7-2) that are used to highlight and select the functions shown on the display screen.

- 
 The Return to Operating Mode Screen button is only displayed if the RCL has been through configuration and set-up. The image on the button displays the real-time Rated Capacity Bar Graphics status.
- 
 The Directional button is used to highlight and select applicable choices and navigate to multiple screens.
- For more choices, press the right arrow  function key.
- To go back to the previous choices, press the left arrow  function key. The Back function returns to the previous screen without saving inputs.
- The up  and down  arrow functions are used to increment or decrement through inputs or screen selections.
- 
 The Select function key confirms the choice that is highlighted.
- 
 The Back button will go back 1 selection during the RCL setup.
- 
 The Escape function returns to the previous screen without saving inputs.

**NOTE:** On start up of the RCL, the Manitowoc splash screen and the National Crane logo screen will appear for a few seconds each before the Main Menu Screen appears (Figure 7-2).

**NOTE:** If the crane is powered up after sitting idle within a 2 hour time period, the Configuration Confirmation Screen 9 (page 7-10) will appear first.

**NOTE:** If one of the RCL sensors have not been calibrated, then the sensor calibration menu will display.

**Alert and Limit Symbols**

The right side of the operating screen displays active alert and/or limit symbols. Only those limits that are set are displayed. If there is a violation of a set limit, the symbol

flashes. In normal operation with no limits set and no alerts active, this portion of the screen is blank.

The warning cluster on the following sample screen shows all alert and limit symbols for illustration purposes only.

RCL Operating Mode Screen (Sample)

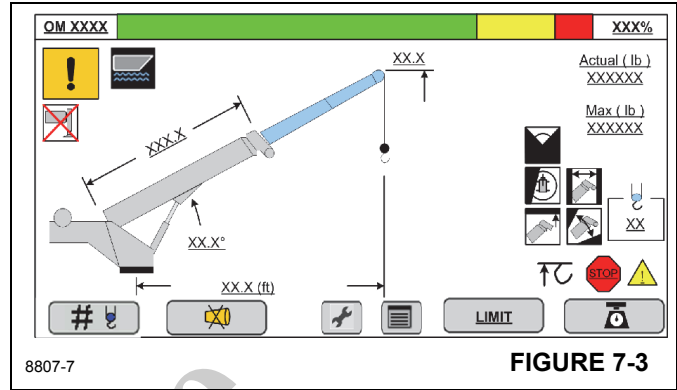







FIGURE 7-3

- 
 RCL Capacity Warning - Continuous visual and audible warning that a overload condition is approaching. The operator can continue with extreme caution.
- 
 RCL Capacity Lockout - Continuous visual and audible warning that an overload condition exists. The following controls are locked out:
  - Hoist Up (Main and Auxiliary)
  - Boom Down
  - Telescope Out
- 
 ATB Limit is Activated - Continuous visual and audible warning that a two-block condition exists. The following controls are locked out:
  - Hoist Up (Main and Auxiliary)
  - Boom Down
  - Telescope Out

**RCL Override Warning**






The RCL override bypasses the RCL for both overload and ATB alerts.







- 
 RCL Override Warning (Red) — Indicates that the RCL is bypassed by the operator. Use extreme caution when the RCL is bypassed.
- 
 ATB Override Warning (Red) — Indicates that the ATB is bypassed by the operator. Use extreme caution when the ATB is bypassed.



 **DANGER**

Use extreme caution when operating the crane with the RCL system overridden. Use of the RCL system override to operate the crane in a non-permissible range can result in death or injury to personnel and/or damage to equipment and property.

-  Horn Silence — Indicates the RCL warning horn is temporarily disabled for a period of 15 seconds per push. The horn silence button icon will be shaded when active.
-  Slew Angle Limit — The slew angle is measured from the centerline of the bearing with the boom in the boom rest to the present boom position. This is to alert the operator of a user set limit.  
  
A positive slew angle is to the right side of the boom rest +.1° to +360° or +.1° > angle > 180° negative slew angle is to the drivers side of the boom rest from -0.0° to -180°.
-  Tip Height Limit — The tip height is measured from the ground to the tip of the boom. This monitors the height of the boom tip to alert the operator of a user set limit (assumes maximum outrigger deployment).
-  RCL Angle Limit — The angle limit is measured by the boom angle. This is to alert the operator of user defined limits above or below these settings.
-  Radius Limit — The radius limit is measured from the center of rotation to the center of the load. This is to alert the operator of a user set limit.

-  RCL WADS Limit — The work area definition (WADS) limit is measured as a straight line from point A to point B anywhere in the work area. This sets up a virtual wall that alerts the operator of a user set limit. The WADS can be configured with three virtual walls.
-  General Warning — Refer to MAIN Menu option 3 “Diagnostics” screen to see the warning that is active.
-  Joystick — Active settings of one or more of the joysticks, current setting lower than 100%.
-  O/R Setup Overridden — Shown to indicate that the operator has manually overridden the sensor data of the current outrigger configuration. This is NOT an RCL lockout condition so no buzzer sounds or functions are disabled.
-  Over Rear Operating Mode — Shown when crane is currently in the Over the Rear load chart mode. If the crane is within the EEPROM value range for Over the Rear, the GREEN icon is shown. If the crane is within 10° of inside limits of these EEPROM values, the icon is yellow. See Figure 7-4.
-  CWT Removal Slew Position — Shown to indicate that the operator is approaching (YELLOW) region where the CWT slab(s) can be pinned to the turret/box. See Figure 7-4.

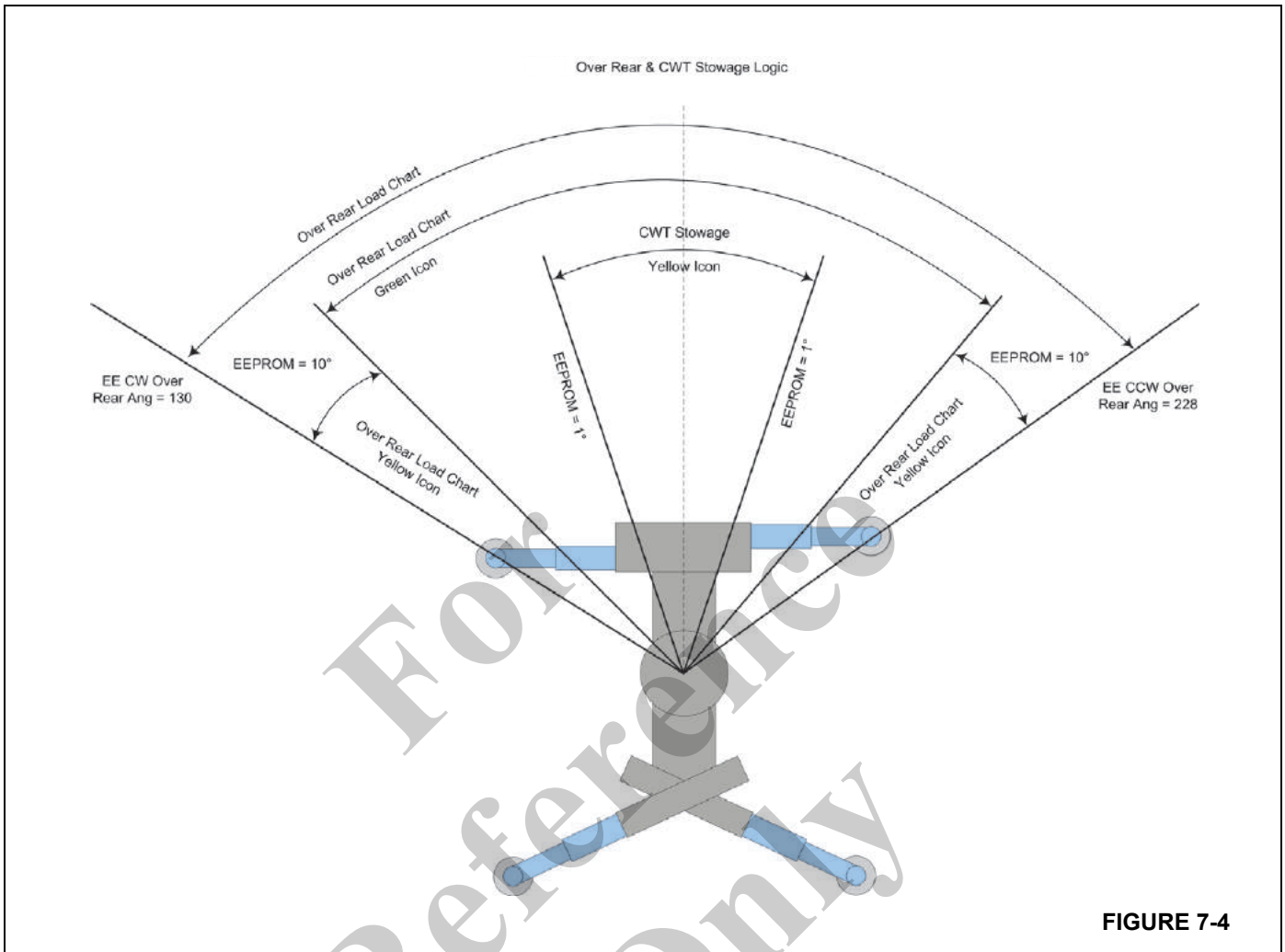


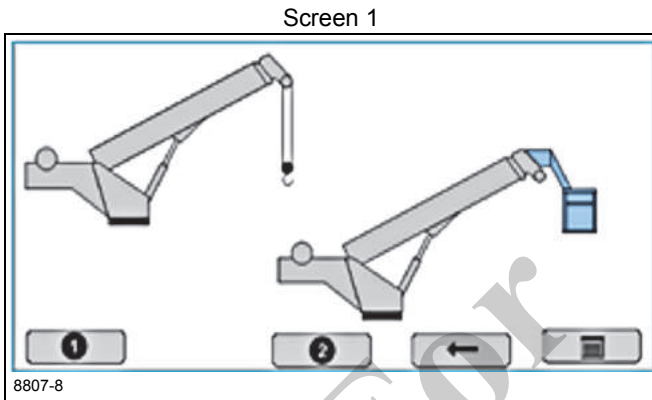
FIGURE 7-4

**RCL SETUP**


The RCL setup is where the lifting configuration of the crane is entered into the system. The RCL setup is required before the crane can be operated.

When the crane ignition switch is turned on, the RCL powers up and displays the National Crane logo screen for a few seconds followed by Screen 1 in the RCL setup sequence.

Select the RCL setup icon on the main menu to begin RCL setup (Figure 7-2).

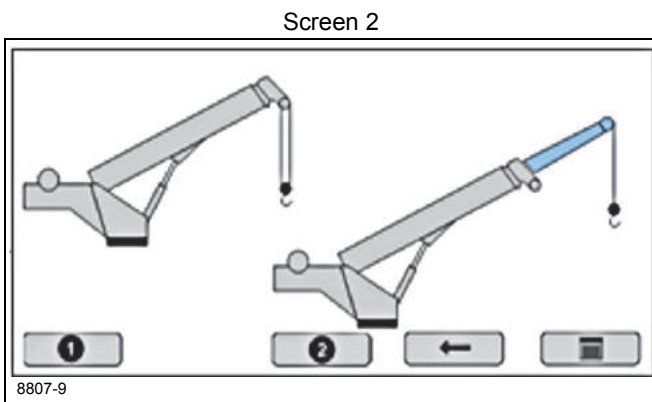


Is a basket attached to the boom or the tip of the jib nose? Select 1 or 2.

-  The Main Menu button here returns to the Main Menu.
- If a basket is selected and the machine is shut down, the RCL will restart without having to complete the setup sequence. This is to enable basket with radio remote operation.

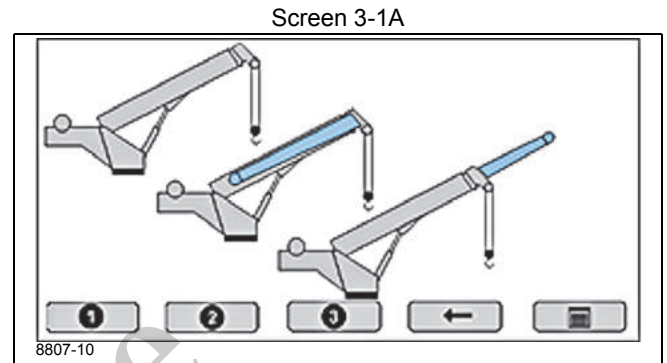
**Boom Configuration**

If the crane is not configured with a jib, the following set up screens will not appear. The system will detect that no jib has been configured for use on the crane and by-pass these screens.



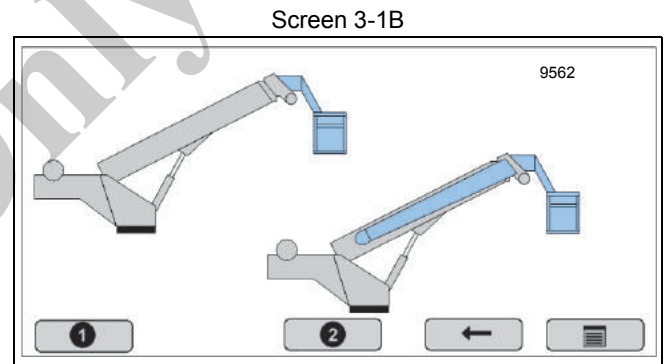
Is a jib attached to the boom nose? Select 1 or 2.

**NOTE:** Screens 3-3 and 4-2 **do not** apply to cranes equipped with a fixed or non-telescoping jib extension and should not appear as a screen selection. The RCL control system will bypass these screens and move to Screen 4-1.



Selected 1 on Screen 2. Now select 1, 2 or 3 on Screen 3-1A:

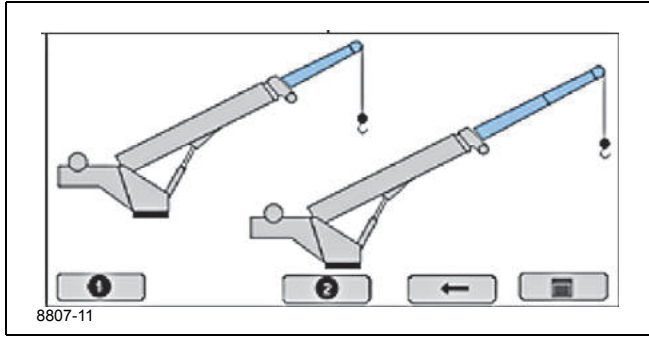
- 1 - No jib
- 2 - Jib stowed on the side of the boom
- 3 - Jib deployed but not reeved
- Screen 3-1A will only appear if the crane is **not** equipped with a personnel basket.



Selected 1 on Screen 2. Now select 1 or 2 on Screen 3-1B; is the jib stowed on the side of the boom?

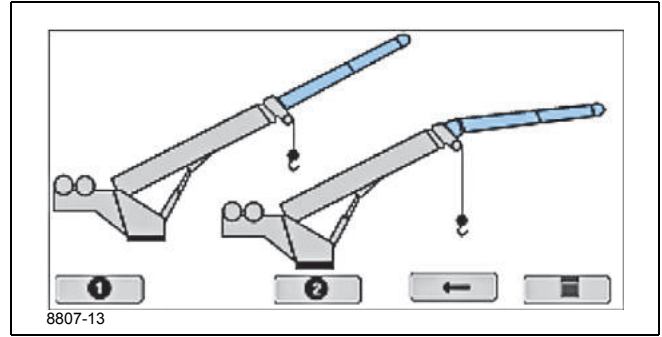
- Screen 3-1B appears only if the crane **is** equipped with a personnel basket.

Screen 3-2



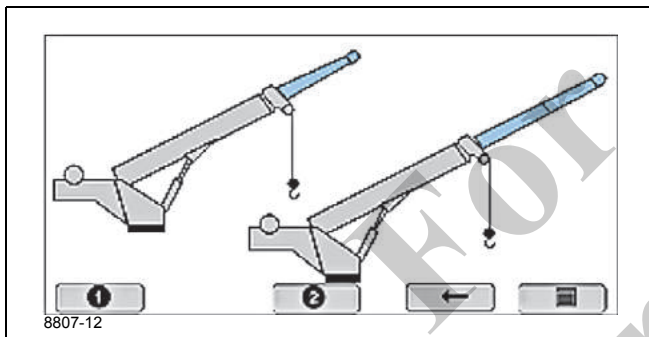
Selected 2 on Screen 2. Now select 1 or 2: is the jib retracted or extended?

Screen 4-2



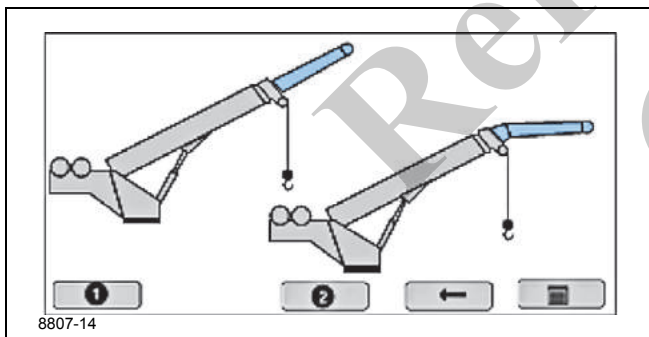
Selected 2 on Screen 3-2. Select 1 or 2: is the extended jib straight (0°) or offset (30°)?

Screen 3-3



Selected 3 on Screen 3-1A. Now select 1 or 2: is the deployed jib retracted or extended?

Screen 4-1



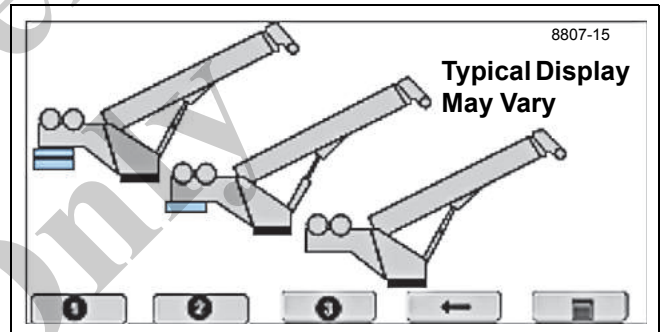
Selected 1 on Screen 3-2. Now select 1 or 2: is the retracted jib straight (0°) or offset (30°)?

### Counterweight Configuration

When the RCL system is configured at the factory it is determined if the crane is equipped with or without a removable counterweight.

If your crane is not equipped with the removable counterweight option the following counterweight configuration screens are not be shown.

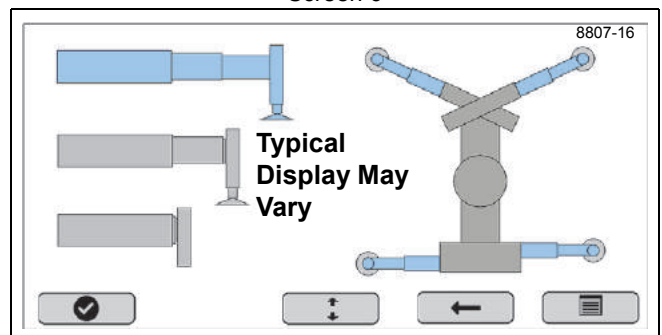
Screen 5-1



Select either 1 or 2 (counterweights) or 3 (no counterweight).

### Outrigger Configuration (w/o jib or basket)

Screen 6



The current outrigger status will be displayed by high-lighting the current outrigger setting in blue, as shown in the left view

of Screen 6. The non-current span setting will be shown in gray.

The position of each outrigger will be shown graphically on the right of the screen and will be either Fully Extended, 50% Extended, 0% Extended, or in between Figure 7-5.

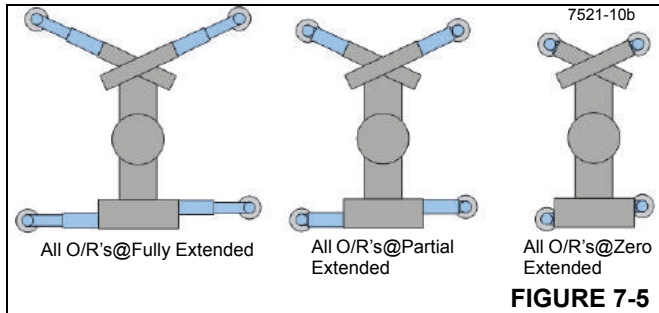


FIGURE 7-5

The shortest outrigger position determines the chart that is to be used. For example:

In Figure 7-6 one side of the outriggers is fully extended and the other side is at 50% extended. In the Figure 7-6 example, the configuration selected by the RCL and shaded in blue on the left of the display screen would be 50% extended. The user can override this pre-selection by using the up/down arrow keys and selecting OK when complete.

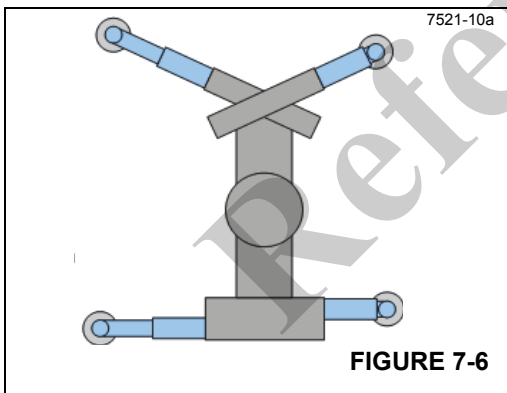


FIGURE 7-6

If any of the four Outrigger Length Monitoring Sensors are out of range or not functioning properly, that beam will show at midspan position and will be colored in red (Figure 7-7).

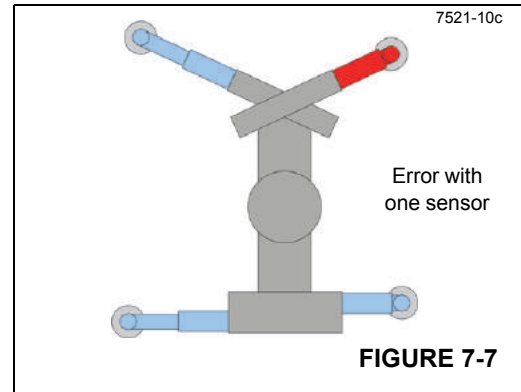
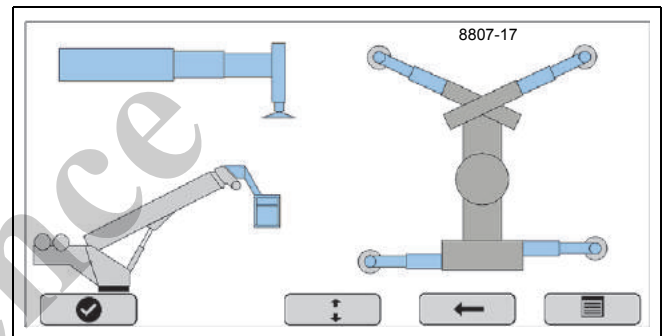


FIGURE 7-7

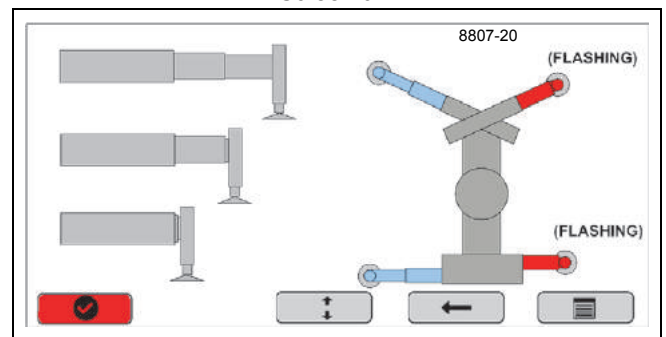
Screen 6-1



When using the personnel basket, Fully Extended outriggers are required. Select OK after machine is in Fully Extended as displayed on Screen 6-1. When within Fully Extended range, the left-hand O/R graphic changes from GRAY to BLUE.

If user attempts to select OK before Fully Extended condition is met, the OK button will color RED when depressed and the user can override the setup using the arrow keys as displayed on Screen 6-2.

Screen 6-2

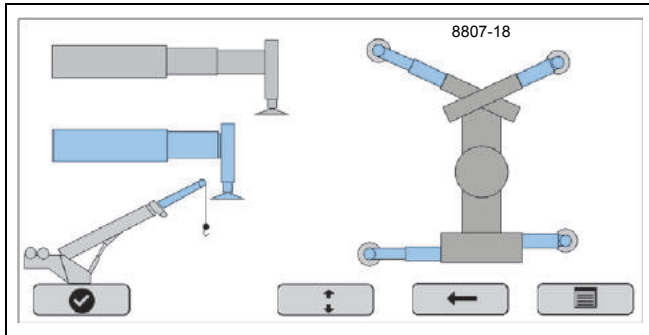


If the user selects a setup configuration different than the one selected by the RCL, the O/R override icon will be displayed on screen 9 and on the RCL Operating Mode Screen shown on page 7-11.

When using the jib, Fully Extended or 50% Extended outriggers are required. Select OK after machine is in Fully

Extended or 50% Extended. When within Fully Extended or 50% Extended range, the appropriate left-hand O/R graphic changes from GRAY to BLUE.

Screen 6-3

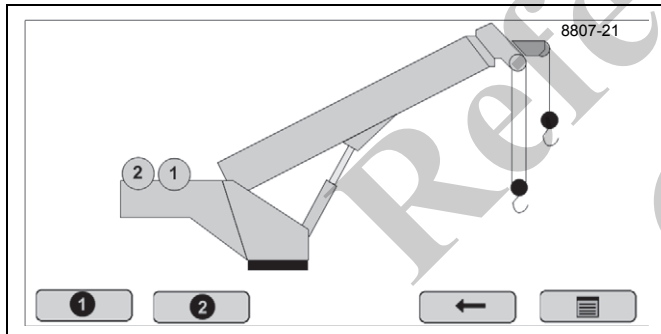


If user attempts to select OK before Fully Extended or 50% Extended condition is met, the OK button will color RED when depressed and the user can override the setup using the arrow keys.

If the user selects a setup configuration different than the one selected by the RCL, the O/R override icon will be displayed on Confirmation Screen (screen 9 on page 7-10) and on the RCL Operating Screen shown on page 7-11.

**HOIST & REEVING CONFIGURATION**

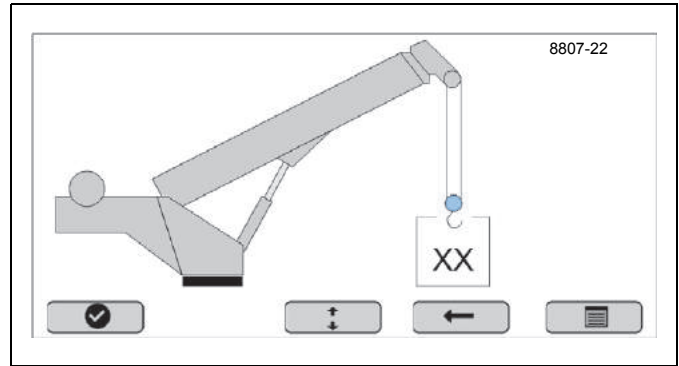
Screen 7



Select 1 to show the Main Hoist enabled. Select 2 to show the auxiliary hoist enabled.

The hoist that is being used will be displayed as in Screen 7 and on the RCL Operating Mode Screen in blue (page 7-4).

Screen 8



If selected 1 (Main Hoist) on Screen 7. Use the up and down arrows to change reeving from 1 part line up to 10 parts line on Screen 8.

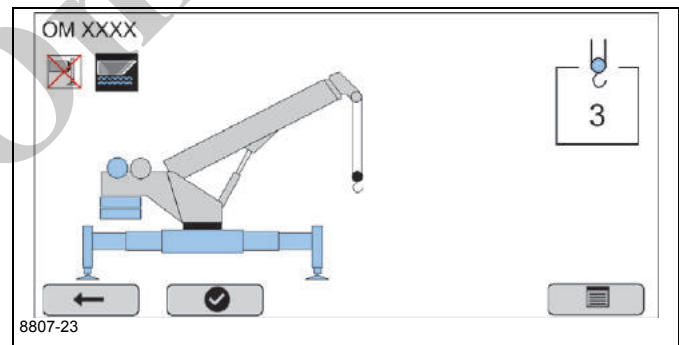
**Confirmation**

After the RCL crane configuration setup is complete, confirmation Screen 9 is displayed. Check the configuration and select OK if the configuration is correct. This verifies the lift configuration of the crane.

If the confirmation Screen 9 is not correct, use the back arrow key to go back to Screen 8 and correct the configuration.

If the machine is shut down and restarted again within 2 hours, the operator can select OK at Screen 9. Selecting OK will automatically return the RCL to the configuration used at shutdown. Re-configuration of the RCL will not be required.


Screen 9












**OPERATING MODE**

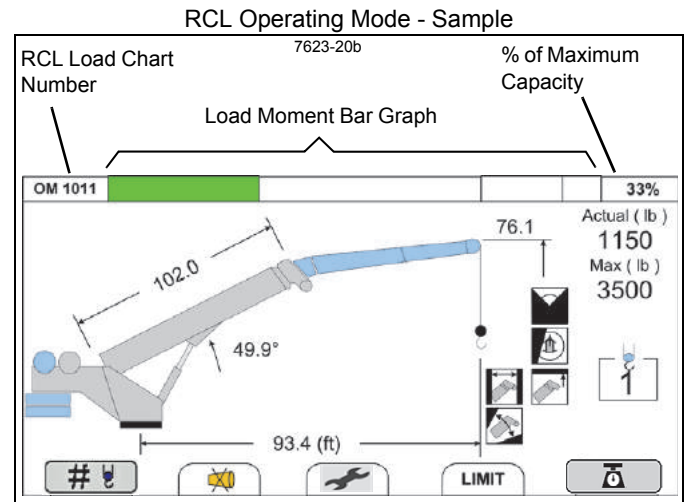
After the RCL setup is complete, the RCL Operating Mode screen is displayed.

The key functions at the bottom of the RCL Operating Mode screen are:

-  — MAIN — Pressing this key returns to the MAIN Menu screen.

-  — Horn Silence indicates the RCL warning horn is temporarily disabled for 15 seconds. The horn silence button icon will be shaded when active.
-  — Reeving selecting screen — pressing this button returns to the reeving configuration screen for number of parts of line selection.
-  — Wrench — pressing this button returns to the diagnostics screen.
- LIMIT — Pressing enables the RCL Limits Menu screen and WADS options main menu.
-  TARE — Pressing will enable/disable Tare or zeros out the current load indicated on the screen to show the active weight of the load only. TARE button icon will flash BLUE when active.
-  — Delete — Pressing this key deletes the current setting or value.
-  — Real Time I/O - Pressing this button will navigate to the Real Time I/O screen.
-  — General Warning — See Diagnostic Screen to see which warning is active.
-  — Barge Mode — Icon shown when barge mode was selected.
-  — Counterweight Removal Position — Shown to indicate that the operator is now approaching (YELLOW) region where the CWT slab(s) can be pinned and/or unpinned to the turret/tbox.

The following *RCL Operating Mode - Sample* has been set up with extended jib @ 30° offset, all limits set and displays the following:



- Boom Length (BL) = 102.0 ft
- Boom Angle (BA) = 49.9°
- Load Radius (LR) = 93.4 ft
- Boom Tip Height (TH) = 76.1 ft
- # Parts of Line (#) = 1
- Maximum Allowable Load (ML) = 3,500 lb
- Actual Load (AL) = 1,150 lb
- % of Maximum Capacity = 33%
- All Active Limits

**TARE Function**

The TARE function calculates the net weight of the load (Total Load –Hook Block). The TARE function must be activated before lifting. To use the TARE function:

- Rig the load to the hook block.
- Before lifting the load, press the TARE function.
- Lift the Load. The net load is shown in the actual number display.

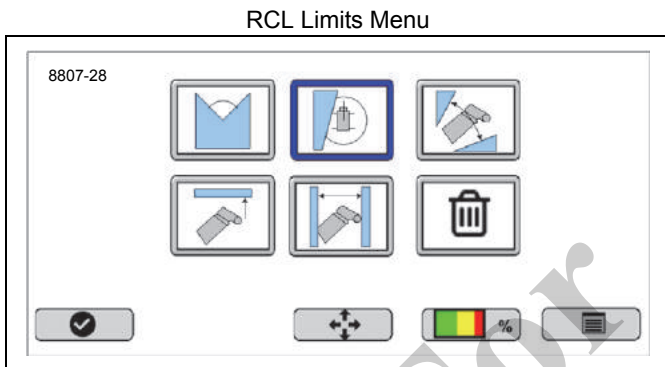
The TARE button icon will flash blue in color when active.

Changing the boom angle or length automatically returns the actual load display back to the total weight (Load +Hook Block).

**OPERATIONAL LIMITS**

Operational limits are set by the operator to limit crane operation to a defined area. The operational limit icons are displayed in the warning cluster on the RCL Operating Mode screen. These icons will flash and a buzzer will sound when the operator violates the limits.

To set operational limits select the LIMIT function key on the RCL Operating Mode screen, the RCL Limits Menu screen will appear.

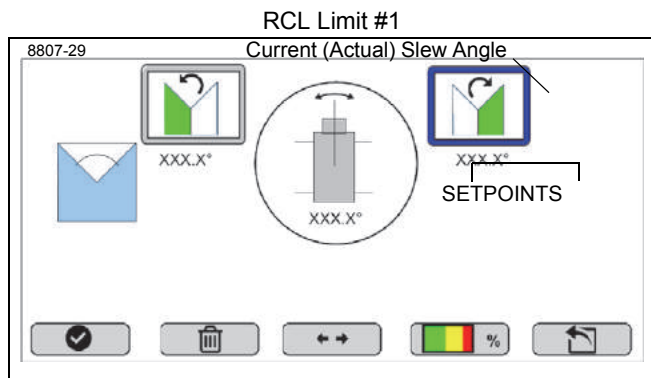


Select the desired operational limit 1 through 6, use the arrow key to scroll back and forth to select the correct operational limit.

Operational limit selections on the display are as follows:

1. Set a slew angle limit.
2. Set a WADS limit.
3. Set a boom angle limit.
4. Set a tip height limit.
5. Set a radius limit.
6. Delete all limits

**Slew Angle Limit**



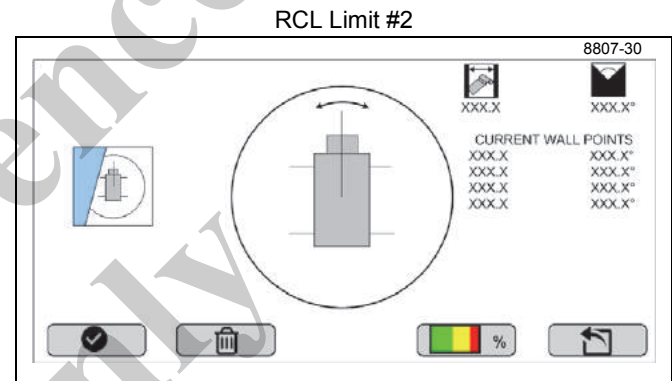
Rotate the crane superstructure to the desired position (the number will appear on the display screen) then:

- Select the SET function key (1 or 3, Figure 7-2) to store the current slew angle.
- Select DEL function key (2 or 4, Figure 7-2) to remove the current setting.
- The RCL #1 screen is updated in real time.
- ESC to return to previous screen when finished.

Use the function key with a ↶ for counter clockwise settings and the function key with a ↷ for clockwise slew settings.

The current slew angle is shown in the top right corner (xxx.x°) of the Limit #1 screen. The left and right slew angle limits appear below the current slew angle.

**WADS Limit**



The RCL Limit #2 screen will allow the operator to create virtual "walls" of operation.

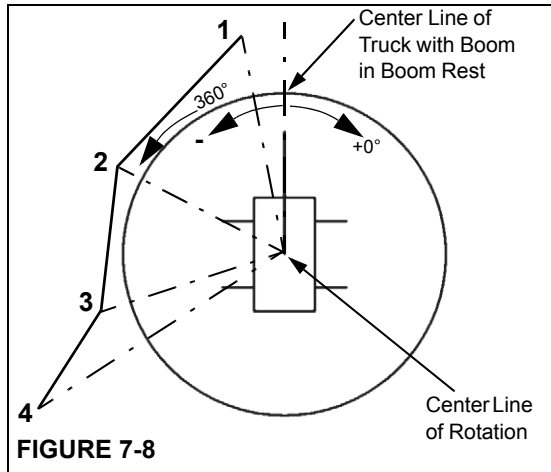
Rotate the crane superstructure to the desired position (the radius and slew angle will appear on the display screen) then:

- Select the SET function key to set the current boom nose position.
- Select DEL function key to remove the current settings.
- Select OK to store each position after input.

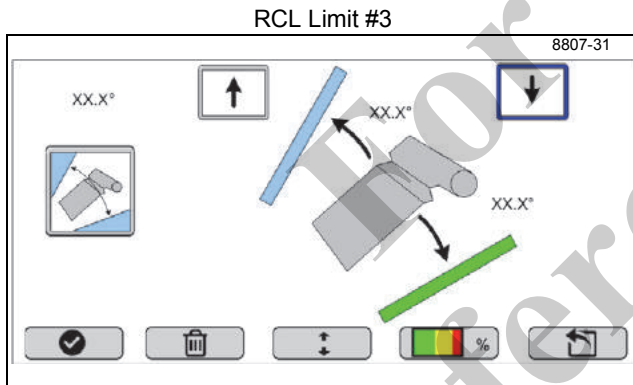
There can be up to four set points which form 3 virtual walls. The points are taken from the rope fall length and highest point of the boom nose.

There needs to be at least two points for a virtual wall. Points are stored as distance in feet (RADIUS) from the center of rotation and angle (SLEW ANGLE) from the center line of truck with the boom in the boom rest, see Figure 7-8.





**Boom Angle Limit**



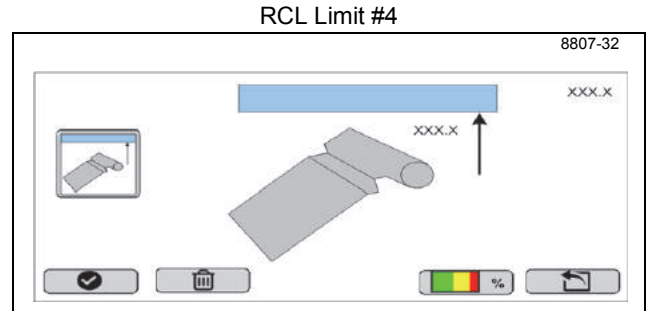
Move the crane boom to the desired boom angle (the angle number will appear on the display screen) then:

- Select SET, function key (1) to set the MAX boom angle.
- Select SET, function key (3) to set the MIN boom angle.
- Selecting either DEL function key will remove the current boom angle setting.
- ESC to return to previous screen with no inputs.

Use this screen to set either the Max boom angle, the Min boom angle or both Min and Max.

The current boom angle is always shown in the upper right hand corner.

**Tip Height Limit**

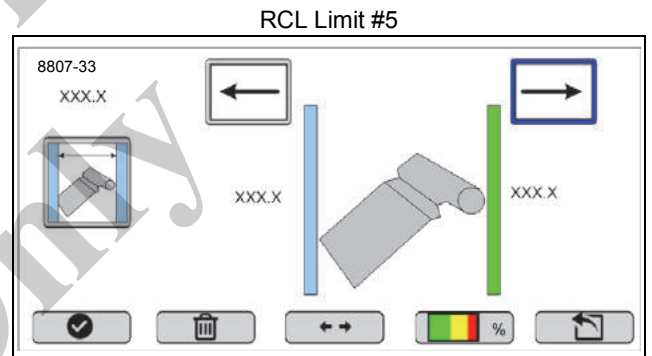


Move the crane boom to the desired boom tip height point (it will appear on the display screen) then select the following:

- Select SET, function key (1) to store the current boom tip position as the MAX.
- Select DEL, function key (2) to delete the established limit.
- ESC to return to previous screen with no inputs.

The current boom tip height is always shown in the upper right hand corner.

**Radius Limit**



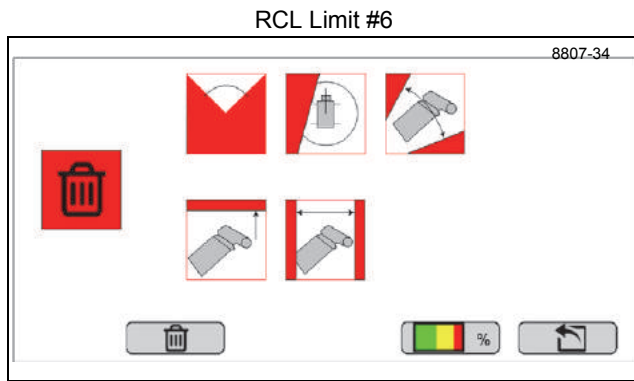
Move the crane boom to the desired boom radius (it will appear on the display screen) then:

- Select SET, function key (1) to set the MAX boom radius.
- Select SET, function key (3) to set the MIN boom radius.
- Selecting either DEL function key will remove that radius limit setting.
- ESC to return to previous screen with no inputs.

Use this screen to set either the Max radius, the Min. boom radius or both the Min and Max radius.

The current radius is always shown in the upper right hand corner.

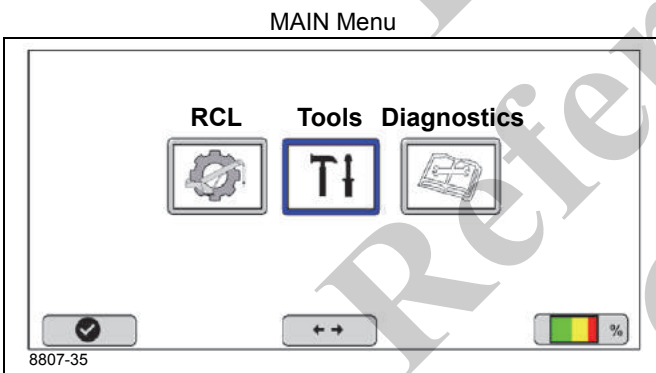
Delete All Limits



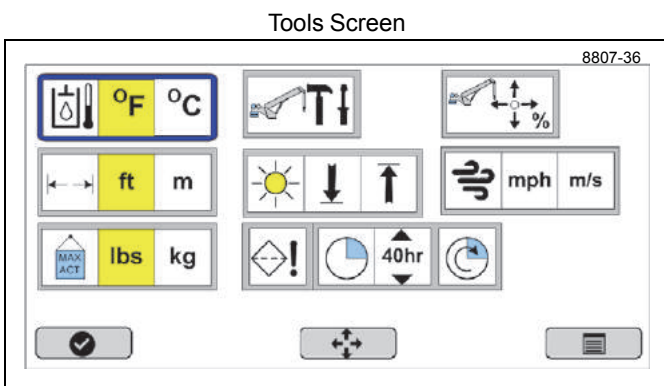
The RCL Limit #6 screen will allow the operator to delete all limit values that exist.

- Select to delete all values.
- ESC goes back to the Main Limits menu screen without deleting any limit values.

TOOLS



Select function key 2, Tools Menu on the MAIN Menu screen.



The Tool Screen will contain the following set up, calibration, tools and measurement display information.

Each selection on the Tools Screen is made by using the arrow keys to scroll and make the selection; select OK after making the selection.

Yellow indicates the currently set value.

- Units of Measure

	Temperature, select either °F (Fahrenheit) or °C (Celsius)
	Length, select either ft (feet) or m (meter)
	Weight, select either lbs (pounds) or kg (kilograms)

- Joystick Output Setup
- RCL Sensor Calibration - Password protected (Pass: 12331 + Enter)
- Hydraulic Filter Reminder Setup - This display allows the operator to setup a reminder to check/replace the hydraulic return and suction filter on the crane. The operator can select three different intervals. When the timer expires, an indicator is turned on for the operator to let him know it is time to change the filter. To reset the timer select the far right icon.


ON/OFF, reminder interval Reset the interval reminder to (40/250/500 hr).

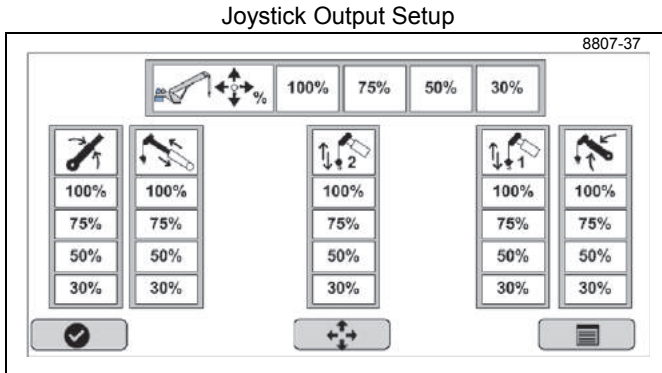
- Screen Brightness - Allows adjustment of backlight over a range of 15 steps.
- Up and down indicator in the time and password boxes correspond to button (4) "OK" to modify selection.

Joystick Output

The crane is equipped with electronic joysticks which allow for more customization from the operator. The maximum speed of all crane functions can be decreased from 100% (default value) to either 75%, 50% or 30% using this feature. If desired, each crane function can be set discretely to a value less than the default value of 100%. For example, the operator can set swing to be 50% and all other outputs to 75% if desired. When these settings are modified from all functions at the default 100% setting, this setup icon is shown on the top left corner of the operating mode screen while the crane is being operated as a visual feedback to the current or future operators that a joystick setting is set. These values change in real-time and are saved at machine shutdown. It is important to note that when a joystick setting is set to less than 100%. full use of the crane joystick is still allowed but the maximum function speed will be decreased according to the speed reduction.

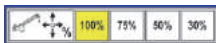
Select function key 2 Tools on the MAIN Menu screen and the Tools Screen will appear.

Select the Joystick Output Setup icon  to display the Joystick Output Setup screen.








The Joystick Output Setup screen allows the operator to select what percentage of maximum hydraulic valve spool shift to use when operating the crane in “Crane Control”, this function does NOT work in “Radio Remote Control”.

- The top horizontal bar on the Joystick Output Setup screen allows the operator to select all the crane functions be set to either 100%, 75%, 50% or 30%.

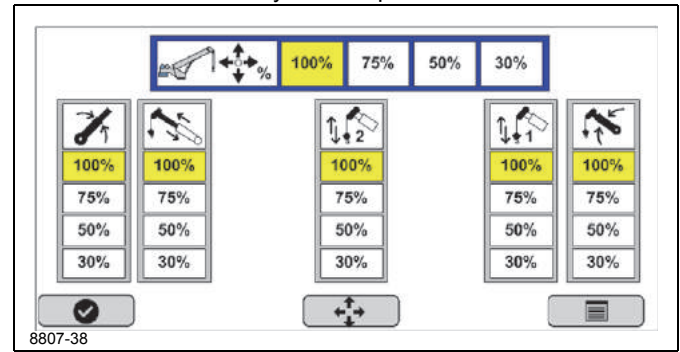


- The five vertical bars on the screen allow the operator to select a range of either 30%, 50%, 75%, or 100% for each function. Each function is identified by the icon at the top of the vertical bar as noted in the following table.

	Swing Control Valve
	Boom Telescoping Valve
	Auxiliary Hoist Valve
	Main Hoist Valve
	Boom Lift Valve

- Yellow indicates the current setting.
- Default value for the Joystick Output screen is all values @ 100%, as shown in Joystick Output #2 screen.

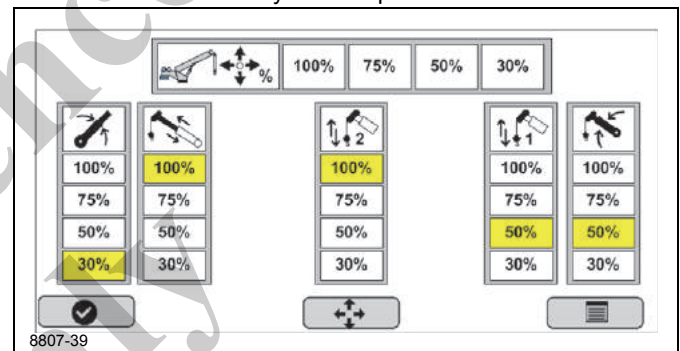
Joystick Output #2



- The operator can also set the desired output for each function as shown in Joystick Output #3 screen.

Using the arrow keys select the new percentage using the vertical bar. The new value will turn yellow indicating it is the current value, Joystick Output #3 screen.

Joystick Output #3




- When a Joystick value is not set at 100% (default standard); the RCL Operating Mode screen (page 7-4) will identify the non-standard setting in the upper left hand corner next to the general error icon.
- Values are saved when the machine is shutdown.

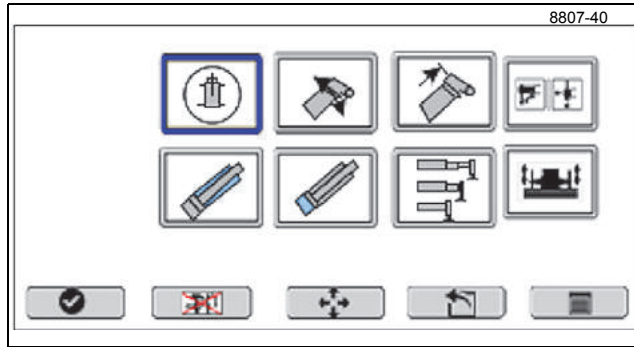
### RCL Sensor Calibration

The RCL sensors are located throughout the crane and are used to monitor the lifting parameters set by the crane operator. To be sure the sensors are working correctly it is sometimes necessary to verify the calibration of each RCL sensor. To perform this calibration:

Select key 2, Tools on the Main Menu.

The Tools Screen will appear, select the  icon, the Main Sensor Calibration Menu will appear.

Main Sensor Calibration Menu



The sensors are displayed in the above Sensor Calibration Menu screen.

**NOTE:** A five digit password is required to do a calibration. Use keys 1,2,3,3,1 then select OK.

Choices are:

1. Slew Angle
2. Boom Angle
3. Boom Length
4. Cab O/R Control Pendant
5. Lift Cylinder Rod Pressure
6. Lift Cylinder Piston Pressure
7. Outrigger Length
8. CWT Switch Panels (if equipped)

Use the right arrow key to move to the function keys

Select ESC goes back to the Main Limits menu screen without deleting any limit values.

### Slew Sensor Calibration

The calibration of the slew sensor is dependent upon whether the crane is equipped with a removable counterweight. Refer to the appropriate calibration procedure based on your crane's configuration.

#### **Cranes without Removable Counterweight**

Select 1 from the Main Sensor Calibration Menu screen to begin the slew angle calibration.

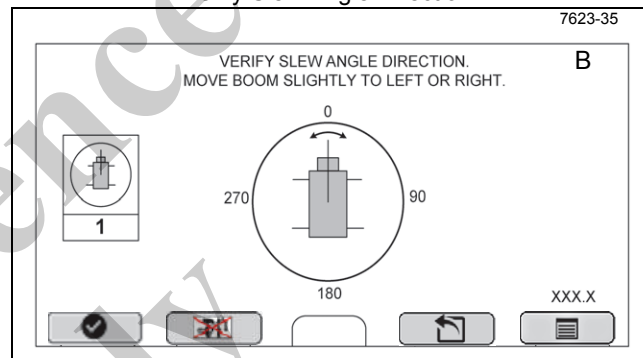
Slew Sensor Calibration



Position the boom on the truck centerline in the boom rest and select OK from the Slew Sensor Calibration screen.

There are two types of slew sensors. If the server is the analog version, screens A and B are shown. If the CAN bus version, only screen A is shown

Verify Slew Angle Direction

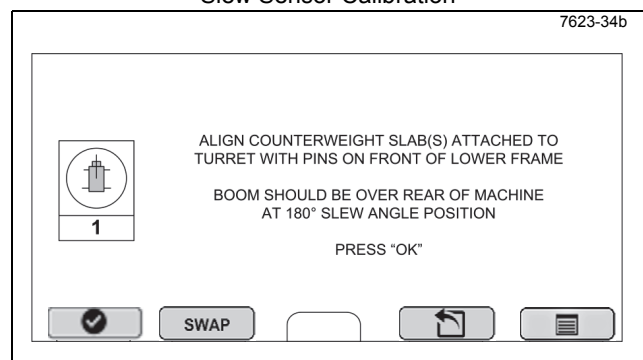


Once OK is selected on the Slew Sensor Calibration screen the Verify Slew Angle Direction screen appears, follow directions on the screen to verify the slew setting.

#### **Cranes with Removable Counterweight**

Select 1 from the Main Sensor Calibration Menu screen to begin the slew angle calibration.

Slew Sensor Calibration

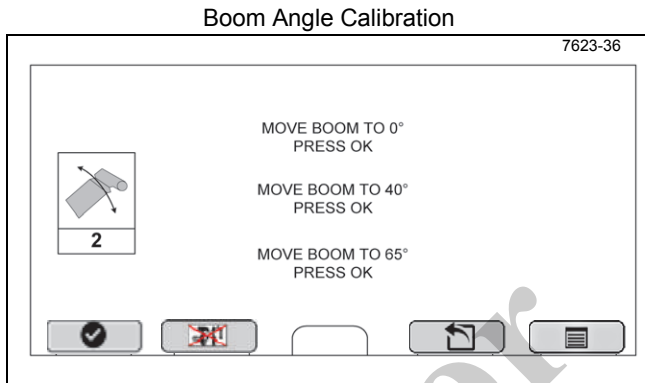


Swing the turret with mounted counterweight until the counterweight aligns with the stowage pins on the lower frame, then select OK from the Slew Sensor Calibration screen.

### Boom Angle Calibration

Select 2 on the Main Sensor Calibration Menu screen to start the boom angle calibration.

Level and set the truck on outriggers before starting the boom angle calibrate procedure. The boom angle needs to be measured accurately with an inclinometer to do an accurate calibration.



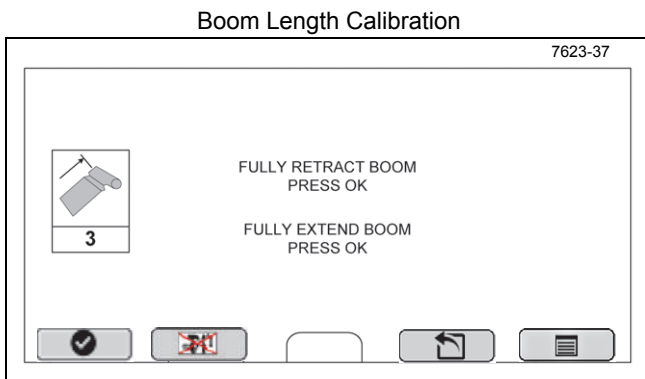
Select 2 from the Main Sensor Calibration Menu screen to start the boom angle calibration.

Three calibration positions are shown one at a time starting with the 0° position on the Boom Angle Calibration screen. Once OK is pressed for the 0° position, the 40° is activated, and then the 65° boom angle.

If the RCL system determines the sensor is not within the established zero range, an error screen will appear. The sensor will then have to be mechanically zeroed internal to the length angle reel.

### Boom Length Calibration

Select 3 from the Main Sensor Calibration Menu screen (page 7-16) to start the boom length calibration.



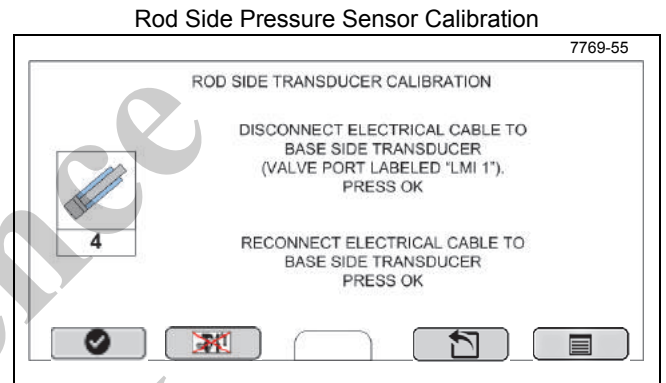
Two calibration positions are shown one at a time starting with the fully retracted position on the Boom Length Calibration screen.

Once OK is pressed for fully retracted position the fully extended position is activated and will appear.

### Rod Side Pressure Sensor Calibration

Each transducer must be calibrated to the zero position separately. To zero the rod side transducer, the base transducer electrical cable must be disconnected.

Select 4 from the Main Sensor Calibration Menu screen (page 7-16) to start the lift cylinder rod side pressure calibration.



Confirm that you have disconnected the electrical cable (port RCL 1) to base side transducer, and then follow the instructions as they appear on the screen.

- Pressing OK sends a signal to the transducer to re-program and power down.

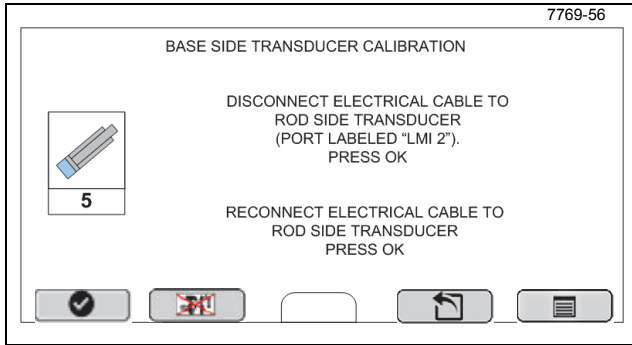
**NOTE:** There is no need to bleed the pressure at each transducer. Simply follow the instructions and disconnect the appropriate electrical cables as indicated

- When prompted by the bottom paragraph, reconnect the base sensor to manifold and press OK to return to the Main Sensor Calibration Menu screen (page 7-16).

### Base Side Pressure Sensor Calibration

Select 5 from the Main Sensor Calibration Screen (page 7-16) to start the lift cylinder base side pressure sensor calibration.

Base Side Pressure Sensor Calibration



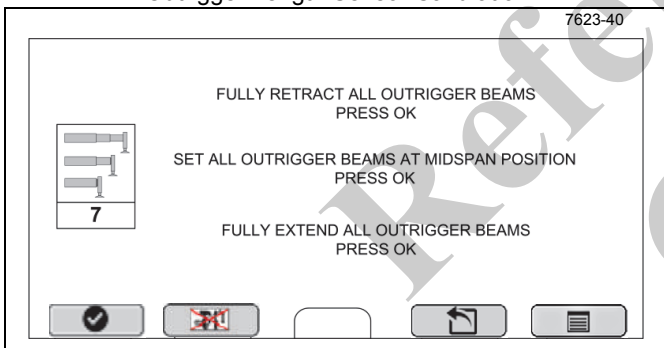
Press OK to disconnect electrical cable (port LMI 2) to rod side transducer, per top paragraph on the screen and then follow the instructions as they appear on the screen.

- Pressing OK sends a signal to the transducer to re-program and power down.
- When prompted by the bottom screen paragraph, reconnect rod side sensor to manifold and press OK to return to the main sensor calibration screen (page 7-16).

Outrigger Span/Length

Select 7 from the Main Sensor Calibration Menu screen (page 7-16) to start the outrigger length sensor calibration.

Outrigger Length Sensor Calibration



Three calibration positions are shown on the Outrigger Length Sensor Calibration screen one at a time starting with the Fully Retract position.

Pressing OK at the activated position automatically activates the next position.

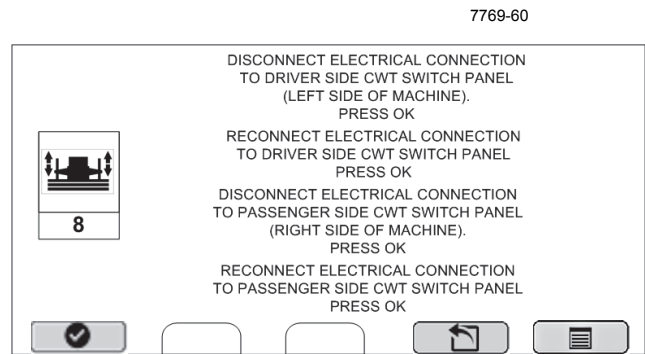
If an error screen appears after OK is pressed, the outrigger sensor for that screen will have to be checked for proper function and wiring.

See new error screen to communicate which sensor or sensors need investigation.

CWT Switch Panel Calibration

If equipped, Select 8 from the Main Sensor Calibration Menu (page 7-16) to begin CWT panel calibration.

CWT Panel Calibration



Confirm that you have disconnected the proper electrical connection and follow the instructions as they appear on the screen.

Load Chart and RCL Upload

Software upgrades, Main Load Chart and the Calibration Chart are up-loaded to the RCL system using a laptop computer connected to the crane control system through the Diagnostic Connector (1, Figure 7-7) in the operator's cab control panel. Contact the distributor for the required software and cables for crane interface.

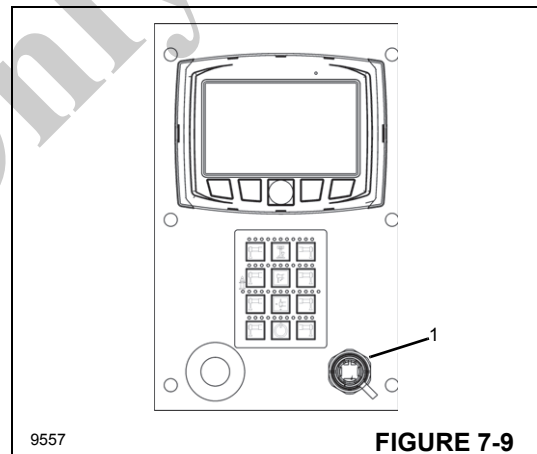


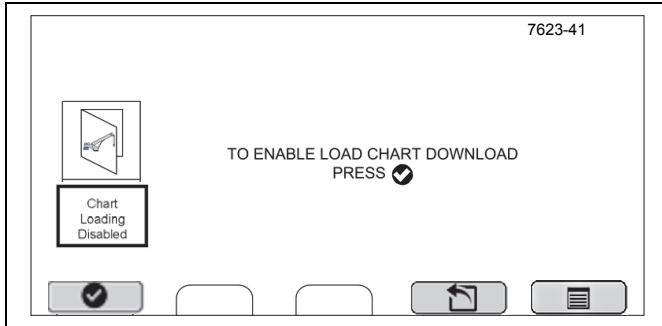
FIGURE 7-9

Connect the laptop to the Diagnostic Connector (1, Figure 7-9) with the interface cable.

If the RCL is in the start up mode and at the Main Menu screen (Figure 7-2), select function key 2, Tools.

At the Main Sensor Calibration Menu (page 7-16), select function key 6 (use arrow keys to scroll).

Upload Screen



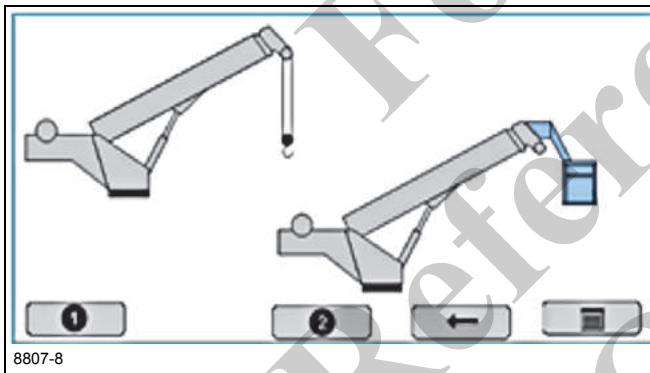
At the Upload Screen, Select OK, check mark to start the upload from the laptop.

Once enabled, the display will return to the sensor calibration menu.

### DIAGNOSTIC

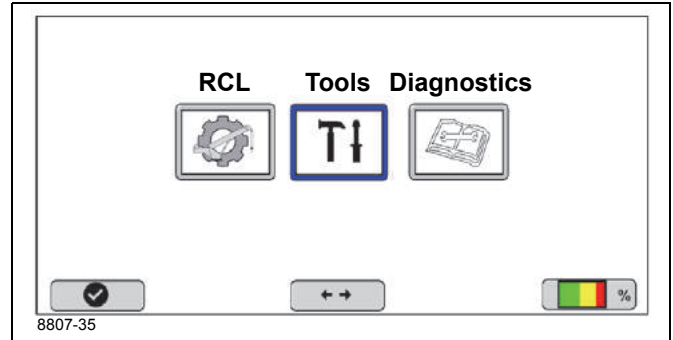
To get to the Diagnostic Menu screen, turn on the crane ignition switch and use the following screens.

Screen 1



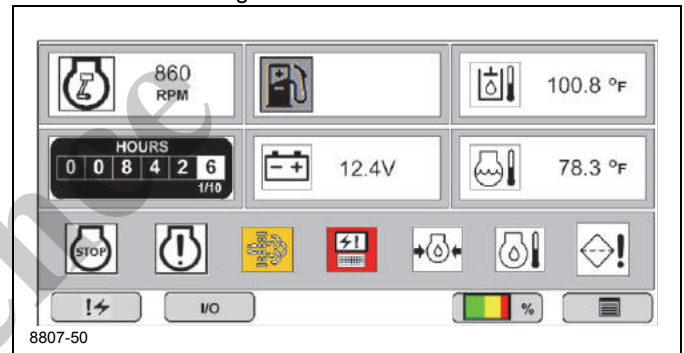
Select function key 5; the ESC function key takes you to the Main Menu.

MAIN Menu




Select function key, Diagnostics.


Diagnostic Menu Screen #1





The Diagnostic Menu screen contains crane and truck operating information and warnings, an hour meter and fault code displays.

Machine information/warnings display in upper left hand corner of the Diagnostic Menu screen.

 Button #1 will navigate to Diagnostic Screen 2 when pressed.

 Button #2 will navigate to real-time IO screen when pressed.

 -Button #4 will only appear when a valid crane configuration has been entered and will navigate to RCL Operating Screen.

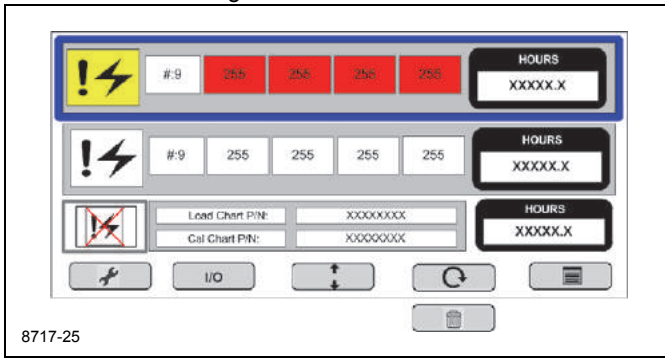
 Button #5 will navigate to Main Screen when pressed.

	<u>Truck Engine RPM</u>
	<u>Truck Diesel Fuel Level</u> — The truck diesel fuel level is displayed as a percentage of maximum fuel level. If the truck diesel fuel level drops below 20% of maximum capacity, the general warning light is shown on the operating mode screen and the truck diesel fuel level icon is highlighted YELLOW on the diagnostics screen.
	<u>Hydraulic Oil Temp</u> — If the hydraulic oil temperature rises above 180°F, the general warning light is shown on the operating mode screen and this icon is highlighted RED. Fahrenheit is default value.
	<u>Crane Hour Meter</u> — Real-time clock is on anytime the crane is operating. The time is saved when crane is shutdown.
	<u>Battery Voltage</u> — If the truck battery voltage drops below 10.5 Volts, the general warning light is shown on the operating mode screen and the truck battery voltage icon is highlighted RED on the diagnostics screen.
	<u>Engine Water Temperature</u> — If the engine water temperature rises above 220°F the general warning light is shown on the operating mode screen and this icon is highlighted RED. Fahrenheit is default value.
	<u>Engine Stop Lamp</u> — If an engine error is detected the icon is highlighted RED.
	<u>Engine Warning Lamp</u> — If an engine warning is detected the icon is highlighted YELLOW.

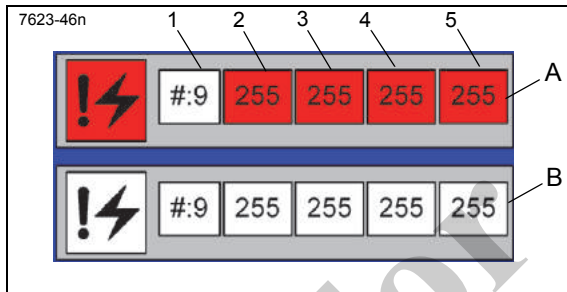
	<u>Truck Regeneration Needed</u> — When the truck is in need of regeneration (first stage and all subsequent stages), the general warning light is shown on the operating mode screen and the truck diesel particulate filter icon is highlighted YELLOW on the diagnostics screen. Gray if not supported.
	Module Fault — turns RED when any lower HED module is missing or has a fault.
	<u>Engine Oil Pressure Warning</u> — If the truck engine oil pressure drops below 5 psi, the general warning light is shown on the operating mode screen and the truck engine oil pressure icon is highlighted RED on the diagnostics screen.
	<u>Engine Oil Temperature</u> — If the truck engine oil temperature rises above 250°F, the general warning light is shown on the operating mode screen and the truck engine oil temperature icon is highlighted RED on the diagnostics screen. Temperature is displayed in degrees Fahrenheit (default value).
	<u>Hydraulic Filter Reminder Warning</u> — If the hydraulic filter reminder limit (see “Tools” screen) has been reached, the general warning light is shown on the operating mode screen and the hydraulic filter reminder icon is highlighted RED on the diagnostics screen.
	Suction Shut-off Valve is Closed — turns RED when valve closes) Crane cannot function = ESTOP



Diagnostic Menu Screen #2




8717-25





Active Fault Box (Red, A) - The crane control system will display up to 20 active faults or errors in the crane and RCL control system(s). Faults numbers only show when fault occurs and clears when fault is corrected. The three digit numbers correspond to a specific fault for a specific module, connector and pin.


- 1 — # Block - Indicates the number of the active fault already in the control system, use the arrow keys to scroll. Numbers are 1 through 20, with maximum of 20 faults.
- 2 — Device Number
- 3 — Group Number
- 4 — Index
- 5 — Error Number


Logged Fault Box (B) - Logged faults are not currently active, use the up/down arrows to scroll through the codes.


 Press the UP/Down button to highlight the Logged Fault Code Box.

 Press the circular arrow button (#3) to scroll through the faults for either the “Active” or “Logged” faults.

 Button #4 will change to “delete” when the clear log icon is selected.

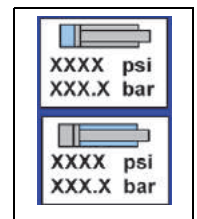
 Button #2 will navigate to real-time IO screen when pressed.

 Press button (#5) to navigate to the Main Menu.

 Press button (#1) to navigate to the Diagnostic Screen #1.

The crane control system will display up to 20 of the most recent logged faults or errors in the crane and RCL control system(s). The circular arrows can be used to scroll through the active faults. This series or three-digit numbers correspond to a specific fault for a specific module, connector and pin. To clear the logged fault codes, the button with the fault code icon and red “X” can be depressed.

Lift Cylinder Pressure Sensor — displays the real time pressures in psi and bar for the base and the rod side pressures.



### ABOUT THE MANITOWOC DIAGNOSTIC CODE APPLICATION

The Manitowoc Diagnostic Code Application is a free mobile application that enables the user to enter and retrieve information about specific crane fault codes on a mobile device. The application is available from the Google and Apple stores and compatible with most Android and Apple mobile smart devices.

To look up a fault code with the Manitowoc Diagnostic Code application:

1. Find the fault code you want to research in the RCL diagnostics screen. For more information, see "Diagnostic" on page 7-19.

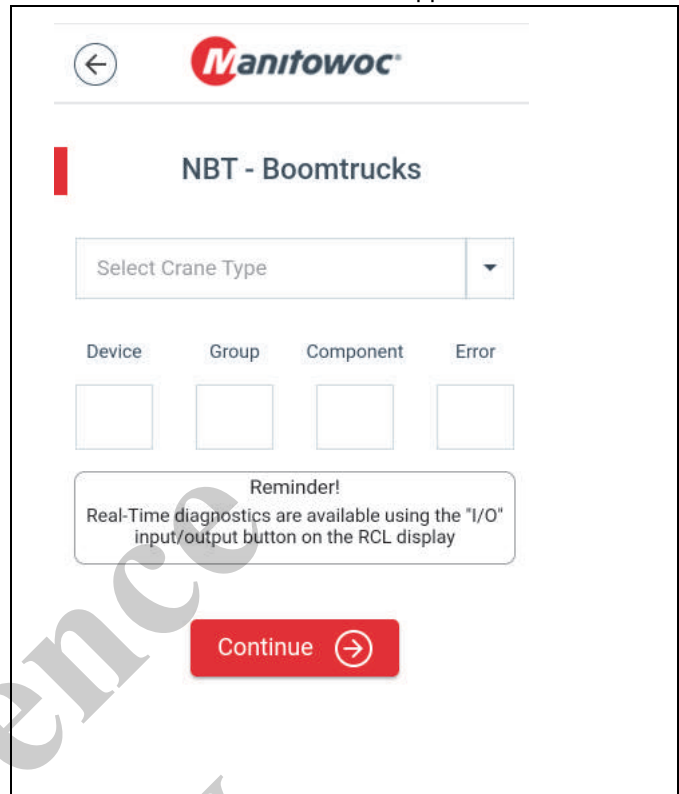
2. Open the Manitowoc Diagnostics Code Application on your smart device.

The Diagnostic Code Application splash screen appears.



3. Click NBT.

The NBT - Boomtrucks screen appears.

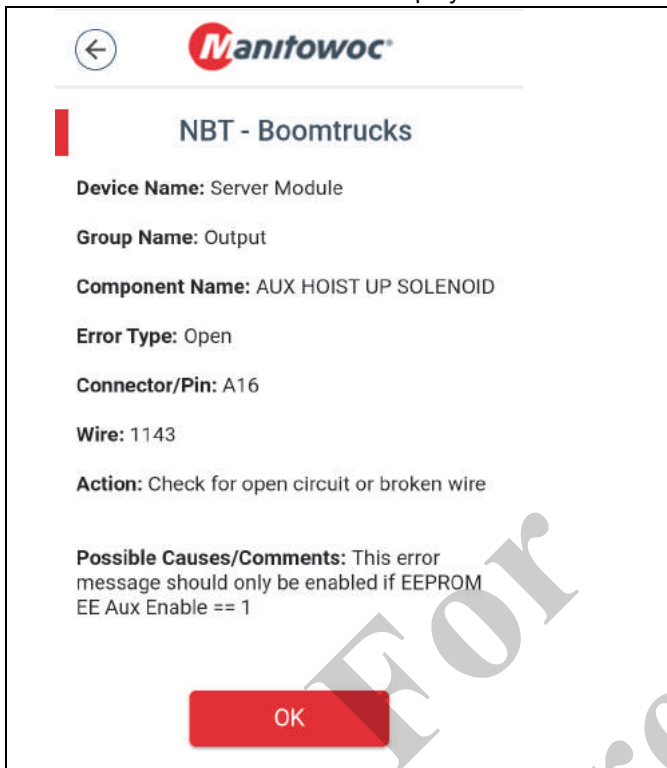


4. Complete the following using information from the error code displayed on the RCL:

- Select Crane Type—Select the NBT crane type from the dropdown list.
- Device—Enter the device number from the fault code.
- Group—Enter the group information from the fault code.
- Component—Enter the component information from the fault code.
- Number—Enter the number information from the fault code.

5. Press Continue.

The Fault code information is displayed.



6. Press OK to return to the main screen.

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