

National Crane NBT30H

Operator Manual



National Crane

OPERATOR MANUAL

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

NBT30H

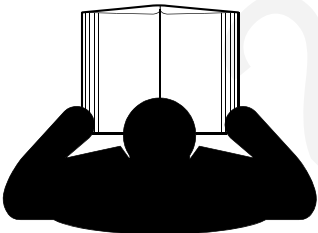
This Manual is divided into the following sections:

SECTION 1	INTRODUCTION
SECTION 2	SAFETY PRECAUTIONS
SECTION 3	CONTROLS AND OPERATING PROCEDURES
SECTION 4	SET-UP
SECTION 5	LUBRICATION PROCEDURE AND CHARTS
SECTION 6	MAINTENANCE CHECKLIST
SECTION 7	LOAD MOMENT INDICATOR

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.



DANGER

An untrained operator subjects himself and others to death or serious injury. Do not operate this crane unless:

- You are trained in the safe operation of this crane. Manitowoc is not responsible for qualifying personnel.
- You read, understand, and follow the safety and operating recommendations contained in the crane manufacturer's manuals and load charts, your employer's work rules, and applicable government regulations.
- You are sure that all safety signs, guards, and other safety features are in place and in proper condition.
- The Operator Manual and Load Chart are in the holder provided on crane.



**CALIFORNIA
PROPOSITION 65 WARNING**

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



**CALIFORNIA
PROPOSITION 65 WARNING**

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

The original language of this publication is English.

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SECTION 1

INTRODUCTION

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GENERAL

This manual has been compiled to assist you in properly operating and maintaining your Model NBT30H 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 machine for use by subsequent operating personnel.

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

The NBT30H 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 service management to coordinate the contact on your behalf.



FIGURE 1-1

Supplemental Information

Supplemental information regarding safety & operation, specifications, service & 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 Distributor for the latest information. Your National Distributor is equipped with the proper tools, necessary parts, and trained personnel to properly maintain and service your crane.

Safety Information

A Safety Compact Disc (CD) 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.

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 Manitowoc 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.

New Owners

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: http://www.manitowoccranes.com/MCG_CARE/Includes/EN/changeOfOwnership.cfm 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.

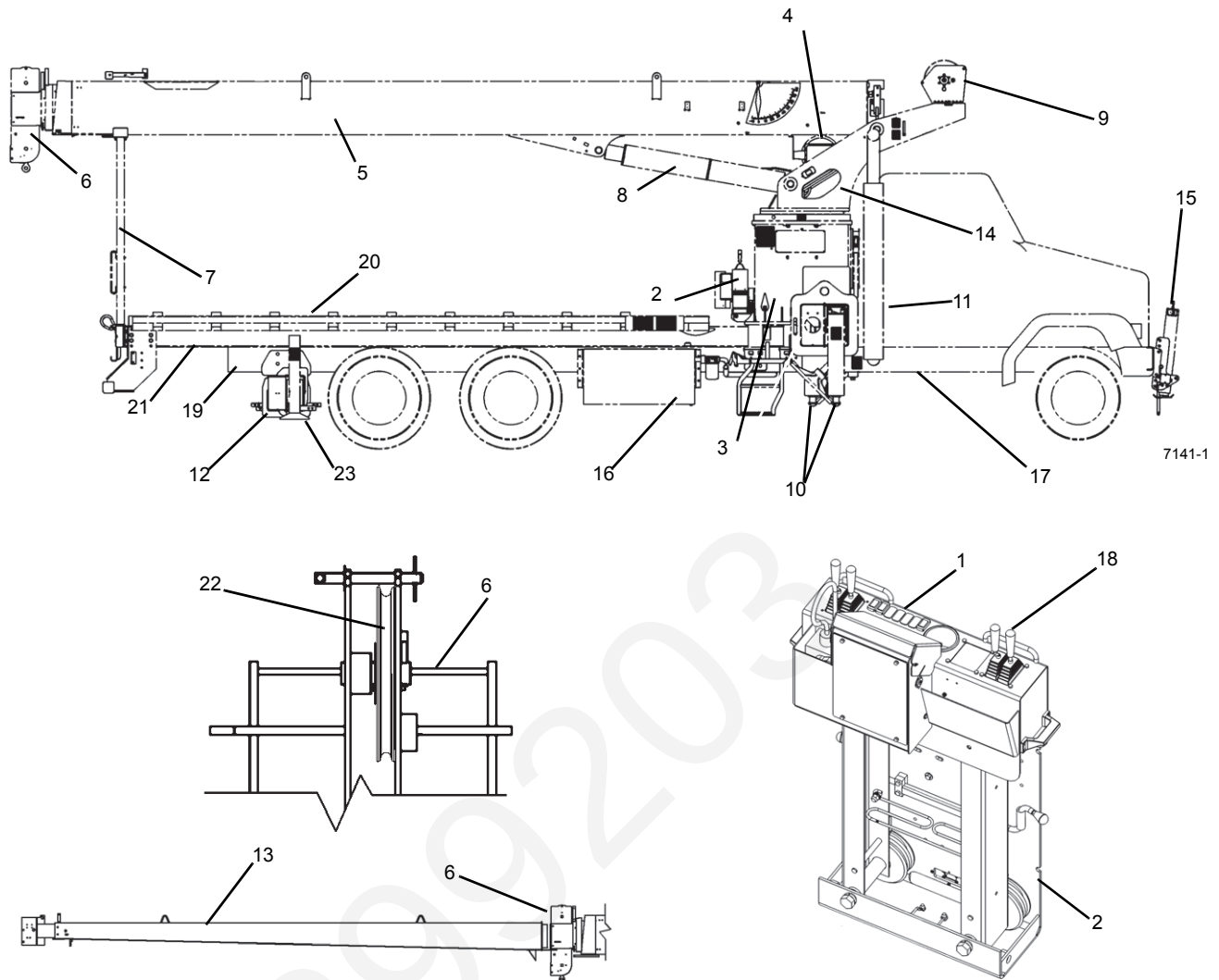


FIGURE 1-2

Item	Component
1	Operator's Console
2	EasyReach™ Pedestal
3	Operators Station
4	Rated Capacity Limiter (RCL) Reel
5	Boom
6	Boom Nose
7	Boom Rest
8	Lift Cylinder
9	Hoist
10	Outrigger Beam
11	Outrigger Box
12	Rear Stabilizer Out and Down (RSOD)

Item	Component
13	Extension
14	Turret
15	Jack Front Outrigger (SFO), Front Outrigger Jack
16	Hydraulic Tank
17	Hydraulic Pump
18	Hydraulic Remote Controller (HRC)
19	Truck Frame
20	Truck Bed
21	Torsion Box, T-Box
22	Sheave
23	RSOD Foot

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SECTION 2

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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 Manitowoc 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 Manitowoc distributor and/or Manitowoc Crane Care.

If this crane becomes involved in a property damage and/or personal injury accident, **immediately** contact your Manitowoc 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

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.

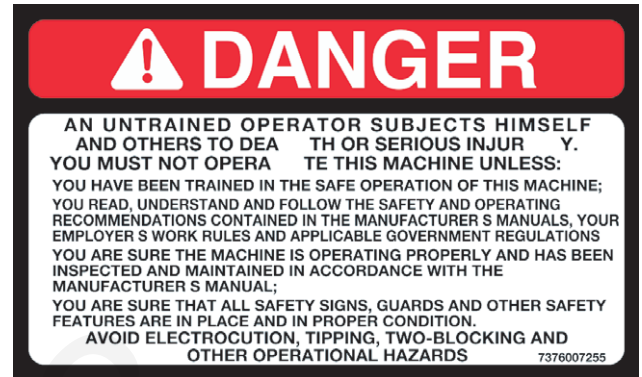
OPERATOR QUALIFICATIONS

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 placards and 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 their operation. Work practice requirements may vary slightly between government regulations, industry standards, and employer policies so a thorough knowledge of all such relevant work rules is necessary.



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 signs, guards, and other safety features are in place and in proper condition.

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

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

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

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

OPERATIONAL AIDS

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

Manitowoc remains committed to providing reliable products that enable users and operators to safely lift and position loads. Manitowoc 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 Manitowoc 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), a safe load indicator (SLI), or an EKS5; Manitowoc 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 wire rope may fail allowing the load, block, etc. to free fall.

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

boom extension 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 wire 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 wire rope as the boom is lowered. Keep load handling devices a minimum of 107 cm (42 in) below the boom nose at all times.

Two-blocking can be prevented. Operator awareness of the hazards of two-blocking is the most important factor in preventing this condition. An Anti-Two-Block System is intended to assist the operator in preventing dangerous two-

block conditions. It is not a replacement for operator awareness and competence.

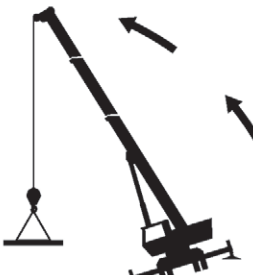
Never interfere with the proper functioning of operational aids or warning devices.

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



TIPPING HAZARD

To avoid death or serious injury, ensure load and crane's configuration are within capacity as shown on crane's load rating chart and notes.

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

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

TO AVOID DEATH OR SERIOUS INJURY:

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

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

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

NEVER get on or off a moving crane.

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



TWO-BLOCKING HAZARD

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

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

DO NOT PASS LOADS OR BOOM OVER GROUND PERSONNEL.

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

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

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FOLLOW INSTRUCTIONS IN OPERATOR'S AND SAFETY HANDBOOK.
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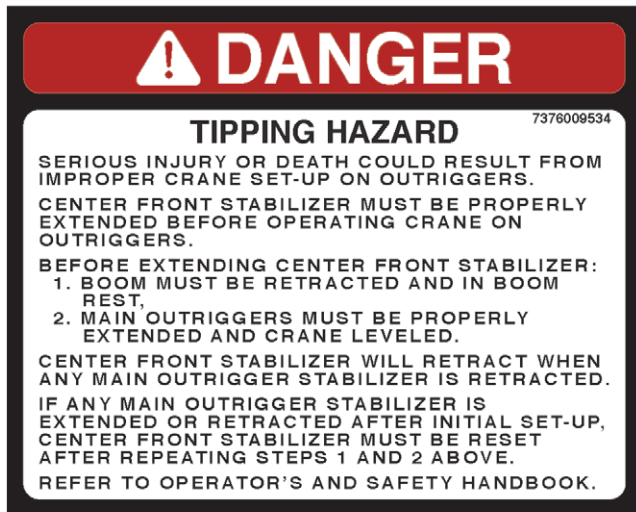
CRANE STABILITY/STRUCTURAL STRENGTH

To avoid death or serious injury, 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.



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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

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.). To assist you in determining prevailing wind conditions, refer to Table 2-1.

Wind forces can exert extreme dynamic loads. **Manitowoc recommends that a lift not be made if the wind can cause**

a loss of control in handling the load. Manitowoc recommends that, if the wind speed (velocity) is between 32 km/h (20 mph) to 48 km/h (30 mph), the load capacities shall be reduced to account for the size and shape of the load and the wind direction in relation to the machine for all boom and boom extension lengths. Further, operation of the crane in wind velocities over 48 km/h (30 mph) is not recommended.

Table 2-1 Beaufort Wind Scale

Wind Force		Wind Velocity km/h (mph)	Visible Indicator Effects of wind as observed on land
Beaufort Scale	Designation		
Zero (0)	Calm	less than 1 (<1)	Calm; smoke rises vertically
1	Light Air	1.1-5.5 (1-3)	Smoke drift indicates wind direction. Leaves and wind vanes are stationary.
2	Light Breeze	5.6-11 (4-7)	Wind felt on exposed skin. Leaves rustle. Wind vanes begin to move.
3	Gentle Breeze	12-19 (8-12)	Leaves/small twigs constantly moving. Light flags extended.
4	Moderate Breeze	20-28 (13-17)	Dust and loose paper raised. Small branches begin to move.
Reduce crane load ratings and operating parameters at 32 km/h (20 mph)			
5	Fresh Breeze	29-38 (18-24)	Branches of a moderate size move. Small trees in leaf begin to sway.
6	Strong Breeze	39-49 (25-30)	Large branches in motion. Whistling heard in overhead wires. Umbrella use becomes difficult. Empty plastic bins tip over.
Cease all craning operations at 48 km/h (30 mph); lower & retract boom			
7	Moderate Gale	50-61 (31-38)	Whole trees in motion. Effort needed to walk against the wind.

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.

Use only one hoist at a time when lifting loads.

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

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 OCT90 "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 Manitowoc 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 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 designated 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 designated person to direct the operation.
- Use one qualified signal person.
- 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.

PILE DRIVING AND EXTRACTING

Pile driving and extracting are applications approved by Manitowoc, provided all equipment is operated within factory guidelines. The following operating requirements must be used during pile driving and extracting with a Manitowoc 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 Manitowoc 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 Manitowoc, 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 or jib.
- 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 or jibs 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, Manitowoc 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

29CFR1926.1400 and ASME B30.5 American National Standard.



WARNING **Electrocution Hazard!**

Manitowoc 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.

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

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



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DANGER

ELECTROCUTION HAZARD TO AVOID DEATH OR SERIOUS INJURY

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

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

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

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

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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.

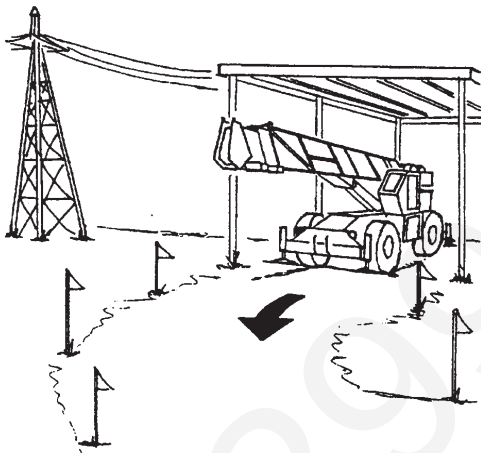
Set-Up and Operation

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 should have no other duties while the crane is working.

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

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

Electrocution Hazard Devices

The use of insulated links, insulated boom cages/guards, proximity warning devices, or mechanical limit stops does

not assure that electrical contact will not occur. Even if codes or regulations require the use of such devices, failure to follow the rules listed here may result in serious injury or death. You should be aware that such devices have limitations and you should follow the rules and precautions outlined in this 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 Manitowoc distributor must be immediately advised of the incident and consulted on necessary inspections and repairs. Thoroughly inspect the wire rope and all points of contact on the crane. Should the distributor not be immediately available, contact Manitowoc 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 Manitowoc 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.

PERSONNEL HANDLING

The American Society of Mechanical Engineers issued a new American National Standard entitled, *Personnel Lifting Systems*, ASME B30.23-2011:

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 new 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 Manitowoc 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 wire 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 Manitowoc.
 - 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
- *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 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.

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.

Manitowoc continues to recommend that cranes be properly maintained, regularly inspected and repaired as necessary. Manitowoc reminds crane owners to ensure that all safety decals are in place and legible. Manitowoc 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 Manitowoc distributor.

Service and Repairs



WARNING

Fall Hazard!

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

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

Service and repairs to the crane must only be performed by a qualified person. All service and repairs must be performed in accordance with manufacturer's recommendations, this manual, and the service manual for this machine. If there is any question regarding maintenance procedures or specifications, contact your Manitowoc 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 Manitowoc is **strictly prohibited**. All replacement parts must be Manitowoc 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 (refer to the *Load Chart*). When inflating tires, use a tire gauge, clip-on inflator, and extension hose which will permit standing clear of the tire while inflating.

Wire Rope

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

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

Always make daily inspections of the wire rope, keeping in mind that all wire rope will eventually deteriorate to a point where it is no longer usable. Refuse to work with worn or damaged wire rope. Wire 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 wire rope begins to decrease when the rope is put to use and continues to decrease with each use. Wire rope will fail if worn-out, overloaded, misused, damaged or improperly maintained.
- The nominal strength, sometimes called catalog strength, of a wire rope applies only to a new, unused rope.
- The nominal strength of a wire rope should be considered the straight line pull which will actually break a new unused rope. The nominal strength of a wire rope should never be used as its working load.
- Each type of fitting attached to a wire rope has a specific efficiency rating which can reduce the working load of the wire rope assembly or rope system.

- Never overload a wire rope. This means never use the wire rope where the load applied to it is greater than the working load determined by the rope manufacturer.
- Never “shock load” a wire 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 wire 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 wire rope and keeping of permanent records signed by a qualified person are required by OSHA for almost every wire rope application. The purpose of the inspection is to determine whether or not a wire 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 wire ropes and attachments, keep all parts of your body and clothing away from rotating hoist drums and all rotating sheaves. Never handle the wire rope with bare hands.

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

- Sheaves that are too small, worn or corrugated cause damage to a wire rope.
- Broken wires mean a loss in strength.
- Kinks permanently damage a wire rope and must be avoided.
- Wire ropes are damaged by knots. Wire 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 wire rope inspection procedure is given in the *Service Manual*.

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

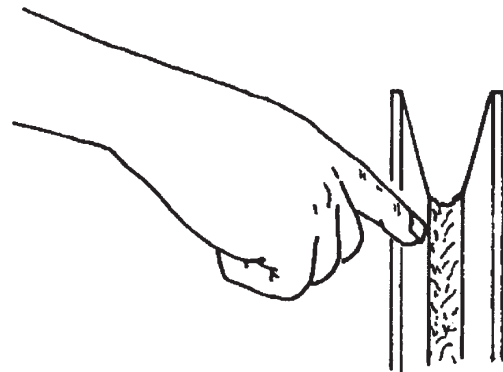
When installing a new rope:

- Keep all parts of your body and clothing away from rotating hoist drums and all rotating sheaves.
- Never handle the wire rope with bare hands.
- Follow proper instructions for removing rope from a reel.
- Apply back tension to the storage/payoff reel of the new rope to 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 wire 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 wire rope life and minimize hook block rotation, it is recommended that even numbers of parts-of-line be used in multiple-part reeving whenever possible.

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 wire rope. However, conventional rope retirement criteria based only upon visible wire breaks may prove inadequate in predicting rope failure. The user of cast nylon sheaves is therefore cautioned that a retirement criteria should be established based upon the user's experience and the demands of his application.

Batteries

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

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

- 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. and the turntable pin swing lock should be engaged. 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.turntable 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.

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

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

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

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

When driving the crane, 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.

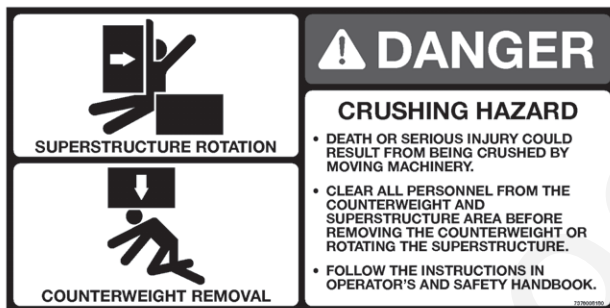
Carbon monoxide fumes from the engine exhaust can cause suffocation in an enclosed area. Good ventilation is very important when operating the crane.

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.

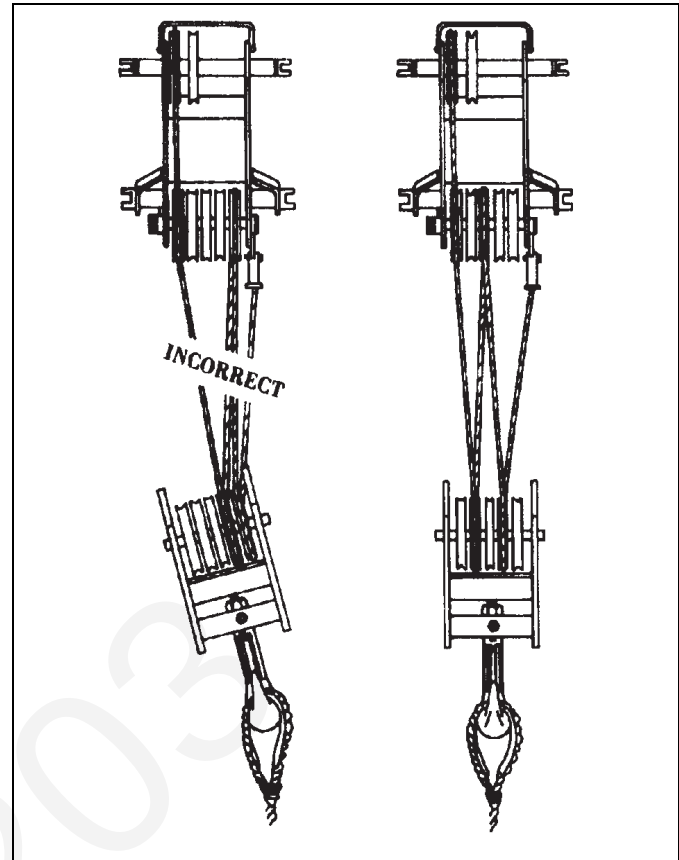
You must always be aware of everything around the crane while lifting or traveling. If you are unable to clearly see in the direction of motion, you must post a look out or signal person before moving the crane or making a lift. Sound the horn to warn personnel.

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

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

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

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

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

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

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 - previously agreed upon and completely understood by the operator and signal person.

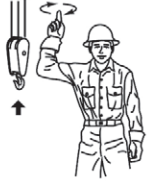
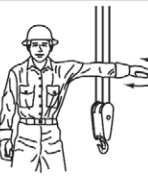
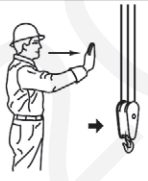
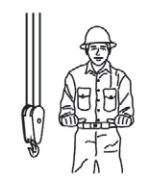
If communication with the signal person is lost, crane movement must be stopped until communications are restored.

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.

STANDARD HAND SIGNALS FOR CONTROLLING CRANE OPERATIONS

Complies with ASME B30.5-2011

 HOIST. With forearm vertical, forefinger pointing up, move hand in small horizontal circle.	 LOWER. With arm extended downward, forefinger pointing down, move hand in small horizontal circle.	 USE MAIN HOIST. Tap fist on head; then use regular signals.	 USE WHIPLINE (Auxiliary Hoist). Tap elbow with one hand; then use regular signals.	 RAISE BOOM. Arm extended, fingers closed, thumb pointing upward.
 LOWER BOOM. Arm extended, fingers closed, thumb pointing downward.	 MOVE SLOWLY. 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).	 RAISE BOOM AND LOWER LOAD. With arm extended, thumb pointing up, flex fingers in and out as long as load movement is desired.	 LOWER BOOM AND RAISE LOAD. With arm extended, thumb pointing down, flex fingers in and out as long as load movement is desired.	 SWING. Arm extended, point with finger in direction of swing of boom.
 STOP. Arm extended, palm down, move arm back and forth horizontally.	 EMERGENCY STOP. Both arms extended, palms down, move arms back and forth horizontally.	 TRAVEL. Arm extended forward, hand open and slightly raised, make pushing motion in direction of travel.	 DOG EVERYTHING. Clasp hands in front of body.	 TRAVEL (Both Tracks). 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.)
 TRAVEL (One Track). 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.)	 EXTEND BOOM (Telescoping Booms). Both fists in front of body with thumbs pointing outward.	 RETRACT BOOM (Telescoping Boom). Both fists in front of body with thumbs pointing toward each other.	 EXTEND BOOM (Telescoping Boom). One Hand Signal. One fist in front of chest with thumb pointing outward and heel of fist tapping chest.	 RETRACT BOOM (Telescoping Boom). One Hand Signal. One fist in front of chest, thumb pointing outward and heel of fist tapping chest.

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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, Manitowoc 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.

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

Never store flammable materials on the crane.

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

TEMPERATURE EFFECTS ON HOOK BLOCKS

The following information applies to Gunnebo Johnston crane hook blocks:

"Never use a crane block in extreme temperatures..."Sudden failure can occur.

Crane blocks shall not be heated above 82°C (180°F). Craneblock Working Load Limit is valid between 82°C (180°F) and service temperature given on the identification tag with normal lifting precautions.

Additional lifting precautions are required below the service temperature given on the identification tag because cold temperature begins to affect the crane block material properties.

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

75% of the WLL 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 2-2]. 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 2-2 and Table 2-3 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.

NOTE: Operators and service personnel must be aware that load movement, as a result of this phenomena, can be easily mistaken as leaking cylinder seals or faulty holding valves. If leaking seals or faulty holding valves are suspected to be the problem, refer to Service Bulletin dealing with testing telescope cylinders. (*Service Bulletin 98-036* applies to TMS700 and *Service Bulletin G06-005A* applies to RT890 and RT9130.

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

Coeff. = 0.00043 (in ³ /in ³ / °F)										
STROKE	Temperature Change (°F)									
(FT.)	10	20	30	40	50	60	70	80	90	100
5	0.26	0.52	0.77	1.03	1.29	1.55	1.81	2.06	2.32	2.58
10	0.52	1.03	1.55	2.06	2.58	3.10	3.61	4.13	4.64	5.16
15	0.77	1.55	2.32	3.10	3.87	4.64	5.42	6.19	6.97	7.74
20	1.03	2.06	3.10	4.13	5.16	6.19	7.22	8.26	9.29	10.32
25	1.29	2.58	3.87	5.16	6.45	7.74	9.03	10.32	11.61	12.90
30	1.55	3.10	4.64	6.19	7.74	9.29	10.84	12.38	13.93	15.48
35	1.81	3.61	5.42	7.22	9.03	10.84	12.64	14.45	16.25	18.06
40	2.06	4.13	6.19	8.26	10.32	12.38	14.45	16.51	18.58	20.64
45	2.32	4.64	6.97	9.29	11.61	13.93	16.25	18.58	20.90	23.22
50	2.58	5.16	7.74	10.32	12.90	15.48	18.06	20.64	23.22	25.80
55	2.84	5.68	8.51	11.35	14.19	17.03	19.87	22.70	25.54	28.38
60	3.10	6.19	9.29	12.38	15.48	18.58	21.67	24.77	27.86	30.96
Length change in inches = Stroke (Ft.) X Temperature Change (°F) X Coeff. (in ³ /in ³ / °F) X 12 in/ft										

Table 2-3 Boom Drift Chart (Cylinder length change in millimeters)

Coeff. = 0.000774 (1/ °C)		Metric									
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											

OVERLOAD INSPECTION

This information supplements the Rated Capacity Limiter (RCL) manual supplied with each Grove 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!

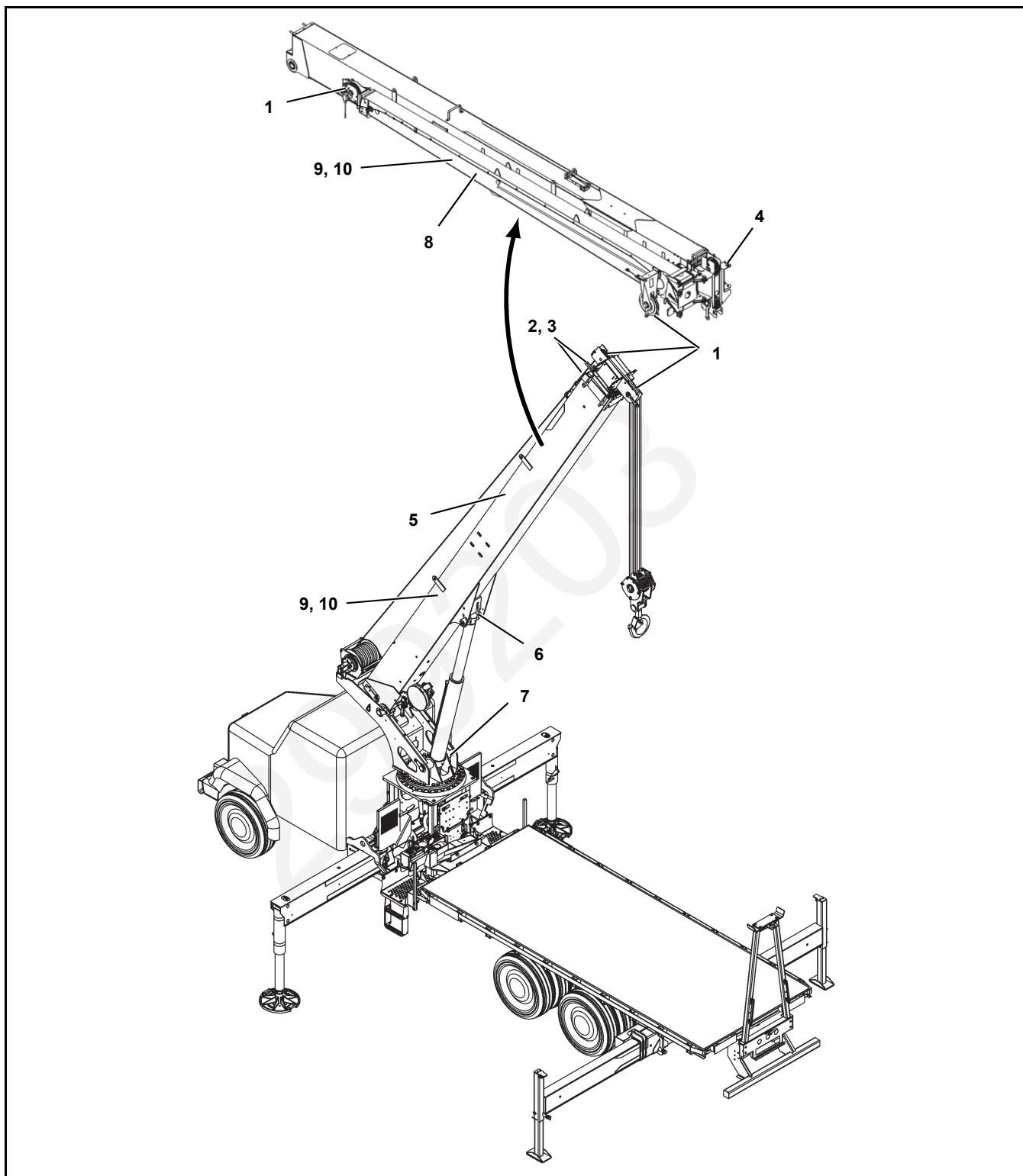
To avoid an accident caused by overload damage to your crane:

- 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.

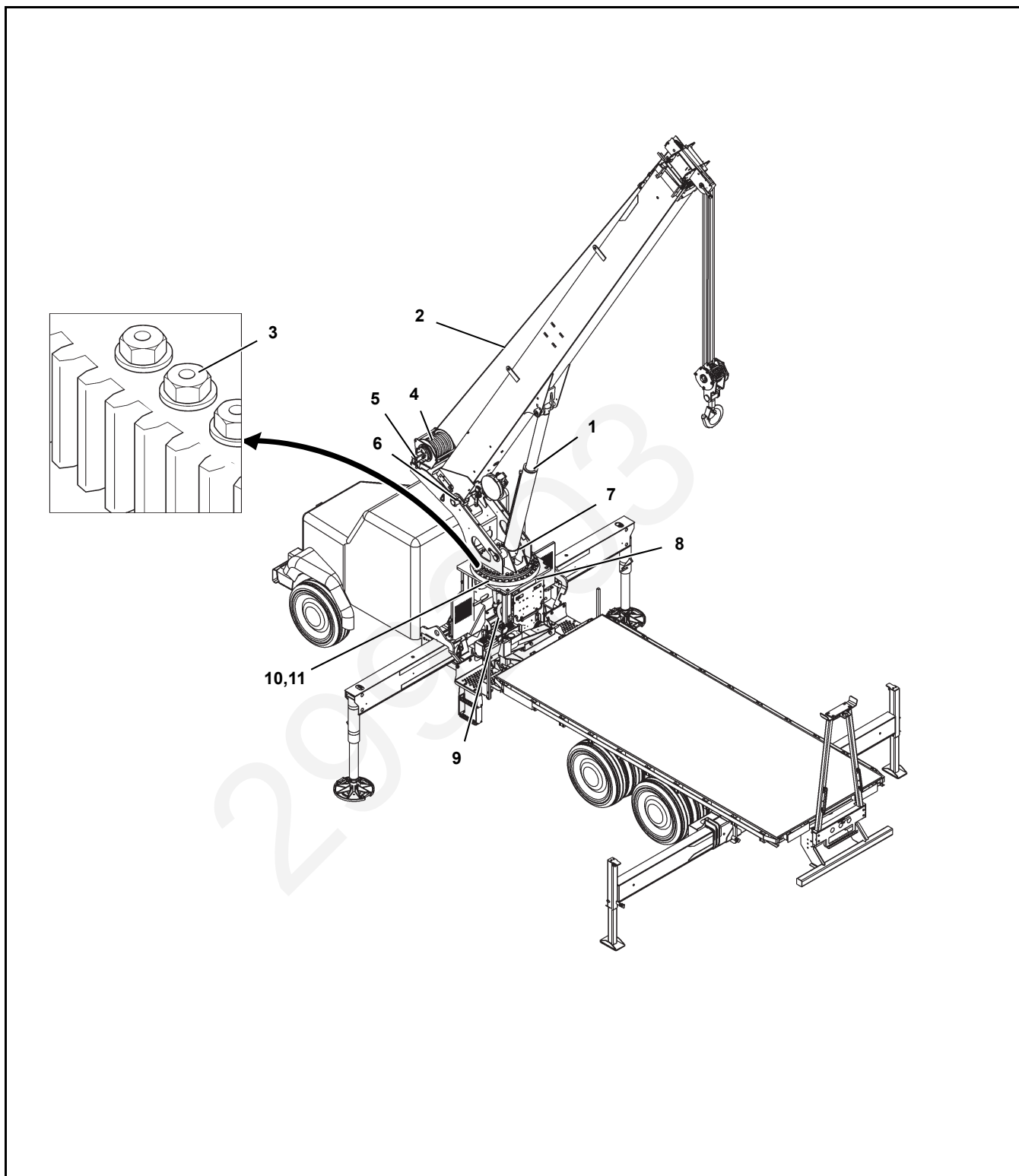
Overload warnings do NOT indicate real time events! Warnings could be sent 24 hours (or more) after the actual event.

Boom Inspection



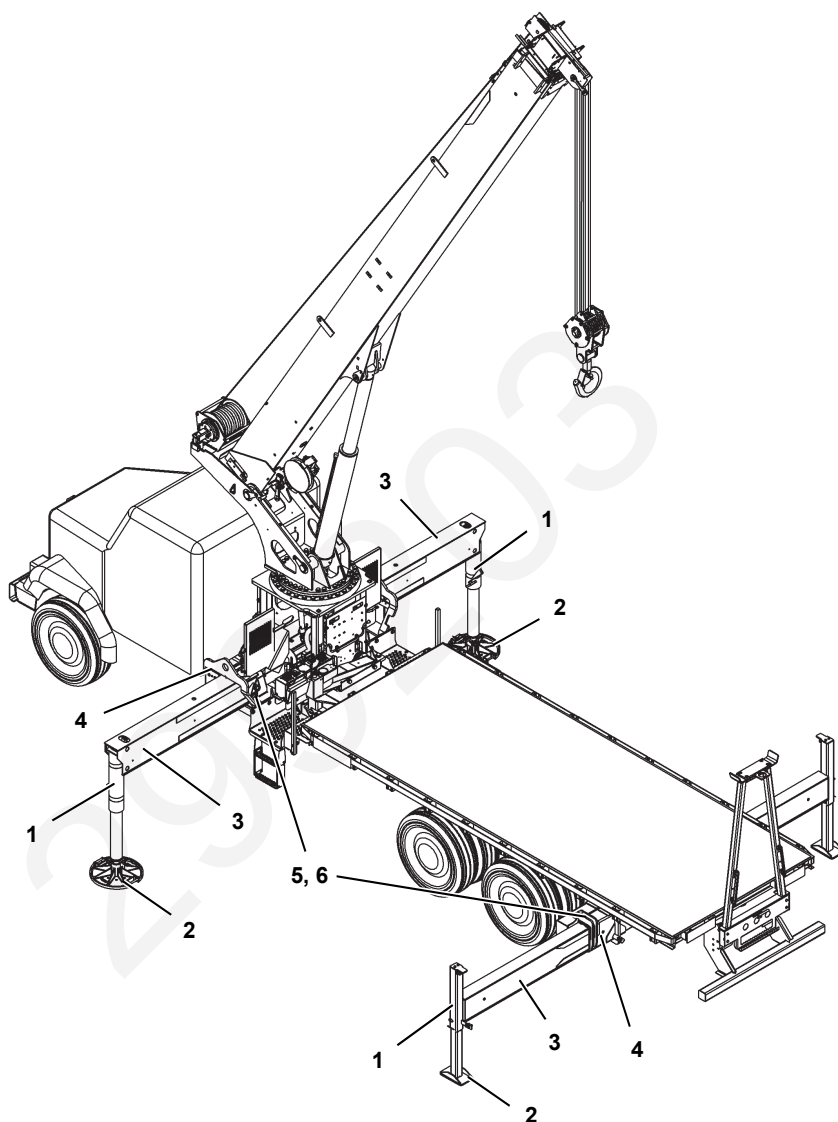
Overload less than 25%			
1	Sheaves, Rope Guides	Inspect all for damage.	
2	Collar-Wear Pads, Pad Retainers	Inspect for damage.	
Overload from 25% to 49%			
1	Sheaves, Rope Guides	Inspect all for damage.	
2	Collar-Wear Pads, Pad Retainers	Inspect all for damage.	
3	Collar-welds	Inspect all for damage.	
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



Overload less than 25%			
1	Lift Cylinder	Inspect for leaks.	
2	Wire 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.
Overload from 25% to 49%			
1	Lift Cylinder	Inspect for leaks.	
2	Wire 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	Mounting Studs	Check bolts for proper torque.	
10	Welds	Inspect for cracks.	
11	Paint	Inspect for cracked paint which could indicate twisted, stretched, or compressed members.	

Carrier Inspection



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

SECTION 3

CONTROLS AND OPERATING PROCEDURES

SECTION CONTENTS

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

- Truck Cab Controls
- EasyReach™ Pedestal
- Outrigger Controls
- Crane Controls
- Operating Procedures
- Hoist System Operation
- Work Site Location
- Load Chart

- Lifting the Load
- Shutdown and Preparation for Travel

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 the crane ignition switch to be operable.

NOTE: The crane ignition switch must be in the STOP position before the truck can be started from the truck cab.

Power Take Off

Manual Shift Control

The Power Take Off (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 the PTO and disengaged when the switch is in the off position. The truck gear shift lever must be in neutral and clutch depressed when the switch is moved. The transmission selector lever must be returned to "N" for stationary vehicle operation. The PTO can be disengaged while in any transmission range provided that the load has 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 push 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 parking brake must be firmly set before leaving cab to begin crane operation. If the ground surface is icy, slick, or sloped, wheel chocks may be required to help immobilize the truck.

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 the truck transmission. Check occasionally to ensure that the switch is working correctly and repair if it is not.

EASYREACH PEDESTAL

The EasyReach™ Pedestal is located on the middle of the truck bed under the boom (Figure 3-1). The operator's console (Figure 3-4) is located on top of the EasyReach pedestal and, when the pedestal is lowered to either down position, provides the operator with an easy reach to the operator's console.



EasyReach Pedestal
(up position)

7782-03

EasyReach Pedestal
(right side down position)



FIGURE 3-1

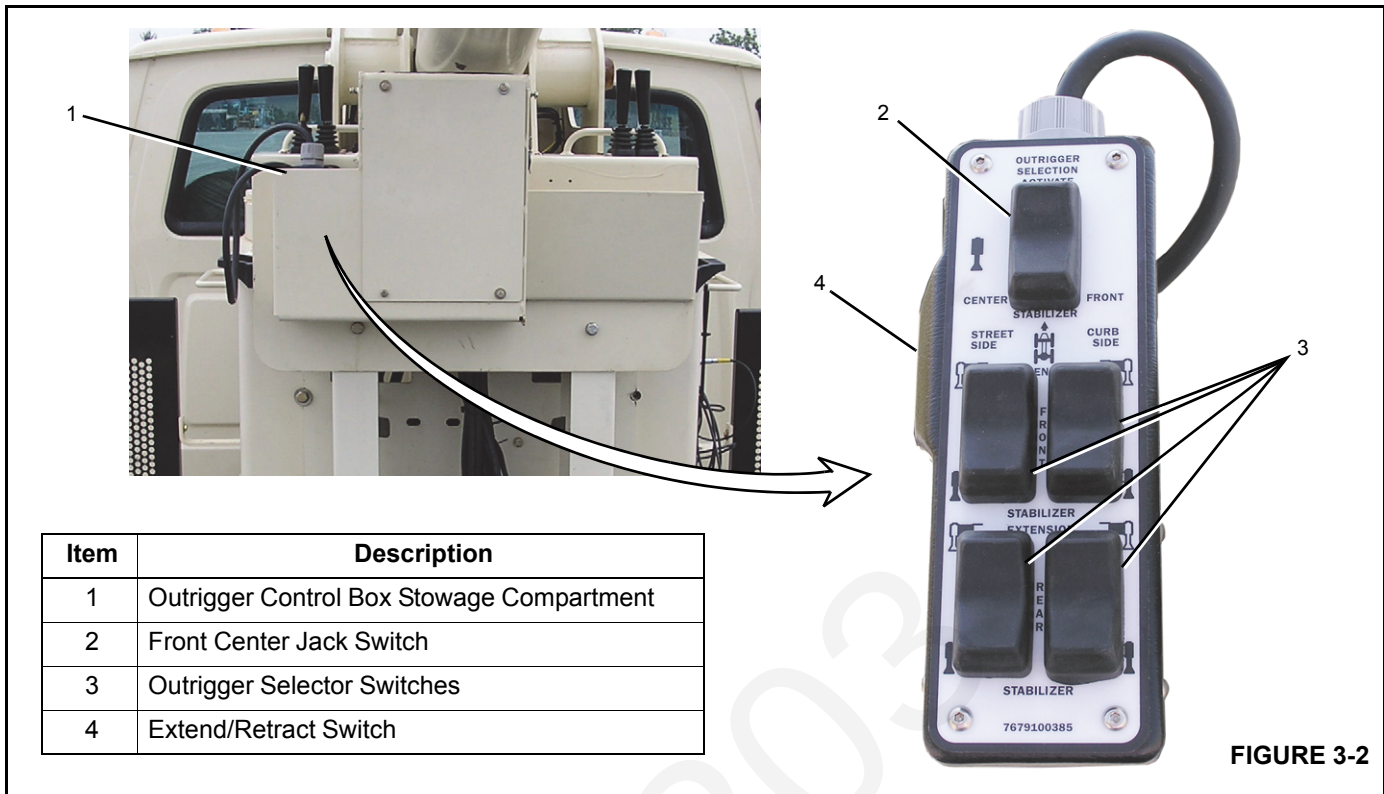


FIGURE 3-2

Outrigger Control Box (Pendent)

The handheld Outrigger Control Box is stowed in a compartment on the front of the EasyReach pedestal (Figure 3-2) and is used to control the outriggers.

Extend/Retract Switch

The Extend/Retract Switch is located on the side of the outrigger control box and is used in conjunction with the outrigger selector switches to control the outrigger functions.

Outrigger Selector Switches

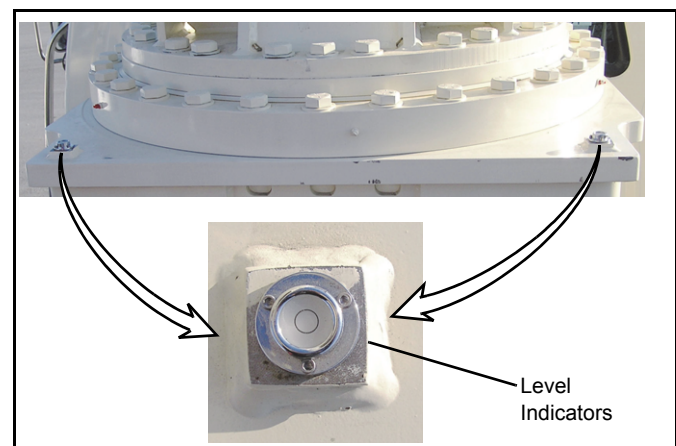
There are four Outrigger Selector Switches on the face of the outrigger control box. To extend or retract an outrigger, first select the component with the Outrigger Selector Switch, then select EXTEND or RETRACT with the Extend/Retract Switch.

Center Front Jack Switch

The Center Front Jack Switch is used to lower and raise the Center Front Jack. To operate the center front jack, press the Center Front Jack Switch and then press Extend/Retract Switch. The Center Front Jack automatically retracts if any of the other jacks are retracted and must be reset if lifting is to be continued.

Crane Level Indicators

The crane has two Level Indicators on either side of the frame that is used to level the crane with the outriggers. Adjust the outrigger jacks until the bubble is in the center of the Level Indicator.



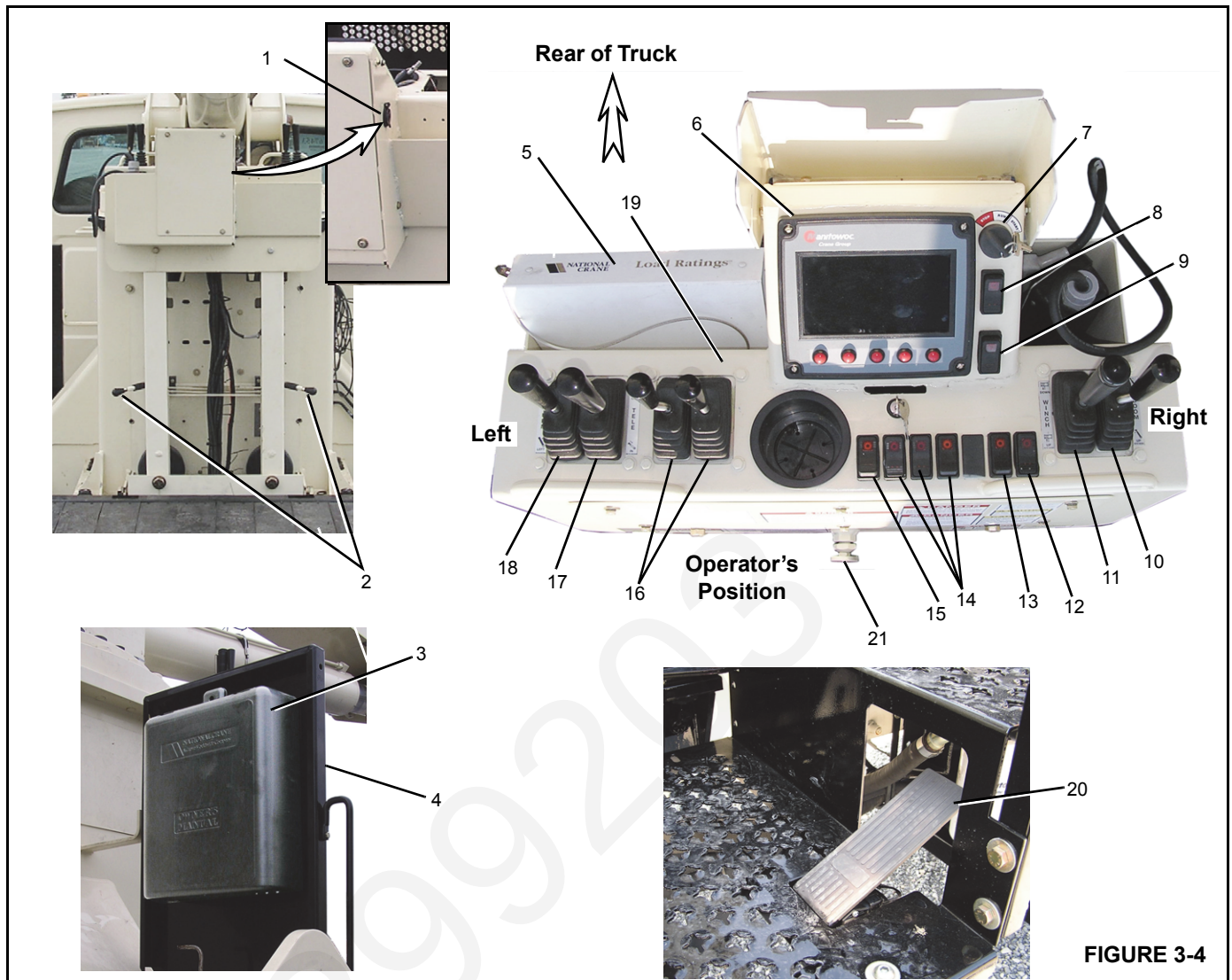


FIGURE 3-4

Item	Description
1	12 V Power Adapter
2	Pedestal Lock Lever
3	Document Case
4	Back Rest
5	Load Charts
6	RCL Display Module
7	Crane Ignition Switch
8	Crane Function Power Switch
9	Remote Control Enable Switch
10	Boom Lift Control Lever
11	Hoist Control Lever w/Rotation Indicator

Item	Description
12	Hoist Speed Switch
13	Momentary RCL Override Switch
14	Option Switches
15	Horn Switch
16	Optional Control Levers
17	Boom Telescope Control Lever
18	Swing Control Lever
19	Operator's Console
20	Foot Throttle
21	Pedestal Lock Pin

CRANE CONTROLS

See Figure 3-4 for item number identification.

Operator's Console

The Operator's Console (19) is located on the EasyReach pedestal and contains the crane controls.

EasyReach Lock Lever

The lock lever (2) secures the EasyReach Pedestal in the upright position. Push the lever up to release and swing the pedestal into the desired down position.

Pedestal Lock Pin

The Pedestal Lock Pin (21) secures the pedestal in one of two down positions. Pull the pin out as the pedestal is swung down to the desired height. Release the pin to secure the pedestal in the down position. Pull the pin to swing the pedestal to the up position.

Crane Ignition Switch

The Crane Ignition Switch (7) is located on the operator's console and controls the truck engine and crane power. The ignition switch has three positions. STOP shuts down engine and crane power, RUN activates truck engine ignition and crane power, and START to start the truck engine.



NOTE: The truck ignition must be in the OFF position and the PTO engaged before the engine can be started with the Crane Ignition Switch. The crane ignition must be in the STOP position before the truck engine can be started with the truck ignition switch.

The EasyReach Console must be lowered into an operating position before the crane can be started. A proximity switch in the pedestal disables the Crane Ignition Switch when the pedestal is not in a lowered operation position.

Crane Function Power Switch

The Crane Function Power Switch (8) is located on the operator's console and is used to disable controllers and prevents inadvertent crane movement. Push the switch to the ON position to enable the controllers. The red LED in the switch is illuminated when the switch is in the ON position.

Boom Telescope Control Lever

The Telescope Control Lever (17) is on the left side of the operator's console. Push the lever forward to extend the boom and pull back to retract the boom.

Hoist Control Lever

The Hoist Control Lever (11) is located on the right side of the operator's console. Push forward to lower the load and pull the lever back to raise the load.



WARNING

Crushing Hazard!

Lower the load as the boom is extended. Failure to do so may cause a two-block condition, causing the loadline to break or damage the crane.

Hoist Speed Switch

The hoist operates at two speeds; the Hoist Speed Switch (12), located on the right side of the operator's console, is used to select the hoist speed.

Hoist Rotation Indicator

The Hoist Rotation Indicator is located on top of the hoist control lever (11). The indicator is electronically driven by a signal from the drum rotation indicator (DRI) sending unit attached to the hoist. A pulsating signal is sensed by the operator's thumb during hoist operation.

The DRI transducer may have an integral optional Last Layer Indicator (LLI) which is programmed to notify the operator when there are three wraps of cable left on the drum.

Warning Horn Switch

The Warning Horn Switch (15) is located on the operator's console. Push the switch to sound the horn button to warn personnel of impending movement of the crane. An amber LED is illuminated when the switch is on.

Swing Control Lever

The Swing Control Lever (18) is located on the left side of the operator's console and controls turret rotation. Push the lever forward to rotate the turret clockwise and pull back to rotate the turret counterclockwise. When the Swing Control Lever is moved to the neutral position, the swing brake is automatically applied.

NOTE: Swing is limited to 410° (205° left, 205° right) (Figure 3-5).

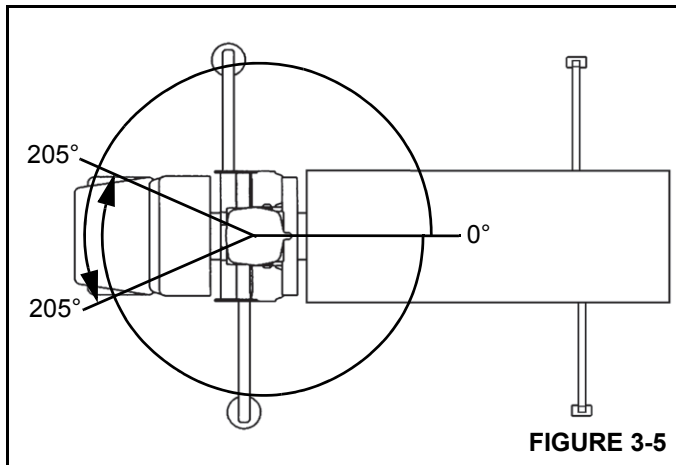


FIGURE 3-5

Boom Lift Control Lever

The Boom Lift Control Lever (10) is located on the right side of the operator's console and is used to raise and lower the boom. Push the lever forward to lower the boom and pull back to raise the boom.

Foot Throttle

The Foot Throttle (20) is located on the floor of the operator's station and is used to control the engine speed. Depress the foot throttle to accelerate the engine speed and release to return to idle.

Load Charts

The Load Charts (5) are contained in a three ring binder and are stored in a pocket located on the front of the operator's console. The Load Chart contains lifting capacities of the crane in all allowable lifting configurations.

Rated Capacity Limiter (RCL) Display Module

The RCL provides the crane operator with information to assist the operator in operation of the crane within its design parameters. The RCL Console (6) 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 nonsafe condition is approached, the RCL warns the operator with an alarm and locks out the crane functions that can aggravate the situation.

Remote Control Enable Switch (Optional)

The Remote Control Enable Switch (9) is used to activate the optional remote controller. Refer to *Crane Remote Control (Optional)*, page 3-17.

Momentary RCL Override Switch

The Momentary RCL Override Switch (13) overrides the RCL system while the switch is pressed in. The RCL is active when the switch is released.

! DANGER

The RCL only aids the operator when programmed with the proper load chart and crane configuration. If the RCL is not programmed correctly, the RCL will not alert the operator when the limits are reached.

Hoist Jog Switch

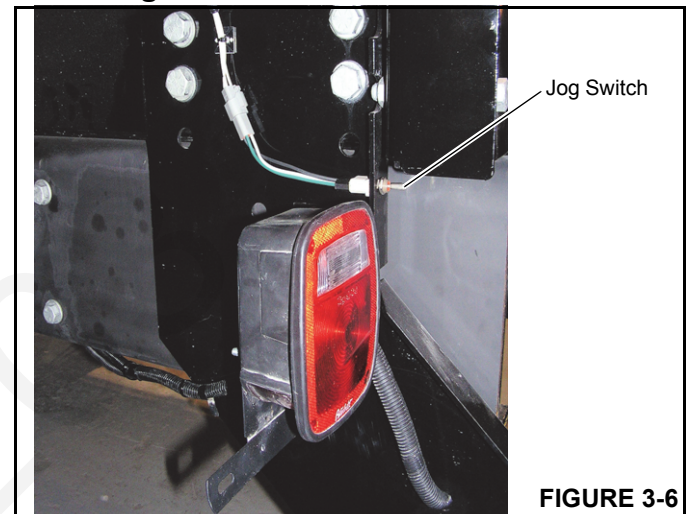


FIGURE 3-6

CAUTION

The A2B switch is overridden when the hoist jog switch is activated. Be careful not to damage the load line when taking in load line.

The Hoist Jog Switch is located at the back left rear corner of the truck and aids the operator in stowing and unstowing the hook block. The two position toggle switch activates the hoist for a 2 second interval in either direction to take up or let out the load line.

NOTE: The Crane Function Power switch must be OFF.

The Anti-Two-Block (A2B) switch is overridden when the Hoist Jog Switch is activated.

Diagnostic Connector

The Diagnostic Connector (not shown) is located inside the panel on the left side of the frame. It is used to connect to the crane/RCL CANbus network.

The connector is designed to connect a laptop computer with appropriate cable and system software to the crane for diagnostic work.



The service software and connection cable are available through Crane Care to those service technicians who have attended the Grove New Technology training course.

Control Levers (Optional)

When installed, these two Control Levers (16) are used for optional equipment such as an auger, auxiliary hoist or hydraulic hose reel. Both levers are two position levers, move the lever forward or pull the lever backward to perform the required function of the option on your machine. Instructions on the control console will help define the function of each lever.

OPERATING PROCEDURES

You need to be familiar with the safety precautions outlined in *Safety Precautions*, Section 2 before operating the crane.

Equipment Familiarization

All crew members should be familiar with the location and operation of the controls, the correct operating procedure, the maximum lifting capacities, and the information in *Safety Precautions*, Section 2 of this manual. Carefully follow the operating procedures outlined below and the information in the load charts located in the crane cab.

Equipment Checks

Prior to placing the unit in operation, do a complete walk-around visual inspection and look for structural damage, loose components, leaks, or other conditions that require immediate correction for safe operation. The following inspection list is suggested. Check:

- for any unusual conditions such as pools of hydraulic fluid or lubricating oil under the chassis, an outrigger which may have crept down or up, signs of damage, or improper maintenance.
- the tires are inflated to the proper pressure.
- the level of the hydraulic reservoir.
- the operation of the "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 cable for kinks, broken strands or other damage in accordance with instructions in *Hoist Cable Inspection and Maintenance*, page 6-3.
- to see that the hydraulic hoses and fittings are in good condition and show no signs of leaking. Repair damaged or leaking hoses 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 very low (i.e., sub-zero) temperatures.

Cranes should have appropriate hydraulic oil, lubricants, and other auxiliary items required for operation in sub-zero 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 3-9).
2. Once 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

Crushing Hazard!

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

Check the anti-two block alarm light and the audible alarm by lifting the anti-two-block weight until the switch is activated. To check the anti-two-block switch:

- manually lift the weight.
- slowly raise the hoist cable.
- slowly extend (telescope) the boom.



DANGER

If the light and audible alarm do not function as described and the crane movements are not stopped, the system is not working properly. The malfunction must be corrected as soon as possible.

Refer to *Operational Aids*, page 2-4 should the anti-two blocking system be inoperative.

If the crane is equipped with an extension that is deployed and rigged for work, repeat the test procedure for the extension anti-two-block switch.

RCL Check



DANGER

If the RCL does not function as described, the system is not working properly. The malfunction must be corrected as soon as possible.

Refer to *Operational Aids*, page 2-4 should the RCL be inoperative.

Lifting personnel is not permitted with a malfunctioning RCL.

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 that the outrigger monitoring system is functioning at all outrigger positions—retracted, mid-extend and full extend. Refer to *Outrigger Monitoring System (OMS)* (Optional—Standard in North America), page 4-2.



DANGER

Tipping Hazard!

If the Outrigger Monitoring System is not functioning, the operator must confirm the proper deployment of the outriggers before continuing with the lift.

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

If there is a deviation between displayed and actual values, an authorized RCL service representative shall be called for repair and/or recalibration of the 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:

- Unwind the hoist 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 cable 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 grades, or locations with overhead obstructions. The outrigger stabilizers 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.
- Put the truck transmission in neutral.
- Set the truck park brake. Wheel chocks may also be required.
- Engage the power takeoff.
- Turn the truck cab switch to OFF.



WARNING

Truck must be in neutral when starting engine from the crane platform to avoid sudden potential movement of truck.

Before Making the Lift

- Set the outriggers as described in *Outrigger Setup, page 4-1*.
- Program the RCL as specified in the RCL Operator Manual which is located in the document case.
- 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

The 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 document case. 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 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 a loaded 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.

NOTE: The standard work area for the NBT30H is 180°. With a front jack the work area is 360°.

- **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 3-8) 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 loadline and to determine to approximate height to which the load can be lifted.

The load chart contains the lifting capacities of the crane in all allowable lifting configurations. The information is presented in three parts, one for outriggers fully retracted, one for outriggers at mid point, and one for the outriggers fully extended. 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.

- The load chart (Figure 3-7) 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 3-8) shows the operating radius and the height from horizontal of the unloaded boom.
- The hoist data chart (Figure 3-9) 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 and weights 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. Get 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 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* for instructions.
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. Meter the controls when moving the load to avoid sudden stops.
5. Retract and lower the boom after the lift is complete.

**RATED LIFTING CAPACITIES IN POUNDS WITH STOWED EXTENSION
32 FT. - 110 FT. BOOM
ON OUTRIGGERS FULLY EXTENDED**

Radius in Feet	#02					
	Main Boom Length in Feet					
	32	46-A	62-B	78-C	94-D	110
6	*59,200 (76.7)					
8	42,200 (72.5)	28,500 (78.6)				
10	35,100 (68.5)	28,400 (76.1)				
12	31,200 (64.4)	27,400 (73.6)	27,550 (78)			
15	26,200 (57.9)	23,400 (69.5)	22,550 (76.1)	19,150 (80)		
20	18,700 (45.9)	17,700 (62.5)	17,050 (71.1)	17,150 (76.4)	16,000 (80)	
25	14,100 (30.6)	13,900 (55)	13,600 (65.9)	13,650 (72.4)	13,400 (76.8)	10,200 (79.3)
30		11,400 (46.3)	11,150 (60.8)	11,150 (68.2)	10,050 (73.4)	8,900 (76.5)
35		8,850 (36.2)	9,350 (54.8)	9,350 (64)	10,000 (70.1)	8,700 (74.1)
40		6,650 (23.9)	7,000 (35)	7,000 (59.6)	8,150 (66.7)	7,450 (71.2)
45			6,000 (42)	6,650 (55.4)	6,600 (63.3)	6,700 (68.7)
50			4,000 (34)	5,200 (50.4)	5,350 (59.4)	5,650 (65.6)
55			3,850 (23.8)	4,200 (45)	4,400 (55.4)	4,650 (62.3)
60				3,350 (39)	3,500 (51.3)	3,750 (58.9)
65				2,650 (32.1)	2,800 (46.8)	3,050 (55.4)
70				2,000 (23.5)	2,250 (42.1)	2,450 (51.8)
75					1,750 (36.9)	1,950 (48.1)
80					1,350 (30.9)	1,500 (44.2)
85					950 (23.4)	1,150 (39.9)
90					600 (11.9)	800 (35.2)
95						500 (29.9)
100						250 (23.4)
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.

#LMI operating code. Refer to LMI manual for operating instructions.

*This capacity requires optional 9/16" dia. 6x25 IWRC cable.

Lifting Capacities at Zero Degree Boom Angle						
Boom Angle	Main Boom Length in Feet					
	32	46-A	62-B	78-C	94-D	
0°	7,200 (29.5)	4,200 (43.5)	2,150 (59.5)	850 (75.5)	550 (91.5)	

NOTE: () Reference radii in feet.

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FIGURE 3-7

7709-3

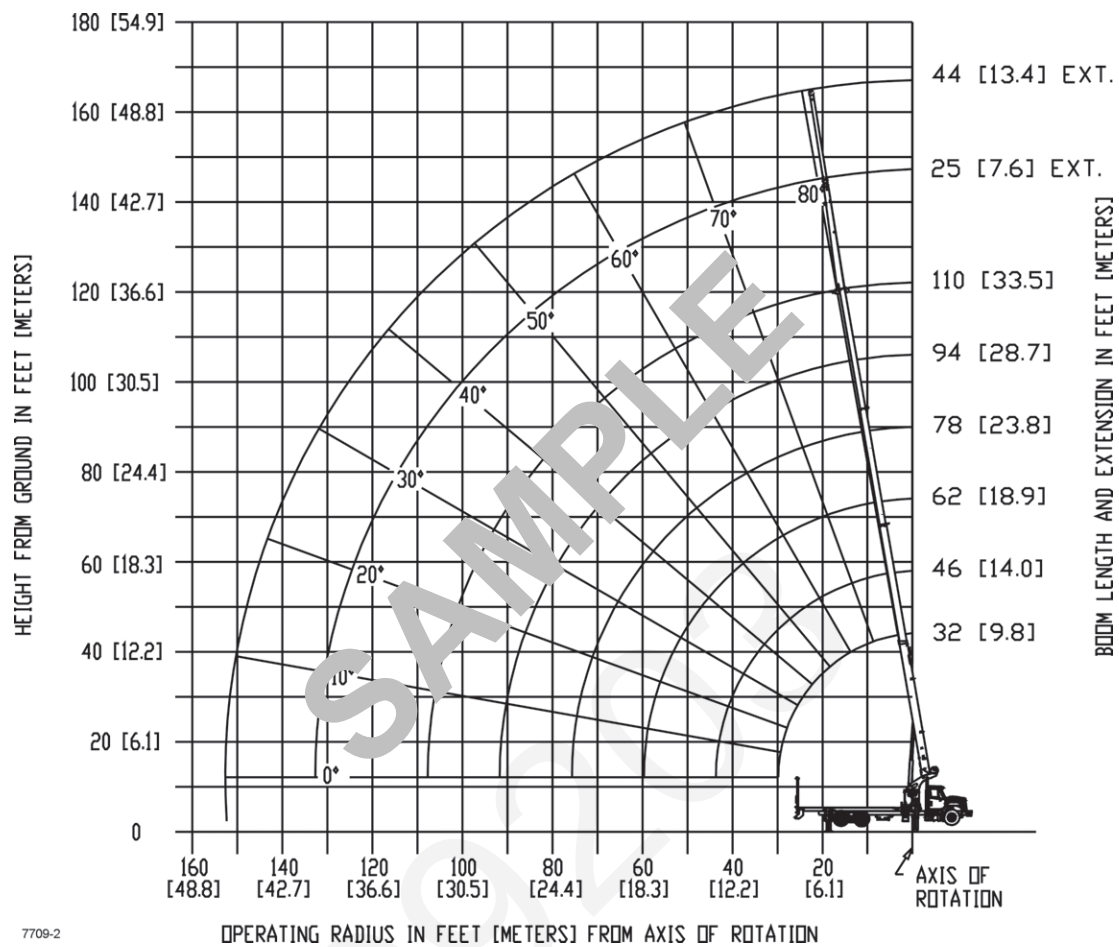


FIGURE 3-8

Parts of line	1	2	3	4	5	6	7
Max. boom length (ft.) at max. elevation with stated rigging and load block at ground level	154	110	94	78	62	46	32
Low speed lift (lb)	7700	15400	23100	30800	38500	46200	53900
High speed lift (lb)	3000	6000	9000	12000	15000	18000	21000

7709-1

FIGURE 3-9

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.

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 cable(s) 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. Ensure the center front jack is fully retracted, if equipped.
4. Ensure the outrigger beams and jacks are fully retracted with the floats properly stowed.

CAUTION

Outrigger beams must be pinned for travel.

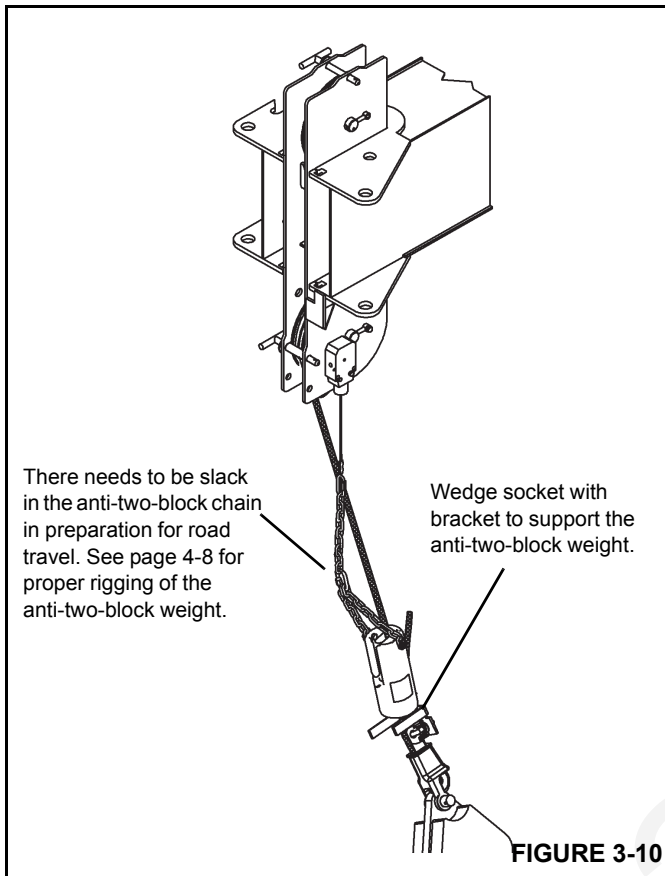
If not pinned, outrigger beams may drift out during travel.

5. Engage the mechanical travel lock at each outrigger beam.
6. Engage the swing brake.
7. Engage the swing lock.
8. 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.
9. Secure the hook block and A2B weight:
 - a. Slowly hoist up until there is a slight tension on the hoist cable. It may be necessary to override the A2B function to tension the cable.
 - b. The 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 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.

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



Unattended Crane



WARNING

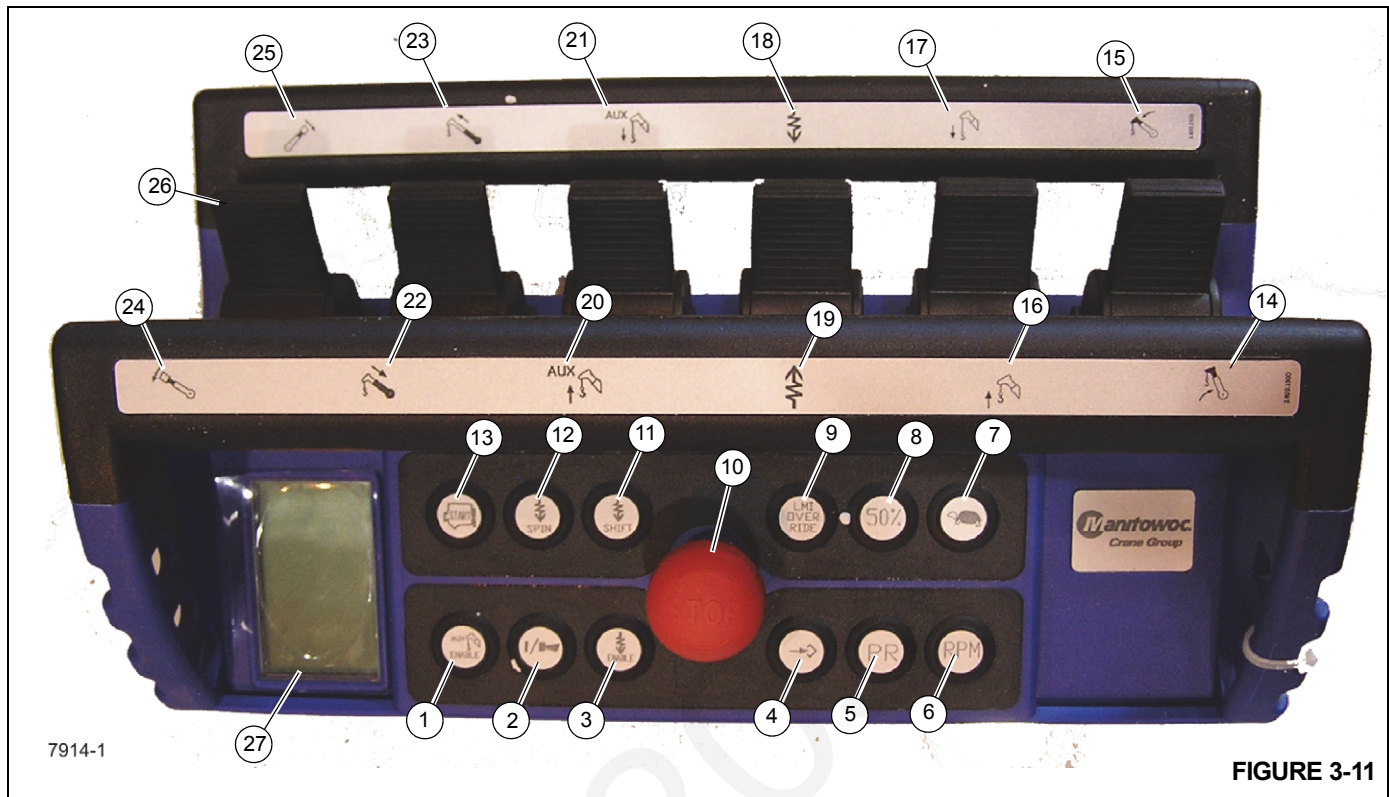
Tipping Hazard!

Changing weather conditions including but not limited to: wind, ice accumulation, precipitation, flooding, lightning, etc. should be considered when determining the location and configuration of a crane when it is to be left unattended.

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

The configuration in which the crane should be left while unattended shall be determined by a qualified, designated individual familiar with the job site, configuration, conditions, and limitations.

CRANE REMOTE CONTROL (OPTIONAL)



The optional Crane Remote Control (Figure 3-11) will allow full remote control of the crane. 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 Optional Auger (not used)
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
11	Optional Auger Shift (not used)

Item	Description
12	Optional Auger Spin (not used)
13	Engine Start
14	Boom Up
15	Boom Down
16	Main Hoist Up
17	Main Hoist Down
18	Optional Auger Dig (not used)
19	Optional Auger Reverse (not used)
20	Auxiliary Hoist Up
21	Auxiliary Hoist Down
22	Boom Retract
23	Boom Extend
24	Swing Counter Clockwise
25	Swing Clockwise
26	Joystick Lever (6 levers, two position)
27	LCD Screen

The LCD Screen (27, Figure 3-11) on the display is used to communicate signal strength, battery level, wireless channel, and remote status (Figure 3-12).

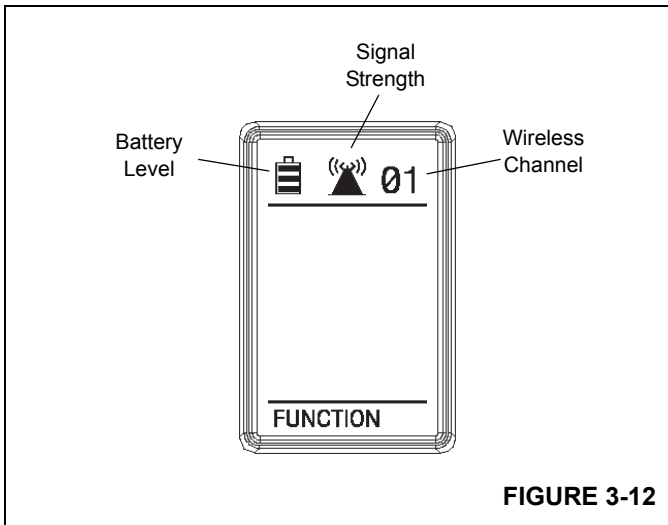


FIGURE 3-12

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

To use this remote, the red STOP button (10, Figure 3-11) must be twisted and released to turn ON the transmitter. To control the crane, the ON/Horn button(2) must be pressed to activate the remote. The crane horn will sound as confirmation that the remote is now active. The crane can now be started by pressing and holding the Engine Start button (13). The remote can now be used to control the crane. To activate a function move the lever (26) that corresponds to the desired movement.

When finished with the remote, press the red STOP button (10). This will shut off the machine. If the remote is left turned ON for more than 60 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 (2) while momentarily pressing the Frequency Change button (4).

Once finished using the Crane Remote, the Remote Power switch should be turned OFF and the Crane Ignition key should be turned to the OFF position. The remote controller should be stored in the truck cab.

Use of rechargeable batteries or standard AA batteries is acceptable.

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SECTION 4

SET-UP

SECTION CONTENTS

Outrigger Setup	4-1	Extension Removal	4-7
Proper Leveling of the Crane	4-1	Extension Maintenance	4-7
Bubble Level Adjustment	4-1	Anti-two Block Weight Installation	4-8
Site Selection	4-2	Multipart Line Reeving	4-8
Setting the Outriggers	4-2	Using Multiple Part Lines	4-8
Outrigger Monitoring System (OMS)		Lifting a 30 Ton (60,000 lb) Load	4-8
(Optional—Standard in North America)	4-2	Hoist Cable Installation	4-10
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Side Folding Swing Around Extension Operation	4-4	Terminator Wedge Installation	4-10
Deployment Procedure	4-4	Wedge Socket Installation	4-12
Stowing Procedure	4-6	Dead-end Rigging	4-12

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

- Set the outriggers
- Erect the extension
- Stow the extension
- Remove the extension
- Use multipart reeving
- Install the hoist cable
- Install the anti-two-block weight
- Install a wedge socket

**WARNING**

Crushing Hazard!

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. Therefore, whether lifting outriggers, it is essential that the crane is level to within 1% of grade. The bubble level that is provided on the crane is calibrated to be accurate within 1% of grade.

To properly level the crane, the boom must be positioned over the front of the crane, fully lowered to horizontal and fully retracted (for cranes fitted with a boom rest, the boom shall be stowed onto the rest). Raise and level the crane using the outriggers; refer to *Setting the Outriggers*, page 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, re level 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. 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 jack float to sink or slide. Avoid areas that are:

- uneven
- rocky
- muddy

Setting the Outriggers

1. The Outrigger Monitoring System (OMS) (Optional—Standard in North America) monitors the position of the outrigger beams at full-extend, mid-extend and retracted through the RCL console. Refer to *Outrigger Monitoring System (OMS) (Optional—Standard in North America)*, page 4-2.

The outrigger setup procedure is as follows:

1. Remove the outrigger controller from the stowage compartment on the EasyReach pedestal (Figure 3-2).
2. On the outrigger controller, select the desired outrigger beam with the extension switch and press the Extend/Retract Switch to extend the outrigger beam.
3. Set all four outrigger beams to:
 - a. the fully retracted position. Does not require the outrigger beams to be extended.
 - b. the mid-extend position. Engage the manual mid-extend over-center locks for the midpoint position.
 - c. the fully extended position.

WARNING Tipping Hazard!

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

4. Remove the front outrigger floats from the carrying brackets and place the floats under the jacks.
5. Select the desired jack with the jack selector switch and press the Extend/Retract Switch to extend the jack.
6. Secure the front outrigger floats to the jacks with the pins and clips.

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. 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.

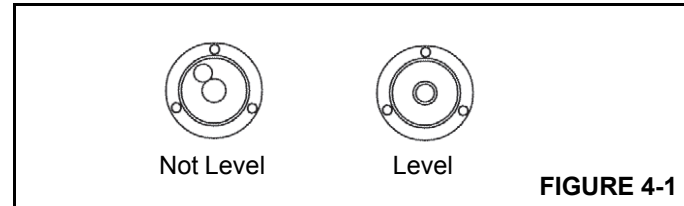


FIGURE 4-1

9. Lower the center front jack only after all other jacks are set. Press the front jack switch to activate and the Extend/Retract Switch to extend. Hold the Extend/Retract Switch for two seconds after the jack contacts the ground. The front jack is automatically set at the correct ground pressure.

WARNING Tipping Hazard!

After the center front jack is set, it automatically retracts if any other jack is adjusted. Reset the center front jack if this occurs.

Outrigger Monitoring System (OMS) (Optional—Standard in North America)

The Outrigger Monitoring System (OMS) aids the operator in accurately programming the Rated Capacity Limiter (RCL) by automatically identifying the position of each outrigger beam. The OMS uses four sensors, one sensor in each outrigger beam, to identify if an outrigger beam is positioned to one of three predefined locations, including fully retracted, mid-extend, and fully extended.

The RCL only indicates the position of the outrigger beam and cannot be used to position the beam.

The OMS indicates to the RCL the position of the four outrigger beams. Based on this information, the RCL will choose the most conservative outrigger beam configuration (i.e. If three outriggers are fully extended and one is retracted, the RCL will select retracted as the outrigger configuration). A confirmation of this configuration is all that is needed. Refer to the *Load Moment Indicator*, page 7-1 for detailed instructions.

EXTENSION SAFETY INFORMATION

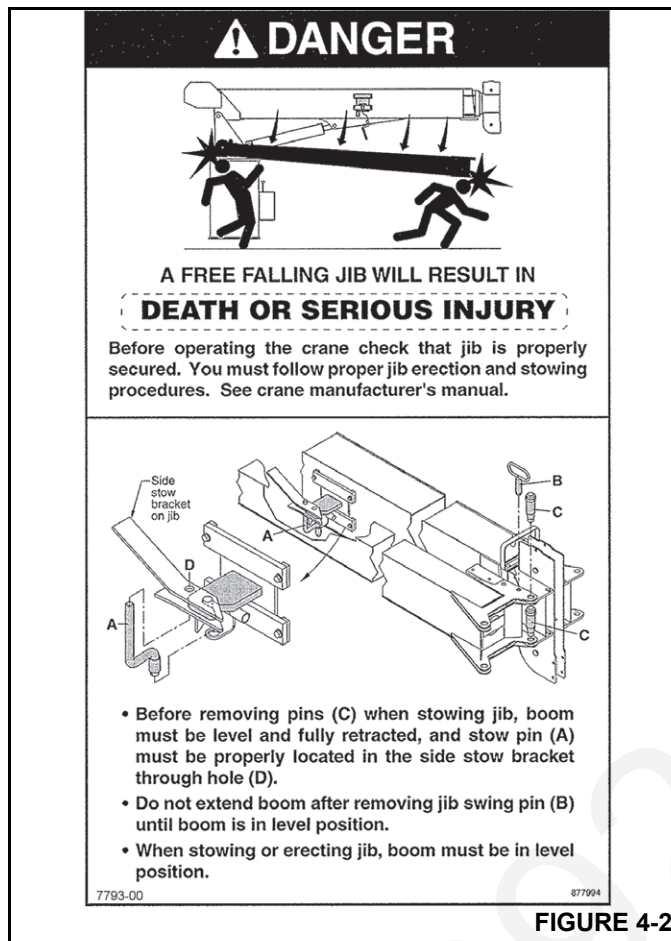


FIGURE 4-2

1. The anti-two-block switch weight and cord must be attached to the extension when deployed.
2. Do not lift the load with the main boom when the extension is pinned on the tip of the main boom.
3. Operate with extension by boom 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.

4. Operate with extension by boom angle when main boom is not fully extended. Do not exceed rated extension 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.

5. Ensure extension is stowed correctly (Figure 4-3):
 - a. Removal of swing around pins, C1, without proper installation of stow pin A and extension swing pin B, may allow extension to fall off.
 - b. Extending boom with extension stowed and failure to remove swing pins, C1, will damage unit upon extension.
6. Only swing extension into working or stowed position when boom is horizontal, stow pin A and extension swing pin B, are removed and swing pins, C1, are in place. Extension could swing uncontrollably if boom is not horizontal.
7. Crane shall be fully set up according to proper set-up procedures outlined previously when stowing or unstowing extension.
8. Operate boom and turn functions very slowly and carefully when using extension since extensions can increase boom length by 50%.
9. Area where extension swings around must be clear of obstructions and power lines when stowing and unstowing extension.

! CAUTION
Eye Injury Hazard!

Use safety glasses when striking pins with a hammer.

10. Do not extend/retract boom unless boom is horizontal when stow pin A and extension swing pin B are removed during stowing or unstowing procedures.
11. Always put spring clips in pins to ensure that they will stay in place.
12. When the extension is stowed, the boom can not be fully retracted if a boom tip attachment option is installed.

Also, on manually extendable extension options:

1. Extension retaining pin E must always be installed when operating.
2. All swing around (stow and unstowing) operations shall be done with extension retracted and pinned.
3. Extendable section may slide out of 1st section extension when pin E is removed. Keep personnel clear of area.

⚠ 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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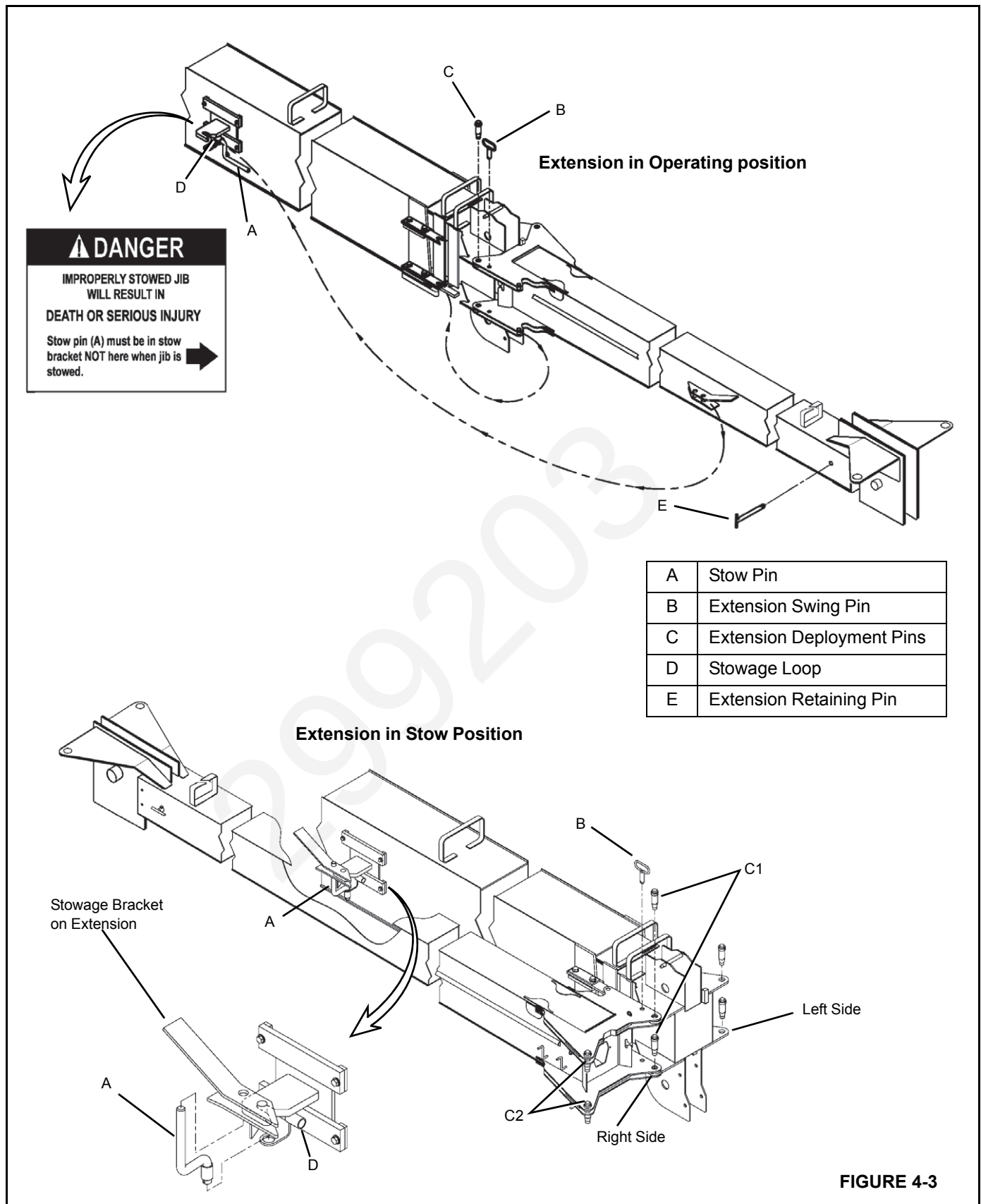
SIDE FOLDING SWING AROUND EXTENSION OPERATION

Deployment Procedure

1. Using boom telescope function, fully retract boom.
2. Using lift function, lower boom so that extension deployment pins C1 (Figure 4-3) and C2 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 creep out when below horizontal.

3. Remove cable keeper pins from boom sheave case and extension. Remove hook block. Pivot extension slightly to allow for loadline to be removed from boom sheave case. Remove loadline from boom sheave case and place in an area to minimize possible damage.
4. Install pins C1 in upper and lower extension ears. Install retainer spring clips. These pins are used as a pivot point to swing extension into the deployed position.
5. Locate the stowed position of pins C2. If in extension attachment holes or boom sheave case extension holes, remove pins from storage location.
6. Remove extension swing pin B from top ear of extension.
7. Remove stow pin A from ramp/side stow bracket assembly on extension and stow in stow loop D and install spring clip.
8. Attach tag line to sheave case end of extension.
9. Using the lift function, raise the boom to the horizontal position.



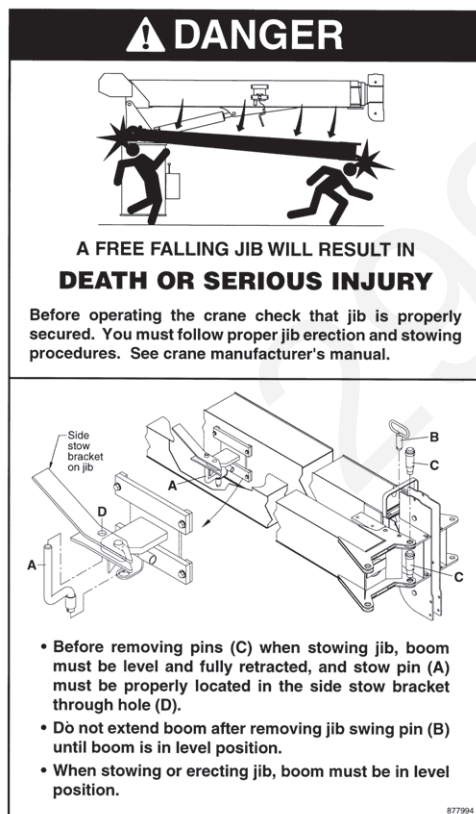
**WARNING****Crushing Hazard!**

Use caution when swinging extension into deployed position. The extension is free to swing away from the boom upon boom extension.

10. Using telescope function, slowly extend boom approximately one foot. This procedure will pull the extension out of the side stow bracket.
11. Using tag line, swing extension into deployed position.
12. Pivot extension into place, visually aligning the upper C2 pin holes. Install upper C2 pin and spring clip. A slight hammer strike may be necessary to install pins.

**CAUTION****Eye Injury Hazard!**

Use safety glasses when striking pins with a hammer.



13. Using extension jack, position extension so that lower C2 pin holes are in alignment and install lower C2 pin and spring clip.

- a. Remove the jack handle and check that the jack release valve is closed.
- b. Extend the jack so that the lower C2 pin holes are aligned.
- c. Install the lower C2 pin and spring clip.
- d. Open the jack release valve and retract the jack.

14. Using hoist function, unspool enough loadline to reeve loadline over extension sheave case. Keep slight tension on loadline to avoid bird caging of loadline on hoist drum.
15. Route loadline over extension sheave and install keeper. Install line block to end of loadline.
16. Remove anti-two-block switch and weight/chain assembly and install on extension tip. Be certain to use keeper provided with switch.
17. Disconnect twist lock quick coupler on anti-two-block cord going to boom anti-two-block switch and attach to quick coupler on extension anti-two-block wire on rear of extension between the upper and lower extension ears.
18. Install extension swing pin B and spring clip into extension ears.
19. For manually extendable extensions, pull extension retaining pin E, and extend second section out by pulling on sheave case. The second section extension, as it extends, will hit a mechanical stop that allows for extension pin E installation. Install pin E and spring clip.
20. Make A2B connections as required.

Stowing Procedure

1. Using lift function, lower boom so that extension deployment pins C1 and C2 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 creep out when below horizontal.

2. For manually extendable extensions, pull extension retaining pin and fully retract extendable 2nd section extension into the 1st section. Retraction of 2nd section may be facilitated by attaching loadline wedge socket to extension nose. Slowly activate the hoist up function until the 2nd section is fully retracted.
3. Reinstall extension retaining pin through the 1st and 2nd section extension assembly and install spring clip.
4. Remove loadline from extension sheave case. Place loadline in area to avoid possible damage from stow procedure.

5. Disconnect twist lock anti-two block wire connector at rear of 1st section extension. Connect twist lock connector to anti-two block switch connector on boom tip. Move weight/chain assembly to boom tip.
6. Attach tag line to sheave case end of extension.
7. Remove spring clips from pins C2 on both upper and lower extension ears.
8. Remove extension swing pin B from the boom nose.
9. Remove pins C2 from upper and lower extension ears. Do not remove C1 pins at this time. C1 pins will be used as a pivot point to swing extension into stow position. A slight hammer strike may be necessary to remove pins. Always use proper eye protection during this step.
10. Raise the boom to the horizontal position.
11. Extend boom approximately 1 ft (.3 m).
12. Using tag line attached to extension sheave case, slowly swing extension into stow position (parallel with 1st section boom), Pins C1 are the extension pivot points during this operation.

CAUTION

Equipment Damage Hazard!

Use caution when swinging extension to avoid unnecessary impact with 1st boom section.

13. Install extension swing pin B with spring clip through extension ear and boom sheave case holes. This pin will keep the extension assembly in line (parallel) with the 1st boom section. Extension swing pin B does not retain the extension in its stowed position on the 1st boom section.
14. Using boom telescope function, slowly retract boom. The ramp/side stow bracket assembly on the side of the 1st section extension will engage the hook on the side of the 1st boom section, first lifting the extension and then engaging the extension side stow bracket and the boom hook completely upon full retraction of the boom.
15. Install stow pin A with spring clip into the ramp/side stow bracket assembly on the extension. Complete engagement of stow brackets and proper installation of pin A is critical for secure extension stow attachment.
16. Remove pins C1 from upper and lower extension ears. A slight hammer strike may be necessary to remove pins.



CAUTION

Eye Injury Hazard!

Use safety glasses when striking pins with a hammer.

17. Reinstall loadline over boom sheave case.



DANGER

Crushing Hazard!

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

Always have at least one of the following in place at all times:

- Side stow bracket completely engaged into stow hook with stow pin A properly in place.
- Both pins C1 in upper and lower extension holes properly in place through mating holes on boom tip.



CAUTION

The 44 ft extension weighs 1470 lb (667 kg) at 147 in (374 cm) when retracted from mounting pin holes.

EXTENSION REMOVAL

Should extension removal from the boom become necessary, proceed as follows:

1. Unstow and swing extension into position on the boom tip according to Steps 1 - 10 in the preceding *Deployment Procedure*, page 4-4.
2. Support and raise the extension at its balance point with a suitable lifting device and straps or chains.
3. Remove the two swing around pins. Extension is now free of boom.

To install, proceed in reverse order of removal.

When the extension is stowed on side of crane, always leave the ram and handle sleeve of the extension jack pushed all the way down to reduce exposure to rusting.

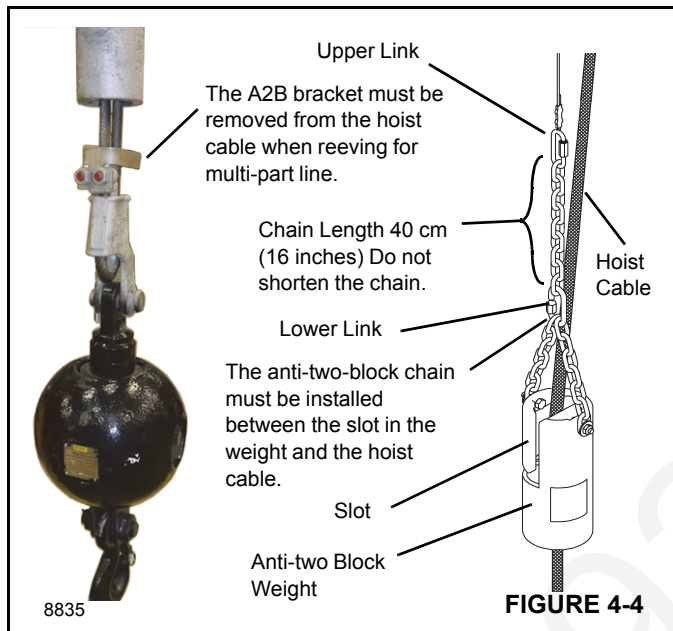
Extension Maintenance

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

ANTI-TWO BLOCK WEIGHT INSTALLATION

To prevent the hoist cable from slipping out of the anti-two block weight, rig the weight as shown in Figure 4-4.

The A2B bracket is for single part line use only. Remove the A2B bracket shown in Figure 4-4 from the hoist cable when changing from a single part line to a multiple part line to allow the hoist cable and wedge socket to reeve through the sheaves on the boom nose and the hookblock. Re-install the clamp and nuts to the cable before performing a lift.



MULTIPART LINE REEVING

Multipart 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 multipart reeving. These ratings are based on providing the proper operating safety factor on the cable supplied with the machine. Therefore, any replacement rope must meet the cable specification in this manual.

The A2B bracket is for single part line use only. Remove the A2B bracket shown in Figure 4-4 from the hoist cable when changing from a single part line to a multiple part line to allow the hoist cable and wedge socket to reeve through the sheaves on the boom nose and the hookblock. Re-install the clamp and nuts to the cable before performing a lift.

Lifting a 30 Ton (60,000 lb) Load

The NBT30H is rated to lift 60,000 lbs (27216 kg) at a 6 ft (1.83 m) radius with all booms retracted with a seven part block. To make this lift the crane must be equipped with optional 6 x 25 IWRC wire rope with a rated breaking strength of 33,600 lb (15241 kg). This rope is required to have the appropriate 3.5:1 safety factor.

It is also necessary to increase the hoist system hydraulic pressure relief valve from 3,300 psi (+100/-0) to 3,450 psi (+100/-0) (22753 kPa (+690/-0) to 23787 kPa (+690/-0)). See the *Service Manual*. This is required to increase the hoist pull to 8,600 lbs (3901 kg) to achieve the 60,000 lbs lift with seven part rigging.

CAUTION

Equipment Damage Hazard!

All components on the crane are rated for intermittent operation under these conditions. After this lift is completed the hoist operating pressure must be reduced back to 3,300 psi.

Continuous operation of the hoist hydraulic system at nominal pressures greater than 3,300 psi will shorten the life of hydraulic components and void their warranty.

1 Part Line	2 Part Line	3 Part Line	4 Part Line	5 Part Line	6 Part Line
Maximum Pull 7,700 lb (3493 kg)	Maximum Pull 15,400 lb (6985 kg)	Maximum Pull 23,100 lb (10478 kg)	Maximum Pull 30,800 lb (13971 kg)	Maximum Pull 38,500 lb (17463 kg)	Maximum Pull 46,200 lb (20956 kg)

7 Part Line (not shown) uses a 7/8 part block**, maximum pull 53,900 lb (24449 kg)

* 60,000 Lbs load requires optional 9/16 in diameter 6 x 25 IWRC cable

** 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.

HOIST CABLE INSTALLATION

To install wire rope, use the following procedure:

1. Unwind the cable from the storage reel and route the cable through the boom cable guides to the hoist from in front of the boom.

CAUTION

Equipment Damage Hazard!

If the cable is wound from a storage reel, rotate the reel in the same direction as the hoist. Damage to the cable will result if incorrectly installed.

2. Install the end of the cable into the hoist using the wedge socket provided(1) (Figure 4-5).

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

3. 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.

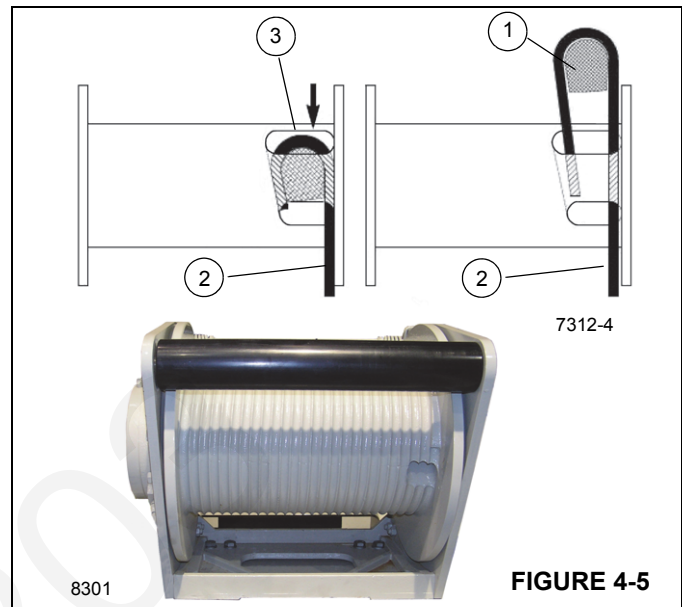


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4. Slowly rotate the drum, ensuring the first layer of cable is evenly wound onto the drum.
5. Slowly rotate the drum, ensuring the first layer of cable is evenly wound onto the drum.
6. Install the remainder of the cable, as applicable.
7. Remove the cable keeper pin from the boom sheave and lay the cable over the top sheave. Replace the keeper pin.
8. Unspool the remainder of the cable. Make sure the cable is straight and without kinks.
9. Attach the wedge socket to the free end of the cable as shown in Figure 4-7. If you are using a terminator wedge socket, see Figure 4-6.
10. Torque the clamp on the dead end of the cable to 95 ft-lb (128 N·m).

NOTE: The torque must be rechecked after the initial operation of the crane. Be sure the clamp is attached to the dead end of the cable only.

11. Start winding the cable onto the hoist drum. Maintain about 500 lb (250 kg) of tension on the cable.
12. Keep the cable wraps tight against each other when the first half of the bare hoist is filling. The second half of the hoist should wrap tightly because the fleet angle of the cable tends to pull the cable to the center of the drum thus wrapping tightly.



13. Continue winding the cable on the second, third and fourth layer of the hoist. Keep the cable paying in straight to the boom to avoid side loading the boom. The preceding layers will wrap smoothly guided by the first layer wrapping.

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 wire 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.

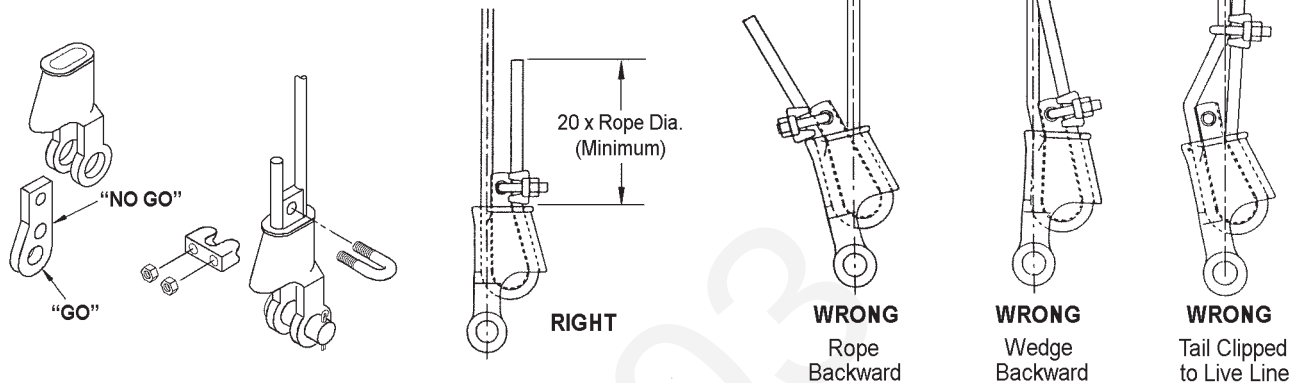
Terminator Wedge Installation

The NBT30H is shipped with a terminator wedge socket which is National Crane's preferred type of socket (Figure 4-6). Other wedge socket configurations are shown in Figure 4-7.

To attach a terminator wedge (Figure 4-6), use the following procedure:

1. Match the socket, wedge, and clip to wire rope size.
 - The wire 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.
5. Do not attach dead end to live end or install wedge backwards.
6. Use a hammer to seat wedge and rope as deep into socket as possible before applying first load.

Terminator Wedge Socket



Torque Value Table

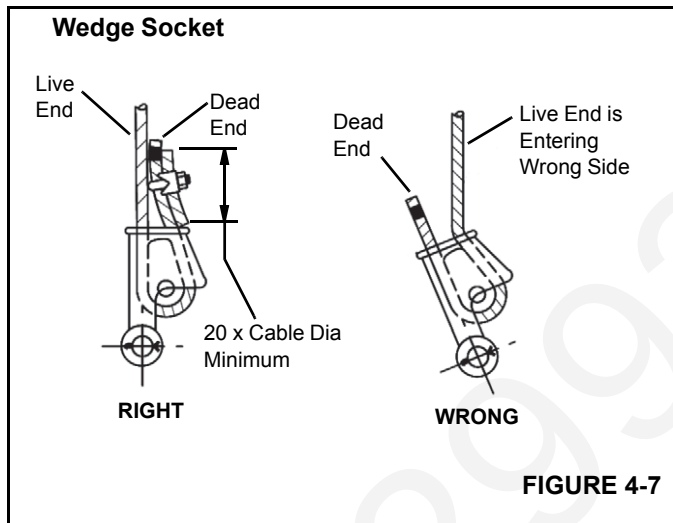
Cable Size (inches)	3/8	7/16	1/2	9/16	5/8	3/4	7/8	1	1-1/8	1-1/4
Torque lb-ft	45	65	65	95	95	130	225	225	225	360

Torque values shown are based upon clean dry threads free of lubrication.

FIGURE 4-6

Wedge Socket Installation

1. Inspect the wedge and socket. Remove any rough edges and burrs.
2. The end of the wire rope should be seized using soft, or annealed wire or strand. If the end of the rope is welded, the welded end should be cut off. 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 wire rope procedures.
3. Make sure the live-end (Figure 4-7) of the rope is directly in line with the ears of the socket and the direction of pull to which the rope will be subjected. If the rope is loaded into the socket incorrectly, under a load the rope will bend as it leaves the socket, and the edge of the socket will wear into the rope causing damage to the rope and eventual failure.



4. Insert the end of the wire rope into the socket, form a loop in the rope, and route the rope back through the socket allowing the dead-end (Figure 4-7) to protrude from the socket. Ensure the dead-end of the rope is of sufficient length to apply end treatment to the dead-end after the wedge has been seated.
5. Insert the wedge into the loop and pull the live-end of the rope until the wedge and rope are snug inside the socket. It is recommended that the wedge be seated inside the socket to properly secure the wire rope by using the crane's hoist to first apply a light load to the live-end.

6. After final pin connections are made, increase the loads gradually until the wedge is properly seated.
7. The wire rope and wedge must be properly secured inside the socket before placing the crane into lifting service. It is the wedge that secures the wire rope inside the socket. 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; refer to *Dead-end Rigging*, page 4-12.

Dead-end Rigging

Sketches A through F (Figure 4-8) illustrate various ANSI approved methods for treating the dead-ends of wire ropes which exit a wedge socket assembly. While use of the loop-back method is acceptable, care must be exercised to avoid the loop becoming entangled with tree branches and other components during crane transport and with the anti-two block system and other components during use of the crane.

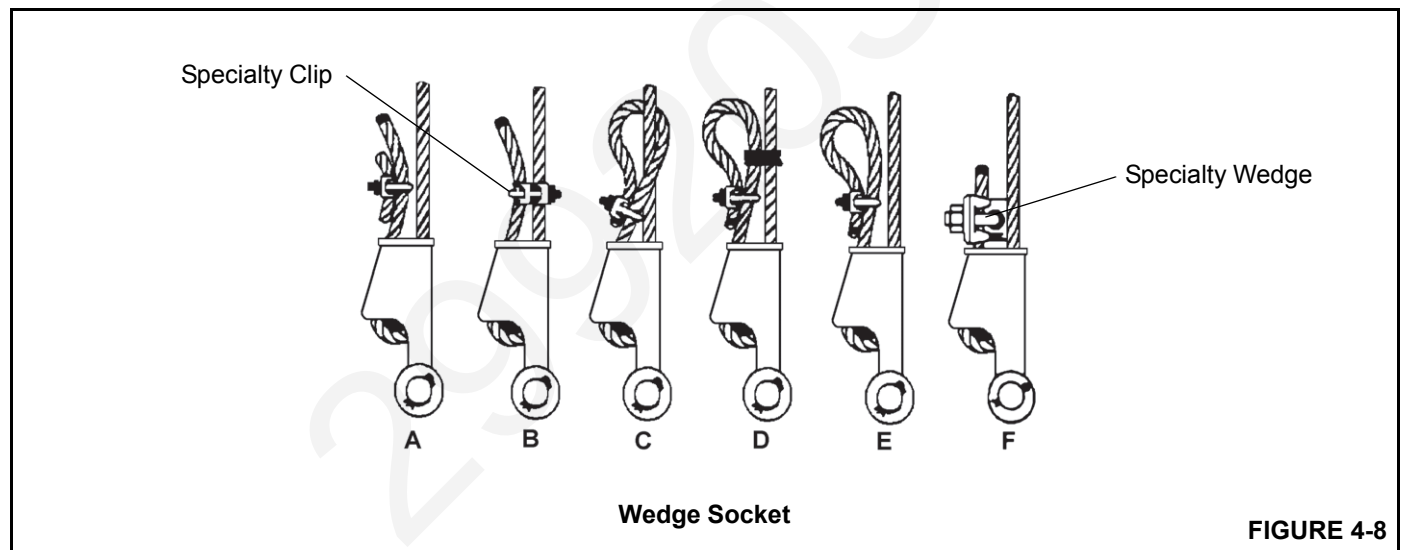
Of the methods shown below, Manitowoc prefers that method A or F be used, i.e., clipping a short piece of wire rope to the dead-end or using a commercially available specialty wedge. Typically, it is recommended that the tail length of the dead-end should be a minimum of 6 rope diameters but not less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

When using method A, place a wire rope clip around the dead end by clamping a short extra piece of rope to the rope dead end. **DO NOT CLAMP THE LIVE END.** The U-bolt should bear against the dead end. The saddle of the clip should bear against the short extra piece. Torque the U-bolts according to the table titled Wire 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 manufacture." Wire ropes are addressed in ASME B30.5, section 5-1.7.2, ROPES, it states, in pertinent part, "(a) The ropes shall be of a construction recommended by the rope or crane manufacturer, or person qualified for that service." Additional information is published by the Wire Rope Technical Board in the Wire Rope Users Manual, latest revised edition.

Table 4-1

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



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SECTION 5

LUBRICATION PROCEDURE AND CHARTS

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GENERAL

Following a designated lubrication procedure is important to ensure 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 the 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 100°F (38°C) 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.

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)" on page 2-1.

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 32°F (0°C) 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.

Surface Protection for Cylinder Rods

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

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

NOTE: Cylinder operation and inclement weather will remove the Boeshield protectant. Inspect machines once a week and reapply Boeshield to unprotected rods.

The following sections 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

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.



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 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.

NOTE:

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.

Table 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	6829001559
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.			

Lubrication Points

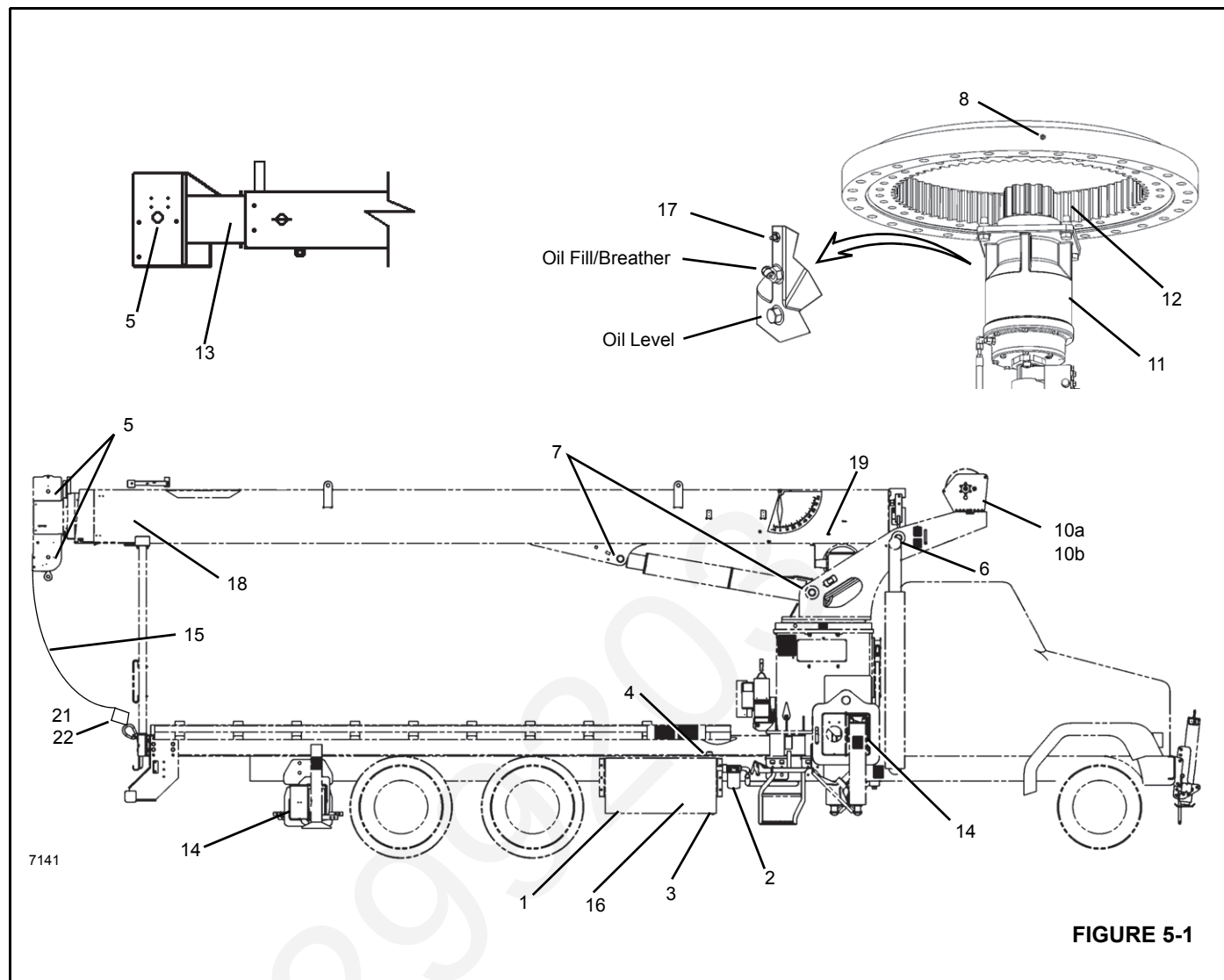


FIGURE 5-1

Table 5-2:

Item	Application	Recommended Lubricant	Procedure	Frequency
1	Hydraulic oil reservoir	HYDO	Check, fill, change	Check Weekly, Change Semi-Annually
2	Oil filter, Hydraulic oil reservoir		Change or clean	After first 40 Hrs. Quarterly thereafter
3	Magnetic Plug, Hydraulic oil reservoir		Clean	At oil filter service interval.
4	Breather, Hydraulic oil reservoir		Clean	Monthly
5	Sheave pins: boom (5 places), extension (1), block (1), rooster sheave (1)	EP-MPG	Grease gun	Weekly
6	Boom pivot pin	EP-MPG	Grease gun	Monthly
7	Lift cylinder pins - 2 ea.	EP-MPG	Grease gun	Monthly
8	Swing bearing	EP-MPG	Grease gun	Weekly
10a	Hoist gearbox.	GL-5	Change/check & fill	Every 1000 hours or 6 months

Table 5-2:

Item	Application	Recommended Lubricant	Procedure	Frequency
10b	Hoist brake	EO-20W-20 or TES295	Change/check & 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 inner, side and bottom wear pads	LTG	See page 5-7	Monthly or as required
14	Outrigger beams, bottom, sides	LTG	Brush or roller	Monthly or as Required
15	Wire rope (hoist cable)	EP-OGL	Brush or spray	Semi-Annually
16	Diffuser strainer, hydraulic oil reservoir		Clean	Semi-Annually with oil change
17	Swing motor pinion bearing	EP-MPG	Grease gun	Sparingly every 50 hours
18	Extend sheaves	EP-3MG	Grease gun	Weekly
19	Retract sheaves: Extend the boom until the retract sheave grease holes are visible through the access holes along side of boom.	EP-3MG	Grease gun	Weekly
20	Extension cables (Not Shown)	WRL	Spray or brush	Any time boom is disassembled or 5 years
21	Hook Block Swivel Bearing	EP-MPG	Grease gun	Monthly
22	Hook Block Sheaves	EP-MPG	Grease gun	Monthly

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

Gearbox Vent

Internal Cable Sheave Lubrication



WARNING

Fall Hazard!

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

A grease gun adapter is required to lubricate the internal sheaves. The required needle grease gun fitting is:

- A 0.25 inch (6.35 mm) diameter nozzle grease gun tip (National Crane P/N 955045).
- Contact Manitowoc Crane Care to obtain this tip.

Lubrication of the extend and retract sheaves is as follows:

1. Extend the boom until the grease access holes on the side of the 2nd and 3rd sections are lined up.
2. Lubricate the pin for the extend cable sheaves (18) (Figure 5-1) until a small amount of grease extrudes from the pin. From in front of the boom, look back through the sheave case at the pin to determine the amount of grease.
3. This position also aligns the access holes in the rear of the 1st and 2nd sections for lubrication.
4. Lubricate the pins for the retract sheaves until a small amount of grease extrudes from the sheave pins. From in back of the boom, look up through the hoist mount at the pins to determine the amount of grease.

Inner Boom Wear Pad Lubrication

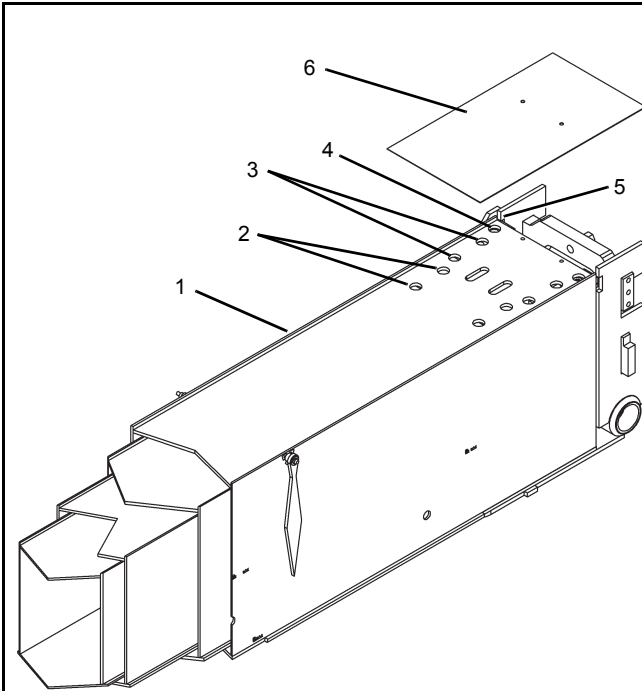
1. Fully extend and set the outriggers.
2. With the boom fully retracted, remove the access plate (6) located on the top rear of the 1st section (Figure 5-2).

3. Apply grease to the wear pads on the top of the 2nd section through the access holes (4) in the 1st section with a grease gun (Figure 5-2).
4. Extend the boom to line up the access holes on the 2nd section (3) with the wear pads on the 3rd section. Apply grease to the 3rd section wear pads with a grease gun.
5. Extend the boom to line up the access holes (2) on the 3rd section with the wear pads on the 4th section. Apply grease to the 4th section wear pads with a grease gun.
6. Raise the boom to at least 75°.
7. Extend the boom about 1/3 and retract to spread the grease.
8. Repeat steps 3 - 6. Extend the boom about 2/3 and retract to spread the grease.
9. Repeat steps 3 - 5. Fully extend and retract the boom to spread the grease.

Side and Bottom Boom Wear Pad Lubrication

Recommended lubricant is EP-3MG grease.

1. Fully extend and set the outriggers.
2. Lower the boom to horizontal.
3. Fully extend the boom and apply grease to the side and bottom of the 2nd, 3rd, and 4th sections with a brush.
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.



Item	Description
1	1 st Boom Section
2	Access Holes for 4 th Section Wear Pad
3	Access Holes for 3 rd Section Wear Pad
4	Access Holes for 2 nd Section Wear Pad
5	2 nd Section Wear Pad
6	Access Plate

FIGURE 5-2

Outrigger Beam Lubrication

DANGER

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 5-3.)
2. Apply grease to all wear pads and contact surfaces at the side and bottom of all beam sections and lower surface of the stabilizer/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.

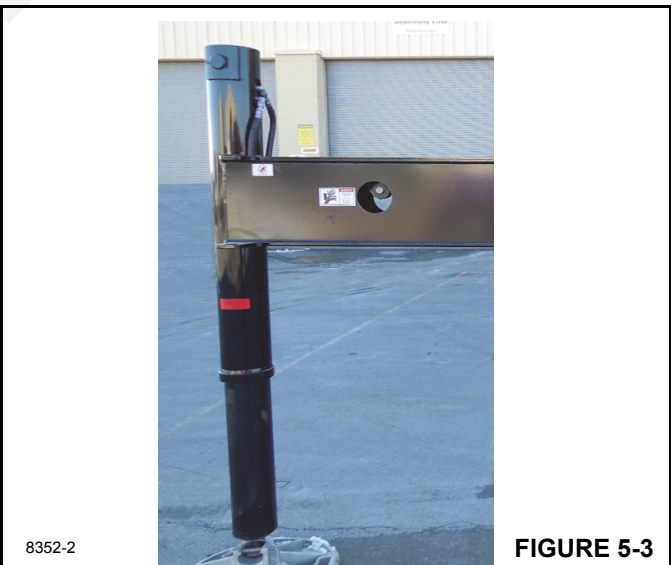


FIGURE 5-3

Hoist Brake Oil

DANGER

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 (Figure 5-4) and visually inspect the oil level. The fluid should be visible within the bottom of the inspection hole. If more fluid is needed, add through the vent plug hole.

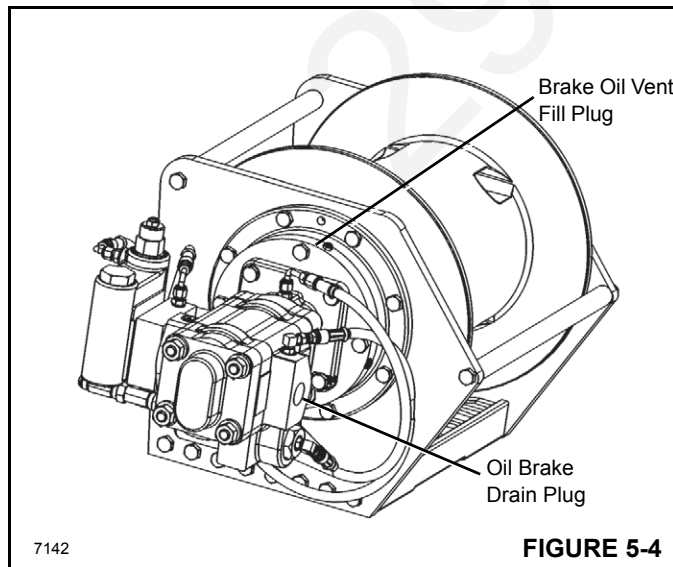
Drain /Add New Hoist Brake Oil

To drain and add new oil, remove the drain plug (Figure 5-4), inspection plug and vent plug and drain the brake oil. Reinstall drain plug and add fluid at the inspection hole reinstall the vent plug and the inspection plug. See "Lubrication" on page 2-3.

NOTE: 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.



Hoist Gearbox Oil

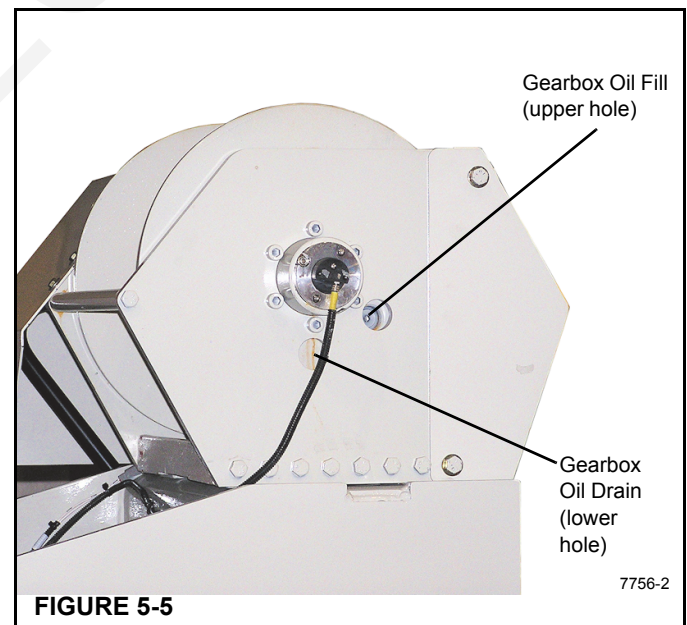
Check hoist gearbox oil level:

- Rotate the drum until the oil fill/level plug (Figure 5-5) is visible in the inspection hole.
- Remove the fill/level plug 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 (Figure 5-5) and then screw a 1" pipe into the drain plug hole to allow the oil to drain. Remove the drain plug with a hex head socket and drain hydraulic oil. Remove the 1" drain pipe and install drain plug.

Fill hoist gearbox with oil.

- To fill with oil, rotate the drum so the fill/level port (Figure 5-5) is visible through the upper hole. Install a 1" pipe with elbow into the fill hole to assist in adding oil. Remove fill/level plug with a hex socket and fill gear box with gear lube oil. See "Lubrication" on page 2-3.

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.



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.

1. Examine the used oil for signs of significant metal deposits.
2. Fill the swing gearbox with the appropriate amount and type of oil and then replace plug and vent. See "Lubrication" on page 2-3 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 of gear lube oil.

Hydraulic Oil Reservoir Level

The hydraulic oil reservoir has a sight gauge and decal located on the side of the reservoir (Figure 5-6). The oil in the hydraulic reservoir is sufficient when the level is between the upper and lower marks on the decal 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.

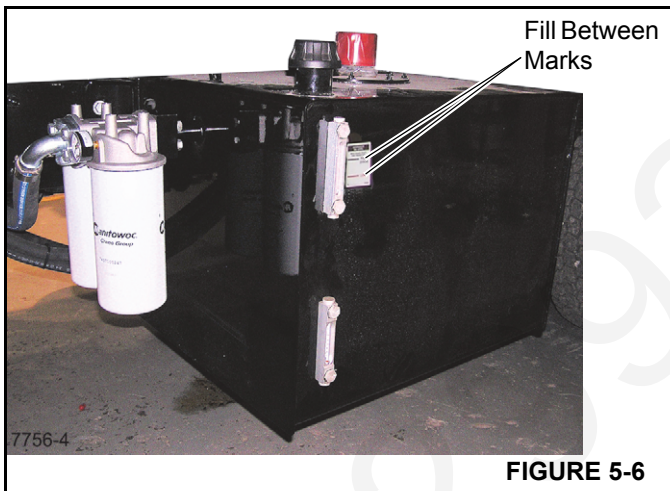


FIGURE 5-6

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.

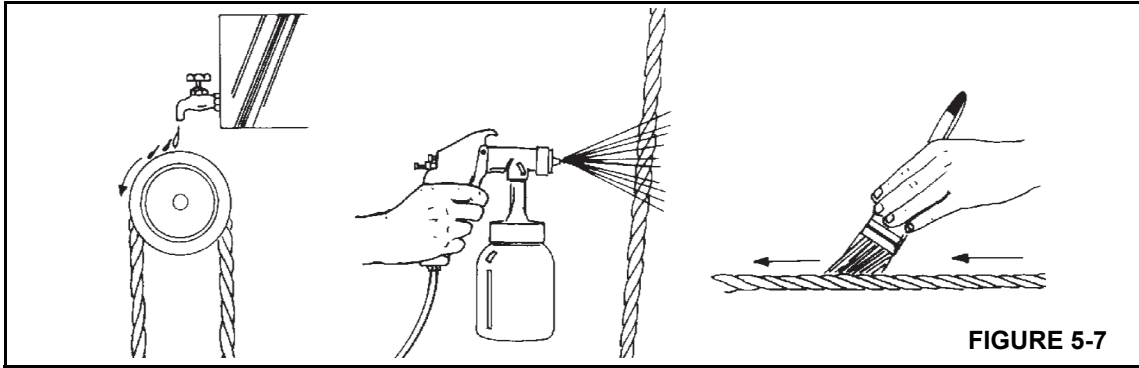
The object of rope lubrication is to reduce internal friction and to prevent corrosion. The type and amount of lubrication applied during manufacture depends on the rope size, type, and anticipated use. This lubrication provides the finished rope with protection for a reasonable time if the rope is stored 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 (i.e. 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.



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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.

 WARNING

Fall Hazard!

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 unit to ensure safe and proper operation. Refer to the *Service Manual* when installing missing or loose fasteners. 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 your National Crane distributor or Manitowoc Crane Care.

 WARNING

If any defect determined during the inspection is a safety hazard the machine 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 cable and end attachment for corrosion, severe kinking, crushing, cutting, or slippage of cable clamps or wedge socket.
8. Loose parts or damage to cable centering hook blocks.
9. Position of cable with guides and on sheaves.
10. Free turning of sheaves.
11. Lubrication as specified by the *Lubrication Procedure and Charts*, Section 5.
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 installation.
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 extension 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 centering block 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 Procedure and Charts*, Section 5.
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 this crane's *Operator Manual* is with the crane. If the manual is missing, obtain the serial number of the crane and order an operator 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 Procedure and Charts*, Section 5.
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. Cable clip bolts above wedge socket at end of loadline should be properly torqued, refer to the *Service Manual*.
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, outrigger 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 the 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 boom 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 mounting bolts for proper torque, refer to the *Service Manual*.
14. Rotation bearing and gearbox mounting bolts for proper torque, refer to the *Service Manual*.
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 unit 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 CABLE INSPECTION AND MAINTENANCE

WARNING

Worn or Damaged Equipment Hazard!

Never use a worn or damaged wire rope. Death or serious injury could result from using worn or damaged wire rope.

Wire 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 machine to machine 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: Wire rope may be purchased through Manitowoc Crane Care.

Any deterioration observed in the wire rope should be noted in the equipment inspection log and an assessment concerning wire rope replacement should be made by a qualified person.

Keeping Records

A signed and dated report of the wire 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 wire rope should be replaced.

It is recommended that the wire rope inspection program include reports on the examination of wire 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 wire 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 wire rope to abrasive material may shorten normal wire rope life. Frequent/periodic inspections and maintenance of wire 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 wire rope to abnormal loads beyond the endurance limit will shorten the wire 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.

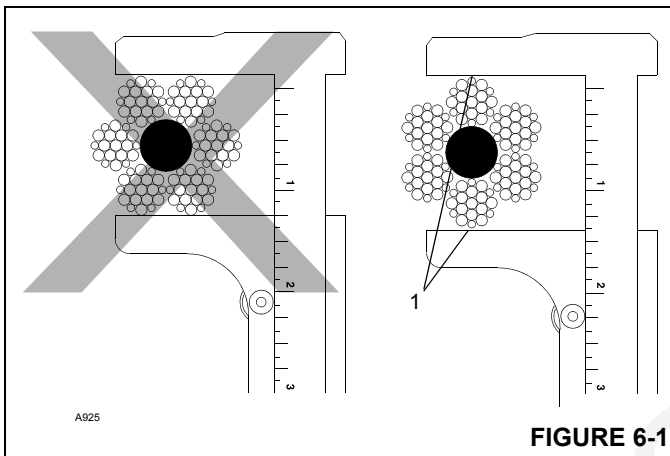


FIGURE 6-1

Inspection

All hoist cable 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 wire 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 wire 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 eye end 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 eye end and length of cable normally used in daily operations. Examine the rest of the cable for kinked, crushed or otherwise damaged points.

Periodic Inspections

Wire 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 wire rope. Periodic inspection should include all previous items listed under *Inspection*, plus the following:

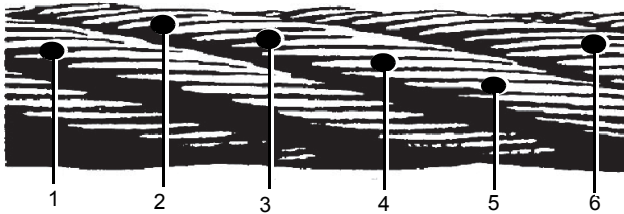
- Inspect for severely corroded or broken wires at end connections.
- Inspect wire rope in areas subjected to rapid deterioration such as:
 - Sections in contact with saddles, equalizer sheaves, or other sheaves where wire rope travel is limited.
 - Sections of wire rope at or near terminal ends where corroded or broken wires may protrude.
- Inspect boom nose sheaves, hook block sheaves, boom extension/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 wire rope.

Inspect the eye end 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.

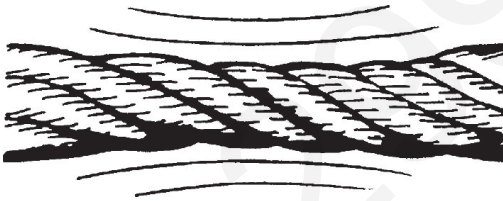
Wire Rope Replacement

It is difficult to determine the exact time for replacement of wire rope (hoist cable) since many variable factors are involved. Proper determination of the condition of a rope depends upon the judgment of an experienced person. The following reasons are sufficient for consideration of rope replacement:

- 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:
 - 0.0156 in (.4 mm) for rope diameters to 0.313 in (8 mm)
 - 0.031 (.8 mm) for rope diameters 0.375 in (9.5 mm) to 0.50 in (12.7 mm)
 - 0.047 in (1.2 mm) for rope diameters 0.561 in (14.3 mm) to 0.75 in (19.1 mm)
 - 0.063 (1.6 mm) for rope diameters 0.875 in (22.2 mm) to 1.125 in (28.6 mm).

- 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.

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 CABLE

If the hoist cable 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.

Standard
9/16 in. (14.3mm) Dia. Wire cable: Rotation Resistant 18X25 Nominal Breaking Strength: 19.25 Tons (17,463 kg)
Optional
9/16 in. (14.3mm) Dia. Wire cable: 6X25 General Purpose 6X25 Nominal Breaking Strength: 16.8 tons (15,241 kg)

CRANE ADJUSTMENTS AND REPAIRS

Before adjustments and repairs are started on a crane, read and be familiar with the safety information outlined under *Maintenance*, page 2-13.

Boom Extension Cable

If a cable replacement is required for the boom extension system, the replacement cable must be obtained through Manitowoc Crane Care. Extension cables are pre-stretched and have special connections for proper installation

Extension 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 Extension Jack

To add oil to the extension 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 Extension 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 the 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 clamps 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 65	480 70	520 75	550 80	590 85	620 90	660 95	690 100	720 105	760 110	790 115	830 120
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) ¹⁴¹ 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) ¹⁴⁴ 6175(H)
225/70R19.5	DUAL	1180(D) ¹¹⁴ 2600(D)	1230 2720	1300 2860	1360(E) ¹¹⁹ 3000(E)	1410 3115	1470 3245	1550(F) ¹²³ 3415(F)	1580 3490	1640 3615	1700(G) ¹²⁶ 3750(G)		
	SINGLE	1250(D) ¹¹⁶ 2755(D)	1310 2895	1380 3040	1450(E) ¹²¹ 3195(E)	1500 3315	1570 3450	1650(F) ¹²⁵ 3640(F)	1690 3715	1740 3845	1800(G) ¹²⁸ 3970(G)		
245/70R19.5	DUAL				1550 3415	1590 3515	1660 3655	1750(F) ¹²⁷ 3860(F)	1790 3940	1850 4075	1950(G) ¹³¹ 4300(G)	1970 4345	2060(H) ¹³³ 4540(H)
	SINGLE				1650 3640	1700 3740	1770 3890	1850(F) ¹²⁹ 4080(F)	1900 4190	1970 4335	2060(G) ¹³³ 4540(G)	2095 4620	2180(H) ¹³⁵ 4805(H)
265/70R19.5	DUAL				1700 3750	1780 3930	1860 4095	1950 4300	2000 4405	2000 4415	2120(G) ¹³⁴ 4675(G)		
	SINGLE				1800 3970	1900 4180	1970 4355	2060 4540	2130 4685	2200 4850	2300(G) ¹³⁷ 5070(G)		
305/70R19.5	DUAL				2060 4540	2120 4670	2200 4860	2300 5070	2370 5230	2450 5410	2575(H) ¹⁴¹ 5675(H)	2620 5770	2725(J) ¹⁴³ 6005(J)
	SINGLE				2240 4940	2330 5130	2420 5340	2500 5510	2610 5745	2700 5945	2800(H) ¹⁴⁴ 6175(H)	2870 6340	3000(J) ¹⁴⁶ 6610(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-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) ¹³⁴ 4675(G)	2230 4915	2300(H) ¹³⁷ 5070(H)
	SINGLE				1900 4190	1980 4370	2060 4550	2120 4675	2220 4895	2300 5065	2360(G) ¹³⁸ 5205(G)	2450 5400	2500(H) ¹⁴⁰ 5510(H)
305/75R22.5	DUAL				2360 5205	2440 5375	2540 5595	2560 5840	2730 6025	2830 6235	3000(H) ¹⁴⁶ 6610(H)	3010 6640	3150(J) ¹⁴⁸ 6940(J)
	SINGLE				2575 5675	2680 5905	2790 6150	2900 6395	3000 6620	3110 6850	3250(H) ¹⁴⁹ 7160(H)	3310 7300	3450(J) ¹⁵¹ 7610(J)
315/80R22.5	DUAL				2575 5675	2650 5840	2750 6070	2900(G) ¹⁴⁵ 6395(G)	2970 6545	3070 6770	3150(H) ¹⁴⁸ 6940(H)	3270 7210	3450(J) ¹⁵¹ 7610(J)
	SINGLE				2800 6175	2910 6415	3030 6670	3150(G) ¹⁴⁸ 6940(G)	3260 7190	3370 7440	3450(H) ¹⁵¹ 7610(H)	3590 7920	3750(J) ¹⁵⁴ 8270(J)
305/85R22.5	DUAL				2430 5355	2520 5550	2620 5780	2725 6005	2820 6215	2920 6435	3075(H) ¹⁴⁷ 6780(H)	3110 6860	3250(J) ¹⁴⁹ 7160(J)
	SINGLE				2650 5840	2770 6100	2880 6350	3000 6610	3100 6830	3210 7070	3350(H) ¹⁵⁰ 7390(H)	3420 7540	3550(J) ¹⁵² 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	TIRE LOAD LIMIT AT VARIOUS COLD INFLATION PRESSURES											
		kPa psi	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) ¹³¹ 4300(G)		
	SINGLE	kg lbs.	1570 3470	1650 3645	1750 3860	1800 3975	1880 4140	1950 4300	2020 4455	2090 4610	2120(G) ¹³⁴ 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) ¹³⁵ 4805(G)		
	SINGLE	kg lbs.	1760 3875	1850 4070	1950 4300	2010 4440	2100 4620	2180 4805	2260 4975	2340 5150	2360(G) ¹³⁸ 5205(G)		
295/75R22.5 275/80R22.5	DUAL	kg lbs.	1860 4095	1950 4300	2060 4540	2130 4690	2220 4885	2300(F) ¹³⁷ 5070(F)	2390 5260	2470 5440	2575(G) ¹⁴¹ 5675(G)	2630 5795	2725(H) ¹⁴³ 6005(H)
	SINGLE	kg lbs.	2040 4500	2140 4725	2240 4940	2340 5155	2440 5370	2500(F) ¹⁴⁰ 5510(F)	2620 5780	2710 5980	2800(G) ¹⁴⁴ 6175(G)	2890 6370	3000(H) ¹⁴⁶ 6610(H)
285/75R24.5 275/80R24.5	DUAL	kg lbs.	1870 4135	1970 4340	2060 4540	2150 4740	2240 4930	2360(F) ¹³⁸ 5205(F)	2410 5310	2490 5495	2575(G) ¹⁴¹ 5675(G)	2660 5860	2800(H) ¹⁴⁴ 6175(H)
	SINGLE	kg lbs.	2060 4545	2160 4770	2240 4940	2360 5210	2460 5420	2575(F) ¹⁴¹ 5675(F)	2650 5835	2740 6040	2800(G) ¹⁴⁴ 6175(G)	2920 6440	3075(H) ¹⁴⁷ 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) 162		
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) 158
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) 162	4880 10700	5000(L) 11000(L) 164
445/65R22.5	kg lbs.	3720 8230	3950 8660	4125 9090	4320 9480	4470 9870	4625(H) 10200(H) 161	4820 10600	4960 11000	5150 11400	5290 11700	5600(L) 12300(L) 168

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) 2680(D) 115	1260 2785	1310 2890	1360(E) 3000(E) 119	1410 3100	1460 3200	1500(F) 3305(F) 122		
	SINGLE	1150 2540	1220 2680	1285(D) 2835(D) 117	1340 2955	1400 3075	1450(E) 3195(E) 121	1500 3305	1550 3415	1600(F) 3525(F) 124		
8R22.5	DUAL	1250 2750	1300 2870	1360(D) 3000(D) 119	1410 3100	1460 3200	1500(E) 3305(E) 122	1570 3455	1640 3605	1700(F) 3750(F) 126		
	SINGLE	1290 2840	1360 2990	1450(D) 3195(D) 121	1500 3305	1550 3415	1600(E) 3525(E) 124	1670 3675	1740 3825	1800(F) 3970(F) 128		
9R22.5	DUAL	1480 3270	1550 3410	1610 3550	1670 3690	1750(E) 3860(E) 127	1820 4005	1890 4150	1950(F) 4300(F) 131	2010 4425	2070 4550	2120(G) 4675(G) 134
	SINGLE	1530 3370	1610 3560	1690 3730	1760 3890	1850(E) 4080(E) 129	1920 4235	1990 4390	2060(F) 4540(F) 133	2120 4675	2180 4810	2240(G) 4940(G) 136
10R22.5	DUAL	1750 3860	1830 4045	1910 4230	2000(E) 4410(E) 132	2080 4585	2160 4760	2240(F) 4940(F) 136	2300 5075	2360 5210	2430(G) 5355(G) 139	
	SINGLE	1850 4080	1940 4280	2030 4480	2120(E) 4675(E) 134	2200 4850	2280 5025	2360(F) 5205(F) 138	2430 5360	2500 5515	2575(G) 5675(G) 141	
11R22.5	DUAL	1990 4380	2080 4580	2160 4760	2250 4950	2360(F) 5205(F) 138	2460 5415	2560 5625	2650(G) 5840(G) 142	2680 5895	2710 5950	2725(H) 6005(H) 143
	SINGLE	2050 4530	2160 4770	2260 4990	2370 5220	2500(F) 5510(F) 140	2600 5730	2700 5950	2800(G) 6175(G) 144	2870 6320	2940 6465	3000(H) 6610(H) 146
11R24.5	DUAL	2110 4660	2210 4870	2300 5070	2390 5260	2500(F) 5510(F) 140	2580 5675	2660 5840	2725(G) 6005(G) 143	2820 6205	2910 6405	3000(H) 6610(H) 146
	SINGLE	2190 4820	2300 5070	2410 5310	2520 5550	2650(F) 5840(F) 142	2770 6095	2890 6350	3000(G) 6610(G) 146	3080 6790	3160 6970	3250(H) 7160(H) 149
12R22.5	DUAL	2170 4780	2260 4990	2350 5190	2440 5390	2575(F) 5675(F) 141	2630 5785	2680 5895	2725(G) 6005(G) 143	2840 6265	2960 6525	3075(H) 6780(H) 147
	SINGLE	2240 4940	2360 5200	2470 5450	2580 5690	2725(F) 6005(F) 143	2820 6205	2910 6405	3000(G) 6610(G) 146	3120 6870	3240 7130	3350(H) 7390(H) 150
12R24.5	DUAL	2300 5080	2400 5300	2500 5520	2600 5730	2650(F) 5840(F) 142	2770 6095	2890 6350	3000(G) 6610(G) 146	3080 6790	3160 6970	3250(H) 7160(H) 149
	SINGLE	2380 5240	2500 5520	2630 5790	2740 6040	2900(F) 6395(F) 145	3020 6650	3140 6910	3250(G) 7160(G) 149	3350 7380	3450 7600	3550(H) 7830(H) 152

SPECIFICATIONS

Hydraulic Pump

Type Variable displacement, axial piston with load sense
 Total Flow 47.5 GPM (179.8 LPM) at 2400 RPM

Hydraulic System

Requirements:

Outrigger System 14 gpm (52.9 lpm)
 Boom Up 21 gpm (79.4 lpm)
 Boom Down 13 gpm (49.2 lpm)
 Telescope Extend 42 gpm (158.9 lpm)
 Telescope Retract 15 gpm (56.7 lpm)
 Hoist System 21 gpm (79.5 lpm)
 Swing 12 gpm (45.4 lpm)

Reservoir

Capacity 73 gal (276 l) at full mark
 System capacity 117 gal (442.9 l)
 Filtration 3 Micron Return

Hoist System

Wire Rope:

Length 390 ft (118.9 m)
 Diameter (Rotation Resistant) 9/16 in (14.3 mm)
 Nominal Breaking Strength 38,500 lb (17,463 kg)

Low Speed Hoist Performance—1 part line				
Layer	Hoist Pull			
	lb	(kg)	fpm	(mpm)
1	10,520.7	(4772.1)	111	(33.8)
2	9,485.9	(4302.7)	123	(37.4)
3	8,636.4	(3917.4)	138.6	(42.2)
4	7,926.6	(3595.4)	151.0	(46.0)
5	7,324.6	(3322.3)	163.4	(49.8)
NOTE: All ratings based on 34 gpm at 3500 psi (128.7 lpm at 24.1 MPa)				

High Speed Hoist Performance—1 part line				
Layer	Hoist Pull			
	lb	(kg)	fpm	(mpm)
1	5,260.3	(2386.0)	206	(62.7)
2	4,742.9	(2151.3)	228	(69.4)
3	4,318.2	(1958.7)	277.3	(84.5)
4	3,963.3	(1797.7)	302.1	(92.0)
5	3,362.3	(1525.1)	326.9	(99.6)
NOTE: All ratings based on 34 gpm at 3500 psi (128.7 lpm at 24.1 MPa)				

Crane Operating Speeds

Rotation 375°	52 sec ±5
Boom up -10° to 80°	34 sec ± 5
Boom Down 80° to -10°	26 sec ± 5
Boom Extend/Retract 100 ft	
Extend (Angle 60°)	65 fpm ± 10
Retract.....	85 fpm ± 10
Boom Extend/Retract 110 ft	
Extend (Angle 60°)	70 fpm ± 10
Retract.....	100 fpm ± 10

Outrigger Speeds

Beam Extend	7 sec ± 3
Beam Retract.....	5 sec ± 3
Jack Extend	8 sec ± 3
Jack Retract.....	6 sec ± 3

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SECTION 7

LOAD MOMENT INDICATOR

SECTION CONTENTS

System Description	7-1	Operational Limits	7-7
Alert and Limit Symbols	7-3	Slew Angle Limit	7-7
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Outrigger Configuration (Optional)	7-4	Tip Height Limit	7-8
Reeving Configuration	7-4	Radius Limit	7-8
Confirmation	7-4	Delete All Limits	7-9
TARE Function	7-5	Tools	7-9
Operating Mode	7-5	Diagnostic	7-10
RCL Operating Modes	7-6		



FIGURE 7-1

SYSTEM DESCRIPTION

The Rated Capacity Limiter (RCL) is an operational aid that warns the operator of an impending dangerous condition that could result in death or injury to personnel and/or damage to equipment and property.

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 Manitowoc RCL system consists of an operator's console, anti-two block switch, length sensor, angle sensor, slew potentiometer, four outrigger length sensors and two 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 operator's console.
- Length/angle sensor with cable reel mounted on the under side of boom.
- Lift cylinder pressure transducers located inside the turret.
- Anti-two block (A2B) switch on the boom nose.
- Slew Potentiometer inside the frame mounted to the bearing.
- Outrigger length string potentiometer mounted inside each outrigger beam.

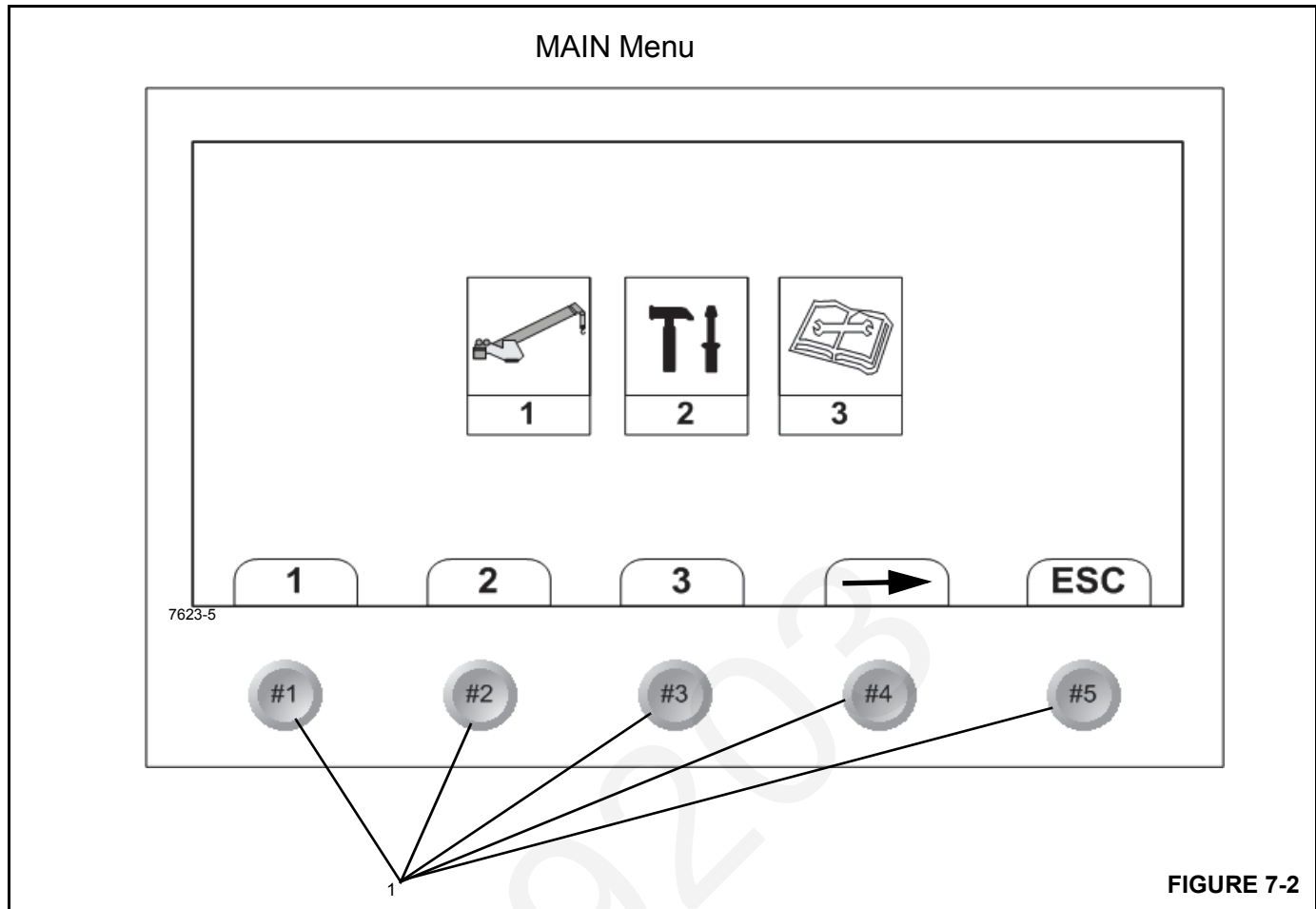


FIGURE 7-2

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 Load Moment Indicator system.

- **RCL Set-Up** - Select function key #1 (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 7-3.
- **Tools** - Select function key #2 (Figure 7-2) to access the tools screen, see page 7-9. This screen includes:
RCL Setup and Sensor Calibration Screens and Measurement Display Information
- **Diagnostic** - Select function key #3 (Figure 7-2) to access the RCL diagnostic menu, see page 7-10. This menu includes:
Software Versions, Load Chart Part Number and Load Chart, Machine Information and Warnings, Crane Electrical Fault Monitoring, Hour Meter and Lift Cylinder PSI

The Main Menu screen has five *function keys* (1, Figure 7-2) that are used to select the functions shown on the display screen above each key.

- For more choices, press the right arrow ➡ function key (#4).
- To go back to the previous choices, press the left arrow ⬅ function key.
- The up ▲ and down ▼ arrow functions are used to increment or decrement through numerical inputs or screen selections.
- The ESC (#5) function returns to the previous screen without saving inputs.

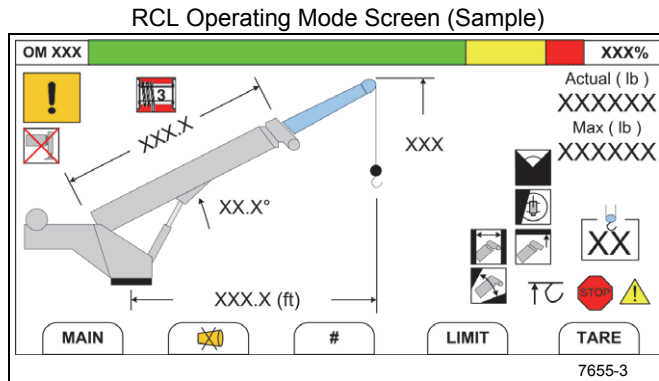
NOTE: On start up of the RCL, the National Crane logo screen will appear for approximately 5 seconds then Screen #1 (page 7-4) appears; to return to the Main Menu screen (Figure 7-2) select ESC.

NOTE: If the crane is powered up after sitting idle within a 2 hour time period, Screen 9 (page 7-5) will appear first.

Alert and Limit Symbols

The left and right sides of the operating screen display 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-Capacity Warning - Continuous visual and audible warning that an 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
- A2B 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 A2B alerts.

- RCL Override Warning (Red) - Indicates that the RCL is bypassed by the operator. Use extreme caution when the RCL is bypassed.

- A2B Override Warning (Red) - Indicates that the A2B is bypassed by the operator. Use extreme caution when the A2B 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.
- 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 $+1.1^\circ$ to $+360^\circ$ or $+1.1^\circ > \text{angle} > 180^\circ$ negative slew angle is to the left 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.
- 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.
- Outrigger (O/R) Setup Overridden - Indicates that the operator has manually overridden the current O/R configuration determined by sensor data. No buzzer sounds and no functions are locked out when the outrigger setup is overridden.

- 
Outrigger (O/R) Configuration Change - Indicates that the current O/R position has changed from the previously configured O/R setup. Buzzer sounds to warn operator of discrepancy, but no functions are locked out.
- 
Last Layer Indicator (LLI)/3rd Wrap - Begins to flash to indicate that the last layer has been reached on the hoist drum.

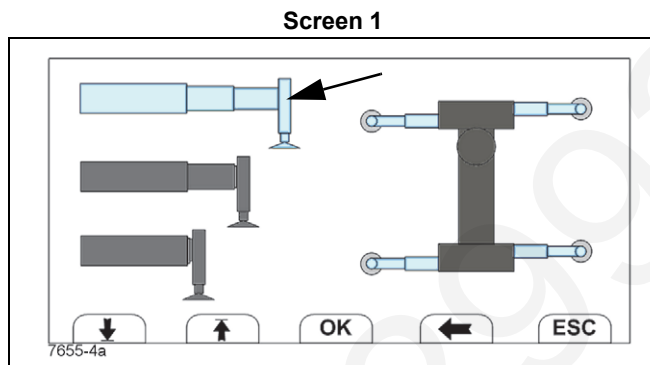
RCL SETUP

The RCL setup is where the outrigger and reeving 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.

Outrigger Configuration (Optional)

This feature applies when the optional Outrigger Monitoring System is installed. Though the screens show the configuration of the outriggers, the outriggers will need to be manually deployed.



The current outrigger status will be displayed by high-lighting the current outrigger setting in light blue, shown on the left side of Screen 1. 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 Full-Span, Mid-Span, Zero-Span, Figure 7-3.

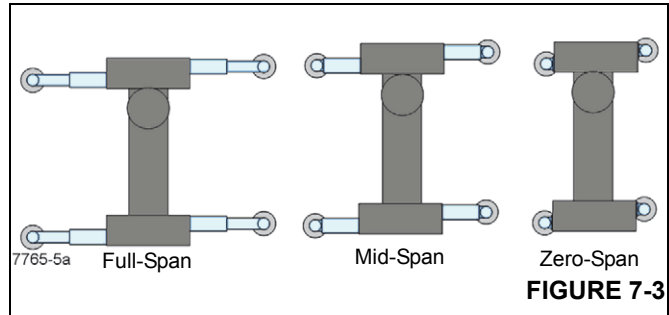
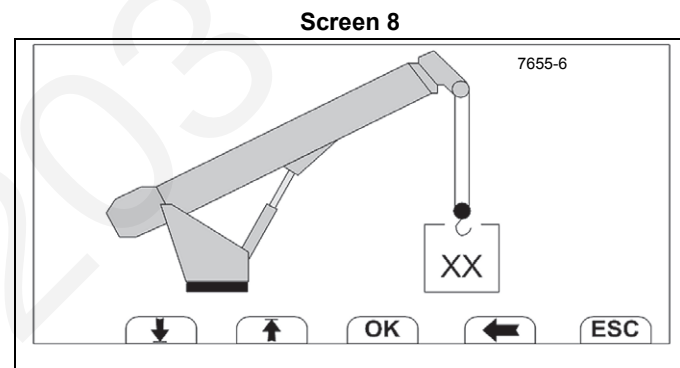


FIGURE 7-3

Least common outrigger position determines the chart that is to be used. For example:

If one side of the outriggers is at full-span and the other side is at mid-span, the configuration selected by the RCL and shaded in light blue on the left of the display screen would be mid-span.

Reeving Configuration



Use the Reeving Configuration Screen 5 to set the current reeving configuration; press either the up or down arrows to change reeving from 1 part line up to 7 parts line.

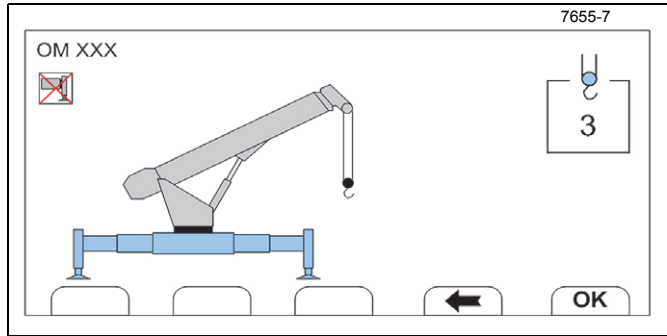
Confirmation

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



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.

Changing the boom angle or length automatically returns the actual load display back to the total weight (Load + Hook Block).

OPERATING MODE

After the RCL setup is complete the RCL Operating Mode screen is displayed.

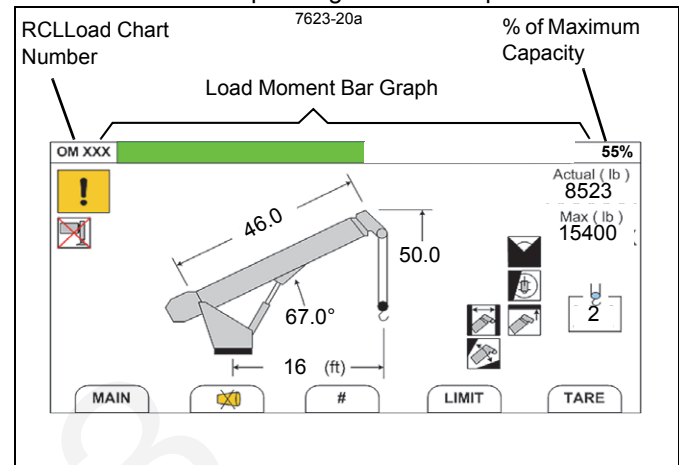
The key functions at the bottom of the RCL Operating Mode screen are:

- MAIN - Pressing this key returns to the MAIN Menu screen.
-  - Horn Silence indicates the RCL warning horn is temporarily disabled.
- # - Reeving selecting screen; pressing this button returns to the number of parts of line selection screen.
- LIMIT - Pressing enables the RCL Limits Menu screen.

- TARE - Pressing temporarily zeros out the Actual Load indicated on the screen to show the weight of the load only.

The following *example* RCL Operating Mode - Sample screen has been set up without a jib, all limits set and displays the following:

RCL Operating Mode - Sample



- Boom Length (BL) = 46.0 ft
- Boom Angle (BA) = 67.0°
- Load Radius (LR) = 16 ft
- Boom Tip Height (TH) = 50.0 ft
- # Parts of Line (#) = 2
- Maximum Allowable Load (ML) = 15400 lbs.
- Actual Load (AL) = 8523 lbs.
- All Active Limits

Function Keys:

- MAIN: returns to the MAIN Menu screen.
- Horn Silence: disables the horn for 15 seconds per press.
- # - Reeving selection screen: returns to the number of parts of line selection screen.
- LIMIT: enables the RCL limits options menu.
- TARE: temporarily zeros out the Actual Load Indicated on the screen to show the weight of the load only.

RCL Operating Modes

Operating Modes 001-014: 100ft or 110ft Main Boom. Full Span O/R's. SAE 85% Chart	
OM#	Description
001	Main boom, no jib stowed
002	Main boom, jib stowed
003	25 ft tele jib
004	44 ft tele jib
005	
006	
007	
008	
009	
010	
011	Personnel basket on main boom
012	
013	Personnel basket on 25 ft tele jib
014	Personnel basket on 44 ft tele jib

Operating Modes 401-404: 100ft or 110ft Main Boom, Mid-Span O/R's, SAE 85% Chart	
OM#	Description
401	Main boom, no jib stowed
402	Main boom, jib stowed
403	25 ft tele jib
404	44 ft tele jib

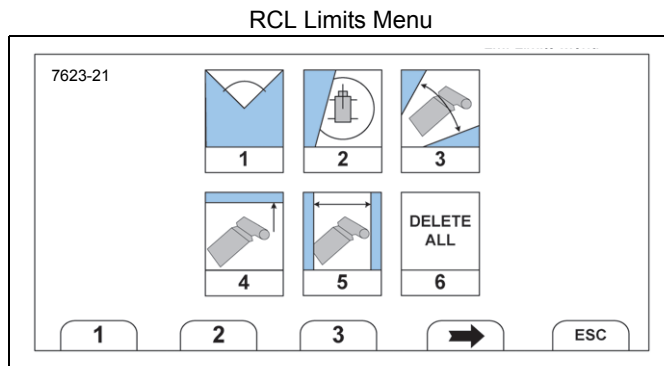
Operating Modes 801-802: 100ft or 110ft Main Boom, Zero-Span O/R's, SAE 85% Chart	
OM#	Description
801	Main boom
802	Main boom, jib stowed

Operating Modes 001-801: 69ft Main Boom, SAE 85% Chart	
OM#	Description
001	Main boom, full-span outriggers
011	Personnel basket on main boom, full span outriggers
401	Main boom, mid-span outriggers
801	Main boom, zero-span outriggers

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 and flash 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.

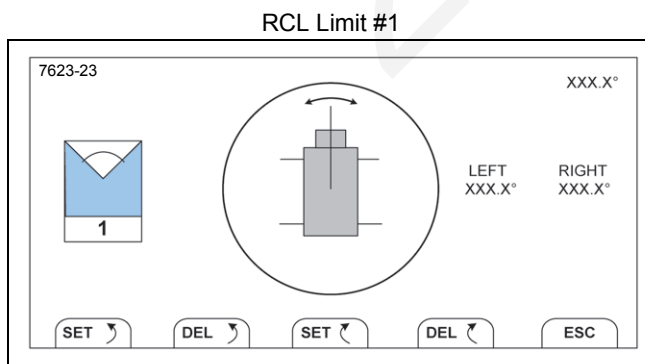


Select the desired operational limit 1 through 6, use the arrow key to scroll back and forth to select the correct operational limit.

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:

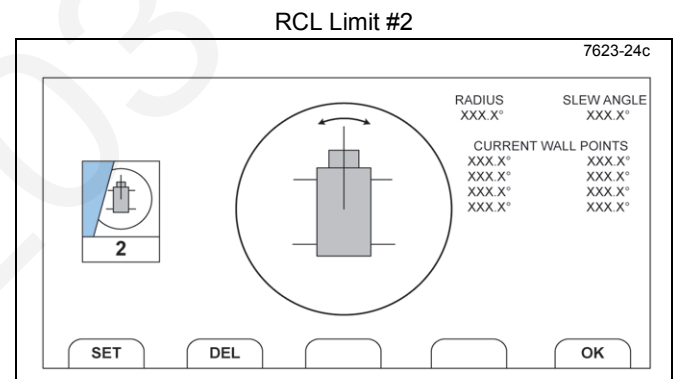
- Select the SET function key (#1 or #3, Figure 7-2) to store the current slew angle.
- Select DEL function key (#2 or #4, Figure 7-2) to remove the current setting.
- The RCL #1 screen is updated in real time.
- ESC to return to previous screen when finished.

Use the function key with a ↶ for counter clockwise settings and the function key with a ↷ for clockwise slew settings.

The SET slew angle is shown in the top right corner (xxx.x°) of the Limit #1 screen. Once set this value is fixed and does not change; the current/operating slew angle will appear below the SET slew angle.

Note the zero position in RCL Limit #1 screen and the plus (+) and minus (-) direction.

WADS Limit



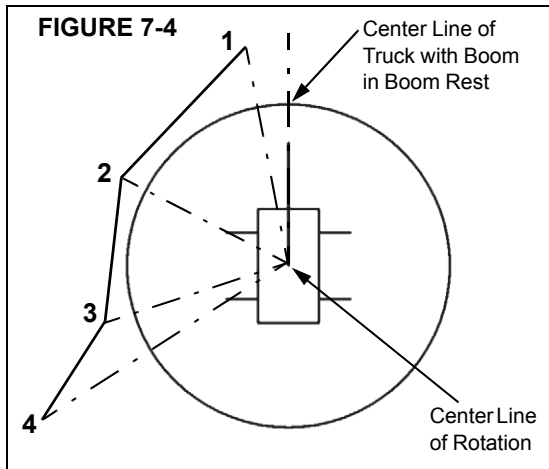
The RCL Limit #2 screen will set the superstructure radius limit slew angle.

Rotate the crane superstructure to the desired position (the radius number will appear on the display screen) then:

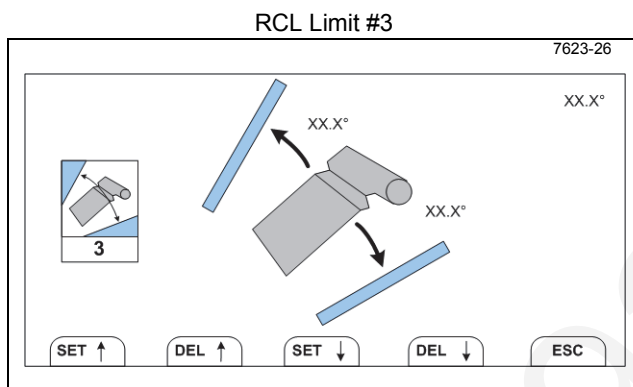
- Select the SET function key (#1, Figure 7-2) to set the current boom nose position.
- Select DEL function key (#2 or #4, Figure 7-2) to remove the current settings.
- Select OK to store each position after selection.

There can be up to four set points which form 3 virtual walls. The points are taken from the load position 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 7-4



Boom Angle Limit



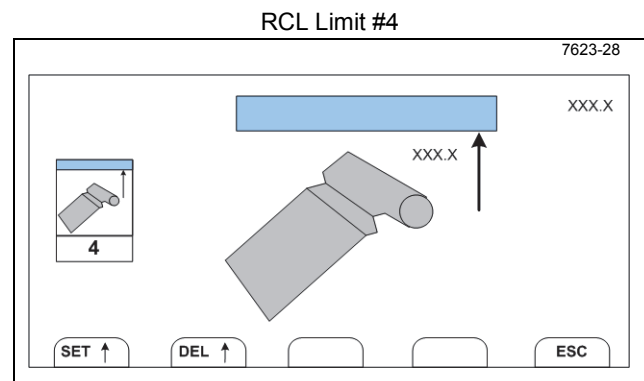
Move the crane boom to the desired boom angle (the angle number will appear on the display screen) then:

- Select SET, function key (#1, Figure 7-2) to set the MAX boom angle.
- Move the boom to the minimum angle and 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

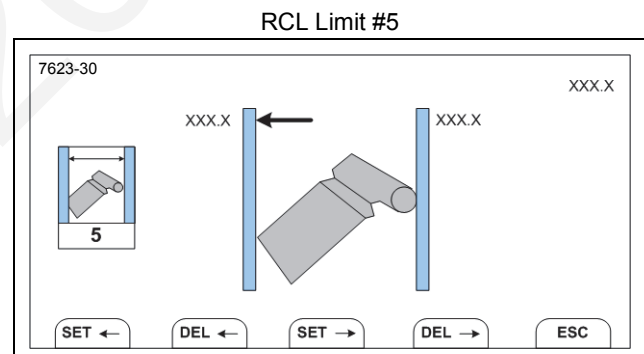


Move the crane boom to the desired boom tip height point (it will appear on the display screen) then select the following:

- Select SET, function key (#1, Figure 7-2) 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



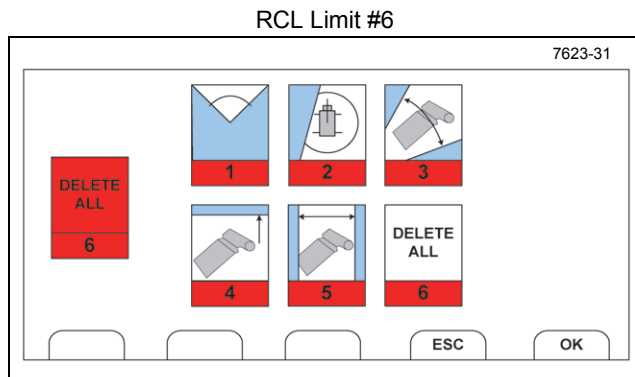
Move the crane boom to the desired boom radius (it will appear on the display screen) then:

- Select SET, function key (#1, Figure 7-2) to set the MAX boom radius.
- Move the boom to the minimum radius and select SET, function key (#3) to set the MIN boom radius.
- 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 radius, the Min. boom radius or both the Min. and Max boom radius.

The current radius is always shown in the upper right hand corner.

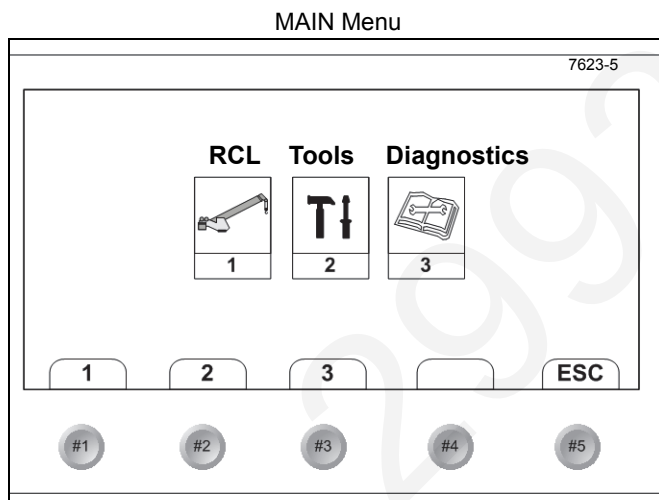
Delete All Limits



The RCL Limit #6 screen will allow the operator to delete all limit values that exist.

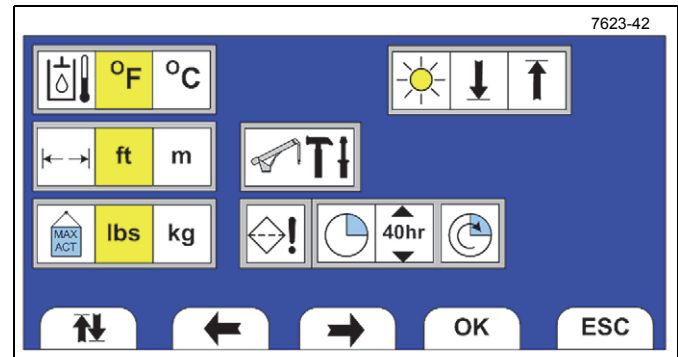
- Select OK to delete all values.
- ESC goes back to the Main Limits menu screen without deleting any limit values.

TOOLS



Select function key #2, Tools Menu on the MAIN Menu screen.

Tools 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; press OK to accept the selection.

- 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)

Yellow indicates the currently set value.

- RCL Sensor Calibration - Sensor calibration is password protected, refer to the *Service Manual*.
- Hydraulic Filter Reminder Setup - ON/OFF, reminder interval (40/250/500 hr.), reset reminder.

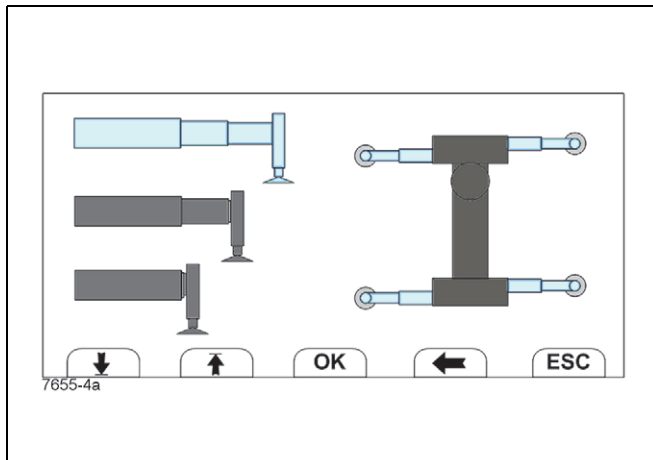
This display allows the operator to setup a reminder to check/replace the hydraulic return and suction filter on the crane. The operator can select three different intervals. When the timer expires, an indicator is turned on for the operator to indicate it is time to change the filter. To reset the timer select the far right icon.

- Screen Brightness - Allows adjustment of backlight over a range of 15 steps.
- Up and down arrows in the time and password boxes correspond to button #1 selection.

DIAGNOSTIC

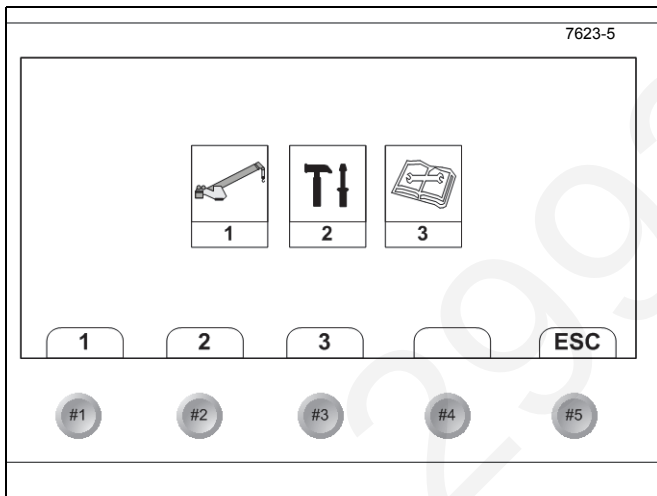
To get to the Diagnostic Menu screen, turn on the crane ignition switch and use the following screens.

Screen 1



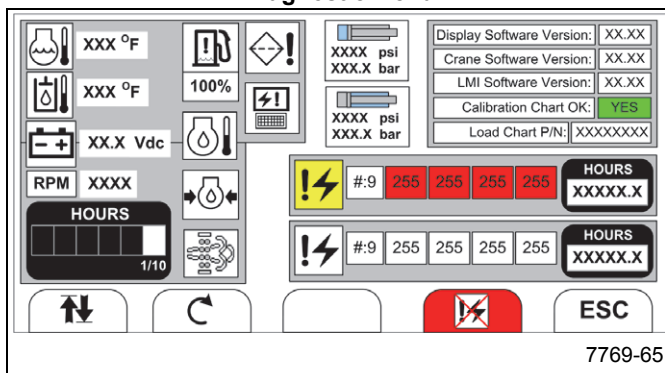
Select function key #5; the ESC function key takes you to the Main Menu.

MAIN



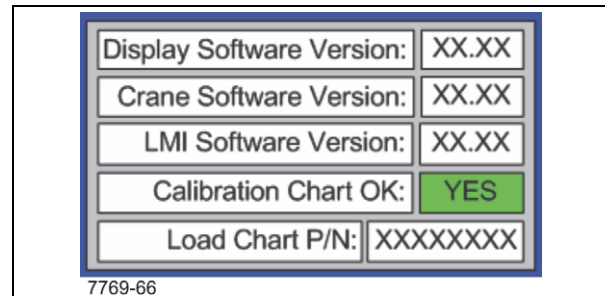
Select function key #3, Diagnostics.

Diagnostic Menu



The Diagnostic Menu screen is divided into five different displays that provide software version and revision, crane and truck operating information and warnings, an hour meter, fault code displays and lift cylinder pressure readings.

1. Crane software versions and diagnostic tool version (screen upper right hand corner).



- Display Software Version - The current RCL display software version is shown. This software pertains to all the graphics shown on the RCL display.
- Crane Software Version - The current crane software version is shown. This software pertains to the software used to control the crane functionality. This is also the version of the diagnostic file that is needed to connect to the crane for troubleshooting.
- RCL Software Version - The current RCL software version is shown. This software pertains to the software used to control the crane's RCL functionality. This is also the version of the diagnostic file that is needed to connect to the crane's RCL for troubleshooting.
- Calibration Chart - If a calibration chart is installed, the box will say YES and is GREEN. If not installed, the box will say NO and is RED. This calibration chart is the file unique to the specific machine and includes the geometric data from the OEM calibration. If there is no calibration chart loaded, the RCL will have inaccurate data on the main operating screen.
- Load Chart P/N - The current RCL load chart version is shown. This load chart is the electronic version of the load chart that is included in the crane cab Load Chart Binder.

2. Machine information/warnings (upper left hand corner of the Diagnostic Menu screen)

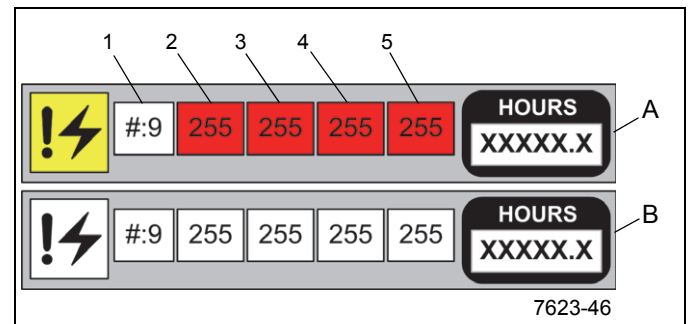
	<u>Engine Water Temperature</u> - If the engine water temperature rises above 300°F the general warning light is shown on the operating mode screen and this icon is highlighted RED. Fahrenheit is the default value.
	<u>Hydraulic Oil Temp</u> - If the hydraulic oil temperature rises above 180°F, the general warning light is shown on the operating mode screen and this icon is highlighted RED. Fahrenheit is the default value.
	<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>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>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>Engine Oil Pressure Warning</u> - If the truck engine oil pressure is 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>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.
	<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.
	Module Fault - turns RED when any module is missing or has a fault which should be present or OK.

3. Crane Hour Meter - Real-time clock is on when Control State equals Crane or Remote, time is saved when machine is shutdown.



4. Crane Electrical Fault Monitor (right hand side and center of Diagnostic Menu screen).



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). Fault numbers only show when a fault occurs and clears when the 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

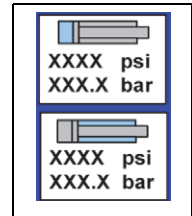
(5) - Error Number

Logged Fault Box (B) - Logged faults are not currently active, use the up/down arrows to scroll through the codes.

The crane control system will display up to 50 of the most recent logged faults or errors in the crane and RCL control system(s). The up/down arrows can be used to scroll through the active faults. This series of 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.

5. Lift Cylinder Pressure Sensor - displays the real time pressures in psi and bar for the base and the rod side pressures.



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