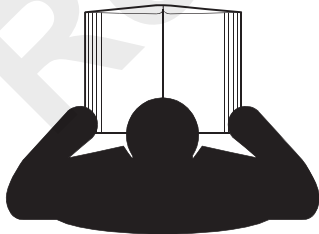



OPERATOR MANUAL

Supplement

Crane Warm-up Procedures

 A silhouette of a person sitting and reading a large open book. The book is held up in front of their face, and their hands are visible at the bottom corners of the pages.	<h2> DANGER</h2> <p>An untrained operator subjects himself and others to death or serious injury. Do not operate this crane unless:</p> <ul style="list-style-type: none">• You are trained in the safe operation of this crane. Manitowoc is not responsible for qualifying personnel.• You read, understand, and follow the safety and operating recommendations contained in the crane manufacturer's manuals and load charts, your employer's work rules, and applicable government regulations.• You are sure that all safety signs, guards, and other safety features are in place and in proper condition.• The Operator Manual and Load Chart are in the holder provided on crane.
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Reference Only

This Supplement provides information regarding the proper warm-up procedures for operating the crane in colder temperatures. The information provided here supplements the *Operator* and *Service Manuals* and must be used in conjunction with these manuals.

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 2).
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.

National Crane

OPERATOR MANUAL

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

500E2

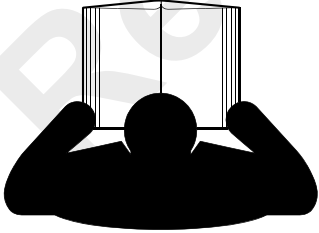
This Manual is divided into the following sections:

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

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's 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.

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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 500E2 Series National Crane.

Before placing the crane in service, all operators and persons working around the crane must thoroughly read and understand the contents of the 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 National Crane 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 Dealer Network want to ensure your satisfaction with our products and customer support. Your local dealer 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 dealer's service management to coordinate the contact on your behalf.

Supplemental Information

Supplemental Information regarding Safety and Operation, Specifications, Service and Maintenance, Installation, and

parts for options such as remote controls, augers, varying control configurations, baskets, grapples, etc. is included in separate sections of this manual, if applicable.

Engine operating procedures and routine maintenance procedures are supplied in a separate manual with each crane, and should be referred to for detailed information.

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



DANGER

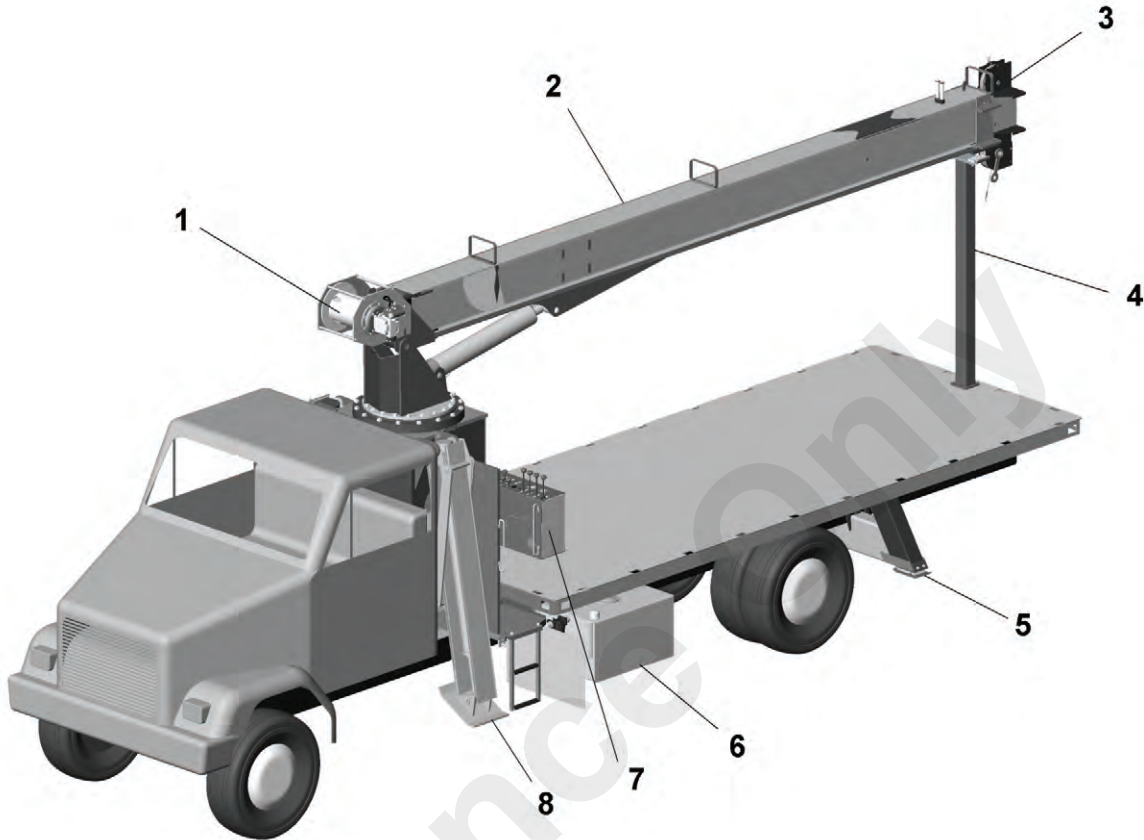
Failure to observe all the instructions contained in this manual will result in death or serious injury to the operator or bystanders or damage to the equipment.

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.

New Owner

If you are the new owner of a Manitowoc crane, please register it with Manitowoc Crane Care so we have the ability to contact you if the need arises. Go to: www.manitowoccranes.com/MCG_CARE/Includes/EN/changeOfOwnership.cfm and complete the form.



500E2 Series Major Components

Item	Component
1	Hoist
2	Boom
3	Sheaves
4	Boom Rest

Item	Component
5	Stabilizers
6	Hydraulic Reservoir
7	Control Console
8	Outriggers

NOTICE TO OWNER/USER

Should this crane become involved in a property damage accident, please contact your local National distributor immediately and relate details of incident including serial number of crane. The Dealer will notify National Crane Corporation.

If accident involves personal injury notify your local distributor and immediately contact the National Crane Corporation Manager of Product Safety and Reliability at the contact numbers listed in the front of this Handbook.

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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 dealer must be immediately advised of the incident and consulted on necessary inspections and repairs. Should the dealer 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 dealer and/or Manitowoc Crane Care.

If this crane becomes involved in a property damage and/or personal injury accident, **immediately** contact your Manitowoc dealer. If the dealer 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'S INFORMATION

You must **read** and **understand** this *Operator's 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's 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's 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'S 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.

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

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-Block Device*, *Two-Blocking Damage Prevention* 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.

Load Moment Indication (LMI) Systems (If Equipped)

Your crane may be equipped with an LMI system which is intended to aid the operator. 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 load moment indicating system installed on the crane, see the manufacturer's manual supplied with the crane.

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 42 in (107 cm) 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.

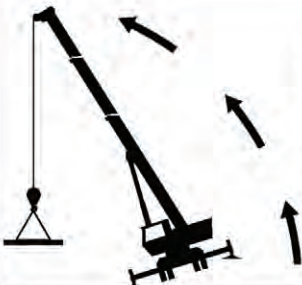

Work Area Definition System (WADS) (If Equipped)

If your crane is equipped with a WADS, you must read and understand the manufacturer's *Operator's Manual* before operating the system. Become familiar with all proper

operating procedures and with the identification of symbol usage.

The work area definition system is intended as an aid to the operator. It is not a substitute for safe crane operating practices, experience and good operator judgements.

⚠ DANGER

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

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

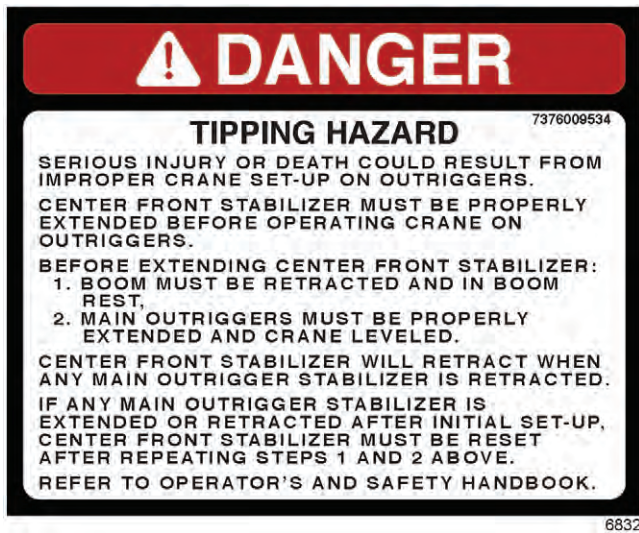
To avoid death or serious injury, ensure that the crane is on a firm surface with load and crane's configuration within capacity as shown on the crane's *Load Chart* and notes.

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 strip, if applicable), the outriggers must also be pinned when operating from the mid-extend position.

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

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



Carefully follow the procedures in this Operator's 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 Load Moment Indicating (LMI) 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 (or tires if lifting on rubber) 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.

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



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

Load Charts

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

Load Chart capacities are based on freely suspended loads.

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

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

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

Work Site

Prior to any operation, you must inspect the **entire** work site, including ground conditions, where the crane will travel and operate. 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 affect the stability of the crane.

Wind Forces

Wind can have a significant affect 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 20 mph (32 km/h) to 30 mph (48 km/h), 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 30 mph (48 km/h) is not recommended.

Table 2-1

Wind Force		Wind Velocity mph (km/h)	Visible Indicator Effects of wind as observed on land
Beauford Scale	Designation		
Zero (0)	Calm	less than 1 (<2)	No wind; smoke rises vertically
1	Light Air	1-3 (2-5)	Wind direction seen by smoke but not by wind vanes
2	Light Breeze	4-7 (6-11)	Wind felt on face; leaves rustle; wind vane moves slightly
3	Gentle Breeze	8-12 (13-19)	Leaves/small twigs in constant motion; wind extends flag
4	Moderate Breeze	13-18 (21-29)	Raises dust & loose paper; moves small branches
Reduce crane load ratings and operating parameters at 20 mph (32 km/h)			
5	Fresh Breeze	19-24 (31-39)	Small trees in leaf begin to sway; on ponds, crested wavelets form
6	Strong Breeze	25-31 (40-50)	Large branches in motion; telegraph wires whistle; umbrellas used with difficulty
Cease all craning operations at 30 mph (48 km/h); lower & retract boom			
7	Moderate Gale	32-38 (52-61)	Whole trees in motion; walking against wind is inconvenient

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 LMI is programmed for the crane configuration. Refer to the LMI handbook 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 OCT80 "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's aids are properly programmed, that the qualified crane operator adheres to the instructions found in the applicable *Load Chart*, *Operator's Manual* and decals on the crane, the crane should not be unstable.

Multiple Crane Lifts

Multiple crane lifts are not recommended.

Any lift that requires more than one crane must be precisely planned and coordinated by a qualified engineer.

If it is necessary to perform a multi-crane lift, the operator shall be responsible for assuring that the following minimum safety precautions are taken:

- Secure the services of a qualified engineer to direct the operation.
- Use one qualified signal person.
- Coordinate lifting plans with the operators, engineer, 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 cranes and rigging of equal capabilities and use the same boom length.
- Use outriggers on cranes so equipped.
- Be certain cranes are of adequate lifting capacity.
- 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.

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.



! 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's 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.

Thoroughly read, understand, and abide by all applicable federal, state, and local regulations.

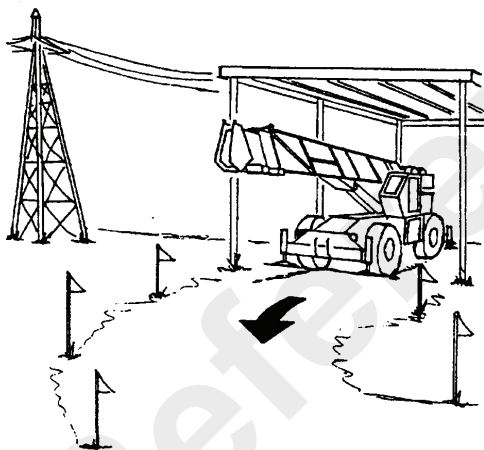
Set-Up and Operation

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 20 ft (6 m) 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 cab. **Don't panic.**
2. Immediately warn personnel in the vicinity to stay away.
3. Attempt to move the crane away from the contacted power source using the crane's controls which 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 dealer 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 dealer not be immediately available, contact Manitowoc Crane Care. The crane must not be returned to service until it is thoroughly inspected for any evidence of damage and all damaged parts are repaired or replaced as authorized by your Manitowoc dealer 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 B30.23-2005*. This standard provides, "lifting and lowering of personnel using ASME B30 Standard hoisting equipment shall be undertaken only in circumstances when it is not possible to accomplish the task by less hazardous means. Unless all of the applicable requirements of this volume are met, the lifting or lowering of personnel using ASME B30 Standard equipment is prohibited." 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*, 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:
 - Use only Manitowoc approved personnel platforms attached to the boom.
 - 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 load moment indicator (LMI) 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 dealer.

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 dealer 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 wear of the individual outside wires of 1/3 of 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.

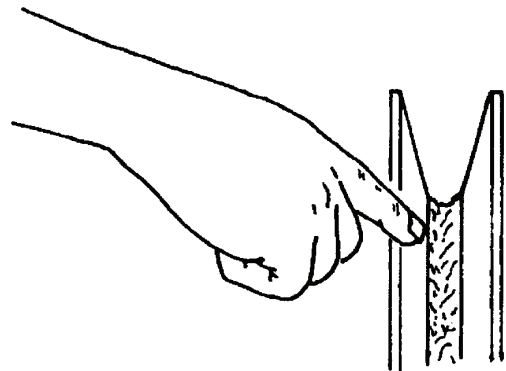
When installing a new rope:

- 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 (nylatron) sheaves, as compared with metallic sheaves, may change the replacement criteria of rotation-resistant wire rope.

NOTE: The use of cast nylon (nylatron) 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.

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

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 slack provided at the center line of sheave to anchor point. Care must be exercised anytime any crane function is being performed while the cable is hooked into the hookblock tie down. Do not draw cable taut.

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 lock.

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

This machine is manufactured with no axle suspension system. Traveling at high speeds, especially on rough ground, may create a bouncing affect that can result in loss of control. If bouncing occurs, reduce travel speed. (RT and Shuttle Lift Only)

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:

- Pick and carry on level surfaces only.
- Refer to the *Operation Section* for more detailed information on traveling on slopes.
- Driving across a slope is dangerous, as unexpected changes in slope can cause tip over. Ascend or descend slopes slowly and with caution.
- Ascend or descend slopes with the boom pointing up the slope.
- 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. LMI).
- 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's 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.

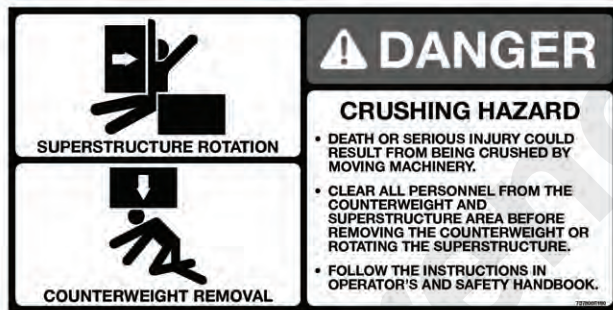
Carbon monoxide fumes from the engine exhaust can cause suffocation in an enclosed area. Good ventilation is very important when operating the crane.

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.

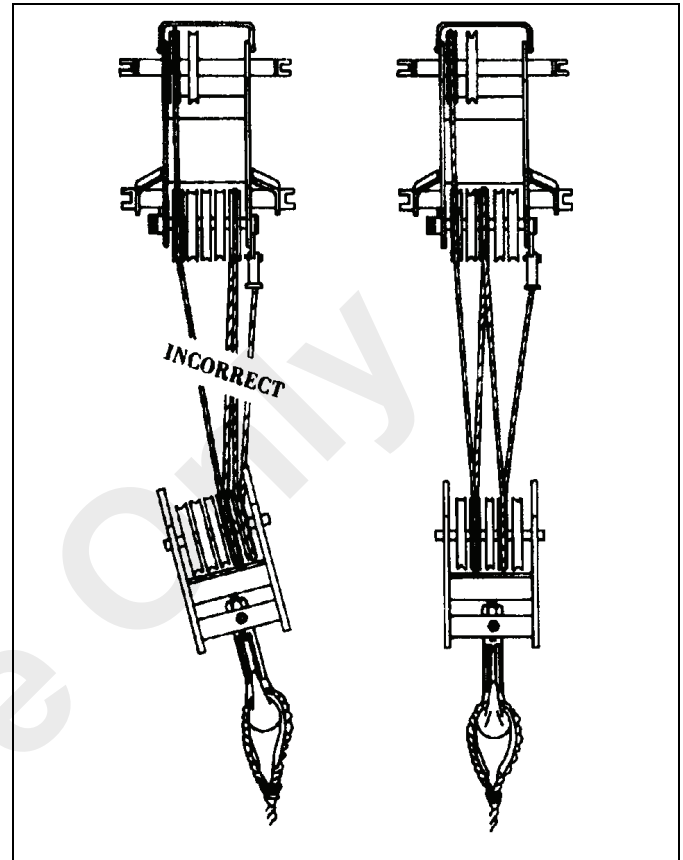
You must always be aware of everything around the crane while lifting or traveling. If you are unable to clearly see in the direction of motion, you must post a look out or signal person before moving the crane or making a lift. Sound the horn to warn personnel.

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).

Do not pull posts, pilings, or submerged articles. Be sure the load is not frozen or attached to the ground before lifting.

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:

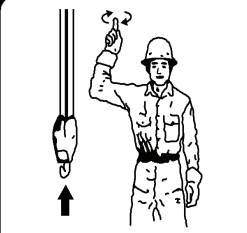
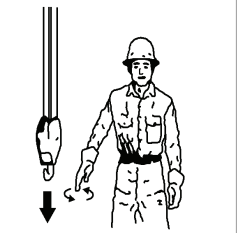
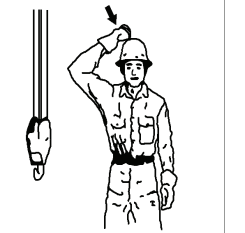
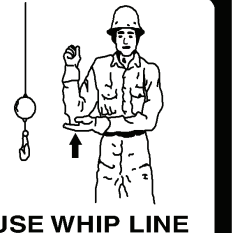
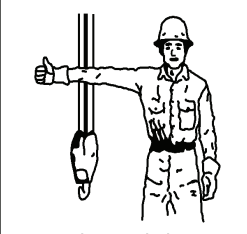
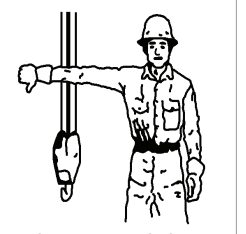
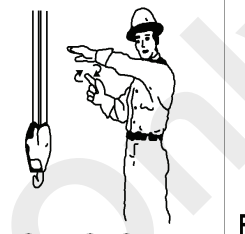
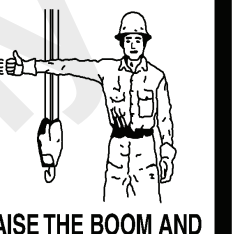
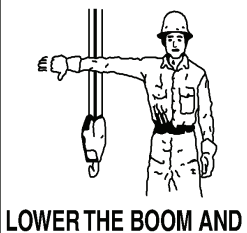
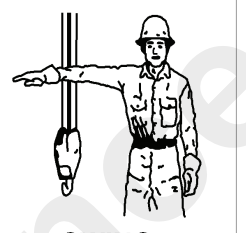
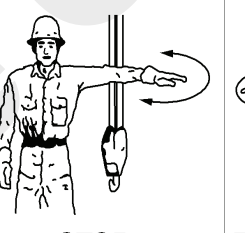
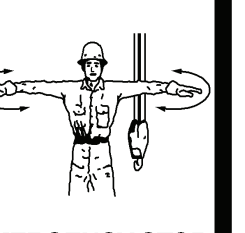
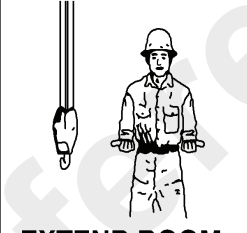
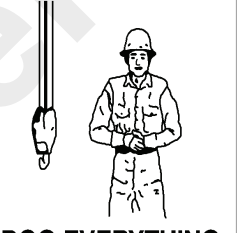
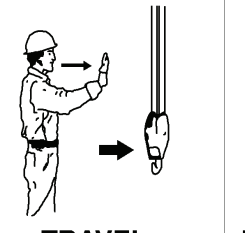
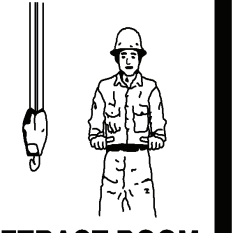
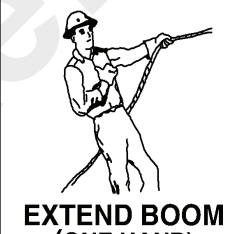
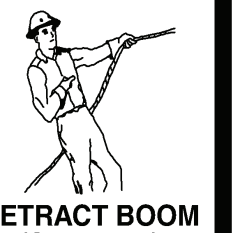
- Working in the vicinity of power lines.
- The crane operator cannot clearly see the load at all times.
- Moving the crane in an area or direction in which the operator cannot clearly see the path of travel.

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.

			
HOIST	LOWER	USE MAIN HOIST	USE WHIP LINE (Auxiliary Hoist)
			
RAISE BOOM	LOWER BOOM	MOVE SLOWLY	RAISE THE BOOM AND LOWER THE LOAD
			
LOWER THE BOOM AND RAISE THE LOAD	SWING	STOP	EMERGENCY STOP
			
EXTEND BOOM	DOG EVERYTHING	TRAVEL	RETRACT BOOM
	HAND SIGNALS <small>Reprinted by permission of The American Society of Mechanical Engineers</small>		
EXTEND BOOM (ONE HAND)			RETRACT BOOM (ONE HAND)

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 in Section 3 of this manual.

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

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

Section 3 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 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.

In cold weather, never park the crane where the tires can become frozen to the ground.

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 180 degrees F. Craneblock Working Load Limit is valid between 180 degrees 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 degrees 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 degrees 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 0.00043 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 25 ft in which the oil cools 60°F would retract

approximately 7 3/4 in (see chart below). A cylinder extended 5 feet in which the oil cools 60°F would only retract approximately 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. (Bulletin 98-036 applies to TMS700 and 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 (FT.)	Temperature Change (°F)									
	10	20	30	40	50	60	70	80	90	100
5	0.26	0.52	0.77	1.03	1.29	1.55	1.81	2.06	2.32	2.58
10	0.52	1.03	1.55	2.06	2.58	3.10	3.61	4.13	4.64	5.16
15	0.77	1.55	2.32	3.10	3.87	4.64	5.42	6.19	6.97	7.74
20	1.03	2.06	3.10	4.13	5.16	6.19	7.22	8.26	9.29	10.32
25	1.29	2.58	3.87	5.16	6.45	7.74	9.03	10.32	11.61	12.90
30	1.55	3.10	4.64	6.19	7.74	9.29	10.84	12.38	13.93	15.48
35	1.81	3.61	5.42	7.22	9.03	10.84	12.64	14.45	16.25	18.06
40	2.06	4.13	6.19	8.26	10.32	12.38	14.45	16.51	18.58	20.64
45	2.32	4.64	6.97	9.29	11.61	13.93	16.25	18.58	20.90	23.22
50	2.58	5.16	7.74	10.32	12.90	15.48	18.06	20.64	23.22	25.80
55	2.84	5.68	8.51	11.35	14.19	17.03	19.87	22.70	25.54	28.38
60	3.10	6.19	9.29	12.38	15.48	18.58	21.67	24.77	27.86	30.96

Length change in inches = Stroke (Ft.) X Temperature Change (°F) X Coeff. (in³/in³/ °F) X 12 in/ft

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

Coeff. = 0.000774 (1/ °C)											
STROKE (m)	Temperature Change (°C)										
	5	10	15	20	25	30	35	40	45	50	55
1.5	5.81	11.61	17.42	23.22	29.03	34.83	40.64	46.44	52.25	58.05	63.86
3	11.61	23.22	34.83	46.44	58.05	69.66	81.27	92.88	104.49	116.10	127.71
4.5	17.42	34.83	52.25	69.66	87.08	104.49	121.91	139.32	156.74	174.15	191.57
6	23.22	46.44	69.66	92.88	116.10	139.32	162.54	185.76	208.98	232.20	255.42
7.5	29.03	58.05	87.08	116.10	145.13	174.15	203.18	232.20	261.23	290.25	319.28
9	34.83	69.66	104.49	139.32	174.15	208.98	243.81	278.64	313.47	348.30	383.13
10.5	40.64	81.27	121.91	162.54	203.18	243.81	284.45	325.08	365.72	406.35	446.99
12	46.44	92.88	139.32	185.76	232.20	278.64	325.08	371.52	417.96	464.40	510.84
13.5	52.25	104.49	156.74	208.98	261.23	313.47	365.72	417.96	470.21	522.45	574.70
15	58.05	116.10	174.15	232.20	290.25	348.30	406.35	464.40	522.45	580.50	638.55
16.5	63.86	127.71	191.57	255.42	319.28	383.13	446.99	510.84	574.70	638.55	702.41
18	69.66	139.32	208.98	278.64	348.30	417.96	487.62	557.28	626.94	696.60	766.26

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

OVERLOAD INSPECTION

This information supplements the Load Moment Indicator (LMI) manual supplied with each Grove crane.

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

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

**WARNING**
Overload Hazard!

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

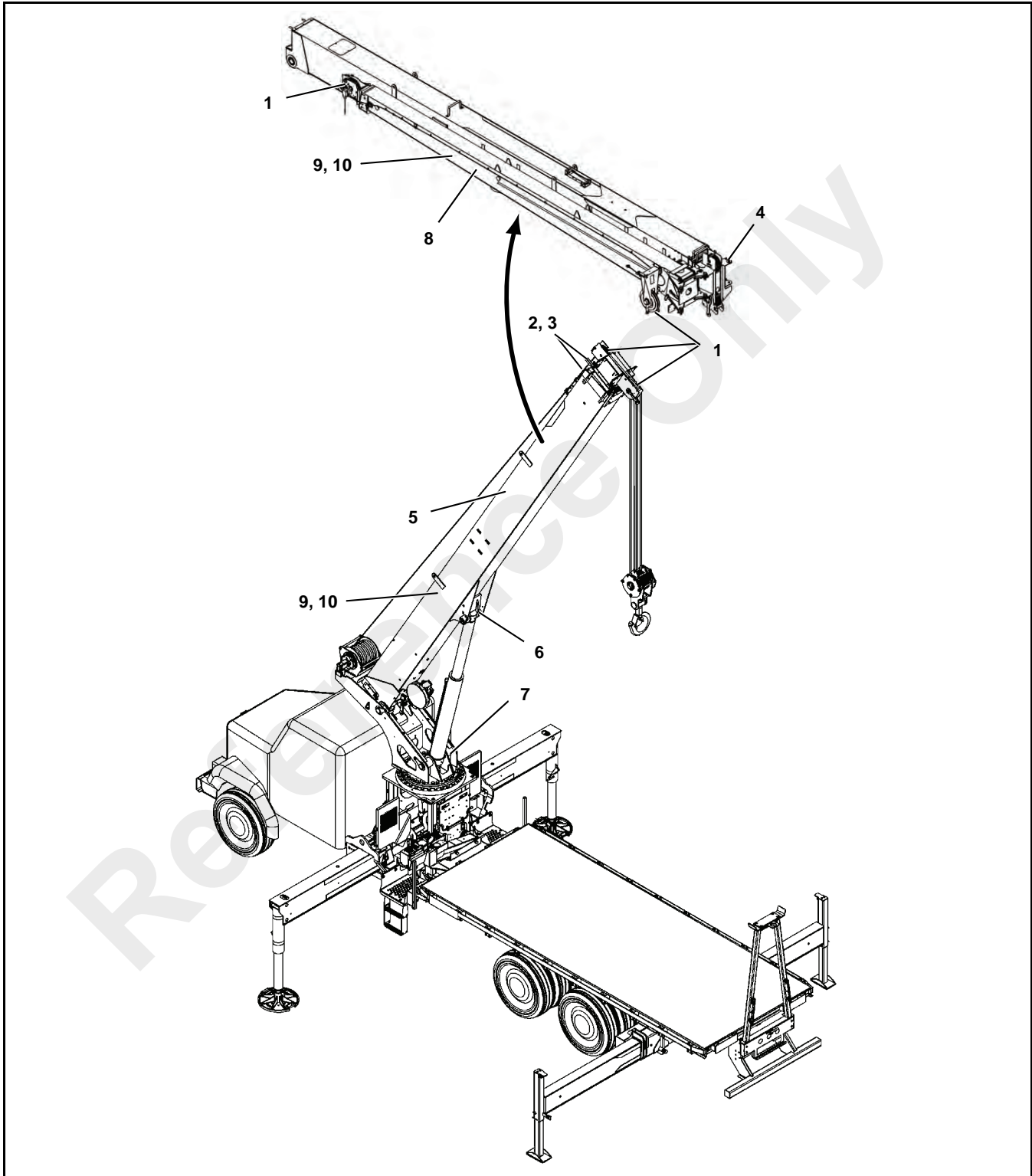
- Perform the inspections outlined in this publication for overloads up to 50%.
- Stop operating the crane and contact Manitowoc Crane Care immediately for overloads of 50% and higher.

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

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

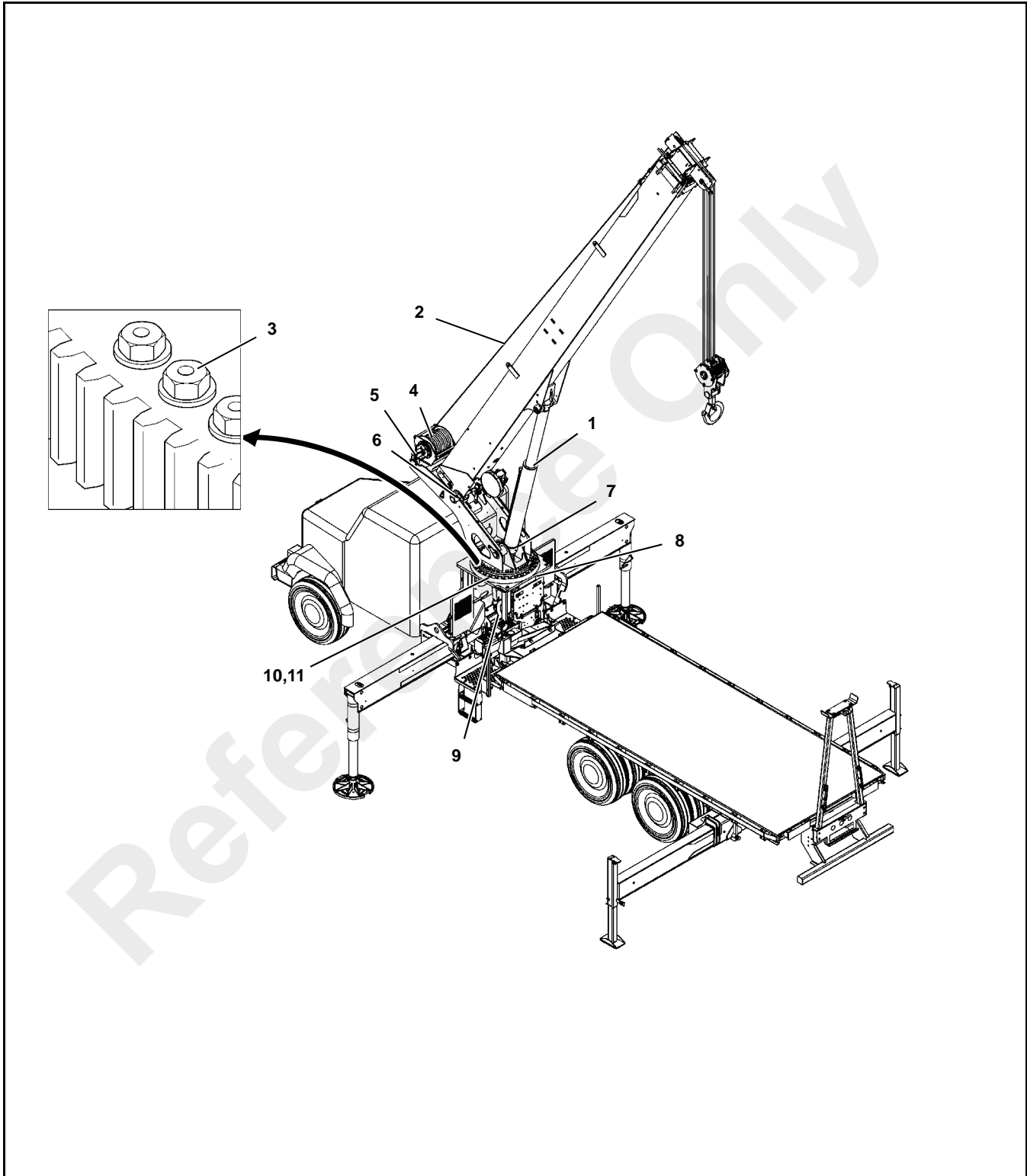
Reference

Boom Inspection



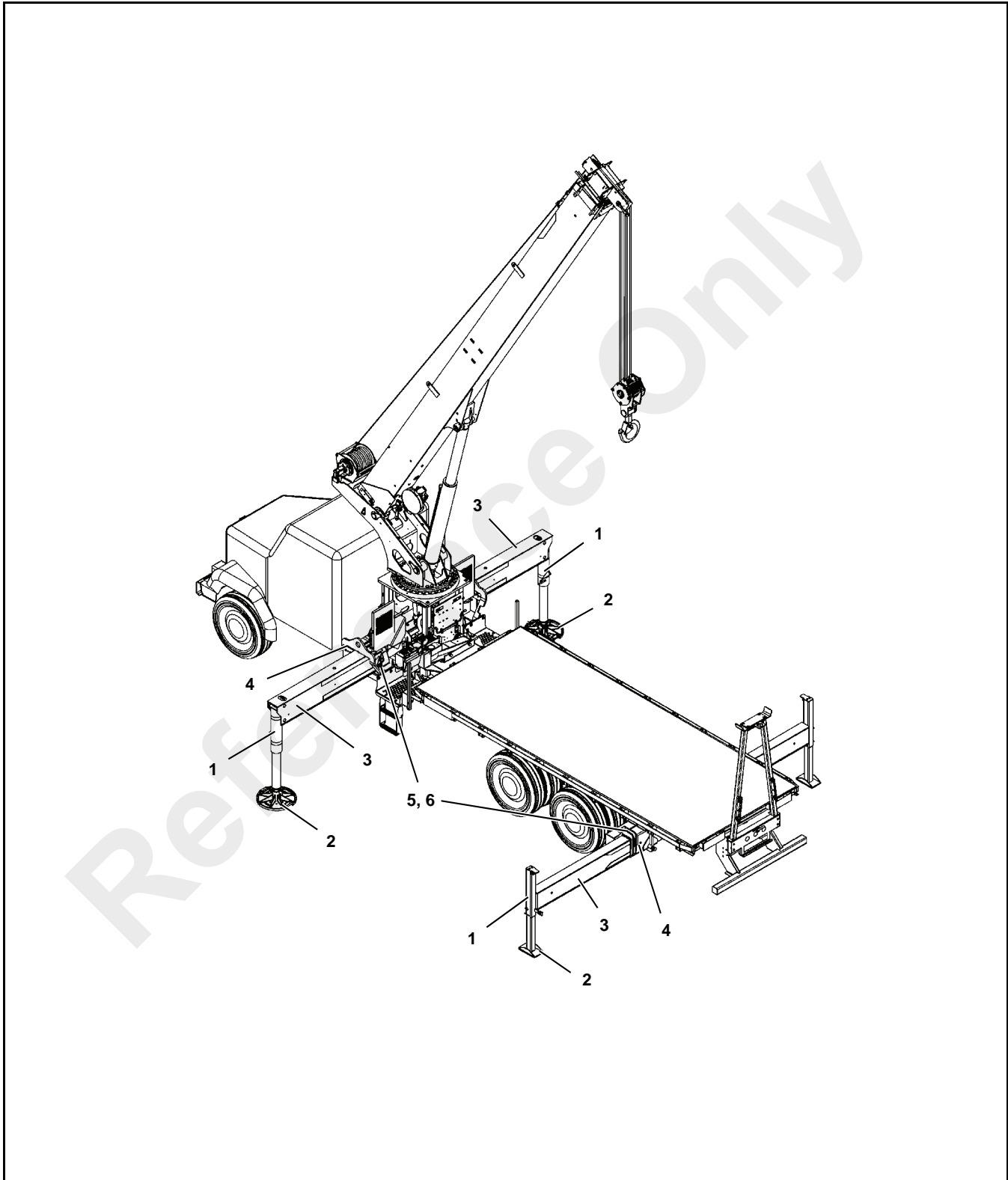
Overload less than 25%			
1	Sheaves, Rope Guides	Inspect all for damage.	
2	Collar-Wear Pads, Pad Retainers	Inspect for damage.	
Overload from 25% to 49%			
1	Sheaves, Rope Guides	Inspect all for damage.	
2	Collar-Wear Pads, Pad Retainers	Inspect all for damage.	
3	Collar-welds	Inspect all for damage.	
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 leaking.	
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 leaking.	
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 leaking.	
2	Outrigger Pads	Inspect for deformation and cracked welds.	
Overload from 25% to 49%			
1	Stabilizer Cylinders	Inspect for leaking.	
2	Outrigger Pads	Inspect for deformation and cracked welds.	
3	Outrigger Beams	Inspect for deformation and cracked welds.	
4	Outrigger Boxes	Inspect for deformation and cracked welds.	
5	Welds	Inspect for cracks.	
6	Paint	Inspect for cracked paint which could indicate twisted, stretched, or compressed members.	

Reference Only

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SECTION 3 OPERATING CONTROLS AND PROCEDURES

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TRUCK CAB CONTROLS

Power Take-Off

Manual Shift Control

The PTO's are engaged when the knobs on dash or floor are pulled out and disengaged when the knobs are pushed in. The truck gear shift lever must be in neutral and the clutch depressed whenever the knobs are moved.

Air Shift Control

The PTO is engaged when the switch is moved to apply air to PTO and disengaged when switch in off position. The truck gear shift lever must be in neutral and clutch depressed when switch is moved. The transmission selector lever must be returned to "N" for stationary vehicle operation. The

power take-off may be disengaged while in any transmission range provided that the load has first been removed from the PTO.

Electric Shift Control

Full torque electric shift PTO's are controlled by a switch. To operate, disengage the clutch, shift to fourth or fifth gear, and operate 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 vehicles equipped with automatic transmission, the power take-off must be engaged with the engine at idle. Refer to transmission manufacturers instructions for special procedures.

Park Brake

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

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.

Only experienced operators should operate cranes at full rated capacities between 0° F (-18° C) and -40° F (-40° C) and for derated capacities in colder temperatures to ensure smooth operation. Shock loading shall be avoided.

Derated capacities for each °C below -40°C

Derate the rated load shown on the capacity charts 3.67 percent for each degree celsius below -40° C.

Derated capacities for each °F below -40°F

Derate the rated load shown on the capacity charts 2 percent for each degree fahrenheit below -40° F

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 CONTROLS

The crane is equipped with control stations on each side of the main frame. Decals on the control knobs or next to the lever indicate the direction to actuate the controls for the various unit functions. Each station is complete and provides

complete control of boom rotation, boom elevation, boom extension, hoist, outriggers, engine foot throttle, the engine emergency stop switch, and a horn switch. All control handles except the outrigger controls are positioned in the same order at both control stations.

Turn

Operate the turn control lever to RIGHT to rotate the boom in a clockwise direction as viewed from the top of the crane. Operate the turn control lever to LEFT to rotate the boom in a counterclockwise direction as viewed from the top on the crane.

For cranes NOT equipped with continuous rotation, a mechanical rotation stop pulls the turn control lever back to the center position when engaged. Boom rotation is stopped over the front of the chassis. On rear mounted cranes NOT equipped with continuous rotation, rotate the boom over the passenger side of the chassis when stowing and unstowing to prevent immediate contact with the mechanical rotation stop.

Swing Speed Adjustment

Located on turn motor inside frame. Turn knob in to increase maximum swing speed. Turn knob out to decrease maximum swing speed.

Boom

Operate the lever to DOWN to lower the boom. Operate the lever to UP to raise the boom.

Boom Telescope

Operate the lever to OUT to extend the boom. Operate the lever to IN to retract the boom.

Hoist

Operate the lever to DOWN to payout and lower the loadline. Operate the lever to UP to reel in and raise the loadline. Refer to hoist system operation section for additional information



DANGER

Payout loadline before extending boom. Failure to do so will cause the loadline to break or damage the crane.

Stabilizers Up/Down

Operate the lever to DOWN to lower and UP to raise.

Stabilizers Extend/Retract

Operate the lever to extend to move beams out and to retract to move beams in.

Outriggers

Operate the lever to up to raise the outrigger legs. Operate the lever to down to lower the outrigger legs.

Foot Throttle

Depress the foot throttle to accelerate the truck engine speed. Release to return to idle speed. Increasing truck speed increases operating speed.

Emergency Stop Switch

Operate the switch to kill the truck engine under emergency conditions. Switch must be reset to the “on” position to operate truck from cab.

Horn

Operate horn button to warn fellow workers on construction site of pending movement of crane.

Hydraulic Capacity Alert System (HCA) Load Range Gauge



DANGER

Do not use the Load Range Gauge with a jib. Refer to “Hydraulic Capacity Alert System” for more information.

The HCA Load Range Gauge aids in determining the load condition of crane. The gauge has three colors on the dial face: (1) Green OK, (2) Yellow Caution, and (3) Red Overload.

HCA Overload Light

Indicator light illuminates when HCA detects crane overload. Boom down, extend out and hoist up functions are disabled when light illuminates.

Anti-Two-Block/Jib Overload Light

Indicator light illuminates when a two block or jib overload conditions detected. On Jib equipped units an Audible Alert sounds when two-block or jib overload conditions are detected.

Key Override Switch

Turn key switch to enable or disable HCAS, jib load limiting device, and ATB override. Some units may be equipped with an optional manual reset valve which does not have an override key switch.

Override Button

With the override key switch in the on position, depress the button to override the HCAS jib load limiting device and the ATB system. Do not use the override to continue lifting operations in an overload or two-blocked condition.

Load Chart

This chart shows capacities of crane at various operating areas and hoist capacities with appropriate reeving.

Boom Angle Indicator

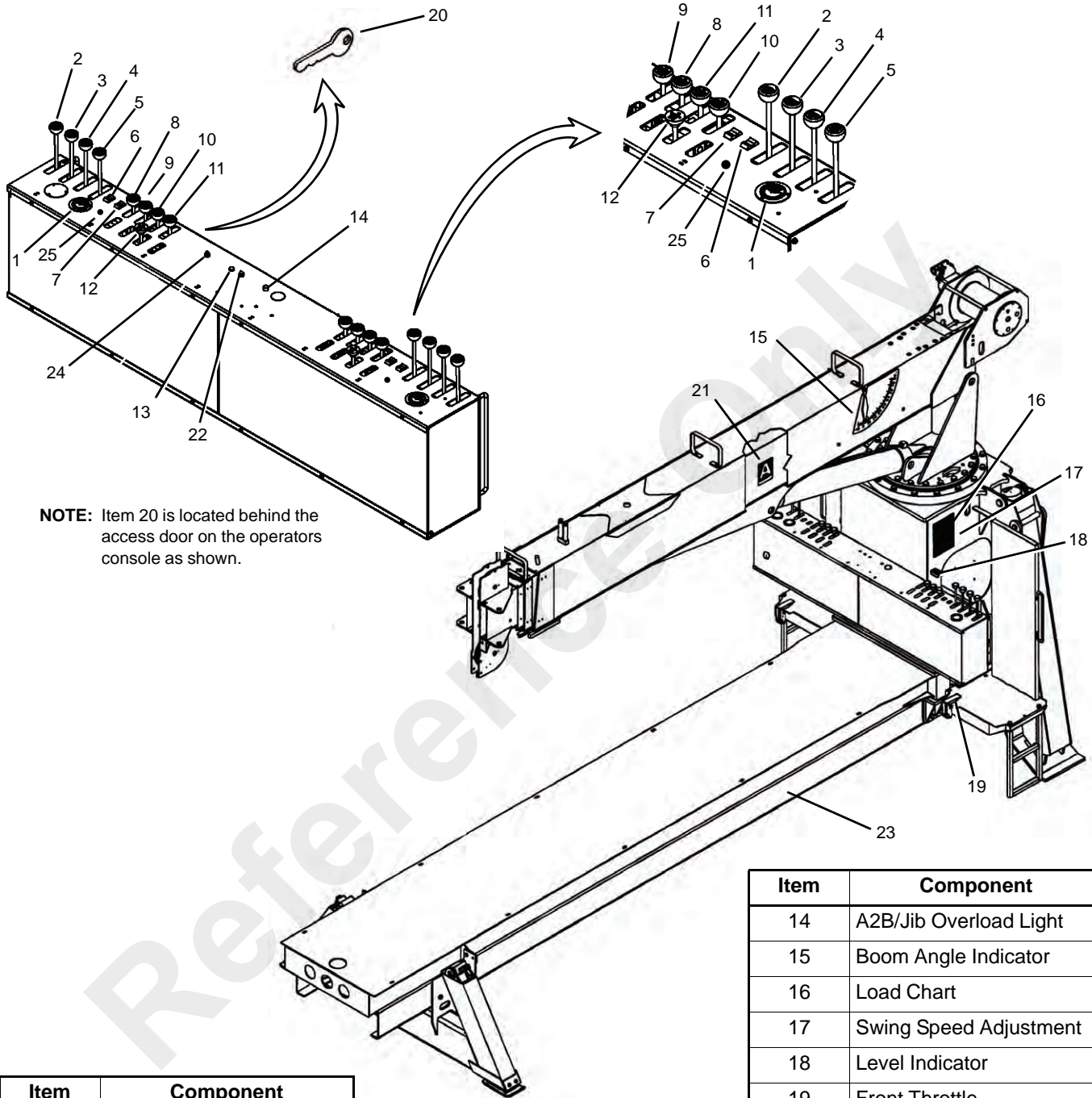
Located on either side of the base boom section and used to determine main boom angle with respect to horizontal. For reference only.

Boom length Indicator

Located on either side of the second boom section. The letters on the intermediate boom lengths correspond to the letters on the load chart. The length indicators are used to define boom length and with the load chart and load radius are used to determine the maximum loads that may be safely lifted. Actual radius must be measured from the centerline of rotation.

Outrigger Status Indicator

The Outrigger Status Indicator is part of the Outrigger Monitoring System and communicates to the operator the position of the outriggers and stabilizers. The Outrigger Status Indicator is a bi-color LED located at each control station. When power is on and the outrigger and stabilizer beams are extended to a point at which they provide maximum stability (stabilizers beams shall be fully extended on cranes equipped with Rear Stabilizer Out and Down (RSOD)), the Outrigger Status Indicator illuminates constant green, indicating a lift can be made. If power is on and one or more outrigger or stabilizer beams are not extended to a position which provides maximum stability, the Outrigger Status Indicator flashes red, indicating a lift should not be made. If the Outrigger Status Indicator illuminates constant red, there is a fault in the OMS.



NOTE: Item 20 is located behind the access door on the operators console as shown.

Item	Component
1	HCAS Load Range Gauge
2	Boom Up/Down
3	Hoist
4	Telescope In/Out
5	Turn Left/Right
6	Emergency Stop Switch
7	Horn

Item	Component
8	O/R This Side
9	O/R Other Side
10	Stabilizer This Side
11	Stabilizer Other Side
12	Front Stabilizers
13	HCAS Overload Light







Item	Component
14	A2B/Jib Overload Light
15	Boom Angle Indicator
16	Load Chart
17	Swing Speed Adjustment
18	Level Indicator
19	Front Throttle
20	HCA-ATB Override Key Switch
21	Boom Length Indicator
22	HCA-ATB Override Button
23	Torsion Box
24	Fuse (10 amp)
25	Outrigger Status Indicator

HOIST SYSTEM OPERATION

The hoist is mounted at the rear of the boom and has capacities independent from the rest of the crane. The hoist can normally pull more than the crane itself can withstand. Therefore, care must be taken to insure that the load being lifted is within boom rating. To lift some of the heavier loads on the load chart, it will be necessary to multiple part reeve the hoist block to increase the lifting capacity of the hoist (the speeds will be proportionately slower) and remain in the strength limitations of the hoist and wire rope.

Using Multiple Part Lines

The hoist load rating chart on each machine provides the information for pull limitations on the hoist with various applicable part reevings. These ratings are based on providing the proper operating safety factor on the wire rope supplied with the machine. Therefore, any replacement rope must meet the rope specification sections of this manual.

1 PART LINE	2 PART LINE	3 PART LINE	4 PART LINE	5 PART LINE	6 PART LINE	NOTICE
						
MAX PULL 7,700 lb	MAX PULL 15,400 lb	MAX PULL 23,100 lb	MAX PULL 30,800 lb	MAX PULL 38,500 lb	MAX PULL 40,000 lb	

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General Rules When Operating Hoist

1. Always payout the loadline while extending the boom. This will maintain clearance between the boom tip and loadline hook.
 2. Do not rely on the ATB System to eliminate two blocking. Use the system as a backup to safe operation.
 3. Make certain the hoist cables are not twisted or kinked and that cables are properly seated on the drum and in the sheaves.
 4. Before lifting a load, always make certain that three full wraps of rope will remain on the drum at all times throughout the lift.
 5. When lifting a load approaching the rated hoist load, raise the load a few inches and return the control to neutral to determine if the brake is working properly.
 6. Do not drag loads in any direction with the hoist.
 7. Never attempt to lift loads which are not loose and free, such as frozen down material or poles out of ground.
 8. Maintain tension on the loadline at all times to prevent the cable from becoming twisted or kinked or improperly seated on the hoist drum or sheaves.
- of the crane and hoist reeving system proceed with lifting the load.
1. Rotate, extend or move up or down until boom tips directly over the load.
 2. The crane is normally equipped with a rotation stop. It is important that you be aware of the position of the stop before lifting in order to assure maximum rotation and prevent excessive handling of the load.
 3. During operations, the controls should always be metered when beginning or terminating movement to prevent sudden starting or stopping, which imposes undue shock loads on the equipment. This is especially true when handling heavy loads. The control should be slightly actuated to begin movement and then slowly increased to desired operating speed. The results obtained from metering the oil flow with the control lever can also be aided by carefully coordinating the throttle control.
 4. Lower loadline and attach load.
 5. Control load by use of a non-conductive tag line.
 6. Do not leave crane unattended with the boom elevated in operating position. Always secure the boom in the boom rest before leaving the work area.

Lifting the Load

After the vehicle and crane have been properly set up and it has been determined the load to be lifted is within the ratings

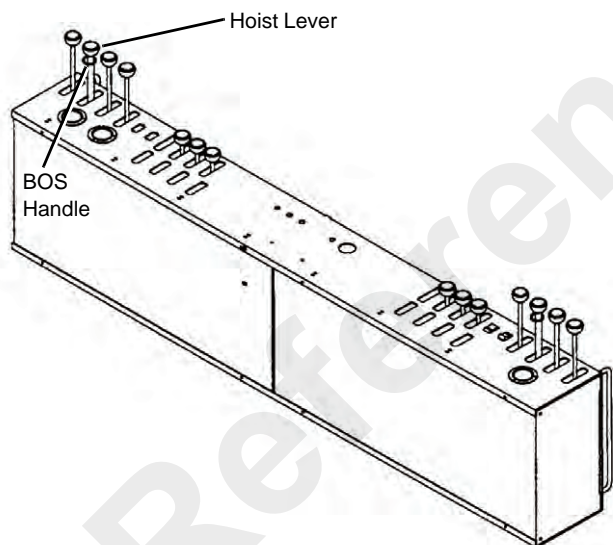
OPTIONAL HOIST BURST OF SPEED (BOS)

The “Burst of Speed” increases hoist line speed 50% over normal operation by diverting oil from the multi-bank control valve to the hoist valve.

The “BOS” is engaged by operating the hoist control valve lever while pulling up on the BOS handle below the hoist knob. The “BOS” feature should only be operated in a temporary manner to reduce oil heat build up, prevent truck PTO overloading, and provide independent operation of the crane and hoist (normal hoist speed will not decrease when crane functions are used). If the “BOS” feature is run continuously or with an overload, damage to the crane or truck could occur. To start the “BOS” smoothly, first pull up on the BOS handle then operate the hoist lever. To stop the “BOS” smoothly, return the hoist lever to its neutral position then release the BOS handle.

CAUTION

If the BOS feature is run continuously or with an overload, damage to the crane or truck could occur.



Note: Maximum Capacity with “BOS”

- One Part Line - 3000 lb (1361 kg)
- Two Part Line - 6000 lb (2722 kg)
- Three Part Line - 9000 lb (4082 kg)
- Maximum line speed on third layer - 271 FPM (73mpm), fourth layer - 294 FPM (81 mpm)

ANTI-TWO BLOCK SYSTEM

With untrained or inexperienced or distracted operators, two blocking the hoist cable is a very real possibility. When the

hoist cable and end attachments contact the underside of the sheave case, whether by hoisting up or extending the boom without paying out the hoist cable, the hoist cable can be damaged by crimping or over tensioning.

The anti-two-block system provided on your National Crane can help prevent cable damage by sensing the position of the hoist cable end attachments with respect to the sheave case and disabling the functions that can cause a two block condition.

The anti-two-block system consists of normally open, work port unloader valves in the main and hoist control valves. When the cartridge solenoid is energized, the crane functions normally, when de-energized, the oil to the boom extend, boom down, and hoist up crane functions are diverted to tank. These solenoids are controlled by a limit switch, which is attached to the boom or jib sheave case. This switch is held in the closed position by a chain suspended weight. The weight, which is looped around the hoist cable, causes the contacts to remain closed until the hoist cable end attachments contact the weight and release the tension on the switch. At this point the contacts in the switch open, breaking electrical continuity through the circuit provided by the internal anti-two-block cord routed through the boom. When this continuity is broken, the unloader cartridges de-energize and divert the function oil to tank. An indicator light is provided on the control console to alert the operator when a two-block condition is detected.

On machines equipped with an optional Load Moment Indicator (LMI) System, the anti-two-block system is integral with the LMI wiring and display. An audible, visual warning of the two block condition is provided in the display console. See LMI Operators Handbook for additional information.

Normal functioning is restored by hoisting down (or retracting boom) until the weight is once again suspended freely. Occasionally if the hoist up and boom extend functions are operated at maximum speed in the dump mode, the back pressure induced in the circuit will cause the hoist up or boom extend functions to creep slightly (with no load on the hook). Such a condition is not cause for alarm, as the back pressure is not of sufficient magnitude to damage the cable or end connections.

OUTRIGGER MONITORING SYSTEM (OMS) (OPTIONAL—STANDARD IN NORTH AMERICA)

The Outrigger Monitoring System (OMS) aids the operator in ensuring that the crane is properly setup on outriggers and stabilizers. The OMS utilizes one sensor in each outrigger and one proximity switch in each horizontally extending stabilizer to identify when the outriggers and stabilizer beams are extended to a point in which they provide maximum stability.

The OMS utilizes an LED indicator to communicate to the operator the position of the outriggers and stabilizers. The Outrigger Status Indicator is a bi-color LED located at each control station. When power is on and the outrigger and stabilizer beams are extended to a point at which they provide maximum stability (stabilizers beams shall be fully extended on cranes equipped with Rear Stabilizer Out and Down (RSOD)), the Outrigger Status Indicator illuminates constant green, indicating a lift can be made. If power is on and one or more outrigger or stabilizer beams are not extended to a position which provides maximum stability, the Outrigger Status Indicator flashes red, indicating a lift should not be made. If the Outrigger Status Indicator illuminates constant red, there is a fault in the OMS.

HYDRAULIC CAPACITY ALERT SYSTEM

System Description

The Hydraulic Capacity Alert System (HCA) is a hydraulically operated, maximum capacity sensing device that will stop all of the normal crane functions that cause overload when maximum capacity is exceeded.

In the event that an over capacity condition occurs, the HCA is actuated by sensing excessive pressure in the lift cylinder. The following systems will be inoperative:

- boom down
- extend out
- hoist up

These are the functions that increase the over capacity condition. This system allows for continued operation of the hoist down, boom up and boom retract functions, the functions that normally allow the operator to bring the load to a shorter operating radius or set the load down in order to eliminate an over capacity condition. Once the excessive cylinder pressure has been reduced by bringing the load to a shorter radius or setting the load down, normal operation can be resumed. This hydraulic capacity alert system uses the work port unloader solenoids in the anti-two-block system as the hydraulic system dump circuit.

The hydraulic capacity alert system has an override switch and button located on the operator's console that momentarily overrides the hydraulic capacity alert and anti-two-block systems and restores power to crane functions.

Indicator Lights

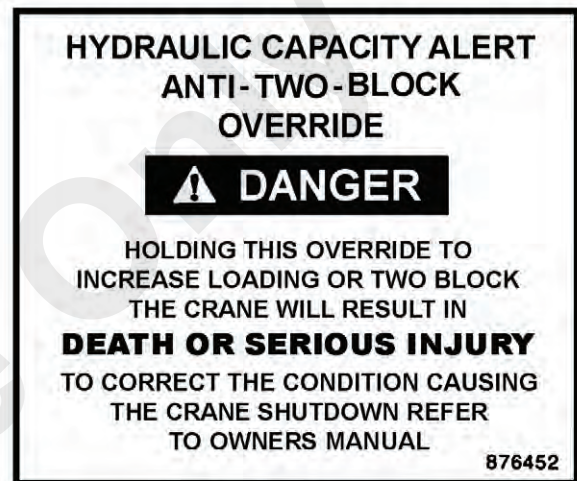
Two indicator lights located on the operator's console alert the operator of function power loss and discriminate between

the HCA and the Anti-Two-Block or jib load limiting systems as the cause of power loss.

CAUTION

Do not use the override to continue lifting operations in an overload or two blocked condition.

HCA Load Range Gauge



The HCA provides a load range gauge at each operator station. This gauge has three colors on the dial face: (1) Green – OK, (2) Yellow – Caution, and (3) Red – Overload. The gauge is plumbed directly to the lift cylinder and the indicator position can be used as an aid in determining the load condition of the crane. The lift control lever must be moved from boom up position to the neutral position to get the most accurate reading when using load range gauge.

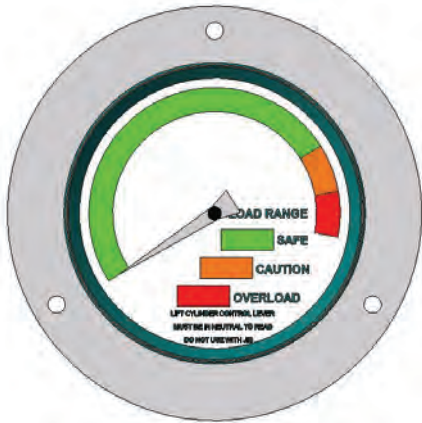
The load range gauge is provided to aid the operator when operating near the rated capacity of the crane.

NOTE: The gauge only provides accurate indication when the lift control lever is in neutral.

The gauge movement is not proportional to the load on the hook. Its not unusual for the indicator to be in the red area at less than rated load condition when operating the lift control, especially during boom down operation

CAUTION

Do not use the load range gauge with a jib.



HCA SYSTEM OPERATION

Once an over-capacity condition is reached, the HCA will not allow the operator to move the load to a greater radius.

Pressure Sensing Switch

When trip pressure is reached, the pressure sensing switch breaks electrical continuity to the work port unloader solenoid in the main control valve. When power is removed from this solenoid, the unloader valves allow the oil flowing to hoist up, telescope out and boom down to flow to tank. This path to tank will prevent further operation of these functions. When the overload condition is corrected by hoisting down, retracting the boom, or raising the boom, the pressure sensing switch allows the work port unloader solenoids to be powered thereby allowing the crane to function normally.

During the operation at near capacity loads, care must be taken to operate the controls smoothly or the system may be shocked into the dump mode prematurely.

Caution should be exercised when operating near 80° of boom elevation. If the boom lift cylinder is fully extended and pressurized above trip pressure, the system solenoid will deactivate and the boom will remain locked at 80°. To correct this condition, momentarily actuate the override switch and boom down approximately 5°. Some units may be equipped with a Manual Reset Valve Option that can be used to unlock the unit from 80°. See Controls and Hydraulics Section for additional description of this system.

The override system consists of a key switch and a momentary push button switch. The key switch provides power to the momentary push button switch located on the console. To momentarily override, activate key switch and depress push button on console. This will activate the work port unloader solenoid and return power to hoist up, telescope out, and boom down functions. The override switch is not to be used during normal use of the crane or as an aid in using the crane in an overload or anti-two blocked condition.

The load range gauge is provided to aid the operator when operating near the rated capacity of the crane. The gauge only provides accurate indication when the lift control lever is in neutral. The gauge movement is not proportional to the load on the hook. It is not unusual for the indicator to be in the red area at less than rated load condition when operating the lift control, especially during boom down operation.

JIB LOAD LIMITING DEVICE

System Description

The jib load limiting device is an electro-mechanically operated, maximum capacity sensing device that stops all normal crane functions that cause overload when maximum capacity of the jib is exceeded. In the event that an over capacity condition occurs, the jib load limiting device is actuated by sensing excessive force on a load cell which causes the boom down, extend out, and hoist up functions to become inoperative. These are the functions that increase the over capacity condition. On jibs with a manually extendable section, a configuration switch operated by the extension retaining pin distinguishes between an extended jib and a retracted jib. This system allows for continued operation of the hoist down, boom up, and boom retract functions, the functions that normally allow the operator to bring the load to a shorter operating radius or set the load down in order to eliminate an over capacity condition. Once the excessive force on the load cell has been reduced by bringing the load to a shorter radius or setting the load down, normal operation can be resumed. This system uses the work port unloader solenoid in the anti-two-block system as the hydraulic system dump circuit.

The jib load limiting system has an override switch and button located on the operator's console that momentarily overrides the hydraulic capacity alert, the jib load limiting device, and the anti-two-block system and restores power to crane functions. Two indicator lights located on the operator's console alert the operator of function power loss and discriminate between the hydraulic capacity alert and the anti-two-block or jib load limiting systems as the cause of power loss. In the event of a two-block or jib overload condition, an audible alarm will sound in addition to the lighting of the indicator light.

Do not use the override to continue lifting operations in an overload or two blocked condition.

System Operation

The jib load limiting device will operate as stated in the System Description Section. Once an over-capacity condition is reached, the system will not allow the operator to move the load to a greater radius. The truck may have to be repositioned closer to the load in order to set the load at the desired location.

When trip force is reached, the jib load limiting device breaks electrical continuity to the work port unloader solenoid in the main control valve. When power is removed from this solenoid, the unloader valves allow the oil flowing to hoist up, telescope out and boom down to flow to tank. This path to tank will prevent further operation of these functions. When the overload condition is corrected by hoisting down, retracting the boom, or raising the boom, the jib load limiting device allows the work port unloader solenoid to be powered thereby allowing the crane to function normally.

During operation at near capacity loads, care must be taken to operate the controls smoothly or the system may be shocked into the dump mode prematurely.

The override system consists of a key switch and a momentary push button switch. The key switch provides power to the momentary push button switch located on the console. To momentarily override, activate key switch and depress push button on console. This will activate the work port unloader solenoid and return power to hoist up, telescope out, and boom down functions. The override switch is not to be used during normal use of the crane or as an aid in using the crane in an overload or two-blocked condition.

These systems do not prevent structural or stability overloads to the crane or hoist caused by:

1. Freely swinging loads or operating in an out-of-level condition which will result in excessive side loading.
2. Side loading due to pulling sideways on the boom with boom rotation or load hoist. Load must always be directly under boom tip.
3. Sudden load movements from erratic operation of the crane functions which will result in excessive shock loading.
4. Improper loadline reeving for loads larger than single line pull capacity.
5. Extending the boom without first paying out the loadline which can result in deadheading (two blocking) the loadline against the boom tip.
6. Loads with lift cylinder fully retracted.
7. Excessive induced loading during auger system operation.
8. Operation without outriggers and stabilizers fully deployed or inadequate footing for the outriggers and stabilizers.

! CAUTION

The HCA and the Jib Load Limiting Device are intended to be used as only aids to prevent overload conditions. Do not use the Hydraulic Capacity Alert System and the Jib Load Limiting Device as substitutes for safe operating practices as outlined in this manual.

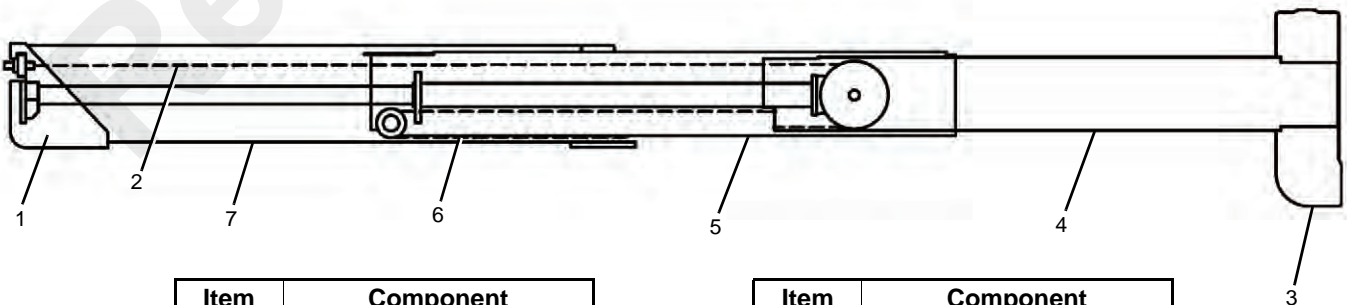
Do not expect the Hydraulic Capacity Alert System and the Jib Load Limiting Device to detect all possible overload conditions.

THREE SECTION BOOM OPERATION

A rod-fed, double-acting cylinder, attached to the 1st and 2nd boom sections, supports and propels the 2nd boom section.

The extend cables attach to the base end of the 1st boom section, are reeved around sheaves attached to the cylinder, and attach to the base end of the 3rd boom section providing support and extension of the 3rd boom section.

THREE SECTION BOOM



Item	Component
1.	Base
2	Extend Cable
3	Tip
4	3 rd Section

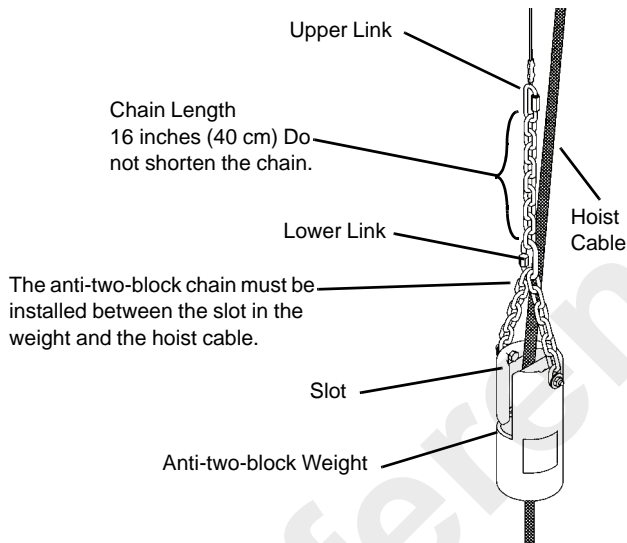
Item	Component
5	2 nd Section
6	Retract Cable
7	1 st Section

The retract cables attach to the tip end of the 1st boom section and are reeved around sheaves attached to the 2nd boom section. They are attached to the base end of the 3rd boom section providing retraction of the 3rd boom section.

This type of boom operation ensures that the 2nd and 3rd section booms extend and retract equally. Proper service and maintenance is required to insure smooth and proper operation

Anti-two-block Weight Installation

To prevent the hoist cable from slipping out of the ant-two-block weight, rig the weight as shown below.



3. Insert the cable through the slot and position around the anchor wedge (1) Figure 3-1.

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

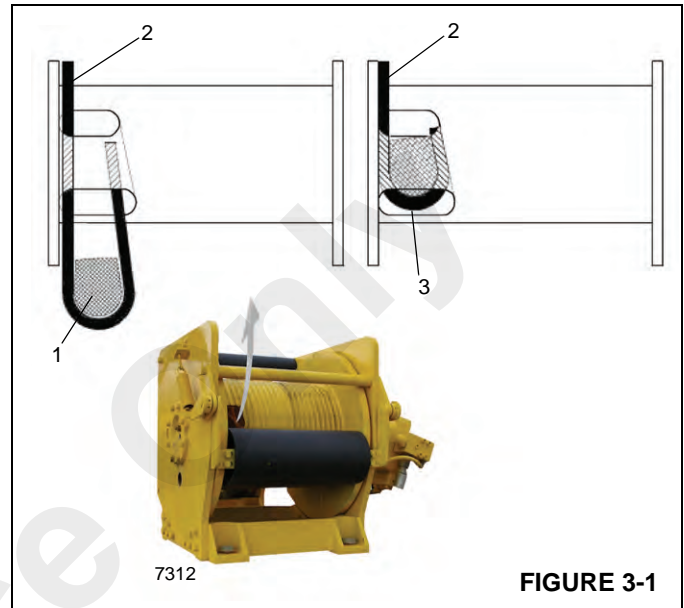
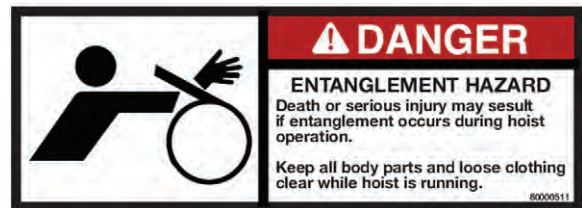


FIGURE 3-1

4. Position the anchor wedge in the drum slot; pull firmly on the free end (2) of the cable to secure the wedge.

NOTE: If the wedge does not seat securely in the slot, carefully tap (3) the top of the wedge with a mallet.



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INSTALLING CABLE ON THE HOIST

CAUTION

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

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

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

1. Position the cable over the boom nose sheave and route to the hoist drum.
2. Position the hoist drum with the cable anchor slot on top.

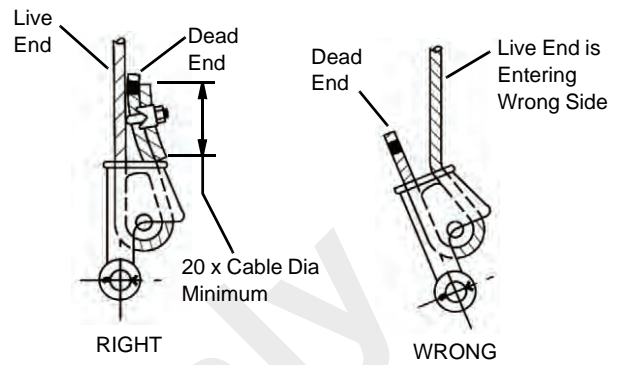
5. Slowly rotate the drum, ensuring the first layer of cable is evenly wound onto the drum.
6. Install the remainder of the cable, as applicable.

WEDGE SOCKET INSTALLATION

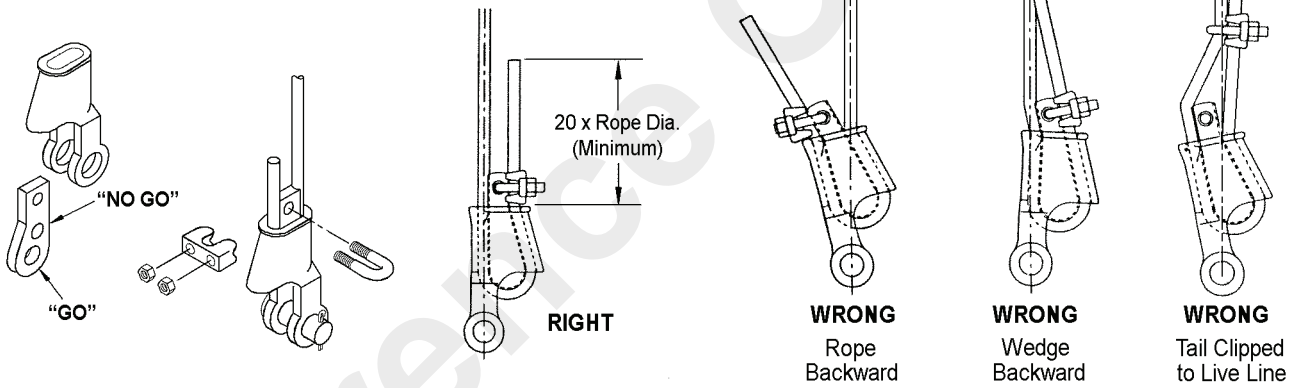
1. Properly match socket, wedge and clip to wire rope size. The wire rope must pass through the “go” hole in the wedge. It must not pass through the “no go” hole in the wedge.
2. Align live end of rope, with center line of pin.
3. Secure dead end section of rope.
4. Tighten nuts on clip to recommended torque. (See Table)

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.

Wedge Socket



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 ft/lbs	45	65	65	95	95	130	225	225	225	360

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

Reference Only

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SECTION 4 SET-UP

SECTION CONTENTS

<p>Equipment Familiarization 4-1</p> <p> Equipment Checks 4-1</p> <p> Pre-Operation Inspection and Calibration Verification 4-1</p> <p> Work Site Selection 4-2</p> <p> Before Leaving the Cab 4-2</p> <p> Lifting Over the Rear 4-2</p> <p> Lifting Over the Front with a Front Stabilizer 4-3</p> <p> Before Making the Lift 4-3</p> <p>Reading and understanding the load Charts 4-3</p> <p> Set-Up 4-4</p> <p> Operation 4-4</p>	<p> Definitions 4-5</p> <p>Determining Load Capability 4-6</p> <p> Load Determination Examples 4-6</p> <p>Jib Operation Safety 4-8</p> <p>Side Folding-Swing Around Jib Operation 4-10</p> <p> Deployment Procedure 4-10</p> <p>Stowing Procedure 4-10</p> <p> Jib Maintenance 4-11</p> <p> Jib Removal 4-11</p> <p> Jib Jack Procedures 4-12</p> <p>Adjustable Swing Speed Valve 4-12</p>
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EQUIPMENT FAMILIARIZATION

All members of the crew should become familiar with the location and operation of controls, the correct operating procedure, the maximum lifting capacities, and the safety precautions applicable to the unit before operating. This crane is a complex piece of equipment and can be overloaded in many ways. Carefully follow the operating procedures outlined below and in the instructional pages of the load rating chart at the operator's station.

Equipment Checks

Perform the following checks prior to placing the unit in operation:

- Inspect for any unusual conditions such as pools of hydraulic fluid or lubricating oil under the chassis, any outrigger which may have crept down or up and any signs of damage or improper maintenance.
- Check that the tires are inflated to the proper pressure.
- Check the level of the hydraulic reservoir.
- Check the operation of the "stop" and horn circuits.
- Check for missing and loose bolts, pins, and ring retainers
- Check for damaged structural members and welds.
- Check all rope guides and cable keepers.
- Check all sheaves for free turning.

- Check the loadline cable for kinks, broken strands or other damage in accordance with instructions in the Lubrication and Maintenance Sections.
- Check to see that the hydraulic hoses and fittings are in good condition and show no signs of leaking. The hoses should be free from cuts and abrasions and there should be no evidence of binding. Any damage or leakage should be repaired immediately.
- Check HCA, anti-two-block system and jib load limiting device for proper operation.

NOTE: Consult truck manufacturer's manual for vehicle checks.

Pre-Operation Inspection and Calibration Verification

1. Check the electrical wiring connecting the various parts of the system for physical damage.
2. Check the anti-two-block switches and weights for free movement.



DANGER

The following tests shall be performed with care to prevent damage to the machine or injury to personnel. Proper functioning of the system requires successful completion of these tests before operating the machine..

If the operator cannot see the load handling device approaching the boom nose, he shall have an assistant (signal person) watch the load handling device. The operator shall be prepared to stop the machine immediately should the anti-two-block system not function properly as indicated by lighting the red warning light, sounding the audible alarm (jib-equipped cranes) and locking the crane movements, hoist up, telescope out and boom down.

Check the anti-two-block alarm light and the audible alarm (jib-equipped cranes) by performing one of the following tests:

- By manually lifting the weight attached to the anti-two-block switches. When the weight is lifted, the audible alarm (jib-equipped cranes) should sound, the anti-two-block alarm light should light.
- Slowly raise the main boom load handling device to create a potential two-block condition. When the load handling device lifts the weight, the audible alarm (jib-equipped cranes) should sound, the anti-two-block alarm light should light and the motion of the load handling device should be stopped. Lower the load handling device slightly to eliminate this condition.
- Slowly extend (telescope) the boom to create a potential two-block condition. When the load handling device lifts the weight, the audible alarm (jib-equipped cranes) should sound, the anti-two-block alarm light should light and the boom telescope out function should be stopped. Lower the load handling device slightly to eliminate this condition.

CAUTION

If the light and audible alarm (jib-equipped cranes) do not function as described and the crane movements are not stopped, the system is not working properly. The malfunction shall be corrected before operating the crane.

- If the crane is equipped with a boom extension (jib) that is deployed and rigged for work, repeat the test procedure for the boom extension (jib) anti-two-block switch.

Work Site Selection

Always seek the best possible work site when parking the crane. An ideal parking location at a job site is firm, level, dry ground or pavement located in close proximity to the work station. Avoid uneven, rocky or muddy terrain, steep grades or locations with unnecessary overhead obstructions. Location should be selected such that outriggers can be fully extended and leg comes down on firm level surface. Particular care must be taken when in the vicinity of overhead power lines so that proper clearance conditions can be maintained. Do not select a location at which the boom could not come within minimum recommended distance of the power lines at full extension.

Its best to select a location on the site such that most of the lifting can be done over the outrigger support or rear of the truck.

Before Leaving the Cab

1. Position the truck so that the outriggers can be extended without encountering obstructions. Set the truck park brake securely and turn front wheels into the curb. Wheel chocks may be required under certain conditions.
2. With the gear shift in neutral, depress clutch (if equipped with a manual transmission), and engage the power takeoff by pulling out the shifting knob.
3. Bring the hydraulic system up to operating temperature (oil reservoir warm to the touch) by allowing the system to operate by actuating the outrigger retract switch with all outriggers fully retracted.



DANGER

To prevent the crane from tipping over.

- Make sure crane is level.
- Do not operate the boom until all outriggers are extended and set providing firm support.
- Make sure the tires are clear of ground.

If operating on sloping ground provide blocks. When lifting is to be done on soft terrain or hot asphalt, support the outrigger and stabilizer pads with bearing pads. Some concrete and asphalt surfaces are relatively thin and cannot support outrigger or stabilizer loading. Concrete can break through and cause instability.

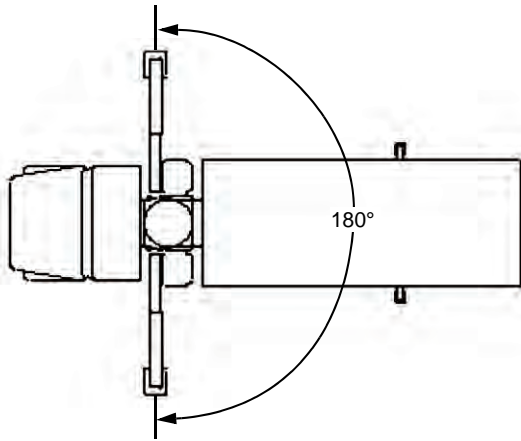
Variation in chassis, outrigger, and mounting configurations will cause outrigger foot loading to differ on each crane, however, outrigger foot loads can be as high as 40,000 lbs (18,145 kg) when outriggers are at full span (131 psi (0.9 MPa) on standard outrigger pads). Support surface bearing capacities vary by a large amount from 833 psi (5.7 MPa) on bed rock down to 14 psi (0.1 MPa) on soft clay. Loose sand or soft asphalt will support even less load. It is imperative that the operator take proper precautions to insure the outrigger foot has adequate cribbing for existing soil conditions.

If specific outrigger foot loading is required for an individual crane, contact National Crane with actual chassis weights and crane details.

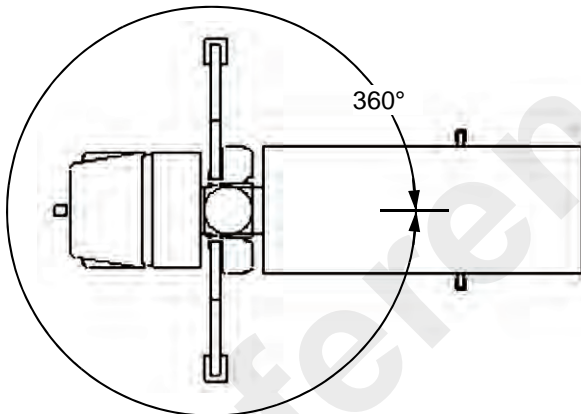
Lifting Over the Rear

Before conducting any boom operations, extend both outriggers until the chassis weights removed from the wheels. Level the crane from side-to-side. A level indicator is provided at either control station. Then extend and lower the stabilizers to level the crane front-to-back. Again refer to the

level indicator to insure that the crane is properly leveled. Always keep the load as close to the ground as possible.



Lifting Over the Front with a Front Stabilizer



A front stabilizer is required when loads are to be lifted over the front of the vehicle. Before conducting any boom operations, extend both outriggers until the chassis weight is removed from the wheels. Level the crane side-to-side using the level indicator located at either control station as a reference. Then extend and lower the rear stabilizers to level the crane front-to-back. Again refer to the level indicator to insure that the crane is properly leveled. After the crane is leveled side-to-side and front-to-back, extend the front stabilizer leg(s) until firm contact is made with the ground. Always keep the load as close to the ground as possible.



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



Check to ensure that the jib, if so equipped, is stowed correctly on the first section boom.

Before Making the Lift

1. Check all controls for proper operation by operating each system through one complete cycle. This is particularly important after the unit has been serviced or repaired. If any abnormal operations are detected, correct the condition before continuing.
2. During all operations, the controls should be metered when beginning or terminating a movement to prevent sudden starting or stopping which imposes undue shock loads on the equipment. This metering can be performed by metering the control lever and the foot throttle.

READING AND UNDERSTANDING THE LOAD CHARTS

The structures and components of your unit are designed to provide satisfactory service if the unit is not loaded in excess of the maximum rated loads specified on the load chart. Overloading can create serious potential safety hazards and can also shorten the service life of your unit. It is important that you know the weight and radius of any load that you are attempting to handle. This should be done by use of a dynamometer and tape measure or by contacting your supervisor.

Overloading a crane can cause many types of failure depending on the configuration and working position of the crane, such as structural damage to almost any part of the crane, hoist or cable failure and tipping the unit over.



$$\begin{array}{r}
 \text{Block} \\
 + \\
 \text{Sling} \\
 + \\
 \text{Load} \\
 \hline
 \text{Total Rated Load}
 \end{array}$$

The load chart shows the maximum rated loads including load (weight being lifted), load handling equipment such as slings, buckets, and downhaul weight that can be handled by the crane and the hoist. The weight of the load handling equipment and boom attachments must be deducted from the maximum load rating shown on the load chart to determine the payload which can be lifted. Additional reduction may be necessary to make allowance for such factors as the effects of freely swinging loads, wind, ground conditions, out-of-level conditions and operating speeds.

The ratings shown on the outrigger full span load chart are maximum loads and are based on:

- the structural integrity of the crane in shaded areas,
- the stability of the crane in non shaded areas.

The stability or non shaded areas represent a stability tipping factor of 85% (Note: For New York City approved units, the stability or non shaded areas represent a stability tipping factor of 75%) when:

1. All outriggers are extended with positive contact on firm, level surface, the tires are free of the ground and the machines level within 1°.
2. The proper amount of counterweight has been installed, if required.
3. The unit is mounted in accordance with factory instructions on a vehicle with proper specifications.
4. The weight of load handling devices is considered as a part of the load being lifted.
5. The correct loadline reevings used for the load to be lifted.
6. Adverse environmental conditions such as wind are not present.
7. The operator controls the loads smoothly.
8. Tires are inflated to the proper pressure.
9. The load to be handled does not exceed the maximum capacity at the boom length and loaded radius.
10. The loads are lifted in the proper area around the truck.

A stability test should have been performed on this crane and can be repeated by referring to the Installation Section of the Service Manual.

All capacities are given in direct relationship to the boom length and loaded radius at which the loads being handled.

- All radii are measured from the centerline of rotation to the loadline with the load suspended.
- All variances of loads and radii of operation are shown on the load chart mounted on the main frame.
- Boom angle should be used as reference only to aid in determining radius.

- The correct loaded radius must be measured and not exceeded during any point of the lifting operation.
- The placards located at the operators platform for the purpose of informing the operator when a load can or cannot be handled.
- Load ratings cannot be interpolated between load points shown on the chart in the boom areas.
- When boom length or radius or both are between points listed on load chart, the smallest load shown at either the next larger radius or boom length shall be used.
- Capacities of the jib cannot be interpolated between angles nor at reduced lengths because the strength of the jib and its attachment point to the boom does not increase when the boom is shortened.

NOTE: Rated loads shown on the load chart pertain to this machine as originally manufactured and equipped. Modifications to the machine or use of equipment that is not factory specified or approved can be hazardous. Refer to capacity deduction chart for weights which must be deducted from rated loads when accessories are attached to boom or loadline.

Set-Up

1. Inspect vehicle and crane including crane operation prior to use each day.
2. Load ratings shown on the chart are maximum allowable loads with the crane mounted on a factory approved truck and all outriggers set on a firm level surface so the crane is level; ensure the Outrigger Status Indicator illuminates green before making a lift. This crane is not rated for use without outriggers.
3. Depending on the nature of the supporting surface, structural supports under the outrigger floats may be necessary to spread the load to a larger bearing surface.
4. Always level the crane with the level indicator located at the operator stations located on either side of the crane frame.

Operation

1. Operation of this equipment in excess of maximum load rating and disregard of instructions is hazardous. Always refer to the load chart for load and area limits before operating the crane. Rated loads at rated radius shall not be exceeded. Over loading this crane may cause structural collapse or instability. Do not rely on the HCA system or the jib load limiting device to weigh the load and control limiting boom angle and radius. Use these system as a backup to safe operation.
2. Use the angle indicator as a reference only. When lifting maximum loads, measure radius.

3. Rated loads do not exceed 85% of the tipping load as determined by SAE Crane Stability Test Code J765a when mounted on a factory recommended truck

NOTE: For New York City approved units, rated load do not exceed 75% of the tipping load as determined by SAE Crane Stability Test Code J765a when mounted on a factory recommended truck.

4. Structural limited ratings on the load chart are shaded. Stability limited loads are not shaded. Machine will not always tip before structural damage occurs.
5. Rated loads include the weight of the hook block, slings, other lifting devices and boom accessories. Their weights must be subtracted from the listed rated load to determine the net load that can be lifted.
6. Rated loads are based on freely suspended loads. Always position the boom tip directly over the load before lifting. No attempt shall be made to push down with the boom or move the load sideways in any direction by pulling or dragging the load.



$$\frac{\text{Block} + \text{Sling} + \text{Load}}{\text{Total Rated Load}}$$

7. The user shall operate at reduced ratings to allow for adverse job conditions such as soft or uneven ground, high winds or erratic operation which produce swinging (side) loads, experience of personnel, two machine lifts, or other hazardous conditions for safe operation.
8. When boom length or radius or both are between points listed on load chart, the smallest load shown at either the next larger radius or boom length shall be used.
9. Do not exceed jib capacities at any reduced boom length. If Jib is between angle ratings on load chart, the smallest load shall be used.
10. Its safe to attempt to telescope or retract any load listed if rating is not exceeded. Capacities at retracted boom length cannot be telescoped without exceeding ratings.
11. Always pay out loadline before extending boom to avoid damaging loadline or crane structure.
12. Loads lifted must be within safe hoist capacity as well as safe crane capacity. Multiple part rope reeving must be used on loads exceeding hoist single part rated pull. Jibs are rated for single part use only.
13. Do not operate the boom over personnel or allow them to walk or stand beneath the boom or load.
14. Do not allow personnel on truck bed or crane frame area when operating crane.

15. Do not allow personnel to ride on hook, hook block, load or any device attached to the loadline. Use only National Crane approved baskets.
16. Operate controls slowly and smoothly to avoid damage to crane or personnel.
17. Boom must be in carrying rack and outriggers fully retracted for travel.
18. Do not operate crane within 10 feet (3.05m) of live power lines.

Definitions

Load Radius

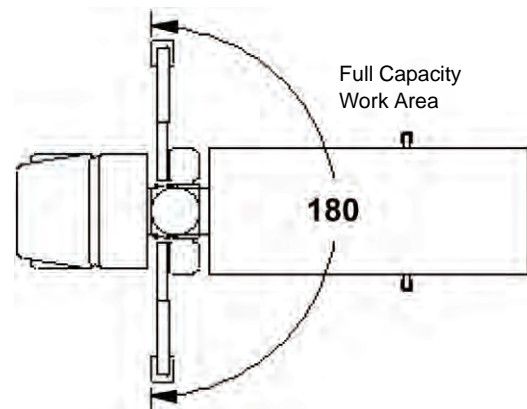
Horizontal distance from the centerline of rotation before loading to the center of the vertical load line or block with load applied.

Loaded Boom Angle

Loaded boom angle is the angle between the first section boom and the horizontal, after lifting the rated load at the rated radius. The boom angle before loading should be greater to account for deflections. The loaded boom angle combined with the boom length give only an approximation of the operating radius.

Working Area

Area measured in a circular arc above the center line of rotation as shown on the Working Area diagram. If no decal is present the work areas 360°.



Freely Suspended Load

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

Length of the boom, from boom pivot pin to wire rope on last main boom section. A decal on either side of the boom shows when certain boom lengths are reached. The letters on the intermediate boom lengths correspond to the letters on the load chart.

Range Diagram

Corresponds to the pictorial in the load chart. The chart shows the operating radius and height of the unloaded boom tip at all boom lengths and angles. The chart should be used as a guide to position unloaded loadline and to determine approximate height to which the load can be lifted.

DETERMINING LOAD CAPABILITY

The following procedure is a typical method which must be used to determine the crane's ability to handle a load. The crane is equipped with a standard hoist:

1. Determine the weight of the load and load handling equipment.
2. Determine the radius from center line of crane rotation to position of load.
3. Determine the radius from centerline of crane rotation to center of point where load is being moved to.
4. Refer to load chart for crane and determine that load and radius of lifting are within capacity of crane.
5. Refer to load chart to determine correct hoist reeving.

Load Determination Examples

The following examples are for illustrative purposes only. The load chart ratings, component weights and dimensional data may not be the same as the actual unit. Always use actual information from the crane and job site when planning a lift.

Example 1

A load is to be lifted from the ground and weighs 2300 lbs (1043 kg) at a radius of 10 ft (3.04 m). The load will be placed on the roof of a building at a radius of 40 ft (12.19 m) and a height of 40 ft (12.19 m) above the ground on the opposite side of the truck.

1. Determine the load.

Load = 2300 lb (1043 kg)

1 Part Load Block = 150 lb (68 kg)

Sling = 30 lb (14 kg)

Total Load = 2480 lb (1125 kg)

2. Starting Radius = 10 ft (3.04 m)
3. Ending Radius = 40 ft (12.19 m)

4. Refer to crane load chart.

Starting point: Assuming the boom is fully retracted [27 ft' (8.23 m) boom length], the capacity at a 10 ft (3.04 m) radius is 18,900 lbs (8,573kg).

In order to get the load on the roof, the load must be:

- hoisted from the ground
- swung around the rear of the truck (dead spot in rotation is over the cab)
- boom extended to 62 ft (18.90 m) extension
- load hoisted to a height that will clear the top of the building
- boom rotated to the point load is to be placed
- boom tip lowered to 40 ft (12.19 m) radius
- load lowered to building roof.

Ending Point: The load rating at the ending point is 3950 lbs (1792 kg). The boom will be at 62 ft (18.90m) extension and the loaded radius is 40 ft (12.19 m).

- The crane has enough capacity at each end of the lift to allow the lift to be made.
- Refer to hoist load chart. Crane is reeved for single part line.
- Allowable load for single part lines 7700 lbs (3492 kg) well above the 2480 lbs (1124 kg) to be lifted.
- Operator should now proceed to lift the load as smoothly as possible

CAUTION

This load could not be lifted if the jib were being used on this machine as maximum capacity of the 23 ft (7 m) jib at 40 ft (12.19 m) radius would only be 1800 lbs (816 kg) at 65°. The capacities remain the same even with the boom retracted.

The hoist in this example can lift 7700 lbs (3492 kg) while the boom is only able to withstand 3950 lbs (1792 kg) at 40 ft (12.19 m) radius. Therefore, one could easily damage the crane by attempting to pull until the hoist stops with a heavier load.

Example 2

Assume a load of 9000 lbs (4082 kg) at 10 ft (3.04 m) radius on the ground beside the truck to be picked up, swung over and placed on the truck bed at an 8 ft (2.43 m) radius from the crane. Crane is reeved for single part.

1. Weight of load and load handling equipment.

Load = 9000 lb (4082 kg)

1 Part Load Block = 150 lb (68 kg)

Sling = 50 lb (22 kg)

Total Load = 9200 lb (4173 kg)

2. Starting Radius = 10 ft (3.04 m)
3. Ending Radius = 8 ft (2.43 m)
4. Refer to crane load chart.

The crane capacity at the 10 ft (3.04 m) radius is 18,900 lbs (8,573 kg). At the 8 ft (2.43 m) radius, the capacity is 19,750 lbs (8,960 kg).

The crane capacity is adequate.

5. Refer to hoist load chart.

The capacity of a 1 part line is 7700 lbs (3492 kg), which is less than load to be lifted.

NOTE: Crane must be reeved for 2 part to lift the 9,000 lbs (4082 kg) load.

Two part hoist capacity is 15,400 lbs (6985 kg)

After reeving for 2 part line the new Step 1 calculation is the weight of load and load handling equipment.

Load = 9000 lb (4082 kg)

1 Part Load Block = 200 lb (90.7 kg)

Sling = 50 lb (22 kg)

Total Load = 9250 lb (4195 kg)

Example 3

A load of 1500 lbs (680 kg) is to be lifted from the roof of a building at a radius of 30 ft (9.14 m) and a height of 80 ft (24.38 m) and placed on the ground on the other side of the truck at a radius of 40 ft (12.19 m).

1. Weight of load and load handling equipment.

Load = 1500 lb (680 kg)

1 Part Load Block = 150 lb (68 kg)

Sling = 30 lb (14 kg)

Total Load = 1680 lb (762 kg)

2. Starting Radius Given = 30 ft (9.14 m)
3. Ending Radius Given = 40 ft (12.19 m)
4. Refer to Crane load chart.

To reach the load on the roof, the jib must be utilized to clear the roof with the load.

CAUTION

Do not attempt to deploy the jib until reading and understanding jib operation information found later in this section of the manual.

Both the retracted 23' jib length and extended 41' jib length have the necessary capacity at a 30' (9.14 m) radius. Only the retracted 23' jib has the capacity at the 40' (12.19 m) radius to accomplish the task.

Starting Point: With the 23 ft (7 m) jib deployed and the boom fully extended, the capacity is 2,450 lbs (1111 kg) at a 30 ft (9.14 m) radius and boom angle of 72.1°.

Ending Point: With the main boom still fully extended, the capacity is 1,800 lbs (816 kg) at a radius of 40 ft (12.19 m) and boom angle of 65.4°.

NOTE: The capacity of the jib remains the same even with the main boom retracted. Operate with jib by radius when main boom is fully extended and operate with jib by boom angle when main boom is not fully extended. Do not exceed rated jib capacities at any reduced boom lengths.

5. Refer to hoist load chart.

The capacity of a 1 part lines 7700 lbs (3492 kg) which is well above the 1,680 lbs (762 kg) to be lifted.

NOTE: The HCA Load Range Gauge does not provide accurate indication of overload conditions when operating with a jib deployed. The HCA will not prevent the crane from being operated in an overload condition. The Jib is equipped with a jib load limiting device which will prevent the jib from being operated in an overload condition.

The operator should proceed to lift the load as smoothly as possible.

JIB OPERATION SAFETY

1. The anti-two-block switch weight and cord must be attached to the jib when deployed.
2. Do not lift load with the boom tip when the Jib is pinned on the boom tip.
3. Operate with jib by radius when main boom is fully extended. If necessary, increase boom angle to maintain loaded radius.

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

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

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

5. Ensure Jib is stowed correctly.
 - a. Removal of swing around pins, C, without proper installation of stow pin A and jib swing pin B, may allow jib to fall off.
 - b. Extending boom with jib stowed and failure to remove swing pins, C, will damage unit upon extension.
6. Only attempt to swing jib to working or stowed position when boom is horizontal, stow pin A and jib swing pin B, are removed and swing pins, C, are in place. Jib 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 jib.
8. Operate boom and turn functions very slowly and carefully when using jib since jibs can increase boom length by 50%.

9. Area where jib swings around must be clear of obstructions and power lines when stowing and unstowing jib.
10. Use safety glasses when necessary.
11. Do not extend/retract boom unless boom is horizontal when stow pin A and jib swing pin B are removed during stowing or unstowing procedures.
12. Always put spring clips in pins to ensure that they will stay in place.
13. When the jib is stowed, the boom can not be fully retracted if a boom tip attachment option is installed.

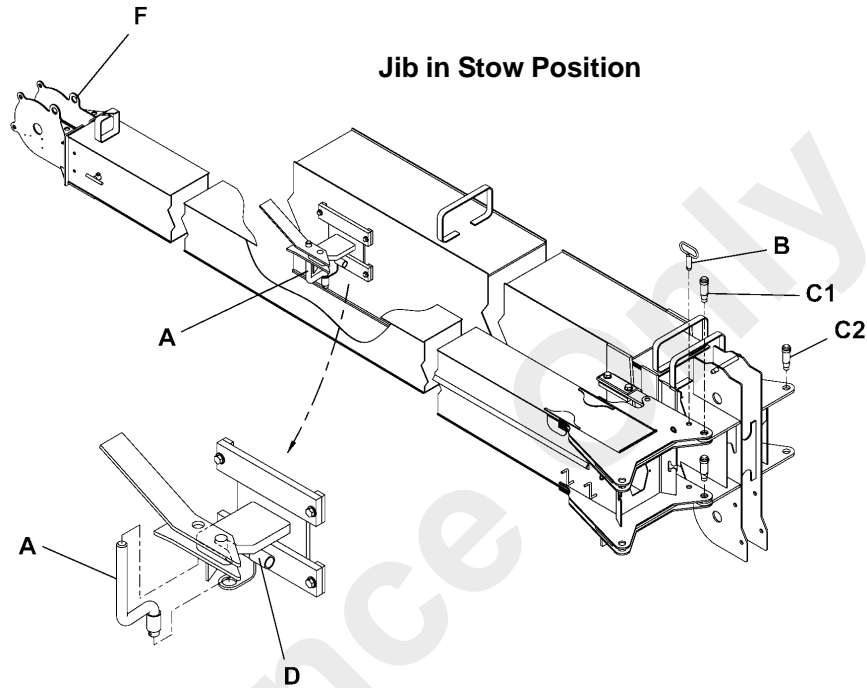


- Boom tip attachment can contact jib in stowed position when boom is fully retracted.
- Contact can cause damage to boom extension system and jib stow system.
- Boom must be left extended 0.5 ft (0.2 m) to prevent contact.
- Boom attachment must be removed for retracted boom lifting operations.

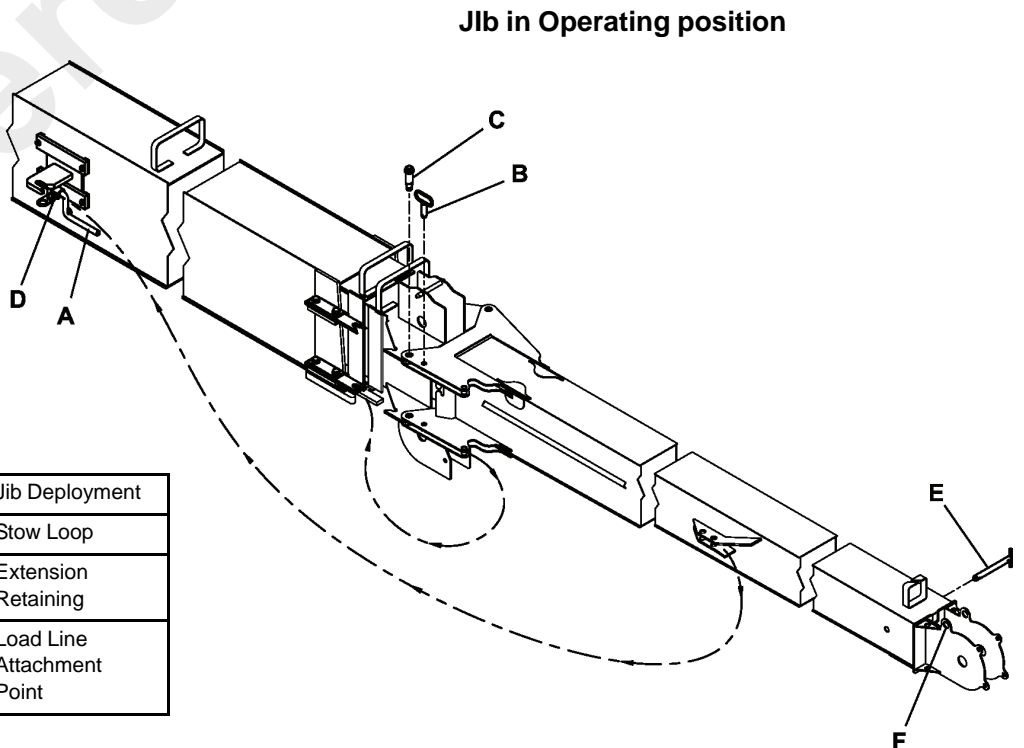
Manually Extendable Jib:

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

A	Stop Pin	B	Jib Swing Pin	C1	Jib Deployment
C2	Jib Deployment	D	Stow Loop	F	Load Line Attachment Point



⚠ DANGER
 IMPROPERLY STOWED JIB
 WILL RESULT IN
 DEATH OR SERIOUS INJURY
 Stow pin (A) must be in stow
 bracket NOT here when jib is
 stowed. →



A	Stow	C2	Jib Deployment
B	Jib Swing	D	Stow Loop
C	Swing Around	E	Extension Retaining
C1	Jib Deployment	F	Load Line Attachment Point

SIDE FOLDING-SWING AROUND JIB OPERATION

Deployment Procedure

1. Using boom telescope function, fully retract boom.
2. Using lift function, lower boom to allow for easier access to jib deployment pins C1 and C2.

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

3. Install pins C1 in upper and lower jib ears. Install retainer spring clips. These pins will be used as a pivot point to swing jib into the deployed position.
4. Locate the stowed position of pins C2. If the pins are in jib attachment holes or boom sheave case jib holes, remove pins from storage location.
5. Remove jib swing Pin B from top ear of jib.
6. Remove stow Pin A from ramp/side stow bracket assembly on jib and stow in Stow Loop D and install spring clip.
7. Attach tag line to sheave case end of jib.
8. Using lift function, raise boom to a horizontal position.
9. Using telescope function, slowly extend boom approximately one foot. This procedure will pull the jib out of the stow bracket.



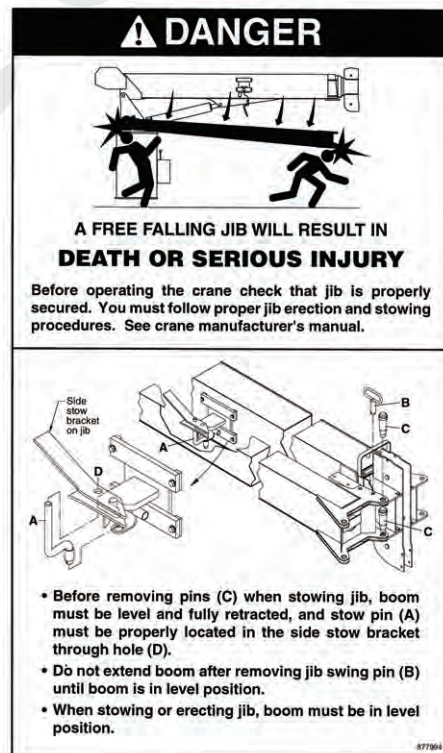
DANGER

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

10. Using tag line, swing jib into deployed position.
11. Remove cable keeper pins from boom sheave case and jib. Remove hook block. Pivot jib 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.
12. Pivot jib 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. Always use proper eye protection during this step.
13. Using jib jack, (Refer to Jib Jack Procedures in this chapter) position jib so that lower C2 pin holes are in alignment and install lower C2 pin and spring clip.
14. Using hoist function, un-spool enough loadline to reeve loadline over jib sheave case. Keep slight tension on loadline to avoid bird caging of loadline on hoist drum.

15. Route loadline over jib sheave and install keeper. Install line block to end of loadline.
16. Remove anti-two-block weight/chain assembly from boom tip switch and install on jib tip switch. 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 jib anti-two-block wire on rear of jib between the upper and lower jib ears.
18. Install jib swing pin B and spring clip into jib ears.
19. For manually extendable jibs, pull extension retention pin E, and extend second section out by pulling on sheave case. The second section jib, as it extends, will hit a mechanical stop that allows for extension pin E installation. Install pin E and spring clip.

STOWING PROCEDURE



1. Using lift function, lower boom so that jib tip is close to the ground.

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

2. For manually extendable jibs, pull extension retention pin and fully retract extendable 2nd section jib into the 1st section. Retraction of 2nd section may be facilitated by

attaching loadline wedge socket to attachment point F on the jib sheave case. Slowly activate the hoist up function until the 2nd sections fully retracted

3. Reinstall extension retention pin through the 1st and 2nd section jib assembly and install spring clip.
4. Remove loadline from jib sheave case. Place loadline in area to avoid possible damage from stow procedure.
5. Disconnect twist lock anti-two-block wire connector at rear of 1st section jib. Connect twist lock connector to anti-two-block switch connector on boom tip. Move anti-two-block weight assembly to boom tip switch.
6. Attach tag line to sheave case end of jib.
7. Remove spring clips from pins C2 on both upper and lower jib ears.
8. Remove pins C2 from upper and lower jib ears. Do not remove C1 pins at this time. C1 pins will be used as a pivot point to swing jib into stow position. A slight hammer strike may be necessary to remove pins. Always use proper eye protection during this step. Utilization of the jib jack at this time will aid in pin hole alignment to facilitate pin removal.
9. Using lift function, raise boom to a horizontal position.
10. Using extend function, extend boom approximately 1 foot.
11. Using tag line attached to jib sheave case, slowly swing jib into stow position (parallel with 1st section boom). Pins C1 are the jib pivot points during this operation.

CAUTION

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

12. Install jib swing pin B with spring clip through jib ear and boom sheave case holes. This pin will keep the jib assembly in line (parallel) with the 1st section boom. Pin B **does not** retain the jib in its stowed position on the 1st section boom.
13. Using boom telescope function, slowly retract boom. The ramp/side stow bracket assembly on the side of the 1st section jib will engage the hook on the side of the 1st section boom, first lifting the jib and then engaging the jib side stow bracket and the boom hook completely upon full retraction of the boom.
14. Install stow pin A with spring clip into the ramp/side stow bracket assembly on the jib. Complete engagement of stow brackets and proper installation of pin A is critical for a secure jib stow attachment.

15. Remove pins C1 from upper and lower jib ears. A slight hammer strike may be necessary to remove pins. Always use proper eye protection during this step.
16. Reinstall loadline over boom sheave case.

DANGER

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

WARNING

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

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

Jib Maintenance

1. Lubricate sheave pin on jib with grease gun containing chassis grease weekly.
2. Check for free rotation of jib sheave daily when using jib.
3. Lubricate jib sheave case pivot pin with grease gun containing chassis grease monthly.

Jib Removal

Should jib removal from the boom become necessary, proceed as follows

CAUTION Jib Weights

The 41 ft (12.49 m) jib weights 960 lbs (435 kg) at 129 in. (328 cm) when retracted from mounting pin holes.

1. Unstow and swing jib into position on the boom tip according to Steps 1 - 10 in the preceding jib deployment section.
2. Support and raise the jib at its balance point and remove the two swing around pins. Jib is now free of boom.
3. To install, proceed in reverse order of removal.

Jib Jack Procedures

The Jib Pin alignment device (Jib Jack) is an aid for installing the fourth or "last" jib pin when setting up a jib. This device has been designed to line up the bottom jib pin hole on the left side of the crane the hole in the boom ear.

The jib pin alignment device consists of a hydraulic jack mounted horizontally on the underside of the jib. A handle for the jack is provided and is installed above the jack on the side of the jib.

Prior to using the Jib Jack, complete Steps 1 to 12 in the "Side Folding-Swing Around Deployment Procedure".

1. Remove jack handle and using the flattened end, close jack release valve by turning the handle clockwise until it is firmly closed.
2. Insert the round end of the handle into the handle sleeve and pump jack until ram contacts boom sheave case.
3. Continue to pump slowly until jib pin holes exactly aligned with hole in boom ear. At this time the final jib pin can be easily tapped into position.

If hole alignment is "over shot" due to jacking too far, the jack can simply be relieved and the process repeated. To relieve the jack, use the flattened end of jack handle to slowly turn relief valve counter clockwise no more than one full turn.

4. After all jib pins are installed, relieve jack.

The jib pin alignment device is also useful when removing the "fourth" pin. Use the jib jack to relieve jib weight induced pressure on the "fourth" pin and it will be much easier to remove.

Once the jib has been erected or stowed, it is important that the jack handle be properly placed back on its stowage hooks and that the cotter key be properly placed in the stowage hook to retain the handle on the hook.

CAUTION

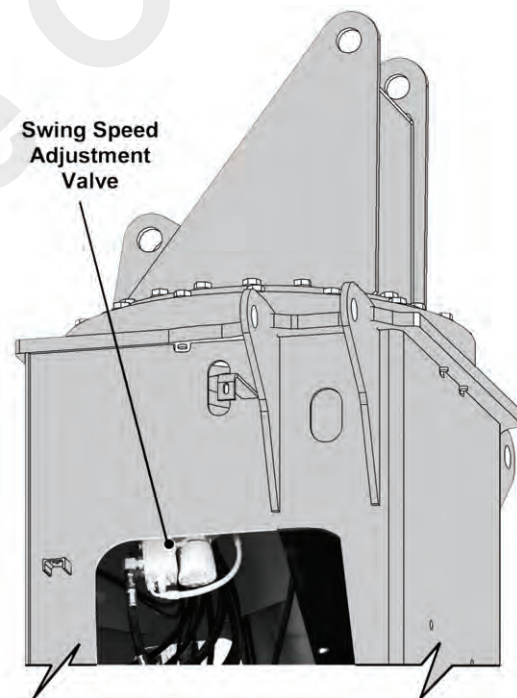
Avoid "shock loads" created by quickly opening and closing the release while jack is under load. This may result in overloading of the hydraulic circuit and possible damage to the jack.

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

ADJUSTABLE SWING SPEED VALVE

This crane is equipped with an adjustable swing speed valve. This valve allows the operator to limit the maximum swing speed of the machine to suit operator preference or varying applications.

An adjustment dial located on the swing holding valve mounted on the swing motor inside the crane frame. The valve has an adjustment screw with a lock collar. Loosen the lock collar when adjusting the speed, then tighten the lock collar to maintain swing speed limit setting. The adjustment dial allows the maximum swing speed to be reduced as required.



SECTION 5 LUBRICATION PROCEDURE AND CHARTS

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GENERAL

Following a designated lubrication procedure is important to ensure a maximum crane life. The procedures and lubrication charts in this section include information on the types of lubricants used, the location of the lubrication points, the frequency of lubrication, and other information. This section does not include lubrication requirements for the truck chassis. Refer to truck service manual for this information.

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

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 -18°C (0°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 Manitowoc 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.

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.

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 F (C)
75W	-40 (-40)
80W	-15 (-26)
85	+10 (-12)
90	+20 (-7)
140	+40 (+5)
250	+50 (+10)

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.

Chassis Grease Low Temp

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

Anti-wear Additives

Excessive wear in the system may cause a loss in volumetric efficiency, and may 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 32°F, 0°C) can cause damage to the extend cylinder.

Standard Hydraulic Oil

Above 10°F (-12°C)

The factory fill standard hydraulic oil is SAE grade 10W-20 Hydraulic Oil. This fluid is acceptable for operating temperatures above -12°C (10°F).

Intermediate Hydraulic Oil

(-10°F to 80°F) (-23°C to 27°C)

For colder operating environments, the standard fluid may be replaced with a Low Service Temperature Multi Viscosity Hydraulic Oil with High Viscosity index 175+.

Wide Range Intermediate Hydraulic Oil.

(-30°F to 80°F) (-34°C to 27°C)

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

Arctic Hydraulic Oil.

(-10°F and below) (-23°C and below)

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. Arctic hydraulic oil is not recommended for service in ambient temperatures above 32°F (0°C).

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.

LUBRICATION POINTS

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.

All oil levels are to be checked with the crane parked on a level surface in transport position, and while the oil is cold, unless otherwise specified. On plug type check points, the oil levels are to be at the bottom edge of the fill port.

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

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

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

CAUTION

Lubrication intervals (page 5-2) 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.

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

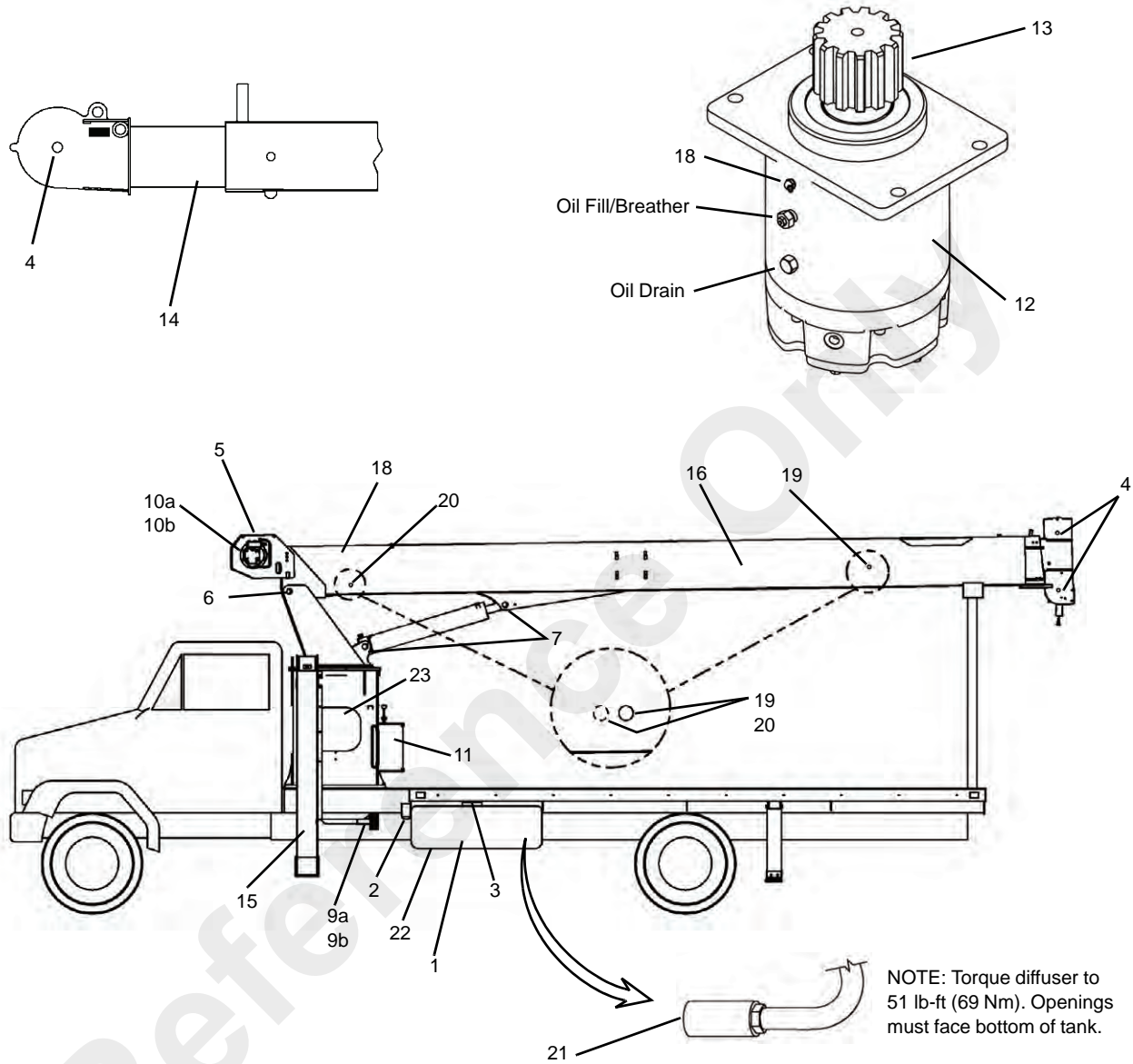
operated daily, exposed rod surfaces will corrode. Some cylinders will have rods exposed even when completely retracted. Assume all cylinders have exposed rods, as corrosion on the end of the rod can ruin the cylinder.

It is recommended that all exposed cylinder rods be protected using Boeshield® T-9 Premium Metal Protectant. Manitowoc CraneCARE 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 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. Lube description and symbols are found in tables below.

Symbol	Description	Manitowoc Lube Specification
EP-MPG	Extreme Pressure Multipurpose Grease - Lithium Soap Base, NLGI Grade 2.	A6-829-003477
EP-3MG	Extreme Pressure Moly Grease	A6-829-015304
GL-5	Extended Service Interval Gear Lubricant - SAE Grade 80W-90	A6-829-012964
AFC - 50/50	50/50 Blended Fully Formulated Antifreeze/Coolant, SAE J1941, ASTM D6210	A6-829-101130
HYDO	Hydraulic Oil - Must meet ISO 4406 cleanliness level 17/14	A6-829-006444
EO-15W/40	Engine Oil - SAE 15W-40, API Service Classification CI-4 or better	A6-829-003483
EP-OGL	Open Gear Lubricant, CEPLATTYN 300 Spray, NLGI Grade 1-2	A6-829-102971
AGMA EP-4	Extreme Pressure Gear Lubricant.	A6-829-100213
WRL	Wire Rope Lubricant	A6-829-015236
LTG	Low Temperature Grease, NLGI Grade 1	A6-829-225828



Item	Application	Recommended Lubricant	Procedure	Frequency
1	Hydraulic oil reservoir	HYDO	Check fill change	Weekly, semi-annually, as required
2	Oil filter, magnetic plug, hydraulic oil reservoir		Change or clean	After first 40 hrs. as indicated by gauge thereafter.
3	Breather, hydraulic oil reservoir		Clean	Monthly
4	Sheave pins: boom (3 plcs), jib (1 pl)	EP-MPG	Grease gun	Weekly
5	Wire rope (loadline)	EP-OGL	Brush or spray	Semi-Annually
6	Boom pivot pin	EP-MPG	Grease gun	Monthly
7	Lift cylinder pins - 2 ea.	EP-MPG	Grease gun	Monthly
8	Swing bearing (turret) (not shown)	EP-MPG	Grease gun	Weekly
9a	Pump drive U-Joint 2 ea.	EP-MPG	Grease gun	Monthly
9b	Pump spline shaft (direct mount)	EP-MPG	Remove pump and apply to shaft or grease gun	Semi-Annually
10a	Hoist gearbox.	SAE 90 EP	Change/check and fill	Every 1000 hours or 6 months

Item	Application	Recommended Lubricant	Procedure	Frequency
10b	Hoist brake	HYDO	Change/check and fill	Every 1000 hours or 6 months
11	Control linkage	EO-15W/40	Oil Can	As Required
12	Swing drive gearbox	GL-5	Change	After 100 operating hours
13	Swing gear teeth	EP-OGL	Spray Can	Monthly
14	Boom extension	LTG	Brush, roller or grease gun	Monthly or as required
15	Outrigger beams, bottom, sides	LTG	Brush or roller	Monthly or as required
16	Extension cables (not shown)	WRL	Spray or brush	Any time boom is disassembled or 5 years
17	Boom Wear Pads (not shown)	EP-MPG	Brush or roller	Monthly or as required
18	Swing Motor Pinion Bearing	EP-MPG	Grease gun	Sparingly every 50 hours
19	Extend Sheaves	EP-3MG	Grease gun	Weekly
20	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
21	Diffuser strainer, Hydraulic oil reservoir		Clean	Semi-Annually with oil change
22	Magnetic plug, hydraulic oil reservoir		Clean	At oil filter service interval
23	Continuous rotation swivel (optional)	EP-MPG	Grease gun	Monthly

Internal Cable Sheave 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

The lubrication points on the sheaves are not equipped with grease fittings (zerks) and will require a grease gun adapter to accomplish the task.

Special Tools:

Nozzle or needle grease gun fitting:

- 0.25 inch (6.35 mm) diameter nozzle grease gun tip (National P/N 955047).
- Contact the Manitowoc Crane Care to obtain this tip.
- Observation through the sheave case for the extend sheaves and the hoist mount for retract

NOTE 1: To determine the amount of grease required, visually inspect the sheaves. From the front of the boom, look back through the sheave case at the extend sheaves. From the back of the boom, look up through the hoist mount at the retract sheaves. A small amount of grease extrusion around the pin is adequate.

The extend sheaves are located on the boom tip end of the extend cylinder, and the retract sheaves are located on the inside rear of the 2nd section. Lubrication is as follows:

1. Extend boom until grease access hole (Item 19 on the Lubrication Points diagram) becomes visible on side of 2nd section.
2. Check alignment between the 2nd section access hole and the 3rd section access holes. When these holes become aligned, the end of the extend cable sheave pin is visible and accessible for lubrication.
3. This boom position also aligns the access holes at the rear of the 1st section for lubrication of the retract sheaves.

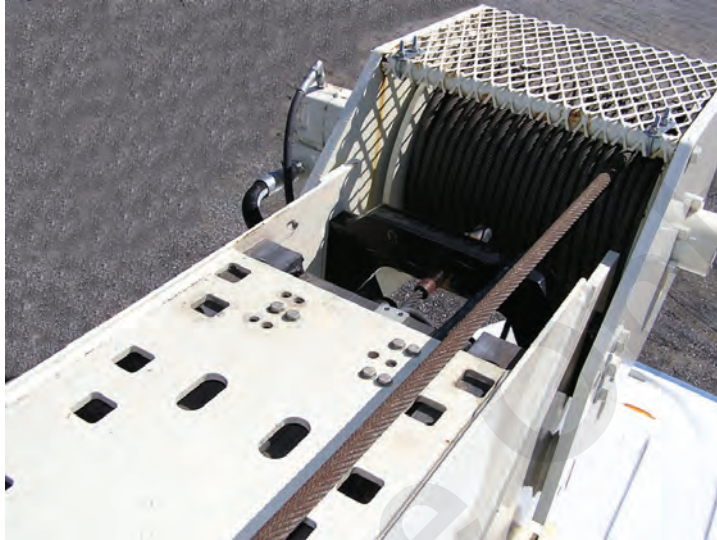
Inner Boom Pad Lubrication

1. With the boom fully retracted, apply grease to the wear pads on the top of second boom section with a small paint brush or a grease gun.
2. Extend boom to position the wear pad access holes directly above the wear pads on the third boom section, apply grease to the pads using the brush or gun.
3. Extend boom to position the wear pad access holes directly above the wear pads on the fourth boom section, apply grease to the pads using the brush or gun.
4. After grease is applied to all wear pads raise the boom to the maximum angle and slowly extend the boom to full extension and slowly retract completely.
5. Repeat steps 1-4 three times to ensure the boom is fully lubricated.

Side and Bottom Boom Wear Pad Lubrication

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 and 3rd sections with a brush.
4. Raise the boom to about 75° and retract the boom
5. Extend and retract the boom several times until the grease is evenly spread.
6. Repeat steps 1-3 as necessary to ensure the boom is fully lubricated.



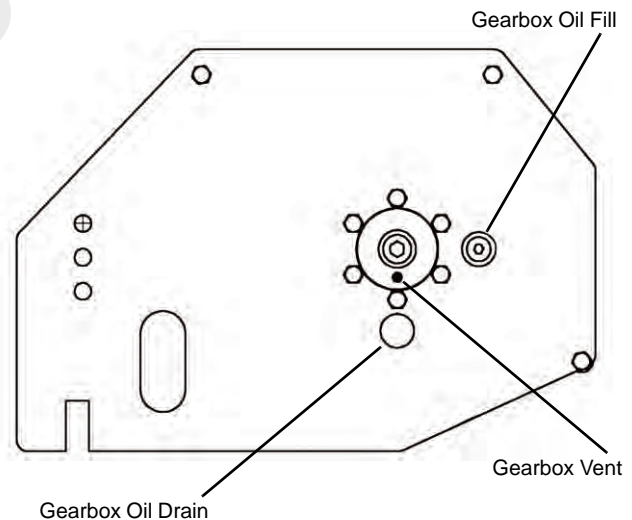
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Hoist Gearbox Oil

To check the hoist gearbox oil level, remove the oil inspection plug in the center of the hoist. The oil should be level with the bottom of the inspection hole.

To add oil, rotate the hoist until the plug is level with the oil fill hole. Add SAE 90 EP gear lube until the oil is level with the bottom of the fill hole.

NOTE: Hoist gear and brake lubricants are satisfactory for operation in temperatures from -10°F to +110°F (-23°C to 43°C). For operation outside this range, contact Manitowoc Crane Care for recommendations.

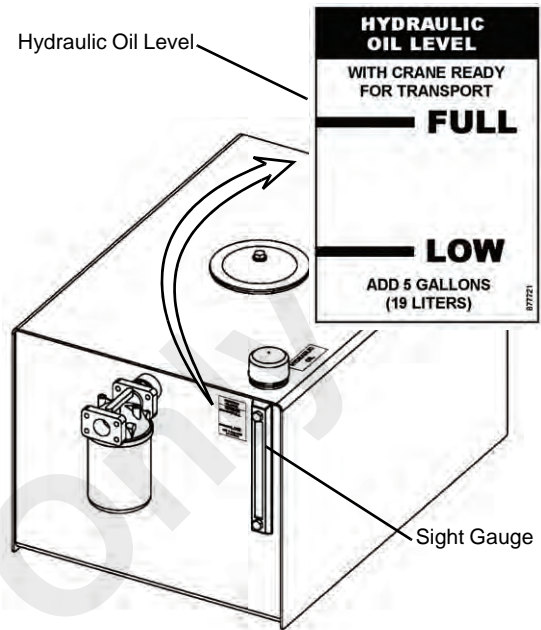
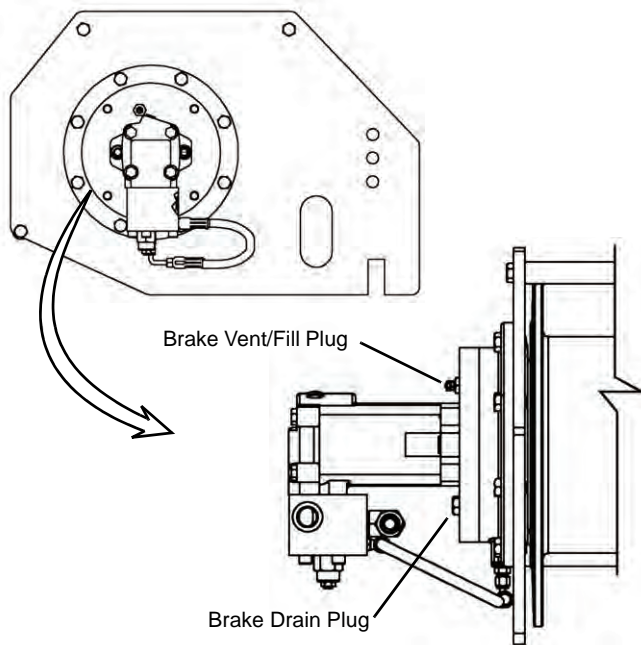


Hoist Brake Oil

To check the hoist brake oil, remove the vent/fill plug and visually inspect the level. The fluid should be level with the bottom of the vent/fill hole. If more fluid is needed, use National Crane hydraulic oil.

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.



HYDRAULIC OIL RESERVOIR LEVEL

The hydraulic oil reservoir has a sight gauge located on the side of the reservoir. This sight gauge has a decal beside it that indicates a "full" level and an "low oil" level. The oil required to bring it from the "low" line to the "full" line is 5 gallons. Do not fill the reservoir above the "full" line. The oil level should be checked with the crane parked on a level surface in the transport condition (all cylinders retracted and boom stowed) and the oil cold.

WIRE ROPE LUBRICATION

A wire rope cannot be lubricated sufficiently during manufacture to last its entire life. Therefore, new lubricant must be added throughout the life of a rope to replace factory lubricant which is used or lost. It is important that lubricant applied as part of a maintenance program shall be compatible with the original lubricant, and to this end, the rope manufacturer should be consulted. Lubricant applied shall be of the type which does not hinder visual inspection. Those sections of rope which are located over sheaves or otherwise hidden during inspection and maintenance procedures require special attention when lubricating rope. The object of rope lubrication is to reduce internal friction and to prevent corrosion.

During fabrication, ropes receive lubrication; the kind and amount depends on the rope's size, type, and anticipated use. This in-process treatment will provide the finished rope with ample protection for a reasonable time if it is stored under proper conditions. But, when the rope is put into service, the initial lubrication may be less than needed for the full useful life of the rope. Because of this possibility, periodic applications of a suitable rope lubricant are necessary.

The following are important characteristics of a good wire rope lubricant:

1. It should be free from acids and alkalis.
2. It should have sufficient adhesive strength to remain on the ropes.

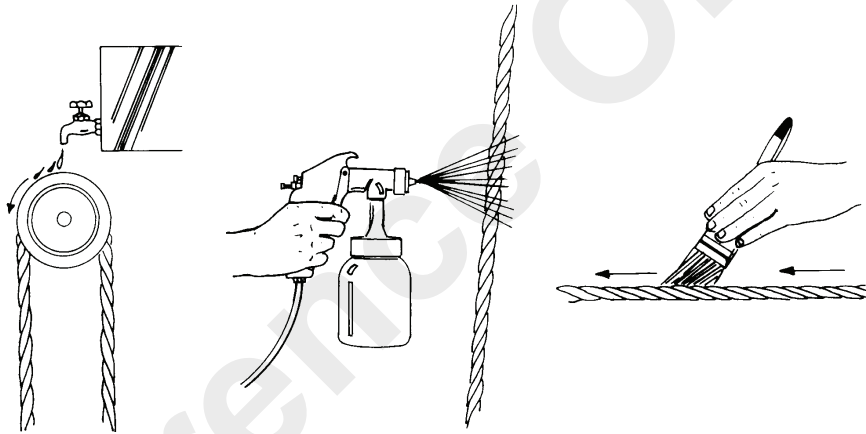
3. It should be of a viscosity capable of penetrating the interstices between wires and strands.
4. It should not be soluble in the medium surrounding it under the actual operating conditions (i.e. Water).
5. It should have a high film strength.
6. It should resist oxidation.

Before applying lubrication, accumulations of dirt or other abrasive material should be removed from the rope. Cleaning can be accomplished by using a stiff wire brush and solvent, compressed air, or live steam. Immediately after the wire rope is cleaned, it should be lubricated. Many techniques may be used to 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. It should be noted, the service life of wire rope will be directly proportional to the effectiveness of the method used and amount of lubricant reaching the working parts of the rope.



SECTION 6 MAINTENANCE CHECKLIST

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CRANE INSPECTION AND MAINTENANCE

A regular schedule of inspection and maintenance is essential to keep your unit in peak operating efficiency. Operators or service personnel responsible for the care of the unit must be completely familiar with the type and frequency of inspections and maintenance operations. The following pages outline the inspections and maintenance required to keep the crane in proper operating condition.

Refer to the Service Manual for complete instructions on performing maintenance on this crane.

Inspection

The following pages list inspections which are to be conducted on your unit to help assure its operating properly and safely. Check all items listed at the frequency listed and make necessary repairs prior to operating. 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 -These items should be visually inspected each day by the operator prior to using the unit.
- Weekly inspections -These items should be visually inspected weekly by the operator.
- Monthly inspections -These inspections are to be performed monthly by the personnel responsible for maintenance and service of the crane.
- Periodic inspections -This inspection is a thorough inspection conducted at least every three months and includes all items listed under Daily, Weekly, and Monthly inspection in addition to those items listed under periodic inspection. Federal Laws through OSHA and ANSI B30.5 require that dated and signed records of these periodic inspections be kept. A crane inspection log book is available from National Crane to assist you in keeping records.

 **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

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 loadline and end attachment for corrosion, severe kinking, crushing, cutting, or slippage of cable clamps or wedge socket.
8. Loose parts or damage to loadline centering blocks.
9. Position of loadline with guides and on sheaves.
10. Free turning of sheaves.
11. Lubrication of points required by Lubrication Chart.
12. Evidence of oil leak from hoses, gearboxes or swivel.
13. Hand and foot controls for malfunction or incorrect adjustment.
14. Truck parking brake operation.
15. Boom proportioning to insure that all boom sections extend and retract equally.
16. All securing hardware such as cotter pins, snap rings, hairpins, pin keepers and capscrews for proper installations.
17. Proper condition and operation of overload and anti-two-block operator aid systems to include switch, weight and chain at boom tip (and jib tip if equipped), power cords, audible alarms and indicator lights on console. Cycle slowly to check for proper operation.
18. Presence and proper operation of load hook safety latch.
19. Hooks and latches for excessive wear, cracks or damage from heat or chemicals.
20. All drain holes at rear of first section boom are clear of all obstructions.

21. All fasteners retaining loadline 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 of points required by Lubrication Chart.
4. Boom lift and outrigger holding valves for proper operation.
5. Torque mounting bolts during first month of operation of machine and then during periodic inspections thereafter (see page 6-15 for Torque Values).
6. Hoist brake for proper operation at hoist capacity load.
7. Torque boom wear pad retaining bolts during first month of operation, then monthly thereafter.
8. Check to see that crane Owner's Manual is with the unit. If the manual is missing, obtain serial number of unit and order manual immediately.

Monthly Inspections

Check the following items:

1. All cylinders and valves for improper operation or signs of leaks.
2. Lubrication of points required by Lubrication Chart.
3. Load hook for cracks or having more than 15 percent normal throat opening or 10 degree twist.
4. All structural members (boom, sub-base, turret and outriggers) for bends, cracks or broken members.
5. All welds for breaks or cracks.
6. All pins for proper installation.
7. All control, safety and capacity placards for readability and secure attachment.
8. Torque of cable clip bolts above wedge socket at end of loadline should be 95 lb-ft.
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. Unspool loadline and check according to rope maintenance procedure.

Periodic/Annual Inspection

Check the following items:

1. All items listed under daily, weekly and monthly inspections.
2. Loose bolts and fasteners in all areas. Torque pin retainer bolts.
3. All pins, bearings, shafts, and gears for wear cracks or distortion to include all pivot, outriggers and sheave pins, and bearings.
4. Boom angle and boom length indicator for accuracy over full range.
5. Hydraulic systems for proper operating pressure.
6. Outrigger pads for excessive wear or cracks.
7. Cylinders for:
 - a. Damaged rods
 - b. Dented barrels
 - c. Drift from oil leaking by piston
 - d. Leaks at rod seals, welds, or holding valves
8. PTO drive line system for proper alignment, lubrication and tightness.
9. Hydraulic hose and tubing for evidence of damage such as blistering, crushing or abrasion.
10. Top and bottom wear pads for excessive wear.
11. Inspect all electrical wires and connections for worn, cut or deteriorated insulation and bare wire. Replace or repair wires as required.
12. Extend and retract cables, sheaves, pins and bearings for wear or abrasion.
13. Main frame and stabilizer mount bolts for proper torque (see Torque Chart).
14. Rotation bearing and gearbox mounting bolts for proper torque (see Torque Chart).
15. Missing or unreadable warning labels.
16. Missing or unusable/unsafe condition of steps, ladders, handrails, guards or seat.

Special Boom Inspection

If the boom has not been disassembled and inspected in the last five years or 3,000 hours of use, the boom is to be completely torn down to allow a thorough inspection of the extend and retract cables, sheaves, and pins.

Stability

Stability of unit throughout working area. Check stability procedure in Installation Section of the Service Manual annually or when any changes 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 5-7 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.

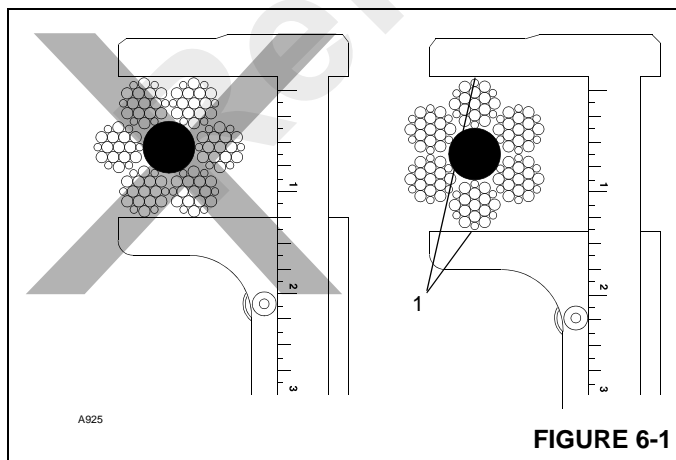


FIGURE 6-1

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:

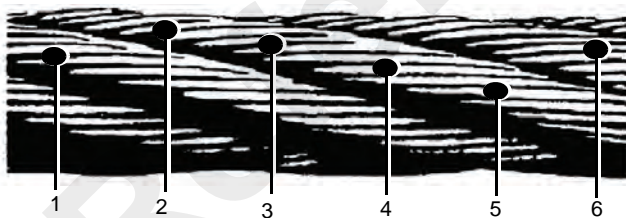
- Inspect for severely corroded or broken wires at end connections.
- Inspect wire rope in areas subjected to rapid deterioration such as:
 - Sections in contact with saddles, equalizer sheaves, or other sheaves where wire rope travel is limited.
 - Sections of wire rope at or near terminal ends where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

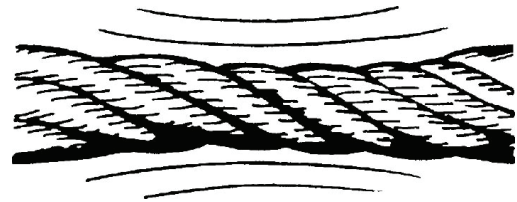
Wire Rope Replacement

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.

Rope Construction

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

If wire rope replacement is required for crane extension system, replacement ropes must be obtained through the Manitowoc Crane Care. Extension ropes are pre-stretched and have special connections for proper operation

If wire rope replacement is required for crane loadline, care should be taken in selecting a wire rope suitable for crane use. Wire rope strength requirements are shown on the crane load chart to match the hoist option selected when the crane was purchased. Rope construction required is optional with 6 x 25 and Dyform being the most common lifting ropes. High strength, rotation resistant is preferred and furnished standard by National Crane. This rope eliminates single part line load spin. It also eliminates load block spin up when multi-part reeving is used which results in prolonged rope life.

CRANE ADJUSTMENTS AND REPAIRS

Before adjustments and repairs are started on a crane, the following precautions shall be taken as applicable:

1. A warning tag should be placed in a conspicuous place at the controls stating that the machine requires adjustment or repair before it can be operated.
2. The crane should be placed where it will cause the least interference with other equipment or operations in the area.
3. All controls at the off position and all operating features secured from inadvertent motion by brakes or other means.
4. All methods used to start the truck's engine rendered inoperative.
5. Power plant stopped or disconnected at take-off.
6. Boom lowered to the ground or otherwise secured against dropping.

7. Load block lowered to ground or otherwise secured against dropping.
8. Relieve hydraulic oil pressure from all hydraulic circuits before loosening or removing hydraulic components.

After adjustments and repairs have been made, the crane shall not be returned to service until all guards have been reinstalled, trapped air removed from hydraulic system if required, safety devices reactivated, and maintenance equipment and all warning tags removed.

Any hazardous conditions disclosed by the inspection requirements listed above shall be corrected before operation of the crane is resumed. Adjustments and repairs shall be done only by designated personnel who are properly trained. Use only parts supplied by your National Crane Distributor or Manitowoc Crane Care to repair the crane.

JIB JACK SERVICE AND MAINTENANCE

Important: Use only a good grade hydraulic jack oil, transmission oil, or turbine oil. Avoid mixing types of oil. Do not use brake fluid, alcohol, glycerin, detergent motor oil, or dirty oil. Improper fluid can cause serious internal damage to the jack rendering it inoperative.

Adding Oil

1. With saddle fully lowered and piston depressed, set jack in upright level position and remove oil filler plug.
2. Fill until oil is level with filler plug hole.

Changing Oil

1. For best performance and longest life, replace the complete oil supply at least once a year.
2. To drain the oil, remove the filler plug.
3. Lay the jack on its side and drain the oil into a suitable drain pan. The oil will run slowly because air must enter as oil drains out.
4. Keep dirt and foreign matter out of the system.
5. Replace with proper oil as described above.

Lubrication

Add proper lubrication oil to all pivoting sections every three months.

Rust Prevention

Check 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.

OIL COOLER SERVICE AND MAINTENANCE (OPTIONAL)

The heat exchanger must be kept clean to allow for efficient operation of the cooler system. Frequent washing of the heat exchanger core will eliminate oil film, road dirt and other foreign object buildup on the heat exchanger fins which reduces cooling efficiency.

Frequent inspection and tightening of hose clamp line connections will eliminate the possibility of end connection failure due to back pressure from cold startup.

If cooler system fails to provide adequate performance, reduced air or oil flow through the heat exchanger is the probable cause. The cooling fan should be inspected for proper operation (see Specifications). 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.

JIB LOAD LIMITING DEVICE

This system is designed to provide load limiting capability for jibs. This is accomplished with the use of an angle sensor, a load cell force sensor, a microprocessor, and enough memory to store 30 table sets containing the maximum force for a given jib head angle and given crane configuration. The system will compare the measured force to the table and will provide lockout when the table value is exceeded. The system should be checked for proper operation during initial crane start up and quarterly thereafter.

Single Character Display

The electronics box of the jib load limiting device is equipped with a single character display that provides the following information:

- startup codes
- table number selected
- current load reading
- current limit value

- error codes
- current angle reading.

On power-up, the unit first displays startup codes. The startup code can consist of up to four digits, but will usually be only the single digit "2". Each number will be displayed for only 0.5 sec. The codes are:

1. The eeprom is being initialized. This should only happen the first time the unit is powered on after it is programmed.
2. The unit is checking for the combination of numbers that erase the previously stored table number in the EEPROM. This will be displayed when the unit is powered on and the switches are not set with this combination of numbers.
3. This is displayed only before a new table number is stored in EEPROM. The 2 will be displayed first.
4. The switches are set up with the combination of numbers to erase the table number. On the next power on, the table number will be read in and stored to EEPROM.

After the startup codes, the table number will be displayed in the form of 3 digits. The first digit will always be a zero. The digits will each be displayed for about 1 second.

After the table number is displayed, the display will begin to sequence through the following information. After reaching the end of the sequence, the display will start again at the current load reading.

- Current load reading (lb): 4 digits, decimal point ON
- Current limit value (lb): 4 digits, decimal point flashing
- Error codes (only if an error exists):
 - 4 digits, first and last digits are blanks.
 - 0-invalid table number,
 - 1-load readings higher than the limit.
- Current angle reading: 4 digits, decimal point OFF, displays in tenths of degrees.

HYDRAULIC SYSTEM TROUBLE DIAGNOSIS

The following chart lists malfunctions which may occur during equipment operation, followed immediately by

possible cause and possible solution. These are not all inclusive but are designed to help isolate the problem and should be checked before calling the factory Service Department

Condition	Possible Cause	Possible Solution
Truck engine will not start	Emergency stop switch on crane control console depressed.	Pull up emergency stop switch. Check all other normal motor vehicle systems as outlined by normal practice.
	Overload system inoperative.	Insure overload system is working properly and Anti-Two-Block/Overload solenoid is powered.
No response to control	Load too heavy.	Check load chart.
	PTO not engaged.	Engage PTO.
	Low hydraulic fluid supply.	Check and fill as required.
	Suction line blocked.	Drain tank and hose and remove blockage.
	Broken hydraulic pressure line.	Replace as required.
	Defective hydraulic pump.	See Pump Service Manual.
	Incorrect relief valve setting	Adjust relief.
	Relief valve sticking.	Clean relief.
Poor hydraulic system performance	Pump not operating at proper speed.	Check PTO ratio, pump size and engine speed for proper oil flow.
	Low hydraulic fluid supply.	Check and fill as required.
	Relief valve sticking.	Remove and clean.
	Relief setting too low.	Readjust to proper setting.
	Worn pump, motor or cylinder.	Replace bad part.
	Plugged filter.	Change filter.
	Valve spools not fully open.	Adjust linkage so valve has full throw.
	Boom holding valves out of adjustment.	Adjust or clean as required.
	Oil temperature too high.	Reduce engine speed, slow cycle time to cool oil or add oil cooler option.
	Hydraulic oil too cold or dirty.	Warm oil or use less viscous oil.
	Line restricted.	Check lines; clean and repair as necessary.
	Internal control valve crack.	Replace valve.
Load too heavy.	Check load chart and reduce load.	

Condition	Possible Cause	Possible Solution
Swing moves erratic or sloppily (Standard system)	Loose turntable bearing.	Torque bearing mounting bolts.
	Loose swing gearbox mounting bolts.	Tighten bolts.
	Worn gears or bearing.	Replace worn parts or adjust gearbox spacing.
	Operator control of lever too erratic.	Operate controls smoothly.
	Motor counterbalance valves dirty or not set properly.	Clean or replace counterbalance valves not set at 600 psi.
	Brake not holding properly.	Replace worn brake parts or shim brake to proper torque. Replace worn brake parts or shim brake to proper torque
	Brake releasing at wrong time or erratically.	Bleed air from brake with bleed screw on side of brake.
	Swing speed adjustment set too low.	Adjust or clean brake for proper release. Adjust valve on turn motor.
Swing will not turn (Standard System)	Turn circuit relief valves sticking.	Clean and check circuit pressure.
	Turntable bearing drag.	Lubricate thoroughly as rotating boom.
	Brake not releasing properly.	Check for 200 + PSI brake pilot pressure. Clean pilot line or adjust motor counterbalance valves.
	Swing speed adjustment set too low.	Adjust or clean brake for proper release. Adjust valve on turn motor.
	Excessive pump noise during operation	Excessive pump speed.
Low oil temperature.		Allow unit to warm up.
Low hydraulic oil supply.		Check and fill.
Suction line kinked, collapsed or blocked.		Clear blockage.
Hydraulic oil too thick.		Warm oil or use oil more applicable to environment.
Relief valve chattering.		Dirt in relief valve or damaged relief.
Hydraulic tubing vibration.		Check for loose tubing.
Tank breather plugged.		Clean breather.
Cylinders drift	Not getting oil to cylinders.	Clean and replace as required.
	Worn or damaged piston seals.	Replace as required.
	Air in hydraulic oil.	Cycle operate crane cylinder to remove air.
	Loose holding valve.	Tighten valve.
	Dirt in holding or check valve.	Clean valve.

Condition	Possible Cause	Possible Solution
Hoist will not lift or hold load	Load too heavy.	Check load and change to applicable multipart reeving.
	Relief valve setting too low.	Check and adjust if required.
	Motor worn excessively.	Replace motor.
	Counterbalance valve defective or leaking.	Clean and replace as necessary.
	Anti-two-block system defective.	Repair anti-two-block system.
	Brake worn out.	Repair or replace brake.
Hoist gearbox heats	Gearbox grease low.	Check and fill as required.
	Duty cycle too high.	Reduce cycle time or speed of hoist.
Boom chatters during extension/retraction or doesn't proportion properly	Boom sections need lubrication.	Grease boom.
	Wear pads not shimmed correctly.	Re-shim as described in boom assembly section.
	Worn wear pads.	Replace pads.
	Extension cables out of adjustment.	Readjust cables and tension properly.
	Extend or retract cables broken.	Disassemble and inspect and replace cables.
Boom will not extend	Proportioning cables not attached.	Reconnect, replace and/or adjust cables.
	Anti-two-block system shut down.	Lower hook, and extend load.
	Defective anti-two-block system	Check anti-two-block system; repair if defective.
System is in a state of constant cut-out	Loose or incorrect wiring.	Carefully check the integrity of all circuits external to the electronics box, from the jib tip to the console. Compare to electrical schematic.
	Loose or incorrect wiring.	Carefully check the integrity of all circuits external to the electronics box, from the jib tip to the console. Compare to electrical schematic.
	Blown fuse.	Check fuse at crane console. Replace if necessary. Remove electronics box from jib, remove electronics from housing, and check 2A fuse on board. Replace if necessary.
	ATB switch open.	Ensure that ATB switch is closed.
	No table selected.	Follow procedure in system installation section to select the correct table for the application.

Condition	Possible Cause	Possible Solution
System is in a state of constant cut-out (continued)	Load cell not calibrated.	To set the zero point, remove all force from the load cell. Remove the electronics from the housing. Set the switch position 8 to ON. Power the system. Do not turn off power until both the zero point and the gain have been set. To set the zero point, press the button on the board. To set the gain, set switch position 8 to OFF. Set the switch to the correct code that matches the load cell gain. This code can be found on the tag that accompanies the load cell. Press the button.
System cuts out too early or too late	Wrong table selected.	Check to see which table is selected using the single character display. If the wrong table is selected, select the proper table using the procedure in the system installation section.
	Single sensor not zeroed.	Ensure that the electronics box is tightly mounted to the jib. Zero the angle sensor using the procedure in the system installation section.
	Configuration switch stuck open or closed (two section jibs only).	Configuration switch must be closed when the jib is Retracted and open when the jib is extended. Adjust or replace switch As necessary.
	Pivot pin not free to move.	Ensure that pivot pin is free, well lubricated, and allows the jib head to pivot freely. Inspect and replace bearings in jib head assembly as required.
	Foreign object stuck between jib head assembly and jib. The only contacts between the jib head assembly and the jib are to be the load cell and the pivot pin.	Remove any foreign objects which interfere with jib head assembly operation.

Jib Jack Troubleshooting

Will not lift load	No oil in system	Add oil to reservoir tank through oil filler hole
	Release valve not closed	Turn handle clockwise tightly
Will lift load only part way	Oil level low	Add oil to reservoir tank through oil filler hole
Will lift load but will not hold	The following valve or valves leaking <ul style="list-style-type: none"> • Suction valve • Delivery valve • Release valve 	Replace jack
	Packings worn or damaged	Replace jack
Jack will not lower	Release valve stuck, probably dirt or foreign matter	Transfer load then replace dirty oil, flush oil reservoir with kerosene
Poor lifting	Dirty oil	Change hydraulic oil
	Air in hydraulic system	Purge air from system
Poor pumping action	Oil seal for pump unit worn in out or damaged	Replace jack

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 sized or the same size tires rated differently. Always check the tire sidewalls to verify the maximum capacity and inflation. Inflation pressure and loading must not exceed the values shown on the wheel or rim.

Tire and Load Inflation Tables

Letters in parenthesis denote the load range for which the bold face loads are a maximum. International load index numbers are shown after the load range. The load range letters and corresponding ply rating are shown below.

D = 8 ply • E = 10 ply • F = 12 ply • G = 14 ply
H = 16 ply • J = 18 ply • L = 20 ply • M = 22 ply • N = 24 ply

Radial Ply Metric Tires for Trucks, Busses, and Trailers Used in Normal Highway Service
 Radial Ply Tires Mounted on 15° Drop Center Rims
 Tire and Rim Association Standard

TABLE TBM-2R		TIRE LOAD LIMITS (kg/lbs.) AT VARIOUS COLD INFLATION PRESSURES (kPa/psi)											
TIRE SIZE DESIGNATION	USAGE	450	480	520	550	590	620	660	690	720	760	790	830
		65	70	75	80	85	90	95	100	105	110	115	120
295/60R22.5	DUAL	1750 3860	1830 4040	1930 4245	2000 4410	2030 4480	2120 4665	2240 4940	2280 5025	2360 5195	2430 5355	2510 5535	2575(H) ¹⁴¹ 5675(H) ¹⁴¹
	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) ¹⁴⁴
225/70R19.5	DUAL	1180(D) ¹¹⁴ 2600(D) ¹¹⁴	1230 2720	1300 2860	1360(E) ¹¹⁹ 3000(E) ¹¹⁹	1410 3115	1470 3245	1550(F) ¹²³ 3415(F) ¹²³	1580 3490	1640 3615	1700(G) ¹²⁶ 3750(G) ¹²⁶		
	SINGLE	1250(D) ¹¹⁶ 2755(D) ¹¹⁶	1310 2895	1380 3040	1450(E) ¹²¹ 3195(E) ¹²¹	1500 3315	1570 3450	1650(F) ¹²⁵ 3640(F) ¹²⁵	1690 3715	1740 3845	1800(G) ¹²⁸ 3970(G) ¹²⁸		
245/70R19.5	DUAL				1550 3415	1590 3515	1660 3655	1750(F) ¹²⁷ 3860(F) ¹²⁷	1790 3940	1850 4075	1950(G) ¹³¹ 4300(G) ¹³¹	1970 4345	2060(H) ¹³³ 4540(H) ¹³³
	SINGLE				1650 3640	1700 3740	1770 3890	1850(F) ¹²⁹ 4080(F) ¹²⁹	1900 4190	1970 4335	2060(G) ¹³³ 4540(G) ¹³³	2095 4620	2180(H) ¹³⁵ 4805(H) ¹³⁵
265/70R19.5	DUAL				1700 3750	1780 3930	1860 4095	1950 4300	2000 4405	2000 4415	2120(G) ¹³⁴ 4675(G) ¹³⁴		
	SINGLE				1800 3970	1900 4180	1970 4355	2060 4540	2130 4685	2200 4850	2300(G) ¹³⁷ 5070(G) ¹³⁷		
305/70R19.5	DUAL				2060 4540	2120 4670	2200 4860	2300 5070	2370 5230	2450 5410	2575(H) ¹⁴¹ 5675(H) ¹⁴¹	2620 5770	2725(J) ¹⁴³ 6005(J) ¹⁴³
	SINGLE				2240 4940	2330 5130	2420 5340	2500 5510	2610 5745	2700 5945	2800(H) ¹⁴⁴ 6175(H) ¹⁴⁴	2870 6340	3000(J) ¹⁴⁶ 6610(J) ¹⁴⁶

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	480	520	550	590	620	660	690	720	760	790	830
		65	70	75	80	85	90	95	100	105	110	115	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	480	520	550	590	620	660	690	720	760	790	830
		psi	70	75	80	85	90	95	100	105	110	115	120
245/75R22.5 235/80R22.5	DUAL	kg	1430	1500	1600	1640	1710	1800	1840	1900	1950(G) ¹³¹		
	SINGLE	lbs.	3160	3315	3525	3615	3765	3970	4055	4195	4300(G) ¹³¹		
265/75R22.5 255/80R22.5	DUAL	kg	1600	1680	1750	1830	1910	2000	2050	2130	2180(G) ¹³⁵		
	SINGLE	lbs.	3525	3705	3860	4040	4205	4410	4525	4685	4805(G) ¹³⁵		
295/75R22.5 275/80R22.5	DUAL	kg	1860	1950	2060	2130	2220	2300(F) ¹³⁷	2390	2470	2575(G) ¹⁴¹	2630	2725(H) ¹⁴³
	SINGLE	lbs.	4095	4300	4540	4690	4885	5070(F) ¹³⁷	5260	5440	5675(G) ¹⁴¹	5795	6005(H) ¹⁴³
285/75R24.5 275/80R24.5	DUAL	kg	1870	1970	2060	2150	2240	2360(F) ¹³⁸	2410	2490	2575(G) ¹⁴¹	2660	2800(H) ¹⁴⁴
	SINGLE	lbs.	4135	4340	4540	4740	4930	5205(F) ¹³⁸	5310	5495	5675(G) ¹⁴¹	5860	6175(H) ¹⁴⁴
285/75R24.5 275/80R24.5	DUAL	kg	1870	1970	2060	2150	2240	2360(F) ¹³⁸	2410	2490	2575(G) ¹⁴¹	2660	2800(H) ¹⁴⁴
	SINGLE	lbs.	4135	4340	4540	4740	4930	5205(F) ¹³⁸	5310	5495	5675(G) ¹⁴¹	5860	6175(H) ¹⁴⁴
285/75R24.5 275/80R24.5	DUAL	kg	1870	1970	2060	2150	2240	2360(F) ¹³⁸	2410	2490	2575(G) ¹⁴¹	2660	2800(H) ¹⁴⁴
	SINGLE	lbs.	4135	4340	4540	4740	4930	5205(F) ¹³⁸	5310	5495	5675(G) ¹⁴¹	5860	6175(H) ¹⁴⁴

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 SIZE DESIGNATION	kPa psi	Tire Load Limits at Various Cold Inflation Pressures												
		480 70	520 75	550 80	590 85	620 90	660 95	690 100	720 105	760 110	790 115	830 120		
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)	181	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 SIZE DESIGNATION	USAGE	TIRE LOAD LIMITS (kg/lbs.) 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				
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)	116	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

Displacements:

- Section P1 34 GPM (128.7 LPM) at 2400 RPM
- Section P2 18 GPM (68.1 LPM) at 2400 RPM
- Section P3 10 GPM (37.8 LPM) at 2400 RPM

Hydraulic System

Requirements:

- Boom and Outrigger System 18 GPM (68 LPM), 3900 psi +100/-000 (26.89 MPa)
- Boom Extend 18 GPM (68 LPM), 2800 psi +50/50 (19.31 MPa)
- Boom Retract 18 GPM (68 LPM), 2900 psi +100/-000 (20.00 MPa)
- Hoist System 30 GPM (128 LPM), 3300 psi +100/-000 (22.75 MPa)
- Turn 10 GPM (38 LPM), 2350 psi +100/-000 (16.20 MPa)

Reservoir

- Capacity 66 Gallons (250 L)
- Filtration 10 Micron Return
- Flow rates listed are at free flow condition (approx. 100 psi/ 1 MPa)

HCA

- Load charts are based on 2650 psi (18.27 MPa) Constant Pressure (2800 psi (19.31 MPa) Trip Pressure on HCA)
- Hoist System Wire Rope Standard 325 ft (99 m) of 9/16 "(14.3 mm) diameter,
- Rotation Resistant Nominal Breaking Strength 38,500 lb (17,463 kg) 325 ft (99 m) of 9/16 "(14.3 mm) diameter
- Rotation Resistant Nominal Breaking Strength 38,500 lb (17,463 kg)

Hoist Speed and Pull

Layer	Hoist Pull		Hoist Speed		BOS Hoist Speed		Rope Capacity	
	lbs	(kg)	fpm	(mpm)	fpm	(mpm)	ft	(m)
1	10,380	(4708)	157	(48)	222	(68)	64	19
2	9,360	(4246)	175	(53)	246	(75)	136	41
3	8,520	(3865)	192	(59)	271	(83)	215	65
4	7,820	(3547)	209	(64)	294	(90)	301	91
5	7,230	(3279)	257	(69)	318	(97)	394	120

NOTE: All ratings based on 34 GPM at 3300 psi (128.7 LPM at 22.75 MPa)
Burst of Speed maximum pull = 3000 lb (1361 kg)

Crane Operating Speeds

Rotation 375°	15 ± 5 sec (1.8 ± 0.2 rpm)	Swing speed based on and adjustment knob in closed position.
Boom up -10° to 80°	25 ± 5 sec	
Boom Down 80° to -10°	20 sec ± 5 sec	
Boom Extend/Retract Three Section 27 - 71 ft		
Extend	53 ± 6 sec, 50 fpm (15.2 mpm)	
Retract	50 ± 6 sec, 53 fpm (16.1 mpm)	
Boom Extend/Retract Three Section 23 - 60 ft		
Extend	44 ± 6 sec, 49 fpm (14.9 mpm)	
Retract	42 ± 6 sec, 51 fpm (15.6 mpm)	

Reference Only

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