

National Crane 500E2

Operator Manual



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Grove

Manitowoc

National Crane

Potain





WARNING

California Proposition 65

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

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

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

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

California Spark Arrestor

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

The original language of this publication is English.

OPERATOR MANUAL

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

500E2

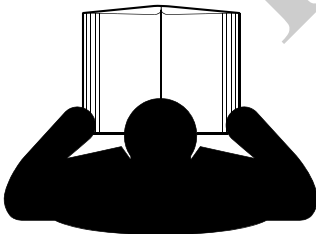
This Manual is divided into the following sections:

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.

	<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. National Crane is not responsible for qualifying personnel.• You read, understand, and follow the safety and operating recommendations contained in the crane manufacturer's manuals and load charts, your employer's work rules, and applicable government regulations.• You are sure that all safety signs, guards, and other safety features are in place and in proper condition.• The Operator Manual and Load Chart are in the holder provided on crane.
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**For
Reference
Only**

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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 Distributor Network want to ensure your satisfaction with our products and customer support. Your local distributor is the best equipped and most knowledgeable to assist you for parts, service and warranty issues. They have the facilities, parts, factory trained personnel, and the information to assist you in a timely manner. We request that you first contact them for assistance. If you feel you need factory assistance, please ask the distributor's service management to coordinate the contact on your behalf.

Supplemental Information

Supplemental Information regarding Safety and Operation, Specifications, Service and Maintenance, Installation, and parts for options such as remote controls, augers, varying control configurations, baskets, grapples, etc. 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 Crane product or this publication, please consult your National Crane distributor for the latest information. Your National Crane distributor is equipped with the proper tools, necessary parts, and trained personnel to properly maintain and service your equipment.

A Safety Compact Disc or a USB flashdrive which includes sections on Operation, Service and a Safety Video for National Crane operators and owners is supplied when the equipment is purchased new. Additional copies are available from your local distributor.

New Owner

If you are the new owner of a National crane, please register it with Manitowoc Crane Care so we have the ability to contact you if the need arises.

Go to https://www.manitowoccranes.com/en/Parts_Services/ServiceAndSupport/ChangeOfOwnershipForm and complete the form.

Basic Nomenclature

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

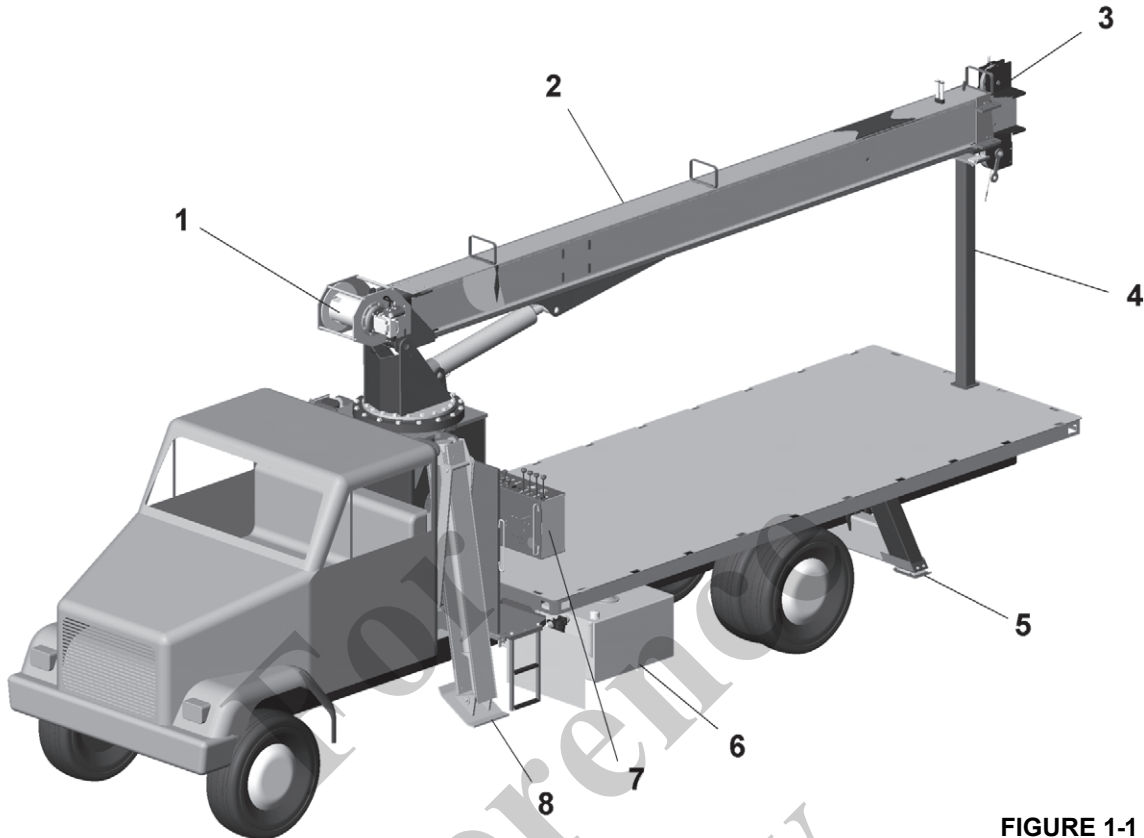


FIGURE 1-1

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 Crane distributor immediately and relate details of incident including serial number of crane. The distributor 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 equipment 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. The

decals shown in this section are examples. Consult the *Parts Manual* for specific decals installed on the crane.

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

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

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

ACCIDENTS

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

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

The Manitowoc Company, Inc.

1565 East Buchanan Trail
Shady Grove, PA 17256-0021

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

Fax: 717-593-5152

E-mail: product.safety@manitowoc.com

OPERATOR INFORMATION

You must **read** and **understand** this *Operator Manual* and the *Load Chart* before operating your new equipment. 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 equipment is in use.

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

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

No personnel shall be allowed to climb onto the equipment or enter the 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 equipment while the equipment is operating or moving, unless they are seated in a two-man cab.

Keep clear of moving outriggers to avoid crushing hazards. Contact with moving components could result in death or serious injury.



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

Inspect the equipment 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 equipment. You risk lives when operating faulty machinery - including your own.

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

OPERATOR QUALIFICATIONS

Qualified person is defined as one who by reason of knowledge, training and experience is thoroughly familiar with equipment 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 equipment are thoroughly familiar with safe operating practices. You must be thoroughly familiar with the location and content of all

decals on the equipment. Decals provide important instructions and warnings and must be read prior to any operational or maintenance function.

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

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



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

You must not operate this equipment unless:

- You have been trained in the safe operation of this equipment.
- 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 equipment has been inspected and maintained in accordance with the manufacturer's manuals and is operating properly.
- You are sure that all safety decals, guards, and other safety features are in place and in proper condition.

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

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

You must be mentally and physically fit to operate equipment. Never attempt to operate equipment 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 equipment, you are granted the authority to stop and refuse to lift loads until safety is assured.

OPERATIONAL AIDS

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

National Crane remains committed to providing reliable products that enable users and operators to safely lift and position loads. National Crane has been an industry leader in the incorporation of operational aids into the design of its equipment. Federal law requires that equipment be properly maintained and kept in good working condition. The manuals that National Crane provides that are specific for each piece of equipment and the manufacturer's manuals for the operational aids shall be followed. If an operational aid should fail to work properly, the equipment 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 equipment when operational aids are inoperative or malfunctioning, the following requirements shall apply for continued use or shutdown of the equipment:

- 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 equipment 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, or the markings and indicator on the boom.

- When an *Anti-Two-Blocking Device*, *Two-Blocking Damage Prevention Device* or *Two-Block Warning Device* is inoperative or malfunctioning, the designated person responsible for supervising the lifting operations shall establish procedures, such as assigning an additional signal person to furnish equivalent protection. This does not apply when lifting personnel in load-line supported personnel platforms. Personnel shall not be lifted when anti-two-block devices are not functioning properly.
- When a *Boom Length Indicator* is inoperative or malfunctioning, the designated person responsible for supervising the lifting operations shall establish the boom lengths at which the lift will be made by actual measurements or marking on the boom.
- When a *Level Indicator* is inoperative or malfunctioning, other means shall be used to level the equipment.

Rated Capacity Limiter (RCL) Systems (If Equipped)

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

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

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

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

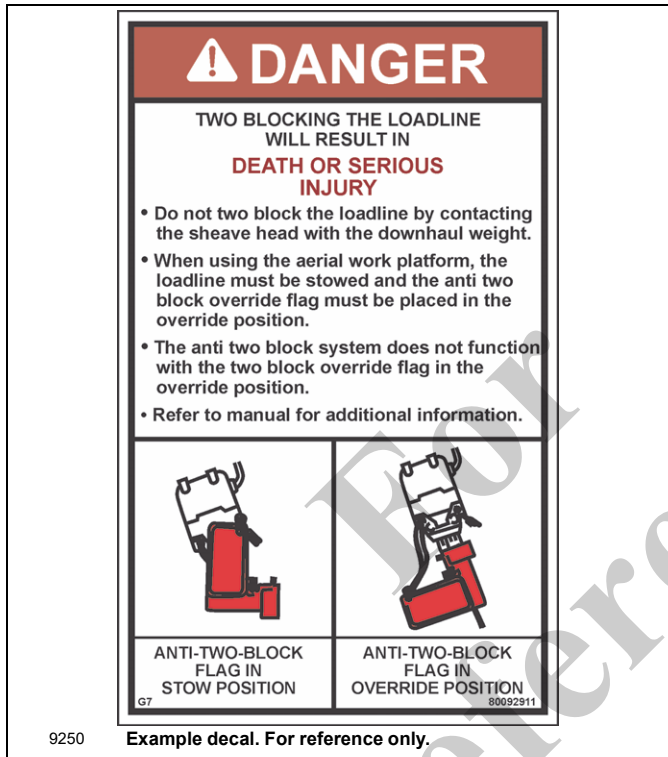
NEVER exceed the rated capacity shown on the *Load Chart*. Always check the *Load Chart* to ensure the load to be lifted at the desired radius is within the rated capacity of the equipment.

For detailed information concerning the operation and maintenance of the RCL system installed on the equipment, see the RCL manufacturer's manual supplied with the equipment. Manufacturers of rated capacity limiters may refer to them in their manuals as a load moment indicator (LMI), a hydraulic capacity alert system (HCAS); National Crane refers to these systems as a rated capacity limiter (RCL) throughout its *Operator* and *Service Manuals*.

Anti-Two-Blocking Device

This equipment 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, jib, etc.). Two-blocking can cause hoist lines (wire rope), rigging, reeving, and other components to become highly stressed and overloaded in which case the rope may fail allowing the load, block, etc. to free fall.



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Example decal. For reference only.

Two-blocking is more likely to occur when both the main and auxiliary hoist lines are reeved over the main boom nose and jib 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 jib nose, thus causing damage to the sheaves, or causing the rope to fail, dropping the lifting device to the ground and possibly injuring personnel working below.

Caution must be used when lowering the boom, extending the boom or hoisting up. Let out load line(s) simultaneously to prevent two-blocking the boom tip(s) and the hook block, etc. The closer the load is carried to the boom nose the more important it becomes to simultaneously let out hoist rope as

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

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

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

Working Area Limiter (If Equipped)

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

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

EQUIPMENT STABILITY/STRUCTURAL STRENGTH

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

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

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

Read and follow the following safety decal for equipment with a single front outrigger.



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

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

Before swinging the superstructure over the side when the outriggers are not fully extended and set, consult the *Load Chart* for any boom angle or boom length restrictions.

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

Outrigger beams and jack cylinders (plus single front outrigger, if equipped) must be properly extended and set to provide precise leveling of the equipment. 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 equipment 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 equipment 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 equipment.

Work Site

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

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

WIND FORCES

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

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

Always check the *Load Chart* to ensure the load to be lifted is within the rated capacity of the equipment.

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

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

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

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

Table 2-1 Beaufort Wind Scale

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

Wind Speeds

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

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

- a) If **V(z)** is ≤ 13.4 m/s (30 mph), then the **allowable** load is the published rated capacity from the Load Chart.
- b) If **V(z)** is > 13.4 m/s (30 mph) and is ≤ 20.1 m/s (45 mph), the **allowable** load is the published rated

capacity multiplied by the Capacity Reduction Factor from Table 2-4 (metric) or (non-metric).

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

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

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

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



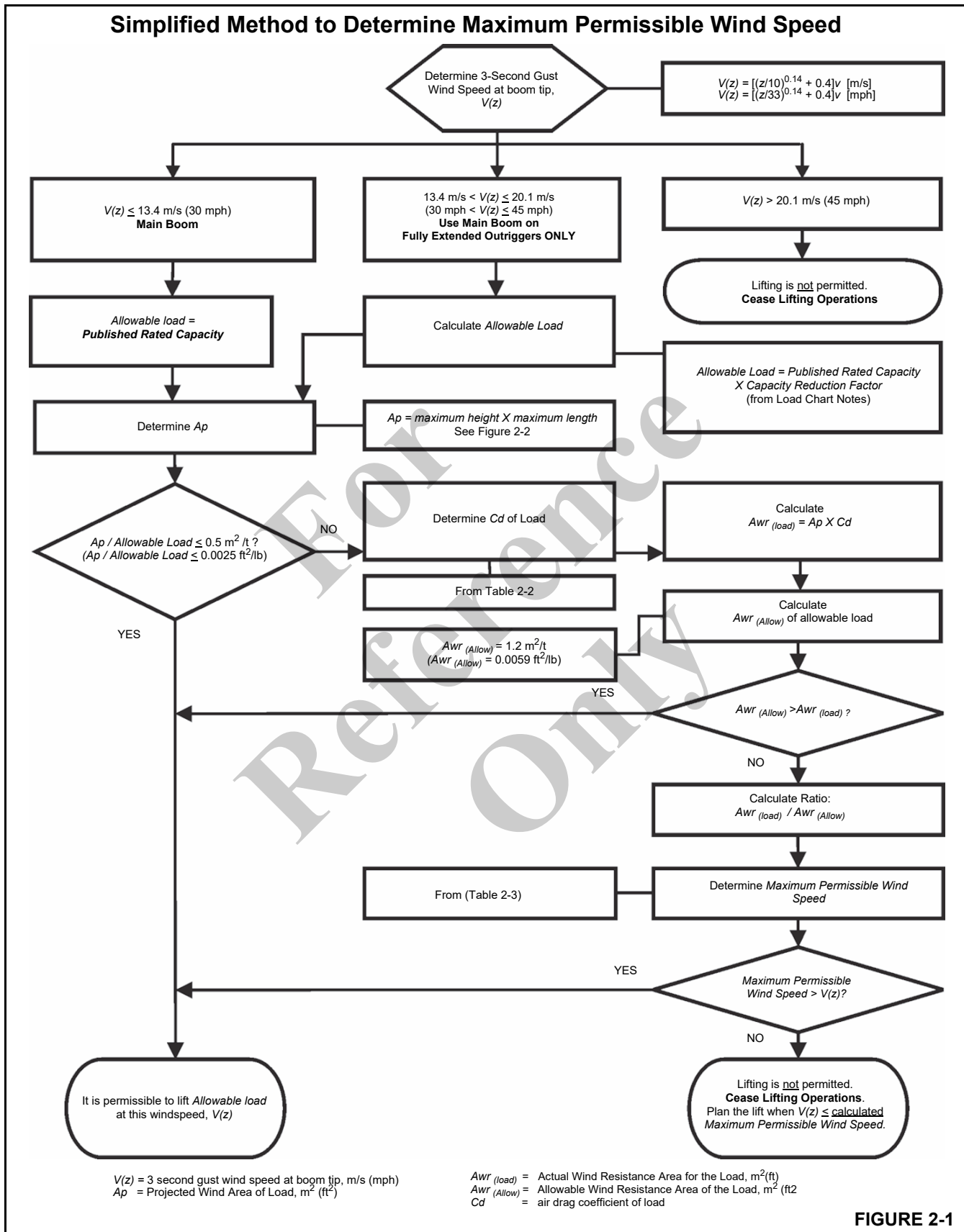


FIGURE 2-1

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

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

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

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

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

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

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

where:

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

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

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

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

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

then:

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

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

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

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

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

Size and Shape of the load:

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

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

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

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

where:

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

Ap [m²] [ft²] - projected wind area,

Cd - wind drag coefficient.

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

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

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

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

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

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

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

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

Calculation of Projected Wind Area (A_p):

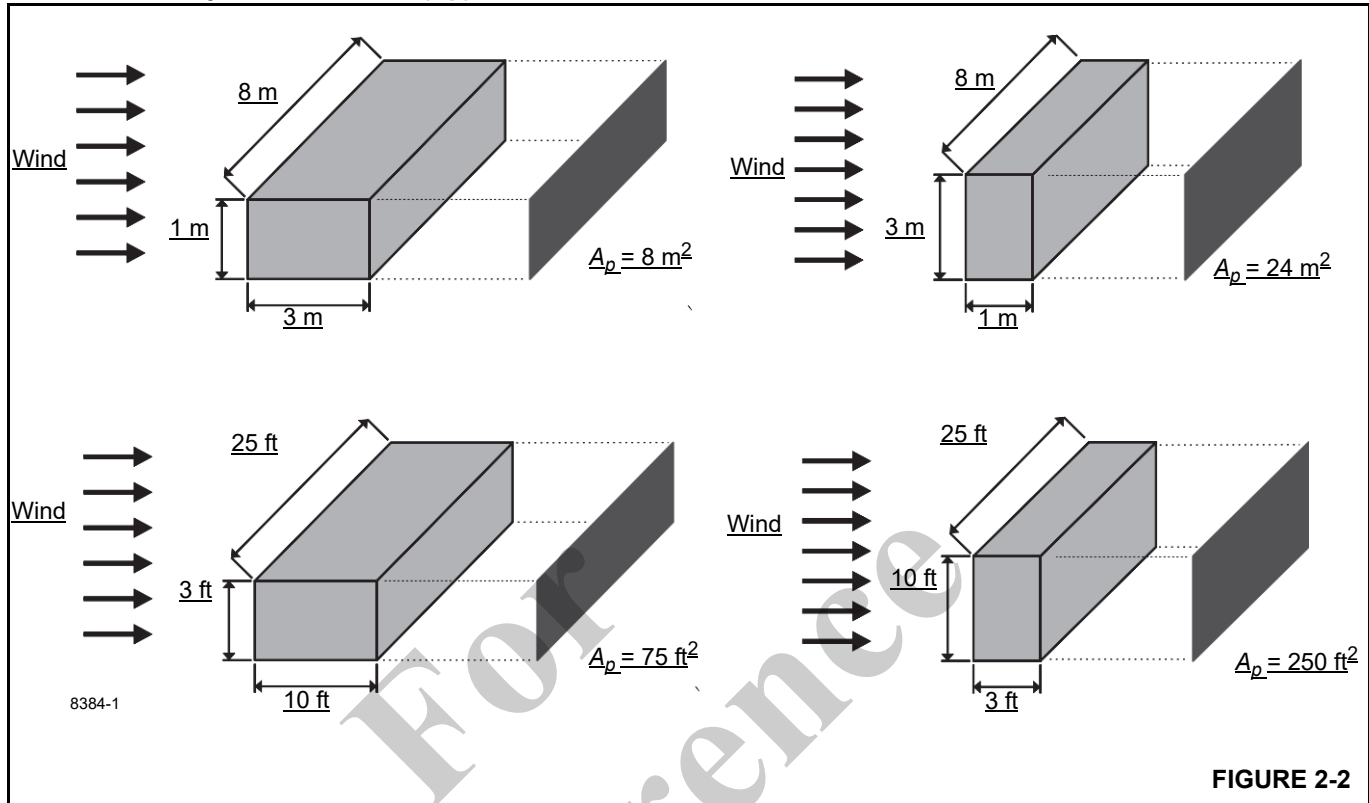


FIGURE 2-2

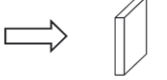


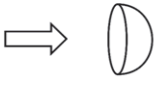



Determining Wind Drag Coefficient (C_d)

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

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

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

Table 2-2 Wind Drag Coefficient

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

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Maximum Permissible Wind Speed

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

Table 2-3 Awr Ratio and Permissible Wind Speed $V(z)$ - Non - metric

Note: Permissible and rated wind speeds in this table are the 3-second gust wind speeds at boom tip height.					
Ratio:	1.2	1.4	1.6	1.8	2
	Maximum Permissible Wind Speed (mph)				
For Rated Capacity at 30 mph	27.4	25.4	23.7	22.4	21.2
For Allowable Capacity at 45 mph	41.1	38.0	35.6	33.5	31.8

Rated Load Chart Example - Metric

RATED LIFTING CAPACITIES IN KILOGRAMS
10.9 m - 33.5 m BOOM
ON OUTRIGGERS FULLY EXTENDED - 360°

Radius in Meters	#0001								
	Main Boom Length in Meters								
	10.9	12.2	15.2	**18.4	21.3	24.4	27.4	30.5	33.5
3	+60,000 (69.5)	40,950 (72)	40,950 (76)						
3.5	53,000 (66.5)	40,950 (69.5)	40,950 (74)	28,350 (78)					
4	47,450 (63.5)	40,950 (66.5)	40,950 (72)	28,350 (75.5)	*18,225 (78)				
4.5	42,875 (60.5)	40,950 (64)	40,950 (70)	28,350 (73.5)	18,225 (76)				
5	39,050 (57.5)	39,025 (61.5)	38,300 (67.5)	28,350 (72)	18,225 (75)	*18,225 (78)			
6	32,950 (50.5)	32,925 (55.5)	32,825 (63.5)	28,350 (68.5)	18,225 (72)	18,225 (75)	*18,225 (78)		
7	28,325 (42.5)	28,300 (49)	28,225 (59)	26,250 (65)	18,225 (69)	18,225 (72)	18,225 (74.5)	*16,725 (78)	*11,400 (78)
8	24,150 (32.5)	24,150 (42)	23,975 (54.5)	23,275 (61)	18,225 (69.5)	18,225 (72)	16,575 (72)	15,250 (74.5)	11,400 (76)
9	20,600 (16.5)	20,550 (33.5)	20,375 (49.5)	20,025 (55)	18,225 (63)	16,575 (67)	15,050 (70)	13,875 (72.5)	11,400 (74.5)
10		17,200 (20.5)	17,125 (42)	17,025 (54)	17,325 (60)	15,125 (64)	13,725 (67.5)	12,700 (70.5)	11,400 (72.5)
12			13,075 (32)	12,925 (45.5)	12,575 (53.5)	12,275 (59)	11,600 (63)	10,725 (66.5)	10,050 (69)
14				9,000 (35)	9,360 (46)	9,730 (53.5)	9,955 (58.5)	9,205 (62)	8,620 (65)
16				6,750 (19)	7,110 (37.5)	7,475 (47)	7,920 (53)	7,980 (57.5)	7,470 (61.5)
18					5,960 (27)	5,960 (39.5)	6,340 (47.5)	6,525 (53)	6,530 (57.5)
20						4,755 (30.5)	5,145 (41)	5,320 (48)	5,495 (53)
22							3,790 (16.5)	4,210 (33.5)	4,380 (42.5)
24								3,435 (23.5)	3,620 (36)
26									2,975 (28)
28									2,400 (16)
30									2,135 (22)
Minimum boom angle (°) for indicated length (no load)									0
Maximum boom length (m) at 0° boom angle (no load)									33.5

NOTE: () Boom angles are in degrees.
 #RCL operating code. Refer to RCL manual for operating instructions.
 *This capacity is based on maximum boom angle.
 + 9 parts line required to lift this capacity (using aux. boom nose) when using wire rope with a minimum breaking strength of 36,287 kg. Refer to Operator's & Safety Handbook for reeving diagram.
 NOTE: For allowable capacities while operating in 3-second wind gust speeds greater than 13.4 m/s and up to 20.1 m/s, refer to Capacity Reduction Factors for wind speed (3-second gust speed) V(z) greater than 13.4m/s.

Lifting Capacities at Zero Degree Boom Angle								
Boom Angle	Main Boom Length in Meters							
	10.9	12.2	15.2	**18.4	21.3	24.4	27.4	
0°	13,775 (9.2)	11,675 (10.4)	8,145 (13.5)	5,930 (16.6)	4,565 (19.6)	3,535 (22.6)	2,860 (25.7)	2,220 (28.7)

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

FIGURE 2-3

Table 2-4 Example-Capacity Reduction Factors for Wind Speed V(z) Greater than 13.4 m/s - Metric

(Only for lifting with main boom on fully extended outriggers, with or without stowed extension)
 For wind speed V(z) (3-second gust speed at boom tip height) $V(z) > 13.4 \text{ m/s} \leq 20.1 \text{ m/s}$, the Reduced Capacity shall be calculated by multiplying the Published Rated Capacity by the following factors:

	Main Boom Length in Meters								
Wind Speed $V(z) > 13.4 \text{ m/s}$ $\leq 20.1 \text{ m/s}$	10.9	12.2	15.2	18.4	21.3	24.4	27.4	30.5	33.5
Factor	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.7	0.6

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

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

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

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

Example and Sample Calculations (metric)

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

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

Example 1: Equipment Configuration:

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

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

The maximum allowable wind resistance area of load is

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

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

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

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

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

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

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

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

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

- Maximum load 12,040 kg
- Maximum wind resistance area of load 14.45 m²

At wind speeds greater than 13.4 m/s, it is not permissible to lift a load greater than 12,040 kg, even if the wind resistance area of the load is less than 14.45 m².

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

Load example 1.1:

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

- load to be lifted of 11,200 kg,
- Projected Wind Area **Ap** = 9.20 m²,
- Wind Drag Coefficient **Cd** = 1.5

wind resistance area of load can be estimated as

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

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

- Is the load to be lifted less than allowable load?
11,200 kg ≤ 12,040 kg YES
- Is **Awr_(load)** less than **Awr_(allow)**?
13.8 m² ≤ 14.45 m² YES

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

Load example 1.2:

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

- Load to be lifted of 10,000 kg,
- Projected Wind Area **Ap** = 5.45 m²,
- Wind Drag Coefficient **Cd** = unknown

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

- the wind resistance area of load can be estimated as

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

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

- Is the load to be lifted less than allowable load?
10,000 kg ≤ 12,040 kg YES
- Is **Awr_(load)** less than **Awr_(allow)**?
13.08 m² ≤ 14.45 m² YES

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

Load example 1.3a:

With large wind resistance area of the load **Awr_(load)**,

- Load to be lifted of 14,000 kg,
- Projected Wind Area **Ap** = 21.85 m²,
- Wind Drag Coefficient **Cd** = 1.2

the wind resistance area of load can be estimated as:

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

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

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

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

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

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

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

- Is **Awr_(load)** less than **Awr_(allow)**?
26.22 m² ≤ 18.06 m² NO

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

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

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

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

Load example 1.3b:

With large wind resistance area of the load **Awr_(load)**,

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

the wind resistance area of load can be estimated as

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

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

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

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

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

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

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

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

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

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

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

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

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

Wind resistance area of load, **Awr_(load)** = projected wind area **Ap** x wind drag coefficient **Cd** for the load.

For wind resistance area of load, **Awr_(load)** > maximum allowable wind resistance, **Awr_(allow)**, refer to equipment Operator Manual.



Reference Only

Rated Load Chart Example - Non-metric

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

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

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

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

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

8382-1

FIGURE 2-4

Example and Sample Calculations (Non-metric)

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

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

Example 2:

Equipment is configured with:

- boom length = 90 ft,
- load radius = 40 ft, and
- wind speed is measured at $V(z) \leq 45$ mph.

The **Rated Load Chart Example - Non-metric** (Figure 2-4), at maximum permissible wind speed, $V(z) = 30$ mph, the rated lifting capacity $m_{(allow)}$ for this configuration is 25,200 lb.

The maximum allowable wind resistance area of load is:

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

$$Awr_{(allow)} = 0.0059 \times 25,200 = 149 \text{ ft}^2$$

Lifting Limits at wind speed $V(z) < 30$ mph at this configuration:

- Maximum load 25,200 lb
- Maximum wind resistance area of load 149 ft²

For the allowable wind speed > 30 mph and ≤ 45 mph, reduce the allowable load. , the Factor for a main boom length of 90 ft is 0.8, thus the allowable load is:

$$m_{(allow)} = 0.8 \times 25,200 = 20,160 \text{ lb}$$

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

$$Awr_{(allow)} = 0.0059 \times 20,160 = 119 \text{ ft}^2$$

Lifting Limits at wind speed $V(z) > 30$ mph and ≤ 45 mph at this configuration:

- Maximum load 20,160 lb
- Maximum wind resistance area of load 119 ft²

Example, wind speeds greater than 13.4 m/s is **NOT** permissible to lift a load greater than 20,160 lb, even if the wind resistance area of the load is less than 119 ft².

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

Load example 2.1:

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

- load to be lifted of 19,500 lb,
- Projected Wind Area **Ap** = 70 ft²,
- Wind Drag Coefficient **Cd** = 1.5

then the wind resistance area of load can be estimated as

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

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

- Is the load to be lifted less than allowable load?
19,500 lb \leq 20,160 lb YES
- Is $Awr_{(load)}$ less than $Awr_{(allow)}$?
105 ft² \leq 119 ft² YES

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

Load example 2.2:

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

- Load to be lifted of 18,000 lb,
- Projected Wind Area **Ap** = 45 ft²,
- Wind Drag Coefficient **Cd** = unknown

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

the wind resistance area of load can be estimated as

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

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

- Is the load to be lifted less than allowable load?
18,000 lb \leq 20,160 lb YES
- Is $Awr_{(load)}$ less than $Awr_{(allow)}$?
108 ft² \leq 119 ft² YES

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

Load example 2.3a:

With large wind resistance area of the load $Awr_{(load)}$,

- Load to be lifted of 22,000 lb,
- Projected Wind Area **Ap** = 180 ft²,
- Wind Drag Coefficient **Cd** = 1.2

the wind resistance area of load can be estimated as:

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

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

- Is the load to be lifted less than allowable load?
22,000 lb ≤ 20,160 lb NO

Conclusion: This load is NOT permissible to lift in wind speed up to 45 mph.

Refer to the above **Lifting Limits at wind speed V(z) up to 30 mph**. Comparing the load to the allowable:

Is the load to be lifted less than allowable load?
22,000 lb ≤ 25,200 lb YES

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

- Is $Awr_{(load)}$ less than $Awr_{(allow)}$?
216 ft² ≤ 149 ft² NO

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

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

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

Conclusion: This load is permissible to lift in wind speed up to 23.7 mph only. **Conclusion:** This load is permissible to lift in wind speed up to 38.0 mph only.

Table 2-7 Awr Ratio and Permissible Wind Speed V(z) - Non-Metric

Note: Permissible and rated wind speeds in this table are the 3-second gust wind speeds at boom tip height.					
Ratio:	1.2	1.4	1.6	1.8	2
	Maximum Permissible Wind Speed (mph)				
For Rated Capacity@ 30 mph	27.4	25.4	23.7	22.4	21.2
For Allowable Capacity@ 45 mph	41.1	38.0	35.6	33.5	31.8

Load example 2.3b:

With large wind resistance area of the load $Awr_{(load)}$,

- Load to be lifted of 12,000 lb,
- Projected Wind Area $Ap = 125 \text{ ft}^2$,
- Wind Drag Coefficient $Cd = 1.3$

the wind resistance area of load can be estimated as:

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

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

- Is the load to be lifted less than allowable load?
12,000 lb ≤ 20,160 lb YES

- Is $Awr_{(load)}$ less than $Awr_{(allow)}$?
162 ft² ≤ 119 ft² NO

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

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

From Table 2-7, the maximum permissible wind speed at ratio of 1.37 (rounded to next higher table value of 1.4) is 38.0 mph.

Lifting Operations

Before lifting, position the equipment on a firm surface, properly extend and set the outriggers, and level the equipment. Depending on the nature of the supporting surface, adequate cribbing may be required to obtain a larger bearing surface.

The equipment is equipped with a bubble level that should be used to determine whether the equipment is level. The load line can also be used to estimate the levelness of the equipment by checking to be sure it is in-line with the center of the boom at all points on the swing circle.

If the jib, or auxiliary boom nose is to be used, ensure the electrical cable and the weight for the Anti-Two-Block Switch are properly installed and the Rated Capacity Limiter (RCL) is programmed for the equipment configuration. Refer to the RCL operator manual supplied with the equipment.

Verify the equipment'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, jib, 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 equipment's *Load Chart*.

Always keep the load as near to the equipment and as close to the ground as possible.

Do not overload the equipment by exceeding the capacities shown on the appropriate *Load Chart*. Death or serious injury could result from the equipment tipping over or failing structurally from overload.

The equipment can tip over or fail structurally if:

- The load and equipment'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 intermediate positions, the outriggers must also be pinned when operating from the intermediate position.
- Cribbing under the outrigger pads is inadequate.
- The equipment is improperly operated.

Do not rely on the equipment's tipping to determine your lifting capacity.

Be sure the hoist line is vertical before lifting. Do not subject the equipment to side loading. A side load can tip the equipment 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 equipment will lean toward the boom and the load will swing out, increasing the load radius. Ensure the equipment'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 equipment from service if the boom is damaged.

Never push or pull with the boom.

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

Using only one hoist at a time when lifting loads is recommended. See "Tilt-Up Panel Lifting" on page 2-20 for additional lifting instructions.

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

Counterweight

On equipment 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. [OSHA 29CFR 1926.1434]

Outrigger Lift Off

Regarding "lifting" of an outrigger pad during craning activities, be advised that the rated loads for these equipment, as indicated on the equipment's *Load Chart*, do not exceed 85% of the tipping load on outriggers as determined by SAE J765 JUNE2017 "Cranes Stability Test Code." An outrigger pad may lift off the ground during operation of the equipment within the capacity limits of the *Load Chart*, yet the equipment will not have reached instability. The "balance point" for stability testing according to SAE and National Crane criteria is a condition of loading wherein the load moment acting to overturn the equipment is equal to the maximum moment of the equipment available to resist overturning. This balance point or point of instability for equipment 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 equipment'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 equipment is properly set up, the equipment is in good working condition, that all operator's aids are properly programmed, that the qualified equipment operator adheres to the instructions found in the applicable *Load Chart*, *Operator Manual* and decals on the equipment, the equipment should not be unstable.

Multiple Equipment Lifts

Multiple equipment lifts are not recommended.

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

- Secure the services of a qualified person to direct the operation.

- Make sure all signals are coordinated through the lift director or person in charge of the lift.
- Coordinate lifting plans with the operators, designated person, and signal person prior to beginning the lift.
- Maintain communication between all parties throughout the entire operation. If possible, provide approved radio equipment for voice communication between all parties engaged in the lift.
- Use outriggers on equipment so equipped.
- Calculate the amount of weight to be lifted by each piece of equipment 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 piece of equipment to the other.
- Do not travel. Lift only from a stationary position.
- The total gross load shall not exceed 80% of the standard load chart. The operator shall be responsible to control this as the RCL does not have a feature to set reduced lifting limits.
- The auxiliary hoist line shall be considered part of the deducts to determine net allowable load.
- The panel shall be lifted so that the hoist lines are in line with the equipment.
- The load shall be controlled to prevent rotation of the load and to ensure the load stays in line with the boom.
- The load must be balanced with the auxiliary: load line not taking more than half the load at any time during the lift. The RCL will not be providing coverage for the line pull of the auxiliary hoist line.
- The effect of wind loads on the equipment and panel shall be taken into consideration. Operations shall be halted if the wind can cause a loss of control in handling the load.
- The main hoist line shall be used to raise the panel into the vertical position.

Tilt-Up Panel Lifting

Requirements and recommendations regarding operation and use of National Cranes are stated on decals and in the Operator and Safety Handbook and other manuals provided with each specific model machine. Using the subject equipment to perform tilt-up panel lifting with two hoist lines poses new and different hazards than does normal lifting use.

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

- The equipment must be set up and operated in accordance with instructions in the Operator and Safety Handbook, Load Capacity Chart, and decals affixed to the equipment.
- The hoist rope from the main hoist shall be reeved over the main boom nose reeved for two parts of line.
- The hoist rope from the auxiliary hoist shall be reeved over the auxiliary boom nose reeved for one part of line.
- The load shall be connected with the main hoist line connected to the end closest to equipment and the auxiliary hoist line connected to the end farthest from the equipment.
- The anti-two block system shall be installed and inspected to confirm that it is active to monitor both hoist lines.
- The RCL hoist selection shall be set to main hoist and two parts of line.
- The wire rope and sheaves shall be inspected prior to and following the lifting operations for chaffing or scrubbing.

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

PILE DRIVING AND EXTRACTING

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

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

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

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

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

Equipment

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

Equipment Inspection

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

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

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

ELECTROCUTION HAZARD

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

United States federal law prohibits the use of equipment closer than 6 m (20 ft) to power sources up to 350 kV and greater distances for higher voltages unless the line's voltage is known [29CFR1910.180 and 29CFR1926.1400].

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

NOTE: For detailed guidelines on operating near power lines, refer to the current edition of OSHA 29CFR1926.1408 and ASME B30.5 American National Standard.



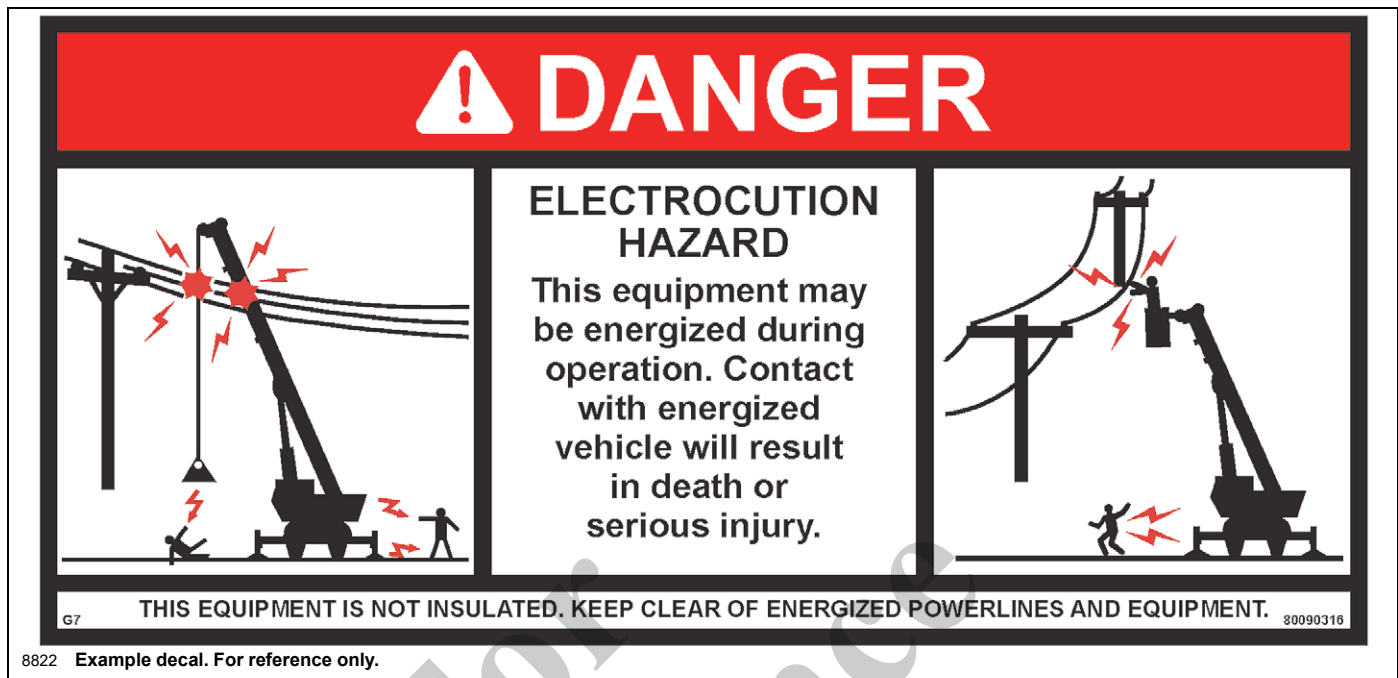
DANGER

Electrocution Hazard!

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

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

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



8822 Example decal. For reference only.

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

Before operating this equipment 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 equipment is **not insulated**. Always consider all parts of the load and the equipment, 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 equipment while operating. Permit no one to lean against or touch the equipment. 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 equipment contacts or comes too close to an electrical power source, everyone in, on, and around the equipment can be seriously injured or killed.

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

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

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

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

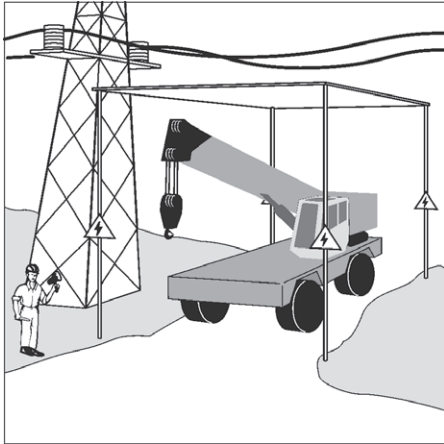
Set-Up and Operation

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

Set up the equipment in a position such that the load, boom, or any part of the equipment and its attachments cannot be moved to within 6 m (20 ft) of electrical power lines or equipment. This includes the equipment boom (fully extended to maximum height, radius, and length) and all attachments (jibs, 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 equipment 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.



8823

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 equipment or load moves near a power source. This person shall have no other duties while the equipment 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 equipment 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 equipment 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 equipment 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 equipment should come in contact with an energized power source, you must:

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

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

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

Special Operating Conditions and Equipment

Never operate the equipment during an electrical thunderstorm.

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

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

Grounding the Equipment

The equipment may become charged with static electricity. This may occur especially when using outrigger pads made of plastic or when the outrigger pads are packed with insulating material (e.g. wooden planks).



WARNING

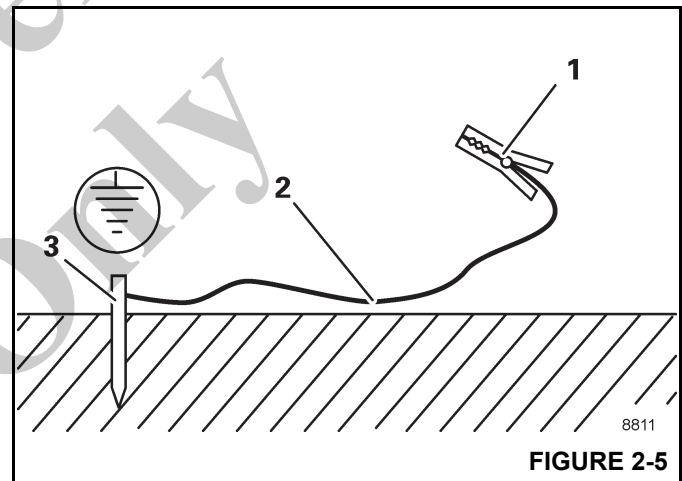
Risk of accidents due to electric shock!

Ground the equipment before you start to work with it

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

Use electrically conducting material for grounding.

1. Hammer a metal rod (3, Figure 2-5) (length of approximately 2.0 m (6.6 ft)) at least 1.5 m (5 ft) into the ground.
2. Moisten the soil around the metal rod (3) for better conductivity.
3. Clamp an insulated cable (2) to the metal rod (3), cross-section of at least 16 mm² (0.025 inches²).
4. Connect the free end of the cable with a clamp (1) to a good electrically conductive location on the frame.



WARNING

Risk of accidents due to electric shock!

Ensure that the connections between the cable and the clamp are electrically conductive.

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

PERSONNEL HANDLING

For equipment that is Dual-Rated as both a crane and an aerial lift, refer to the Safety Precautions - Aerial Lift section.

Also see the optional equipment manual titled Personnel Basket Manual which addresses safety, inspection, testing, operation, installation, and lubrication.

The following information is for machines that are not Dual Rated.

The American Society of Mechanical Engineers publishes the American National Standard entitled, *Personnel Lifting Systems*, ASME B30.23-2016:

This Volume establishes the design criteria, equipment characteristics, and operational procedures that are required when hoisting equipment within the scope of the ASME B30 Standard is used to lift personnel. Hoisting equipment defined by the ASME 830 Standard is intended for material handling. It is not designed, manufactured, or intended to meet the standards for personnel handling equipment, such as ANSI/SIA A92 (Aerial Platforms). The equipment and implementation requirements listed in this Volume are not the same as that established for using equipment specifically designed and manufactured for lifting personnel. Hoisting equipment complying with the applicable Volumes of the ASME B30 Standard shall not be used to lift or lower personnel unless there are no less hazardous alternatives to providing access to the area where work is to be performed. The lifting or lowering of personnel using ASME B30-compliant hoisting equipment is prohibited unless all applicable requirements of this volume have been met.

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

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

Use of a National Crane 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 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 equipment.
- The crane is level within one percent of level grade and located on a firm footing. Cranes with outriggers shall have them all deployed following manufacturer's specifications.
- The crane's *Operator's Manual* and other operating manuals are at the operator's station and readily accessible to the operator.
- The platform meets the requirements as prescribed by applicable standards and regulations.
- For rope suspended platforms:
 - The crane is equipped with a hook that can be closed and locked, eliminating the throat opening.
 - The crane is equipped with a functional Anti-Two-Block Device.
 - The platform is properly attached and secured to the load hook.
- For boom mounted platforms:
 - On a crane equipped with a boom mounted personnel platform, use only a platform approved by National Crane.
 - The platform is properly attached and secure.

To avoid death or serious injury:

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

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

- *ASME (formerly ANSI) B30 Series American National Safety Standards For Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings; ASME B30.5, Mobile And Locomotive Cranes, and ASME B30.23, Personnel Lifting Systems*, are available by mail from the ASME, 22 Law Drive, Fairfield, New Jersey, 0700-2900

- or -

online at: www.asme.org/kb/standards

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

ENVIRONMENTAL PROTECTION

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

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

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

When filling and draining equipment 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 equipment 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 equipment.

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

Shut down the equipment 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 equipment maintenance as well as equipment operations.

Keep the equipment 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 equipment must be performed by a qualified person(s) according to the recommendations in the *Manitowoc Crane Care Maintenance and Inspection Manual*. Any questions regarding procedures and specifications should be directed to your National Crane distributor.

Service and Repairs



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

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

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

Any modification, alteration, or change to equipment which affects its original design and is not authorized and approved by National Crane is **strictly prohibited**. All replacement parts must be National Crane approved. Such action invalidates all warranties and makes the owner/user liable for any resultant accidents.

Hydraulic Fluid:

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

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

- If any hydraulic fluid is injected into the skin, obtain medical attention immediately or gangrene may result.
- Do not attempt to repair or tighten any hydraulic hose or fitting while the engine is running, or when the hydraulic system is under pressure.
- Never disconnect any hydraulic lines unless the boom is fully lowered, the engine is shut off, and the hydraulic pressure is relieved. To relieve hydraulic pressure, stop the engine and move the hydraulic controls in both directions several times.
- Hot hydraulic fluid will cause severe burns. Wait for the fluid to cool before disconnecting any hydraulic lines.
- Hydraulic fluid can cause permanent eye injury. Wear appropriate eye protection.

Moving Parts:

- Do not place limbs near moving parts. Amputation of a body part may result. Turn off the engine and wait until the fan and belts stop moving before servicing equipment.
- 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 equipment:

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

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

Ensure all lug nuts are properly torqued.

Ensure pneumatic tires are inflated to the proper pressure. When inflating tires, use a tire gauge, clip-on inflator, and extension hose which will permit standing clear of the tire while inflating.

HOIST ROPE

Synthetic Hoist Rope

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

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

Always make daily inspections of the hoist rope, keeping in mind that all hoist rope will eventually deteriorate to a point

where it is no longer usable. Refuse to work with worn or damaged hoist rope.

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

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

Wire Rope

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

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

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

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

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

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

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

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

- Sheaves that are too small, worn or corrugated cause damage to a rope.
- Broken wires mean a loss in strength.
- Kinks permanently damage a rope and must be avoided.
- Ropes are damaged by knots. Rope with knots must never be used.

- Environmental factors such as corrosive conditions and heat can damage a wire rope.
- Lack of lubrication can significantly shorten the useful life of a wire rope.
- Contact with electrical wires and resulting arcing will damage a wire rope.
- An inspection should include verification that none of the specified removal criteria for this usage are met by checking for such things as:
 - Surface wear; nominal and unusual.
 - Broken wires; number and location.
 - Reduction in diameter.
 - Rope stretch (elongation).
 - Integrity of end attachments.
 - Evidence of abuse or contact with another object.
 - Heat damage.
 - Corrosion.

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

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

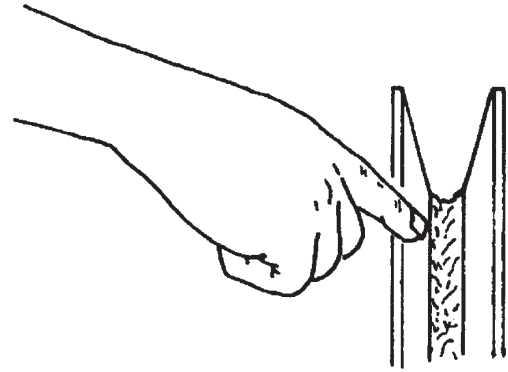
When installing a new rope:

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

When using a wedge socket:

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

Sheaves



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

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

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

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

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

Batteries

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

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

- Wear safety glasses when servicing batteries.

- If equipped, disconnect battery with the battery disconnect switch before disconnecting the ground battery cable.
- Do not break a live circuit at the battery terminal. Disconnect the ground battery cable first when removing a battery and connect it last when installing a battery.
- Do not short across the battery posts to check charge. Short circuit, spark, or flame could cause battery explosion.
- Maintain battery electrolyte at the proper level. Check the electrolyte with a flashlight.
- If applicable to your equipment, 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 equipment only with the engine turned off. Do not smoke while fueling the equipment. Do not store flammable materials on the equipment.

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 equipment equipped with intake manifold grid heaters.

TRANSPORTING THE EQUIPMENT

Before transporting the equipment, check the suitability of the proposed route with regard to the equipment 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 equipment and transporting vehicle.

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

Ensure the equipment is adequately secured to the transporting vehicle.

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

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

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

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

TRAVEL OPERATION

Only the equipment operator shall occupy the equipment when traveling.

When traveling, the boom should be completely retracted and lowered to the travel position. If equipped with boom rest, lower the boom into the boom rest and engage the turntable swing lock pin and/or 360 degree swing lock.

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

Traveling at high speeds, especially on rough ground, may create a bouncing effect that can result in loss of control. If bouncing occurs, reduce travel speed.

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

Follow the instructions in this manual when preparing the equipment 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 equipment, ensure the cab is level, if equipped with a tilting cab.

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

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 with equipment, check suitability of proposed route with regard to equipment height, width, and length.

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

On equipment equipped with air-operated brakes, do not attempt to move the equipment 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 equipment's weight.

If it is necessary to take the equipment 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 equipment carefully obeying speed limits and highway regulations.

Stay alert at the wheel.

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

Slopes:

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

WORK PRACTICES

Personal Considerations

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

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

Equipment 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 equipment. Falling from any elevation could result in serious injury or death.

Never exit or enter the equipment operator 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 equipment.

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

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

Do not step on surfaces on the equipment that are not approved or suitable for walking and working. All walking and working surfaces on the equipment 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 equipment.

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 equipment cab/operator's station or climbing onto the equipment 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 equipment. This practice will prevent ground personnel from being crushed or electrocuted when they attempt to access personal belongings stored on the equipment.

Job Preparation

Before equipment use:

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

You must ensure that the outriggers and stabilizers are properly extended and set before performing any lifting operations. On models equipped with outriggers that can be pinned at the intermediate positions, the outriggers must also be pinned when operating from the intermediate positions.

Clear all personnel from the outrigger area before extending or retracting the outriggers. Carefully follow the procedures in this *Operator Manual* when extending or retracting the outriggers. Death or serious injury could result from improper equipment 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 their direct control. When safety of an operation is in doubt, operator shall stop the equipment's functions in a controlled manner. Lift operations shall resume only after safety concerns have been addressed or the continuation of equipment operations is directed by the lift supervisor.

Know the location and function of all machine controls.

Make sure all persons are away from the equipment and the Travel Select Lever is in the "N" (Neutral) position with the parking brake engaged before starting the engine.

Sparks from the equipment's electrical system and/or engine exhaust can cause an explosion. **Do not** operate this

equipment in an area with flammable dust or vapors, unless good ventilation has removed the hazard.

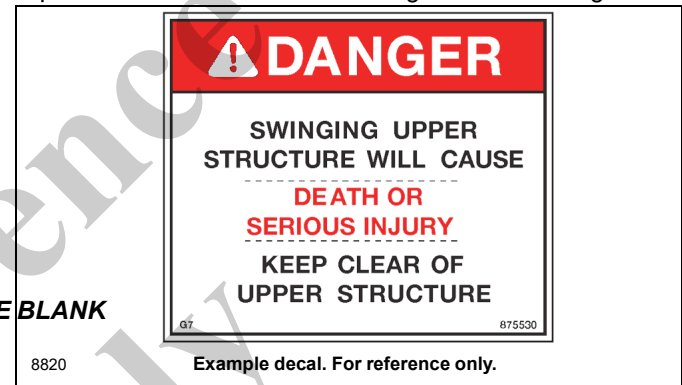
Carbon monoxide fumes from the engine exhaust can cause suffocation in an enclosed area. Good ventilation is very important when operating the equipment.

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

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

Always be aware of your working environment during operation of the equipment. Avoid contacting any part of the equipment 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 equipment operator shall occupy the equipment when in operation.

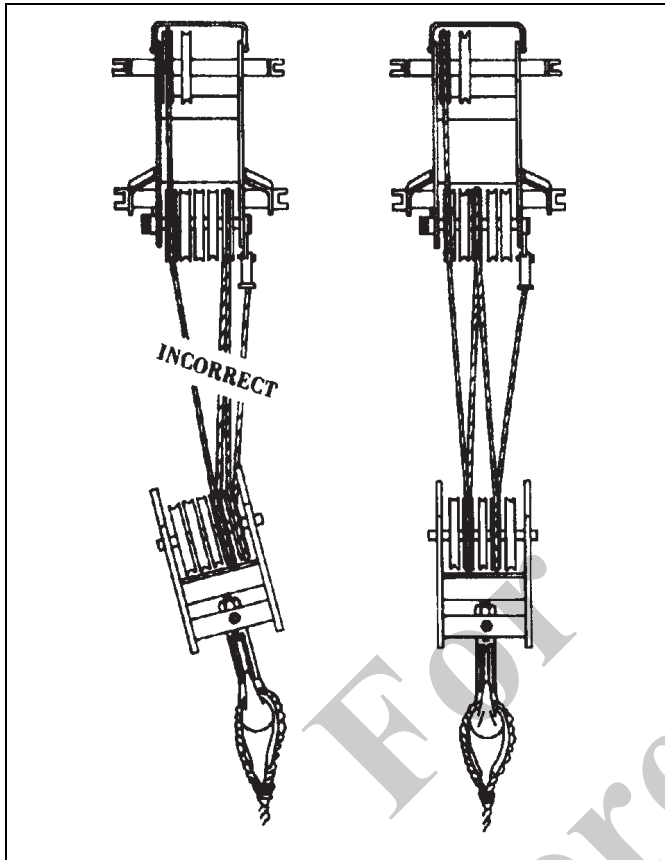
You must always be aware of everything around the equipment while lifting or traveling. If you are unable to clearly see in the direction of motion, you must post a look out or signal person before moving the equipment or making a lift. Sound the horn to warn personnel

Operate the equipment from the operator's control station. Do not reach in a window or door to operate any controls.

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

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

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



Lifting

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

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

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

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

Never leave the equipment with a load suspended. Should it become necessary to leave the equipment, 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 equipment!

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 equipment. Even though the original setup may have been checked, situations do change.

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

Never push or pull loads with the equipment's boom; never drag a load.

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

If the boom should contact an object, stop immediately and inspect the boom. Remove the equipment 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 equipment's capacity on *Load Chart*.

Avoid sudden starts and stops when moving the load. The inertia and an increased load radius could tip the equipment 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 equipment 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 equipment operator cannot clearly see the load at all times.
- Moving the equipment in an area or direction in which the operator cannot clearly see the path of travel.

At all times use standardized hand signals (Figure 2-6) - previously agreed upon and completely understood by the operator and signal person.

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

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

Obey a signal to stop from anyone.

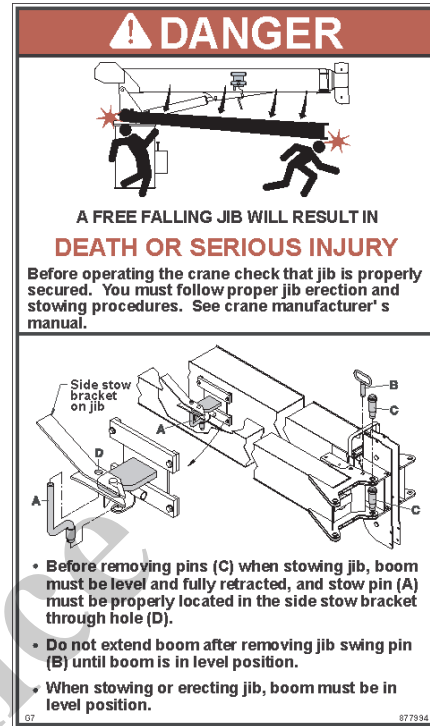
JIB

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

Install and secure all pins properly.

Control movement of jib at all times.

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



Example decal. For reference only.

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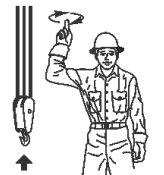

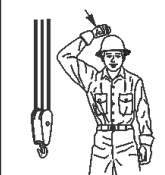
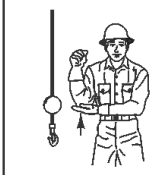
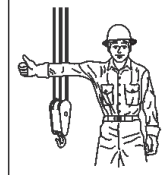
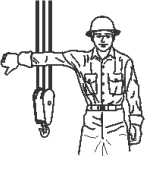
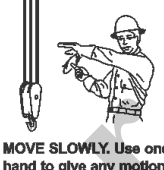

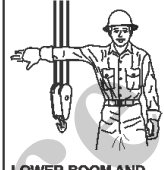
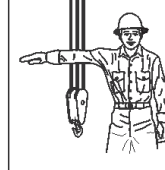
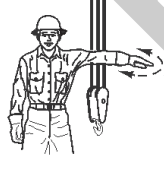
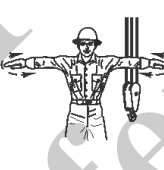
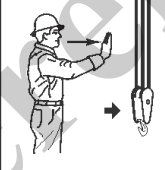
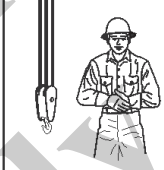
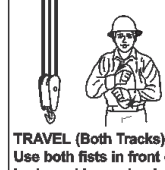
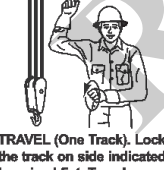
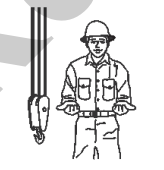
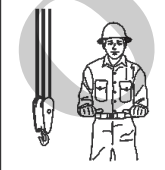

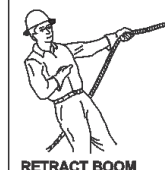
Do not remove all the pins from stowage brackets unless the jib is pinned to the right side of the boom nose.

Properly inspect, maintain, and adjust jib and mounting.

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

Stay outside of jib sections and lattice work.

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

STANDARD HAND SIGNALS FOR CONTROLLING CRANE OPERATIONS				
Complies with ASME B30.5-2014				
 <p>HOIST. With forearm vertical, forefinger pointing up, move hand in small horizontal circle.</p>	 <p>LOWER. With arm extended downward, forefinger pointing down, move hand in small horizontal circle.</p>	 <p>USE MAIN HOIST. Tap fist on head; then use regular signals.</p>	 <p>USE WHIPLINE (Auxiliary Hoist). Tap elbow with one hand; then use regular signals.</p>	 <p>RAISE BOOM. Arm extended, fingers closed, thumb pointing upward.</p>
 <p>LOWER BOOM. Arm extended, fingers closed, thumb pointing downward.</p>	 <p>MOVE SLOWLY. Use one hand to give any motion signal and place other hand motionless in front of hand giving the motion signal (hoist slowly shown as an example).</p>	 <p>RAISE BOOM AND LOWER LOAD. With arm extended, thumb pointing up, flex fingers in and out as long as load movement is desired.</p>	 <p>LOWER BOOM AND RAISE LOAD. With arm extended, thumb pointing down, flex fingers in and out as long as load movement is desired.</p>	 <p>SWING. Arm extended, point with finger in direction of swing of boom.</p>
 <p>STOP. Arm extended, palm down, move arm back and forth horizontally.</p>	 <p>EMERGENCY STOP. Both arms extended, palms down, move arms back and forth horizontally.</p>	 <p>TRAVEL. Arm extended forward, hand open and slightly raised, make pushing motion in direction of travel.</p>	 <p>DOG EVERYTHING. Clasp hands in front of body.</p>	 <p>TRAVEL (Both Tracks). Use both fists in front of body, making a circular motion about each other, indicating direction of travel, forward or backward. (For land cranes only.)</p>
 <p>TRAVEL (One Track). Lock the track on side indicated by raised fist. Travel opposite track in direction indicated by circular motion of other fist, rotated vertically in front of body. (For land cranes only.)</p>	 <p>EXTEND BOOM (Telescoping Booms). Both fists in front of body with thumbs pointing outward.</p>	 <p>RETRACT BOOM (Telescoping Boom). Both fists in front of body with thumbs pointing toward each other.</p>	 <p>EXTEND BOOM (Telescoping Boom). One Hand Signal. One fist in front of chest with thumb tapping chest.</p>	 <p>RETRACT BOOM (Telescoping Boom). One Hand Signal. One fist in front of chest, thumb pointing outward and heel of fist tapping chest.</p>
<p>Reprinted from ASME B30.5-2014, by permission of The American Society of Mechanical Engineers. All Rights Reserved.</p>				

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FIGURE 2-6

PARKING AND SECURING

WARNING

Tipping Hazard!

When parking the equipment and leaving it unattended follow the instructions for the Controls and Operating Procedures of this manual.

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

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

The Controls and Operating Procedures section of this manual provides instructions for parking and securing equipment when it is to be left unattended. These instructions are intended to allow the equipment to be placed in the most stable and secure position. However, National Crane recognizes that certain jobsite conditions may not permit the boom and jib 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 equipment should be left in the smallest, most stable, valid operational configuration that the job site practically allows.
- The equipment cannot 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 equipment configured in as stable a configuration as possible (boom angle, superstructure orientation, jib offset angle, etc.)
- In high winds the boom and jibs 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 equipment when it is to be left unattended.

SHUT-DOWN

Use the following steps when shutting down the equipment:

- Fully retract and lower the boom.
- Engage the swing lock pin and/or 360 degree swing lock.
- Place controls in neutral position.
- Shut down the engine and remove the ignition key.
- Chock the wheels, if not on outriggers.

- Lock the operator's cab (if applicable) and install vandal guards, if used.

COLD WEATHER OPERATION

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

Check operating procedures in this manual for cold weather starting.

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

Clean the equipment of all ice and snow.

Allow ample time for hydraulic oil to warm up.

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

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

Never store flammable materials on the equipment.

National Crane recommends use of cold weather starting aids that are provided on your equipment, use them. The use of aerosol spray or other types of starting fluids is prohibited.

TEMPERATURE EFFECTS ON HOOK BLOCKS

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

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

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

TEMPERATURE EFFECTS ON HYDRAULIC CYLINDERS

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

The change in the length of a cylinder is proportional to the extended length of the cylinder and to the change in temperature of the oil in the cylinder. For example, a cylinder extended 7.6 m (25 ft) in which the oil cools 15.5°C (60°F)

would retract approximately 196 mm (7 3/4 in) [see Table 2-8]. A cylinder extended 1.5 m (5 ft) in which the oil cools 15.5°C (60°F) would only retract approximately 38 mm (1 1/2 in). The rate at which the oil cools depends on many factors and will be more noticeable with a larger difference in oil temperature verses the ambient temperature.

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

If a load and the boom is allowed to remain stationary for a period of time and the ambient temperature is cooler than the trapped oil temperature, the trapped oil in the cylinders will

cool. The load will lower as the telescope cylinder(s) retracts allowing the boom to come in. Also, the boom angle will decrease as the lift cylinder(s) retracts causing an increase in radius and a decrease in load height.

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

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

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.



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

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

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

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

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

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

OVERLOAD INSPECTION

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

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

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



WARNING

Overload Hazard!

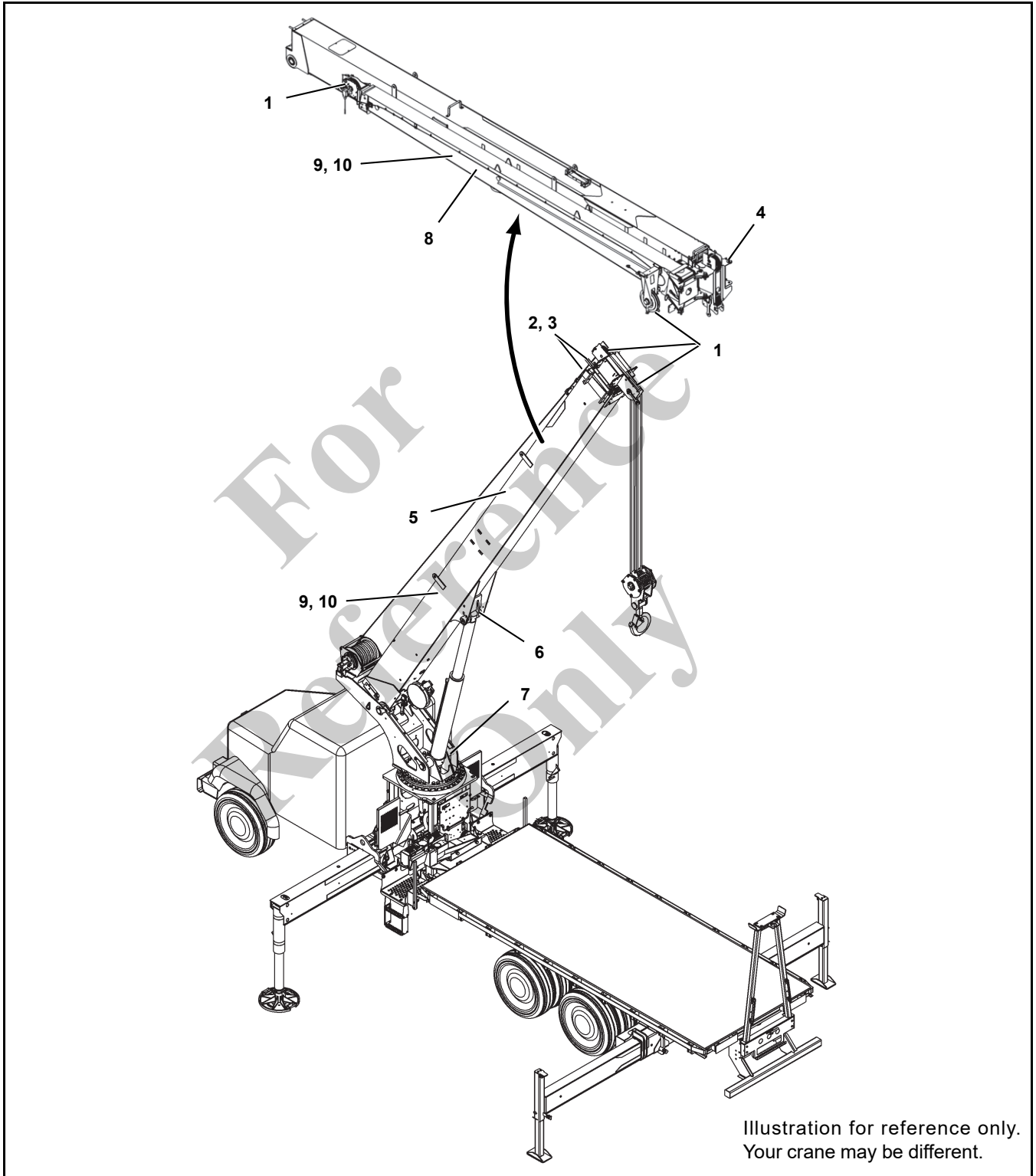
To avoid an accident caused by overload damage to your crane:

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

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

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

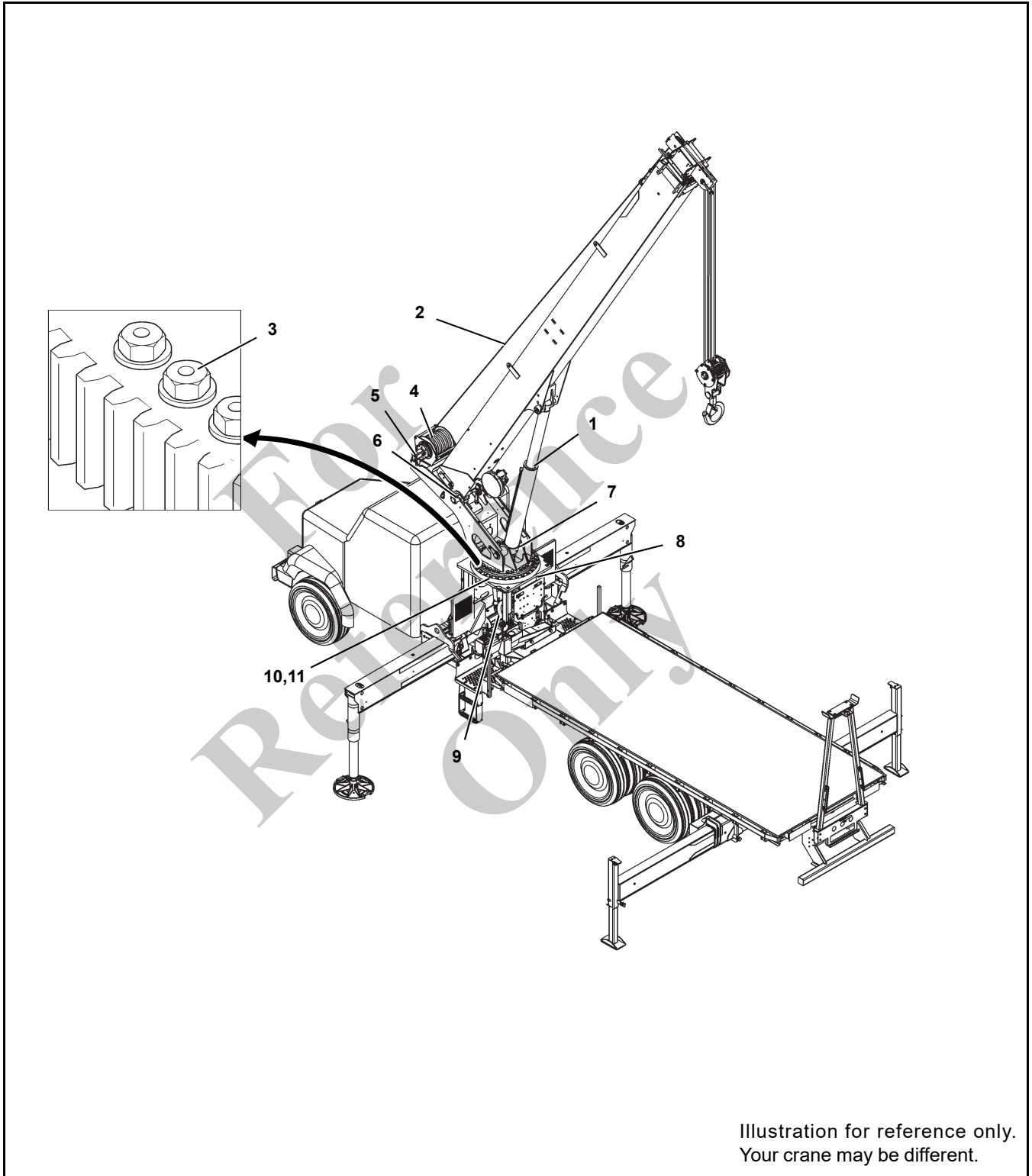
Boom Inspection



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

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.	

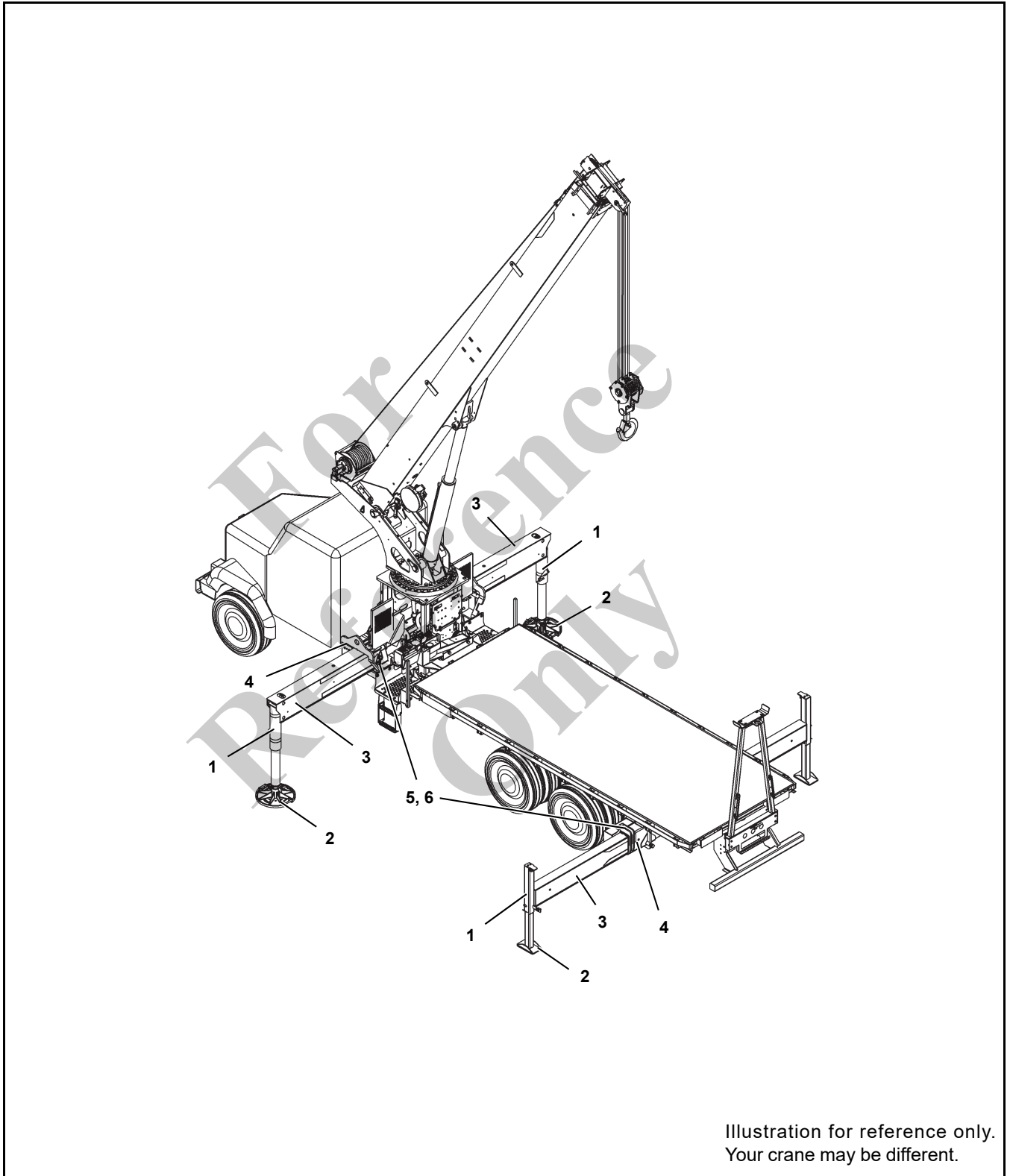
Superstructure Inspection



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

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



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

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

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

Electric Shift Control

Full torque electric shift PTO's are controlled by a switch. To operate, disengage the clutch, shift to fourth or fifth gear, and 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 regions with ambient temperatures below -9°C (15°F) which are considered arctic.

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

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

Operation Below -40°C

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

Operation Below -40°F

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

CRANE WARM-UP PROCEDURES

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

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

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

Engine

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

Warm-up Procedures for All Temperature Ranges:

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

Transmission

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

Operating the transmission with a sump temperature below normal operating temperature is limited to:

- operating in the neutral gear or
- driving with an unloaded crane while not exceeding 1500 engine RPM and not exceeding half throttle.

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

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

Hoist

Performing a warm-up procedure is recommended at every startup and is required at ambient temperatures below 4°C (40°F).

Warm-up Procedures:

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

JUMP STARTING HAZARD

Do not attempt to jump start the crane.

CAUTION

It is strongly recommended that the batteries not be "jumped" with a different vehicle, portable power pack, etc. The surge of power from these sources can irreparably damage the various electronic controls and computer systems. Jump starting the crane batteries with a different vehicle while the engine is running can damage the donor vehicle electronics as well if done improperly.

All crane models, particularly those produced since 2000, have multiple computer systems (crane control, RCL, engine and transmission control) that are highly susceptible to voltage/amperage surges in the electrical system.

The batteries should be completely disconnected from the crane electrical system and charged using a battery charger of appropriate voltage level or replace the batteries with fully charged batteries. Refer to *Charging the Battery*, page 3-3.

CHARGING THE BATTERY

When charging the batteries, do not turn on the battery charger until the charging leads have been connected to the battery(s). Also, if the battery(s) are found to be frozen, do not attempt to charge them. Remove the battery(s) from the crane, allow them to thaw, and then charge the battery(s) to full capacity.

"Slow charging" is preferred to "fast charging". Fast charging saves time but risks overheating the battery(s). Slow charging at six (6) amps or less develops less heat inside the battery and breaks up the sulfate on the battery plates more efficiently to bring the battery up to full charge. The use of a "smart charger" that automatically adjusts the charging amperage rate should be used.

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

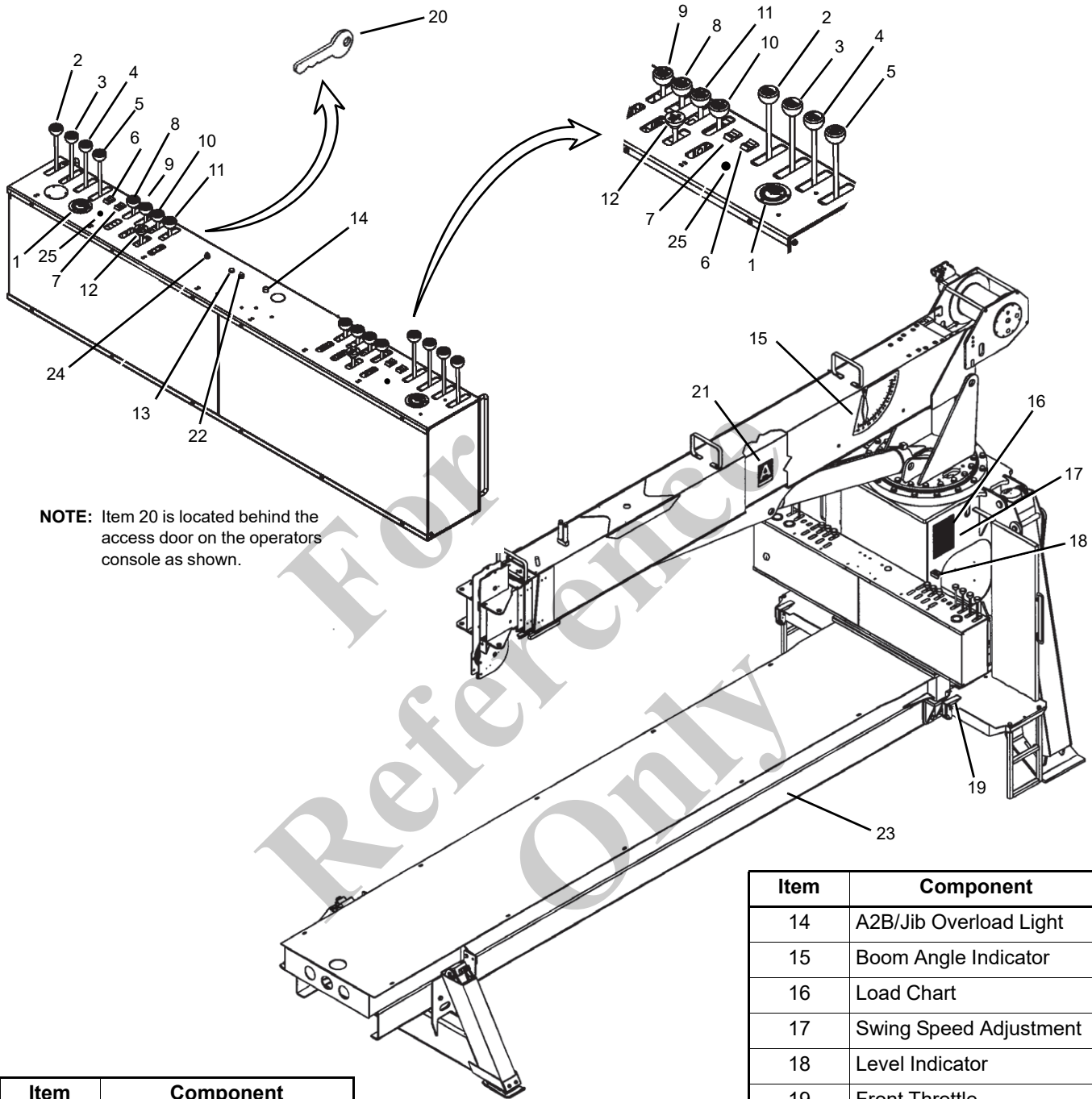
Located on either side of the base boom section and used to determine main boom angle with respect to horizontal. For reference only.

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	Single Front Outrigger
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

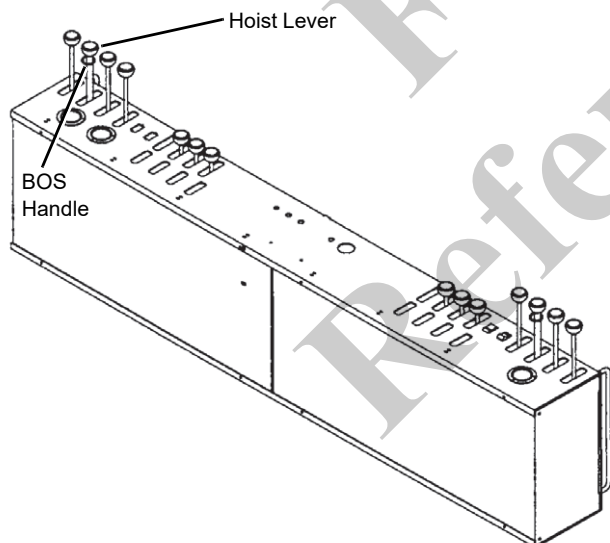
OPTIONAL HOIST BURST OF SPEED (BOS)

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 Rated Capacity Limiter (RCL) System, the anti-two-block system is integral with the RCL wiring and display. An audible, visual warning of the two block condition is provided in the display console. See RCL 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

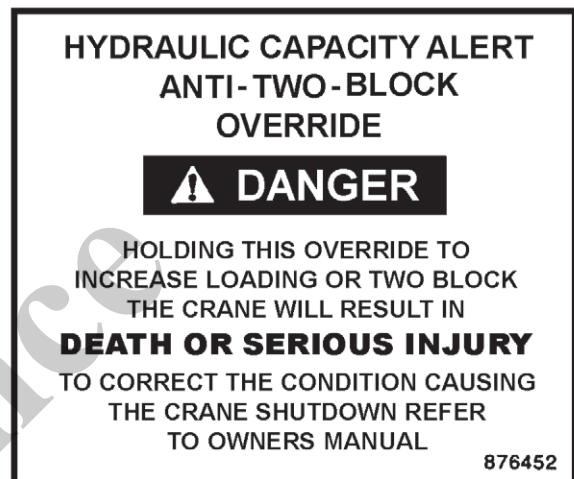
Two indicator lights located on the operator's console alert the operator of function power loss and discriminate between

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 out lined in this manual.

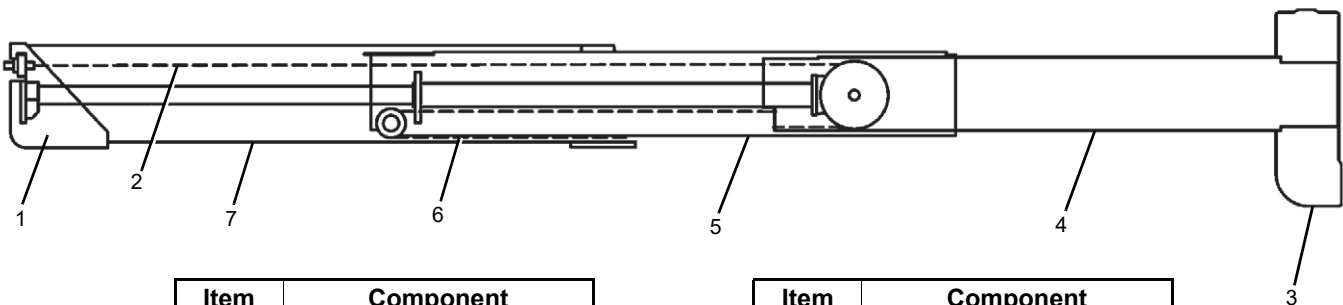
Do not expect the Hydraulic Capacity Alert System and the Jib Load Limiting Device to detect all possible overload conditions.

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

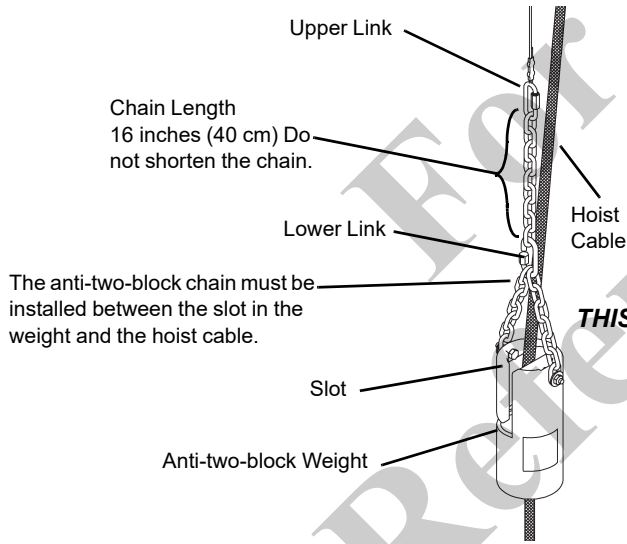
Item	Component
5	2 nd Section
6	Retract Cable
7	1 st Section

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.

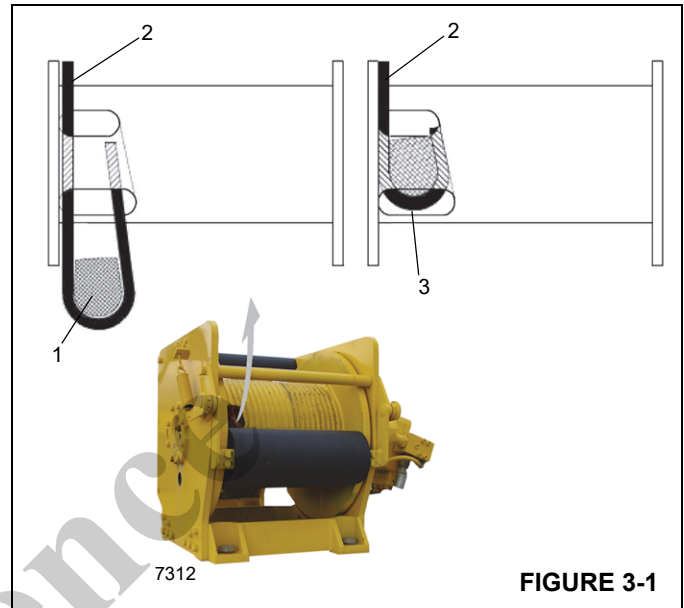
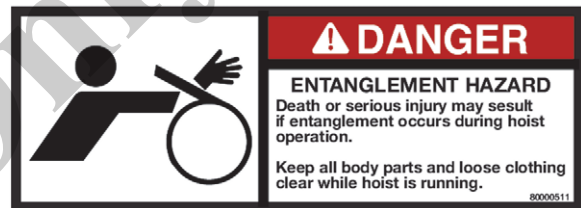


FIGURE 3-1

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

THIS PAGE INTENTIONALLY LEFT BLANK If the wedge does not seat securely in the slot, carefully tap (3) the top of the wedge with a mallet.



7196

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.

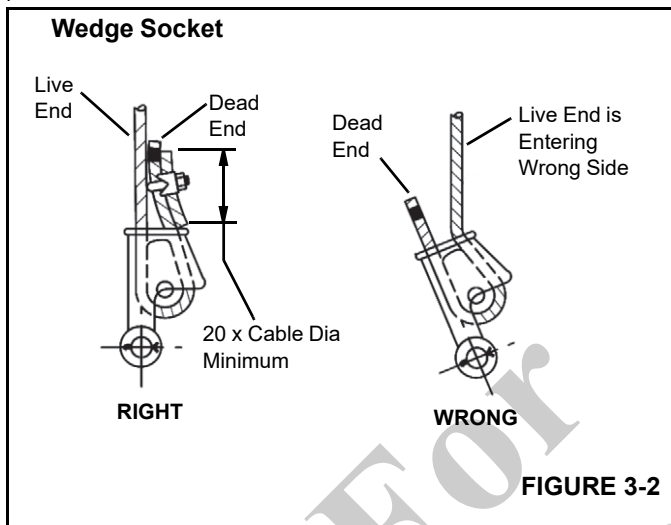
1. Position the cable over the boom nose sheave and route to the hoist drum.
2. Position the hoist drum with the cable anchor slot on top.

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. Inspect the wedge and socket. Remove any rough edges and burrs.
2. The end of the wire rope should be seized using soft, or annealed wire or strand. If the end of the rope is welded, the welded end should be cut off. Do not weld on size 6×37 rope. This will allow the distortion of the rope strands, caused by the bend around the wedge, to adjust themselves at the end of the line. Refer to SECTION 1 - INTRODUCTION in the *Service Manual* for wire rope procedures.

3. Make sure the live-end (Figure 3-2) of the rope is directly in line with the ears of the socket and the direction of pull to which the rope will be subjected. If the rope is loaded into the socket incorrectly, under a load the rope will bend as it leaves the socket, and the edge of the socket will wear into the rope causing damage to the rope and eventual failure.



4. Insert the end of the wire rope into the socket, form a loop in the rope, and route the rope back through the socket allowing the dead-end (Figure 3-2) to protrude from the socket. Ensure the dead-end of the rope is of sufficient length to apply end treatment to the dead-end after the wedge has been seated.
5. Insert the wedge into the loop and pull the live-end of the rope until the wedge and rope are snug inside the socket. It is recommended that the wedge be seated inside the socket to properly secure the wire rope by using the crane's hoist to first apply a light load to the live-end.
6. After final pin connections are made, increase the loads gradually until the wedge is properly seated.
7. The wire rope and wedge must be properly secured inside the socket before placing the crane into lifting service. It is the wedge that secures the wire rope inside the socket. The dead-end treatment is used to restrain the wedge from becoming dislodged from the socket should the rope suddenly become unloaded due to the downhaul weight or hook block striking the ground, etc; refer to *Dead-end Rigging*, page 3-13.

Dead-end Rigging

Sketches A through F (Figure 3-3) illustrate various ANSI approved methods for treating the dead-ends of wire ropes which exit a wedge socket assembly. While use of the loop-back method is acceptable, care must be exercised to avoid

the loop becoming entangled with tree branches and other components during crane transport and with the anti-two block system and other components during use of the crane.

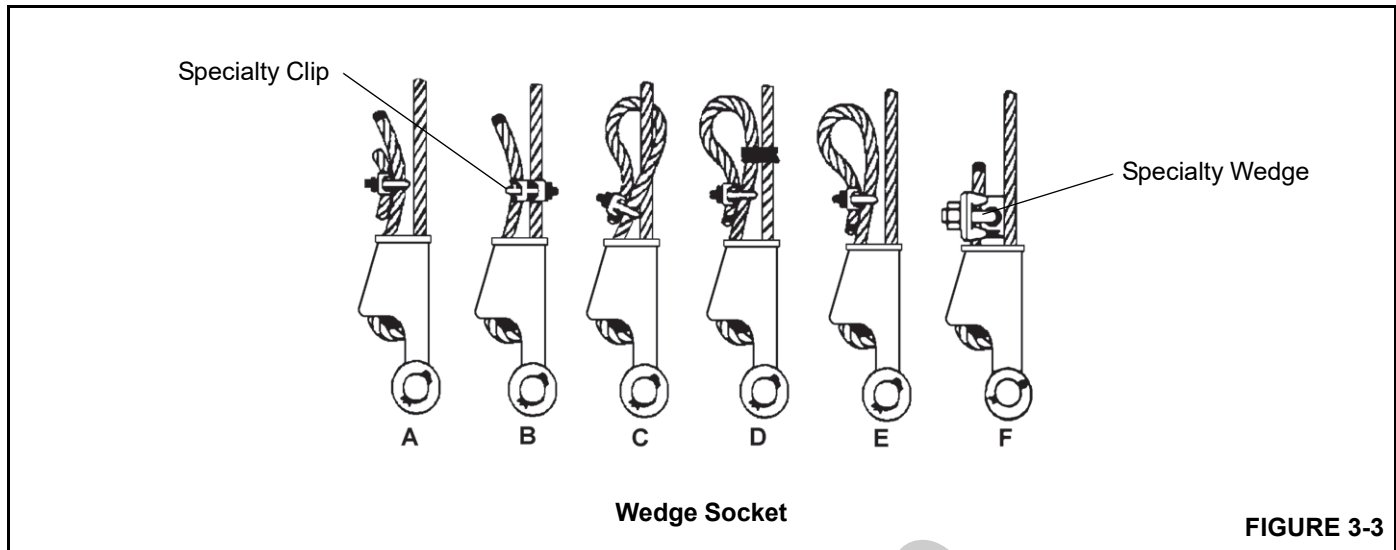
Of the methods shown below, National Crane prefers that method A or F be used, i.e., clipping a short piece of wire rope to the dead-end or using a commercially available specialty wedge. Typically, it is recommended that the tail length of the dead-end should be a minimum of 6 rope diameters but not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

When using method A, place a wire rope clip around the dead end by clamping a short extra piece of rope to the rope dead end. **DO NOT CLAMP THE LIVE END.** The U-bolt should bear against the dead end. The saddle of the clip should bear against the short extra piece. Torque the U-bolts according to the Table 3-1.

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

Table 3-1 Wire Rope Clip Torque Values

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



Wedge Socket

FIGURE 3-3

REMOTE CONTROL

The following sections describe the remote control function. For detailed installation and troubleshooting information, see the *Service Manual*.

Safety

! DANGER

This crane is not insulated. The remote control provides no protection against the electrocution hazard. Do not operate near live electrical power lines. All warnings in the Safety and Operation Section of this manual and on the crane relative to operating and safety procedures and power line clearances must be observed when using the crane remote control.

The remote control system offers an excellent solution to safety, speed and ease of use, less downtime, and overall maneuverability. Like any device, there are precautions and common sense that work hand in hand to assure safe and reliable operations.

Never allow any operation until the operator has read all instructions and has become completely familiar with the total system. Should **anything** happen unexplained, unpredicted, or incorrect operation, immediately shut down the complete system and investigate! This includes shutting down all electronics, hydraulics, power take-offs, and engines. **Never** resume operation until the problem has been corrected!

Danger Remote Start Hazard

! DANGER

Starting truck engine with drive train engaged will cause unexpected movement of the truck resulting in death or serious injury.

Do not install remote start relay on any chassis that can be started while transmission is in gear.

Before a remote start relay can be installed, the chassis must be equipped with a switch that prevents the engine from starting while the transmission is in gear.

The remote start relay has been intentionally supplied separately from the rest of the remote engine compartment wiring. Before installing the remote start relay on any chassis, the installer must verify that the chassis can not be started while the transmission is in gear. The remote start relay is only to be installed on a chassis that is equipped with a switch (neutral safety switch) that prevents the engine from starting while the transmission is in gear. A chassis not equipped with or that can not be equipped with a neutral safety switch will not have the start relay installed and therefore can not be started with the radio transmitter only.

! DANGER

Starting truck engine with drive train engaged will cause death or serious injury.

Do not start truck engine unless drive train is in neutral.

Before attempting to start truck with remote control make sure the drive train is in neutral.

When not using the remote control, disconnect power to the remote control system with the selector switch installed in the

truck cab. This will prevent inadvertent operation of the crane if the hand control is operated. Protect and monitor the hand control unit to prevent damage and unplanned operation.

Operation

1. Position crane at job site, set park brake, and shift transmission to neutral.
2. Start truck from inside truck cab.
3. Engage P.T.O.
4. Set outriggers.
5. Stop truck engine.
6. Connect hand control cord to receptacle on crane. (If equipped with hard wire remotes).
7. Turn Hydraulic Capacity Alert/RCL and Remotes/SLP power switches ON - in truck cab.
8. Starting truck for remote operation:
 - If truck is equipped with the remote start relay (see warning before installing start relay), then activate ignition/start switch on hand control to start truck.
 - If truck is not equipped with remote start relay; then activate ignition/start switch on hand control to the ON position and start truck with the ignition switch in the truck cab.
9. Set engine throttle control if not equipped with automatic throttle advance.
10. Actuate desired crane function switch.
11. Slowly squeeze speed trigger to increase crane operating speed.
12. Slowly release speed trigger to decrease crane operating speed.
13. Release crane function switch.
14. Stow crane and shut off hand control ignition/start switch.
15. Turn Hydraulic Capacity Alert/RCL and Remotes/SLP power switches OFF - in truck cab.
16. Disconnect hand control and store in truck, (If equipped with hard wire remotes).
17. Start truck from inside of cab.
18. Stow outriggers.
19. Disengage P.T.O.

Hydraulic System Description

Solenoid Valve Assembly

Flow Control Valve in Inlet Section

1. Electrically controlled priority flow control valve which can be remotely actuated to control the amount of oil flow from the inlet to the bypass or the regulated ports.
 - a. Oil supply of 5 - 18 GPM is pumped to inlet port.
 - b. With electrical voltage up to 2 volts on the valve coil, 0 GPM of inlet oil is directed to the solenoid valve sections and the remaining oil goes through the bypass port and into the manual control valve, then back to tank.
 - c. As voltage increases linearly from 2 to 9 volts, there is a resulting linear increase of oil flow to the solenoid sections to 18 GPM maximum. Any remaining oil is directed back to tank through the bypass port.

Solenoid Valve Sections

2. An electrically actuated directional control valve which receives oil from the regulated port of the flow control valve and directs it to the various crane functions.
 - a. When 12 VDC power is applied to any of the electromagnetic coils on the valve, the resulting force pushes a spring centered spool from its neutral position to allow oil flow out the work port opposite the energized coil.
 - b. Oil flow through the solenoid valve is then increased and decreased at the flow control valve to get desired crane operating speeds.
3. Pressure relief valve (part of solenoid valve) in inlet section.
 - a. Protects remote control hydraulic circuit from over pressurization. Must be set to match crane manual system pressure.

Shuttle Valve

Biased shuttle valves are located in the turn and hoist functions on units equipped with remote hoist operation. They block the open oil path through the main control valve during remote operation.

RADIO REMOTE CONTROLS

The following sections describe the radio remote controls. For detailed maintenance, installation, and troubleshooting information about the radio remote controls, see the *Service Manual*.

Safety

The radio remote control system offers an excellent solution to safety, speed and ease of use, less downtime, and overall maneuverability. Like any device, there are precautions and common sense that work hand in hand to assure safe and reliable operations.

Never allow any operation until the operator has read all instructions and has become completely familiar with the total system. Should **anything** happen unexplained, unpredicted, or incorrect operation, immediately shut down the complete system and investigate! This includes shutting down all electronics, hydraulics, power take-offs, and engines. **Never** resume operation until the problem has been corrected!



DANGER

Starting truck engine with drive train engaged will cause death or serious injury.

Do not start truck engine unless drive train is in neutral.

Before attempting to start truck with remote control make sure the drive train is in neutral.

When not using the remote control, disconnect power to the remote control system with the selector switch installed in the truck cab. This will prevent inadvertent operation of the crane if the hand control is operated. Protect and monitor the hand control unit to prevent damage and unplanned operation.

Always turn the truck ignition off and start the unit using the remote hand control. This will allow the truck engine to be turned off with the remote hand control. If the truck ignition is on, the stop and emergency stop functions will not function.

Operation

General

The system consists of a Modulator/Transmitter unit and a receiver/decoder (Receiver) unit. The system operates on the 5 RF channels in accordance with FCC Subpart D - Lower Power Communications Devices, Part 15.117. Use of this device is subject to the provisions of FCC Part 15.103. A license is NOT required to operate this system.

Transmitter

The transmitter generates an RF signal which is FM modulated. The Modulation is a 120 bit data stream with start and stop bits, information concerning the selected switch being activated, and a specialized algorithm developed to ensure the validity of the transmission. Also transmitted are address information to enable it to "talk" to its associated receiver. This address information is set at the factory so no two devices will be the same. There may be over 20000 units in the same vicinity without any cross activation.

Receiver

The receiver receives the signal transmitted by the transmitter, decodes the data stream and checks for validity of the address and the start and stop bits of the received data. If this is correct, a proprietary software algorithm is performed to accept or reject the information to be passed on to the outputs. If for any reason this test fails, no output will be allowed to function. Once this test has passed, the appropriate output will be activated.

Single Proportional Control

The radio system is designed with its own amplifier circuit that supplies a pulse width modulation output. (An independent amplifier card is not required for the proportional valve.)

Input Voltage	10-30 VDC
Output Voltage	Same as input voltage
Output Current	5 amps maximum
Proportional Setting	Independent low end / high end settings

The independent proportional low and high end settings match the potentiometer travel with the proportional valve's working voltage and range.

The proportional valve is remote mounted between the hydraulic reservoir and the existing valve bank. A trigger controlled potentiometer is mounted in the grip of the hand held control that is spring loaded. This creates a single control, "metering" fluid to all the valves mounted on a manifold.

Electrical Circuit Description

Receiver Electrical Supply

1. Positive 12 VDC power is supplied from the battery to a 15 amp thermal circuit breaker then to plug letter "A" in the receptacle.
2. When the receiver cord is plugged in, +12 VDC power becomes available to the receiver.

Hand Control Circuitry

1. The hand control (transmitter) is activated by turning the power switch to the ON position. The radio transmits ten seconds to "initialize" the receiver. **This switch should be placed in the OFF position when not using the remote controls.** Failure to do so will greatly reduce the life of the 9 volt battery in the hand control (transmitter).



DANGER

Failure to do so could cause inadvertent operation of the crane.

2. OFF-START switch in "CENTERED" position.

- a. Ignition circuit not energized until truck is started.
- 3. OFF-START switch in “START” position (Momentary).
 - a. “L” (Ignition) circuit energized and stays energized when switch returns to central position.
 - b. “M” (Start) circuit energized to power start relay at truck engine.
 - c. “N” (Throttle Advance) circuit energized to power the throttle advance relay at truck engine (if equipped).
- 4. Function Switch (Turn, Telescope, Hoist, Boom, etc.) thrown (Momentary).
 - a. Energizes the selected circuit to power one of the solenoid valve coils at the crane frame.
 - b. At the same time, energizes “N” (throttle advance) circuit to power the throttle advance relay at the truck engine (if equipped). Throttle stays activated for five seconds after function switch is deactivated.
- 5. Trigger
 - a. Attached directly to potentiometer shaft.
 - b. Controls the speed that a crane function will operate. The more it is moved, the faster the function will operate.

the microprocessor and awaits for a special code from the transmitter to activate a relay to make power available to the output driver circuit.

When the transmitter is turned on, it will transmit a special code for 10 seconds to instruct the receiver to initialize. This will happen only if the transmitter is Not transmitting a function such as switch being activated. During this initial 10 seconds a function may be activated once the receiver has been Initialized. The initialization is instantaneous so you will not have any delay in operation. If the transmitter is “out of range” or a function is activated when the transmitter is turned on, the receiver will not be initialized. Once the receiver has been initialized, the unit will be allowed to operate. Should an emergency situation occur, the receiver may be “shut down” by pressing the Emergency Stop Switch on the transmitter. This must be pressed while transmitter power is in the ON position. This special code will be transmitted for a period of 10 seconds.

When the receiver receives this special code, the power to the output driver circuit will be de-activated. To resume operation, the transmitter must again send the special code to re-activate the receiver. To achieve this, turn transmitter power off and back on.

The transmitter will again go through its routine to initialize the receiver. **Please instruct your operators how to use this “Emergency Stop” and insist that they operate this feature to become familiar with the characteristics involved.**

Emergency Stop Function

This unit is equipped with an Emergency Stop. The transmitter has a momentary push button switch near the antenna. When initially using the radio remote control system, turn the receiver power on first. This allows power to

Frequently Asked Questions

Question	Answer
What kind of range can be expected?	Advertised at 400 feet. Very likely to be much greater. The environment, terrain, antenna placement, and transmitter’s position can play an important role in achieving maximum range.
What method of transmission is being utilized?	The radio uses Radio Frequency (RF) at 49 Megahertz (49 MHz).
Why 49 MHz?	The Federal Communications Commission (FCC) dictates the frequency spectrum for the purpose of radio control devices. There are several bands that can be used. A lower band was chosen to reduce the “line-of-sight” characteristic. Lower frequencies tend to follow the curvature of the Earth, which will allow control in areas that are not “line-of-sight” such as ravines, embankments, cliffs, and even buildings.
Do you use amplitude modulation (AM) or frequency modulation (FM)?	FM is utilized. FM is a must in electrically noisy environments. These environments include areas with welders, power lines, industrial machinery, etc. A good analogy is a standard automobile radio. In the above mentioned areas, the radio will have static on AM stations. Your FM stations assure definite clarity and a common extended range.



Question	Answer
Will our current 2-way radio affect the operation of the wireless controller?	No. Two-way radios are assigned to different bands in the frequency spectrum and at high frequencies. At the lower frequencies such as 49 MHz, the power density in a given area is much lower than at higher frequencies therefore much less chance of interference.
Is the unit affected by outside interference?	Any receiver will receive frequency to which it is tuned. Should the radio remote unit receive an interfering signal which is at the same frequency, the "Smart Logic" analyzes the incoming signal to determine validity. First, it must be a digitally modulated FM carrier, it must have the exact data stream length and appropriate baud rate. The data stream length totals 120 bits of information. The baud rate is the speed at which these bits are transmitted. The first 120 bits are stored and compared to the next consecutive 120 bit data stream(s). Each of these 120 bit data streams are broken down into groups of bits called data words or bytes. These bytes reflect each individual switch and/or position along with additional information of the transmitter. Also included is an address code that must match the codes of the appropriate transmitter. If any bits of this data stream are wrong or missing the outputs will not be updated. Should there be a possible interfering signal present, normally the wireless transmitter is operated at a closer range than the interfering signal and the receiver will perform properly since it will pick up the strongest signal.
Will two radio remote units in the same vicinity operate each other?	No. Each receiver and transmitter have address codes which are set by the factory and are shipped as a set. Therefore, serial numbers should be recorded for future reference should assistance from the factory be necessary.
Is the unit protected from environmental conditions?	Yes. The unit is operable in temperature ranges from -25°F to +150°F (-32°C to +66°C). Placement of the receiver is recommended to be in the cab or tool box. The printed circuit boards in both the receiver and transmitter are coated with conformal material for protection against high humidity and moisture. The transmitter may be used in rainy conditions, do not submerge the unit in water for any prolonged period of time. Should water get inside, remove top cover of transmitter and allow components to air dry. Replace battery, reassemble and continue use.
What type of battery is used?	A standard alkaline 9 volt battery is recommended. The Duracell Copper Top is a representative battery that fits the battery enclosure correctly and provides an acceptable service life.
How long will the battery last?	This will depend on the frequency and duration of use. Customers who use their wireless controller extensively have indicated a span of 4 to 10 weeks.
How many operations can be done simultaneously?	Two functions can be activated at the same time. However, a single flow control is used to supply both functions. The single flow control allows the function operating at the lower pressure to take priority. In some cases, the function demanding the higher pressure will remain stationary until the lower pressure function reaches the end of stroke or is deactivated.

SECTION 4

SET-UP

SECTION CONTENTS

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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.

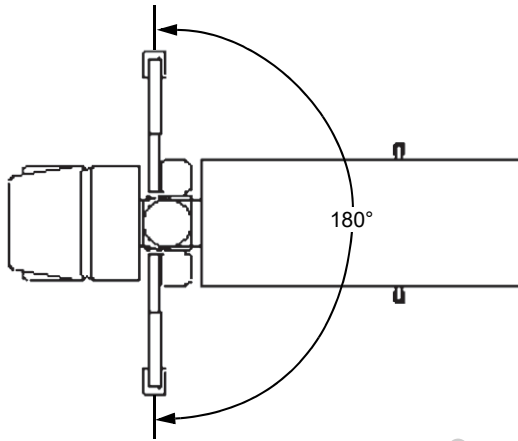
Variation in chassis, outrigger, and mounting configurations will cause outrigger foot loading to differ on each crane, however, outrigger foot loads can be as high as 40,000 lbs (18,145 kg) when outriggers are at full span (131 psi (0.9 MPa) on standard outrigger pads). Support surface bearing capacities 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.

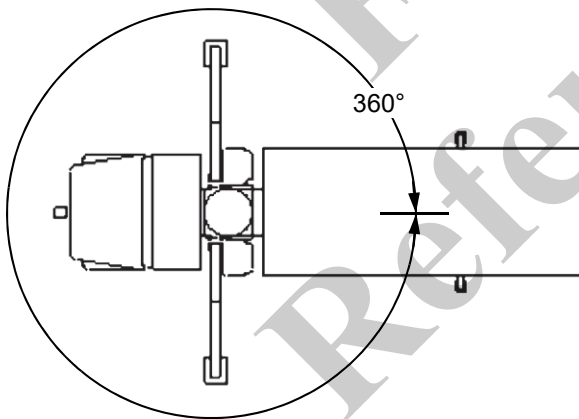
Lifting Over the Rear

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 Single Front Outrigger (SFO)



A single front outrigger (SFO) 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 SFO leg(s) until firm contact is made with the ground. Always keep the load as close to the ground as possible.

DANGER

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.

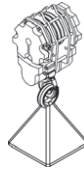
Before Making the Lift

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.



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

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

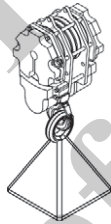
1. Operation of this equipment in excess of maximum load rating and disregard of instructions is hazardous. Always refer to the load chart for load and area limits before operating the crane. Rated loads at rated radius shall

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.



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

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

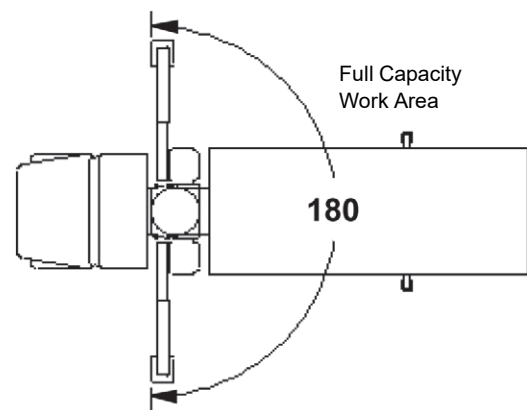
Horizontal distance from the centerline of rotation before loading to the center of the vertical load line or block with load applied.

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.

$$\begin{aligned} \text{Load} &= 2300 \text{ lb} \quad (1043 \text{ kg}) \\ 1 \text{ Part Load Block} &= 150 \text{ lb} \quad (68 \text{ kg}) \\ \text{Sling} &= 30 \text{ lb} \quad (14 \text{ kg}) \\ \text{Total Load} &= 2480 \text{ lb} \quad (1125 \text{ kg}) \end{aligned}$$

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 cannot be fully retracted if a boom tip attachment option is installed.

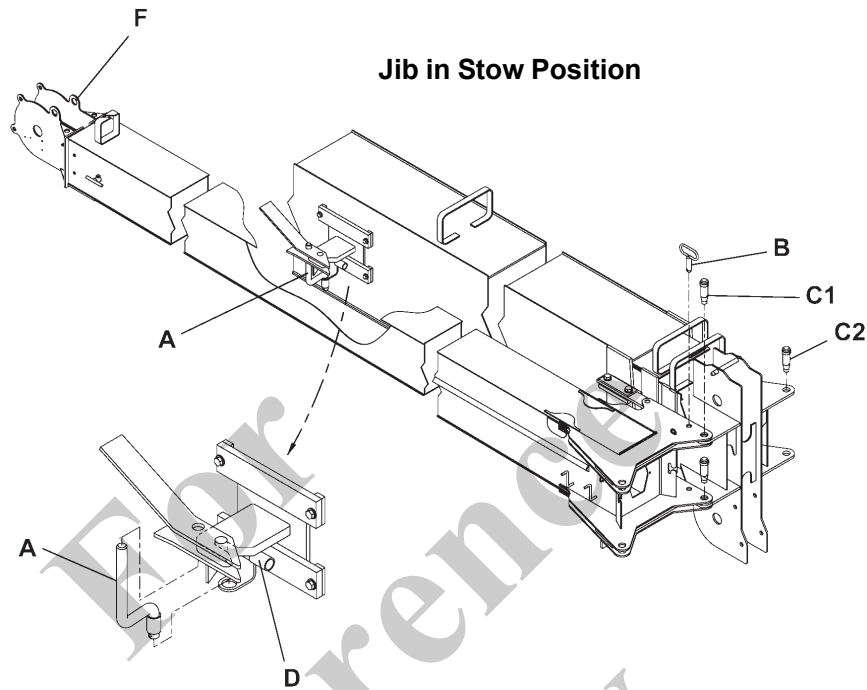
 **CAUTION**

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

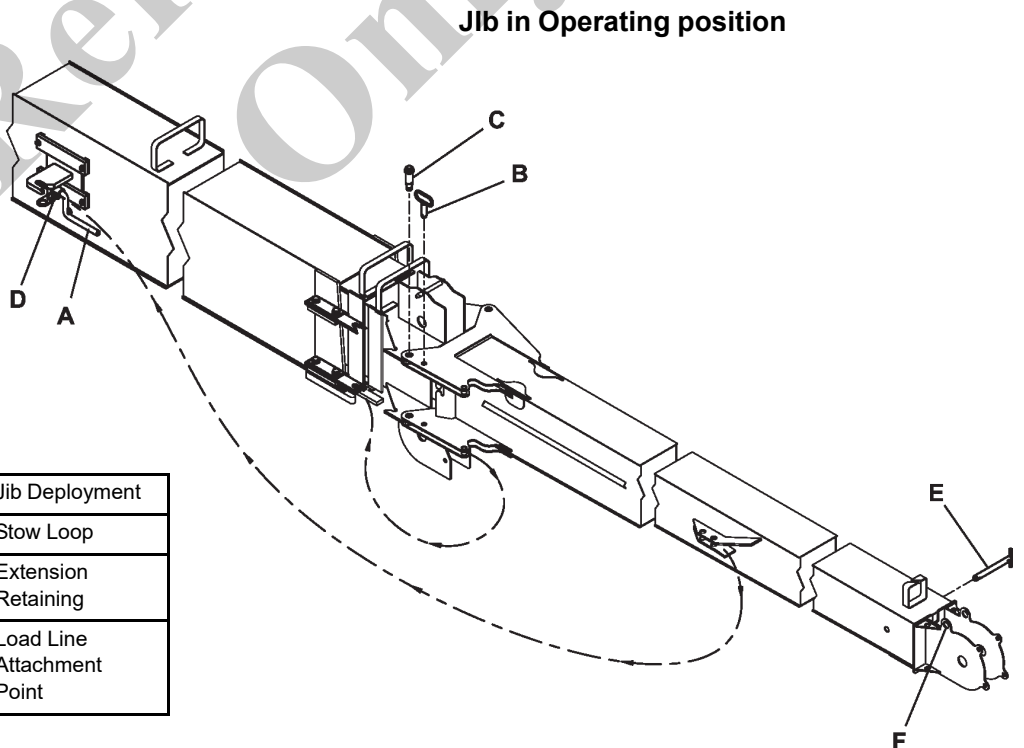
Manually Extendable Jib:

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

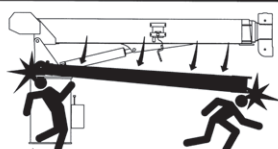
Use Caution during this step. The Jib is free to swing away from the boom upon boom extension.

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.

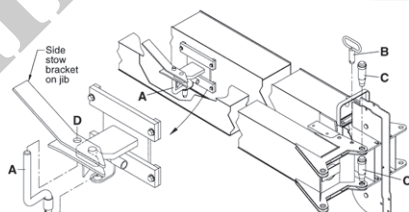
STOWING PROCEDURE

⚠ DANGER



A FREE FALLING JIB WILL RESULT IN DEATH OR SERIOUS INJURY

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



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

877994

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.

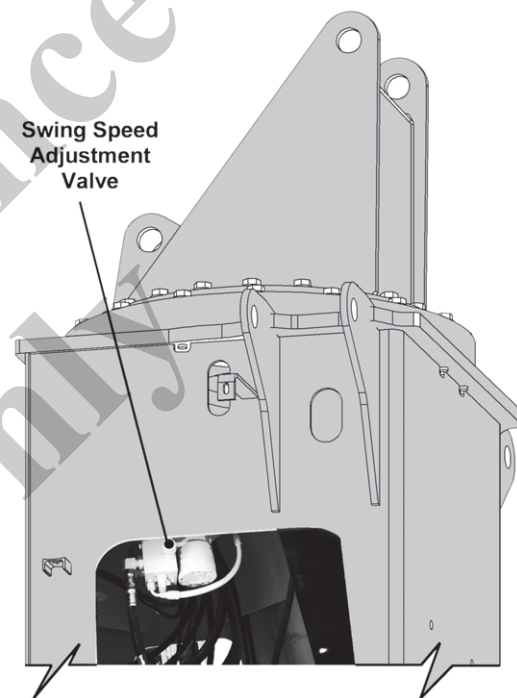
Once the jib has been erected or stowed, it is important that the jack handle be properly placed back on its stowage hooks and that the cotter key be properly placed in the stowage hook to retain the handle on the hook.

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.



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.

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.

ENVIRONMENTAL PROTECTION

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

Potentially harmful waste used in National Cranes includes — but is not limited to — oil, fuel, grease, coolant, air conditioning refrigerant, filters, batteries, and cloths which

have come into contact with these environmentally harmful substances.

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

When filling and draining crane components, observe the following:

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

Lubricants

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

Arctic Conditions Below -9°C (15°F)

In general, petroleum based fluids developed especially for low temperature service may be used with satisfactory

results. However, certain fluids, such as halogenated hydrocarbons, nitro hydrocarbons, and phosphate ester hydraulic fluids, might not be compatible with hydraulic system seals and wear bands. If you are in doubt about the suitability of a specific fluid, check with your authorized National Cranes distributor or Manitowoc Crane Care.

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

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

Chassis Grease

CAUTION

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

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

CAUTION

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

Low Temperature Grease

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

Extreme Pressure Multipurpose Gear Lubricant (EPGL)

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

SAE Viscosity Number	Minimum Ambient Temperature C (F)	
75W	-40°C	(-40°F)
80W	-26°C	(-15°F)
85	-12°C	(+10°F)
90	-7°C	(+20°F)

SAE Viscosity Number	Minimum Ambient Temperature C (F)	
140	+5°C	(+40°F)
250	+10°C	(+50°F)

Open Gear Lubricant

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

Antifreeze/Coolant (for Cab Heater)

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

Anti-wear Additives

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

Hydraulic Oil

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

CAUTION

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

NOTE: When operating the crane in temperatures -9°C (15°F) and below, follow the procedures in the section titled "Cold Weather Operation" on page 3-2.

Standard Hydraulic Oil

Temperature Above -9°C (15°F)

The factory fill standard hydraulic oil is ISO grade 46/68 Hydraulic Oil. This fluid is acceptable for operating temperatures above -9°C (15°F).

NOTE: On units equipped with self-leveling platforms, low temperature service oils are necessary to provide

proper boom functions at temperatures below -9°C (15°F).

CAUTION

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

Arctic Hydraulic Oil

Temperature Down to -9°C (15°F) to -29°C (-20°F)

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

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

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

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

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

Hydraulic Oil Inspection

Environmental and other conditions can dramatically affect the condition of hydraulic oil and filters. Therefore, specific intervals for servicing/changing hydraulic oil, filters and hydraulic tank breathers cannot be set. However, it is imperative for the continued satisfactory performance that inspections be performed on the basis of how and where each crane is used. Air borne and ingested contaminants can significantly reduce the life of oil and the condition of hydraulic oil filters and tank breathers.

Under normal operating conditions, it is recommended that hydraulic oil, filter and breathers be inspected at least every three to six months and more frequently for severe operating conditions. The inspections should be for air borne and/or ingested particles and water that deteriorate and contaminate the oil. For example, if oil appears "milky" or no longer has a transparent clear to amber color. The return filter by-pass indicator should be observed daily to determine if contaminant content is high. If the indicator reaches the red zone or indicates a by-pass condition, the hydraulic oil must be sampled. The hydraulic tank breather should also be

inspected to assure that it is not restricting air flow into and out of the reservoir.

To inspect the hydraulic oil, fill a small glass container with a sample of the reservoir oil and another glass container with fresh oil. Let the samples stand, undisturbed, for one or two hours. Then, compare the samples. If the reservoir oil is heavily contaminated with water, the sample will appear "milky" with only a small layer of transparent oil on top. If the "milky" appearance is due to air foaming, it will dissipate and the oil should closely match the fresh oil. Remember, replacement oil must meet ISO 17/14 or better cleanliness level and must meet John Deere Standard JDM J20C. Contact your National Crane distributor or Manitowoc Crane Care if you have any questions.

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.

LUBRICATION

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

⚠ DANGER

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

CAUTION

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

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

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

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

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

CAUTION

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

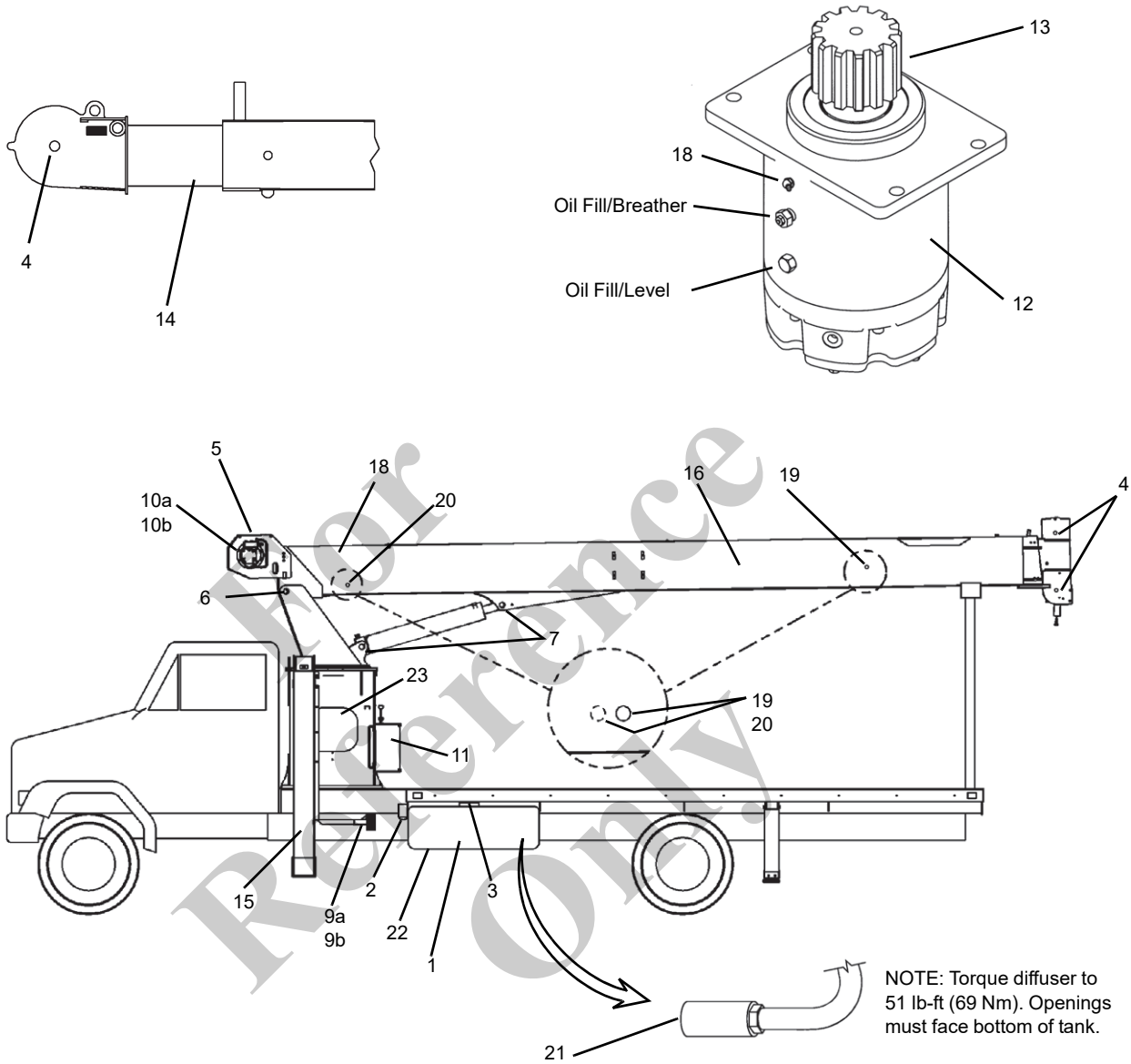
The following describe the lubrication points and gives the lube type, lube interval, lube amount, and application of each. Each lubrication point is numbered, and this number corresponds to the index number shown in "Lubrication Chart" on page 5-5. Lube description and symbols are found in table below.

Table 5-1

Symbol	Description	National Crane Lube Specification	
		Standard	Cold Weather - 40°C (-40°F)
AFC	Antifreeze/Coolant (for Cab Heater)	6829101130	6829104212
EP-MPG	Extreme Pressure Multipurpose Grease	6829003477	6829104275
GL-5	GL-5 Gear Lubricant	6829012964	6829014058
HYDO	Hydraulic Oil	6829006444	6829001559
EP-OGL	Open Gear Lubricant, CEPLATTYN 300 Spray, NLGI Grade 1-2	6829102971	6829102971
AGMA EP-4	Extreme Pressure Gear Lubricant.	6829100213	6829103636
WRL	Wire Rope Lubricant	6829015236	6829010993
EO-20W-20	Engine Oil (Light non-EP Oil), Mil-L-46152	6829005570	-
TES 295	TES295 Compliant Fluid	-	6829101690

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

LUBRICATION CHART



Item	Application	Recommended Lubricant	Procedure	Frequency
1	Hydraulic oil reservoir	HYDO	Check and Fill	Check and Fill: Weekly, Fill as required
			Change	Change: Semi-annually
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

Item	Application	Recommended Lubricant	Procedure	Frequency
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	Check and Fill Change	Check and Fill: As part of daily crane inspection, check the gearbox for visible leaks. Change: Every 1000 hours or 6 months.
10b	Hoist brake	HYDO	Check and Fill Change	Check and Fill: As part of daily crane inspection, check the gearbox for visible leaks. Change: Every 1000 hours or 6 months.
11	Control linkage	EO-15W/40	Oil Can	As Required
12	Swing drive gearbox	GL-5	Check and Fill Change	Check and Fill: As part of daily crane inspection, check the gearbox for visible leaks. Change: After first 50 operating hours, and every 500 operating hours thereafter
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: 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.



Hoist Gearbox Oil

Use the following procedures to change the hoist gearbox oil (Figure 5-1).

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.

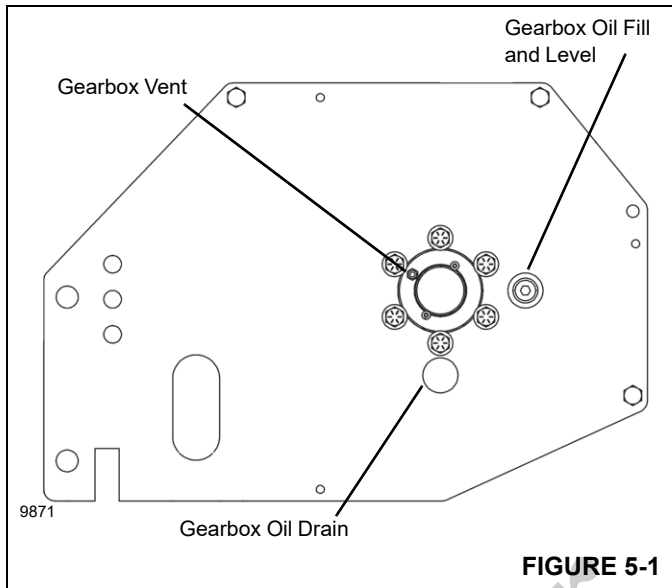


FIGURE 5-1

Hoist Gearbox Oil Change

To change the hoist gearbox oil, rotate the drum so that the plug is visible through the lower hole in the side plate (See 33, Figure 5-2, *view 1*). Screw in a piece of 1 inch pipe in the gearbox oil drain to allow the oil to drain. Remove the gearbox vent (30, Figure 5-2, *view 1*), then with a hex wrench remove the drain plug located inside of the 1 inch pipe (See Figure 5-2, *view 2*). Examine the used oil for signs of significant metal deposits and then dispose of it in a proper manner. Remove the 1 inch pipe.

Rotate the drum so that the port is visible through the gearbox oil fill and level hole in the side plate (Figure 5-1). Install a 1 inch pipe with elbow into the upper hole in the side plate (See Figure 5-2, *view 3*). Fill the gearbox with 1.42 liters (1.50 quarts) of oil. Remove the pipe and elbow, then replace the plug.

For information about changing hoist brake oil, see “*Drain / Add New Hoist Brake Oil*” on page 5-8. See “*Lubrication Chart*” on page 5-5 for recommended oil type and grade for your application.

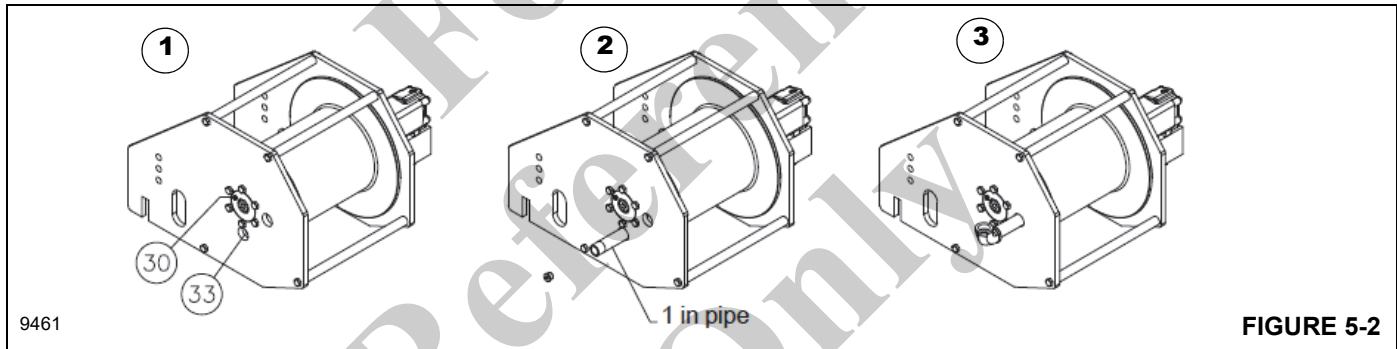


FIGURE 5-2

Hoist Brake Oil



DANGER

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

Check Hoist Brake Oil



CAUTION

The maximum fill capacity for the hoist brake is 0.23 liter (0.25 quart). Over-filling the hoist brake can cause damage to the hoist.

To check the hoist brake oil, remove the vent and fill plug (Figure 5-3) and visually inspect the oil level. The maximum fill capacity for the hoist brake is 0.23 liter (0.25 quart). See “*Lubrication Chart*” on page 5-5 for recommended oil type.

Drain /Add New Hoist Brake Oil

To drain and add new oil, remove the brake vent/fill plug and brake drain plug (Figure 5-3) and drain the brake oil. Examine the oil for metallic particles or burning. Reinstall drain plug and add fluid at the brake vent/fill hole. The hoist brake fill capacity is 0.23 liter (0.25 quart). Reinstall the brake vent/fill plug.

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



DANGER

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

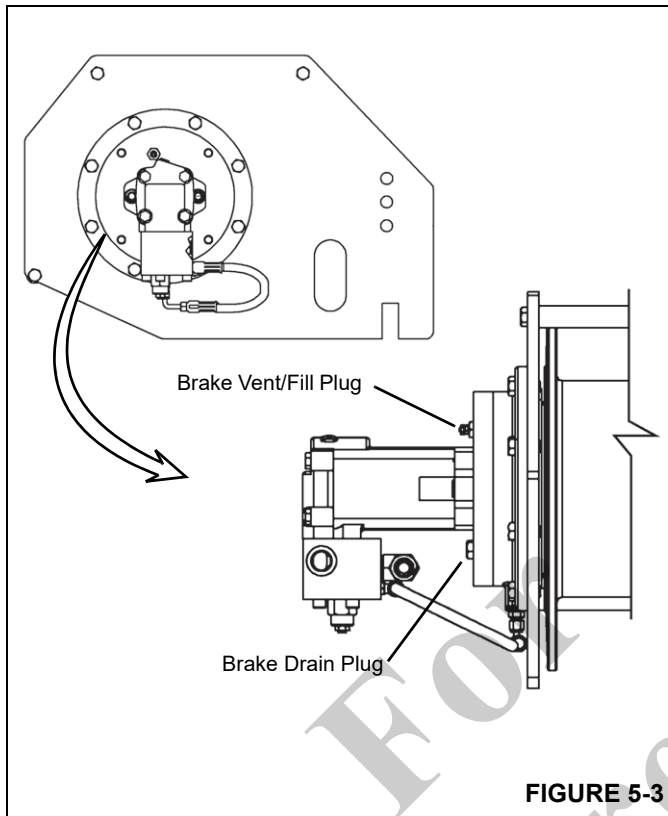
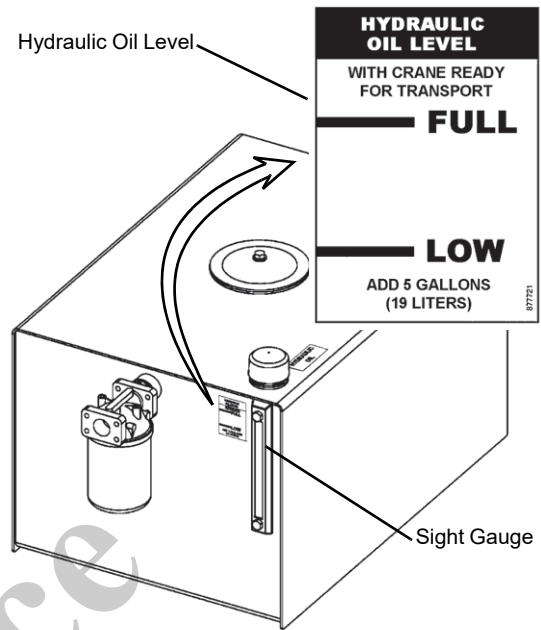


FIGURE 5-3

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.

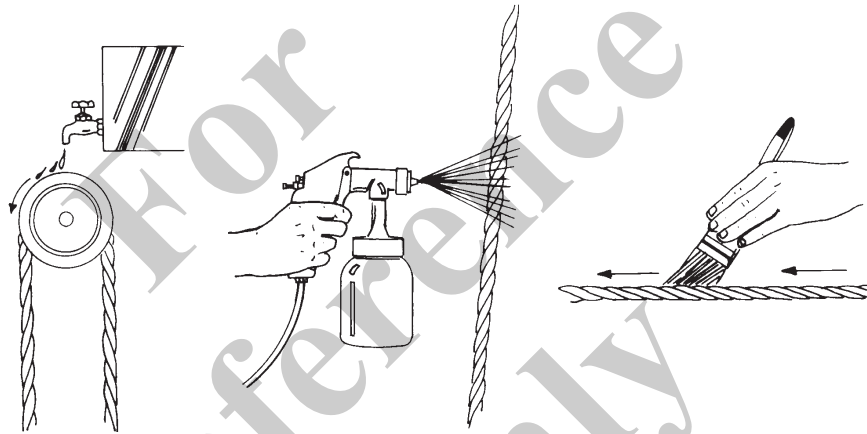
3. It should be of a viscosity capable of penetrating the interstices between wires and strands.
4. It should not be soluble in the medium surrounding it under the actual operating conditions (i.e. Water).
5. It should have a high film strength.
6. It should resist oxidation.

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.



CARWELL® RUST INHIBITOR

Protecting Cranes From Corrosion

National Cranes are manufactured to high quality standards, including the type of paint finish demanded by today's industry. In partnership with our paint supplier, we are also doing our part to help prevent premature corrosion of cranes.

National Cranes will be treated with a rust inhibitor called Carwell® T32-CP-90. While a rust inhibitor cannot guarantee that a machine will never rust, this product will help protect against corrosion on National Cranes that are treated with this product.

Carwell® is a treatment, not a coating. It contains no silicones, solvents, CFCs or anything that would be classified as hazardous under OSHA Regulation 29 CFR 19.10.1200. The product is a liquid blend of petroleum derivatives, rust inhibitors, water-repelling and water-displacing agents.

Special equipment is used to spray a light film onto the entire undercarriage and various other areas of each new crane

prior to shipment. When applied the product has a red tint to allow applicators to view coverage during application. This red tint will turn clear on its own within approximately 24 hours after application.

Once applied, Carwell T32-CP-90 can appear to leave a slightly "oily" residue on painted surfaces and until the red tinting fades could initially be mistaken for a hydraulic oil leak. While the product is not harmful to painted surfaces, glass, plastic or rubber, it must be removed using standard steam-cleaning techniques.

Carwell works in various ways: (1) it eliminates the moisture containing salt, dirt and other pollutants by lifting and removing them from the metal surface; (2) the film creates a barrier to repel further moisture from coming in contact with the metal; and (3) it penetrates crevices.

In addition to the factory-applied Carwell coating, National Crane owners must provide proper maintenance and care to help ensure long-term protection of their crane against corrosion. This procedure provides information and guidelines to help maintain the paint finish on National Cranes.

The most common causes of corrosion include the following:

- Road salts, chemicals, dirt, and moisture trapped in the hard-to-reach areas;
- Chipping or wear of paint, caused by minor incidents or moving components;
- Damage caused by personal abuse, such as using the decks to transport rigging gear, tools, or cribbing; and
- Exposure to harsh environmental hazards such as alkaline, acids, or other chemicals that can attack the crane's paint finish.

While the surfaces of the crane that are easily seen have the biggest impact on the appearance of the crane, particular attention should be given to the undercarriage of the crane to minimize the harmful effects of corrosion.


Exercise special care and increase the frequency of cleanings if the crane is operated:

- on roads where large quantities of salt or calcium are applied to treat icy and snowy road surfaces;
- in areas that use dust control chemicals;
- anywhere there are increased levels of wetness - especially near salt water;
- during prolonged periods of exposure to damp conditions (e.g., moisture held in mud), where certain crane parts may become corroded even though other parts remain dry; or
- in high humidity, or when temperatures are just above the freezing point.

Cleaning Procedures

To help protect against corrosion of National Cranes, Manitowoc Crane Care recommends washing the crane at least monthly to remove all foreign matter. More frequent cleanings may be needed when operating in harsh environmental conditions. To clean the crane, follow these guidelines:

- High pressure water or steam is effective for cleaning the crane's undercarriage and wheel housings. Keeping these areas clean will not only help retard the effects of corrosion, but will also improve the ability to identify potential issues before they grow into larger problems.



CAUTION

High pressure water can be forced into spaces and infiltrate beyond seals. Avoid pressure washing in the vicinity of electrical controls, panels, wiring, sensors, hydraulic hoses and fittings, or anything that can be damaged by high pressure cleaning/spraying.

- Rinse the dirt and dust off before washing the crane. Dirt can scratch the crane's finish during washing/cleaning.
- Hard to clean spots caused by road tar or bugs should be treated and cleaned after rinsing and prior to washing. Do not use solvents or gasoline.
- Wash using only soaps and detergents recommended for automotive paint finishes.
- Rinse all surfaces thoroughly to prevent streaking caused by soap residue.
- Allow the crane to dry thoroughly. You can accelerate drying by using compressed air to remove excess water.

NOTE: Polishing and waxing (using an automotive-type wax) is recommended to maintain the original paint finish.

Inspection and Repair

- Immediately following cleaning, Manitowoc Crane Care recommends an inspection to detect areas that may have become damaged by stone chips or minor mishaps. A minor scratch (one that has not penetrated to the substrate surface) can be buffed with an automotive-type scratch remover. It is recommended that a good coat of automotive wax be applied to this area afterwards.
- All identified spots and/or areas that have been scratched through to the metal should be touched up and repaired as soon as possible to prevent flash rusting. To repair a major scratch (down to bare metal) or minor damage, follow these procedures:

NOTE: Manitowoc Crane Care recommends that a qualified body repairman prepare, prime and paint any major scratch(es) or minor damage.



CAUTION

To the extent any damage is structural in nature, Manitowoc Crane Care must be contacted and consulted as to what repairs may be required.

- For scratches and marks in highly visible areas:
- Sand to remove the scratch and feather outward from the mark to blend the repair into the original surface. Body putty may be applied as necessary to hide the defect; then sand smooth.
- Cover all bare metal with a primer that is compatible with the original paint finish
- and allow to dry thoroughly.
- Prepare the surface prior to applying the finish coat of paint.

- Apply a finish coat paint using accepted blending techniques. Use of original paint colors is recommended to insure the best color match possible.

For scratches and marks in areas of low visibility:

- Consider touching up the spots with a brush technique to cover the bare metal. This will retard the effects of corrosion and enable you to do the repair at a later time during a normal maintenance interval.

Spots should be touched up with quality paint. Primers tend to be porous; using a single coat of primer only will allow air and water to penetrate the repair over time.

Application

Depending upon the environment in which a crane is used and/or stored, the initial factory application of Carwell T32-CP-90 should help inhibit corrosion for up to approximately 12 months.

It is recommended that Carwell T32-CP-90 be periodically reapplied by the crane owner after that time to help continue to protect against corrosion of the crane and its components.

However, if a crane is used and/or stored in harsh environments (such as islands, coastal regions, industrial areas, areas where winter road salt is regularly used, etc.), reapplication of Carwell T32-CP-90 is recommended sooner than 12 months, e.g., repeat treatment in 6-9 months.

- Do not apply to recently primed and painted areas for at least 48 hours after paint is properly dried and cured. For minor touch up areas a 24 hour period is needed for cure time before applying Carwell.

NOTE: Unit must be completely dry before applying Carwell.

- Do not allow product to puddle or build-up on weather stripping, rubber gaskets, etc. Unit should not have puddles or runs evident anywhere.

- To ensure proper coverage of Carwell, the product needs to be fogged on the unit.
- Use of pressure pots to apply the Carwell to the unit being processed is recommended.
- Carwell T32-CP-90 is available in 16 ounce spray bottles from Manitowoc Crane Care (order part number 8898904099).
- After application of the Carwell is complete, wash or clean film residue from lights, windshield, grab handles, ladders/steps and all access areas to crane, as necessary.

Please contact Manitowoc Crane Care should you have any questions.

Areas of Application

- The underside of the unit will have full coverage of the rust inhibitor. These are the only areas that a full coat of the rust inhibitor is acceptable on the painted surfaces. Areas include; Valves, hose end and fittings, Swivel, pumps, axles, drivelines, transmission, all interior surfaces of the frame
- Frame application areas are; hose ends and fittings, all unpainted fasteners and hardware, all bare metal surfaces, outrigger pads, and back up alarms.
- Superstructure applications are; hose end and fittings, wire rope on hoist roller tensioning springs on hoists, all unpainted fasteners and hardware, valves, slew ring, all bare metal surfaces.
- Boom applications areas are; pivot pins, hose end and fittings, jib pins and shafts, all bare metal surfaces, downhaul weight / hook block pins and fasteners.
- All hardware, clips, pins, hose connections not painted will have Carwell applied.



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Item	Description
1	Boom Nose Pins, Clips
2	Wire Rope
3	All Hardware, Clips, Pins, Hose Connections not painted O/R Pins, Clips
4	Pivot Shaft
5	Hoist Plumbing Connections
6	Mirror Mounting Hardware
7	O/R Hose Connections
8	O/R Pins, Clips

Item	Description
9	Power Train Hardware
10	Valve Bank, Hose Connections Inside Turntable
11	Entire underside of unit
12	Hook Block/Downhaul Weight
13	Turntable Bearing Fasteners
14	Pins, Clips for Jib (Not Shown)
15	Hanger Hardware for Jib (Not Shown)

For
Reference
Only

SECTION 6 MAINTENANCE CHECKLIST

SECTION CONTENTS

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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 5-9 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.

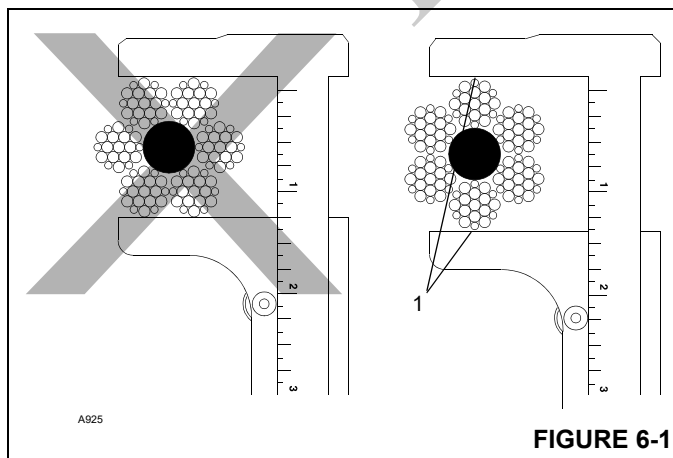


FIGURE 6-1

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.
- Reductions from nominal diameter of more than 5%.
- Severe corrosion as evidenced by pitting.
- Core failure in rotation resistant ropes.
- Prior electrical contact with a power line or other electric arc damage.
- Significantly cracked, bent, or worn end connections.
- In running ropes, six randomly distributed broken wires in one lay or three broken wires in one strand in one lay.
- In standing ropes, more than two broken wires in one lay in sections beyond end connections or more than one broken wire at an end connection.
- In rotation resistant rope, two randomly distributed broken wires in six rope diameters or four randomly distributed broken wires in 30 rope diameters.
- National Crane recommends that for cable extended booms, a single damaged wire rope assembly shall require replacement of the entire set of extension cables.
- National Crane recommends for cable extended booms, that boom extension cables be replaced every seven (7) years.

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:

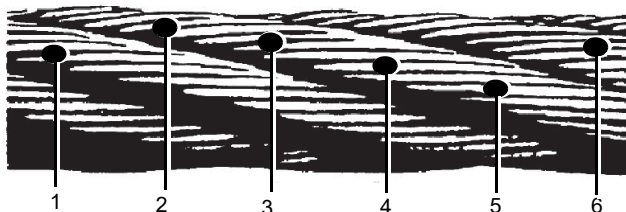
- Inspect for severely corroded or broken wires at end connections.
- Inspect wire rope in areas subjected to rapid deterioration such as:
 - Sections in contact with saddles, equalizer sheaves, or other sheaves where wire rope travel is limited.
 - Sections of wire rope at or near terminal ends where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

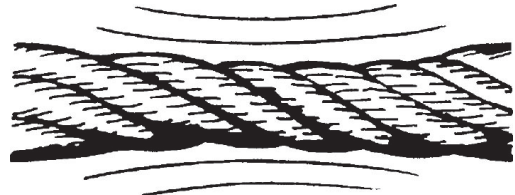
Wire Rope Replacement

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 speed.	Adjust foot throttle or check for too high PTO ratio.
Excessive pump noise during operation	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.
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) ¹³⁴	2230 4915	2300(H) ¹³⁷ 5070(H) ¹³⁷
	SINGLE				1900 4190	1980 4370	2060 4550	2120 4675	2220 4895	2300 5065	2360(G) ¹³⁸ 5205(G) ¹³⁸	2450 5400	2500(H) ¹⁴⁰ 5510(H) ¹⁴⁰
305/75R22.5	DUAL				2360 5205	2440 5375	2540 5595	2560 5840	2730 6025	2830 6235	3000(H) ¹⁴⁶ 6610(H) ¹⁴⁶	3010 6640	3150(J) ¹⁴⁸ 6940(J) ¹⁴⁸
	SINGLE				2575 5675	2680 5905	2790 6150	2900 6395	3000 6620	3110 6850	3250(H) ¹⁴⁹ 7160(H) ¹⁴⁹	3310 7300	3450(J) ¹⁵¹ 7610(J) ¹⁵¹
315/80R22.5	DUAL				2575 5675	2650 5840	2750 6070	2900(G) ¹⁴⁵ 6395(G) ¹⁴⁵	2970 6545	3070 6770	3150(H) ¹⁴⁸ 6940(H) ¹⁴⁸	3270 7210	3450(J) ¹⁵¹ 7610(J) ¹⁵¹
	SINGLE				2800 6175	2910 6415	3030 6670	3150(G) ¹⁴⁸ 6940(G) ¹⁴⁸	3260 7190	3370 7440	3450(H) ¹⁵¹ 7610(H) ¹⁵¹	3590 7920	3750(J) ¹⁵⁴ 8270(J) ¹⁵⁴
305/85R22.5	DUAL				2430 5355	2520 5550	2620 5780	2725 6005	2820 6215	2920 6435	3075(H) ¹⁴⁷ 6780(H) ¹⁴⁷	3110 6860	3250(J) ¹⁴⁹ 7160(J) ¹⁴⁹
	SINGLE				2650 5840	2770 6100	2880 6350	3000 6610	3100 6830	3210 7070	3350(H) ¹⁵⁰ 7390(H) ¹⁵⁰	3420 7540	3550(J) ¹⁵² 7830(J) ¹⁵²

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
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 <i>psi</i>	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 <i>lbs.</i>	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 <i>lbs.</i>	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 <i>lbs.</i>	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 <i>lbs.</i>	3720 8230	3950 8660	4125 9090	4320 9480	4470 9870	4625(H) 10200(H) ¹⁶¹	4820 10600	4960 11000	5150 11400	5290 11700	5600(L) 12300(L) ¹⁶⁸

Radial Ply Tires for Trucks, Busses, and Trailers Used in Normal Highway Service

Radial Ply Tires Mounted on 15° Drop Center Rims

Tire and Rim Association Standard

TABLE TTB-3R

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

SPECIFICATIONS

Hydraulic Pump

- Pump Speed 2500 RPM
- Displacements:
 - Section P1 18 GPM (68.1 LPM) at 3900 psi +100/-000 (26.89 MPa)
 - Section P2 34 GPM (128.7 LPM) at 3300 psi +100/-000 (22.75 MPa)
 - Section P3 10 GPM (37.8 LPM) at 2350 psi +100/-000 (16.20 MPa)

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	10,200	(4627)	111	(34)	157	(48)	64	19
2	9,200	(4173)	123	(38)	173	(53)	136	41
3	8,400	(3810)	135	(42)	191	(59)	215	65
4	7,700	(3493)	147	(45)	207	(64)	301	91
5	7,100	(3221)	159	(49)	220	(68)	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°	35 sec ± 5 sec
Boom up -10° to 80°	25 sec ± 5 sec
Boom Down 80° to -10°	20 sec ± 5 sec
Boom Extend/Retract Three Section 27 - 71 ft	
Extend	55 sec ± 5 sec
Retract	50 sec ± 5 sec
Boom Extend/Retract Three Section 24 - 60 ft	
Extend	45 sec ± 5 sec
Retract	40 sec ± 5 sec

For
Reference
Only

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