National Crane NBT40 Series

Operator Manual

Grove Manitowoc National Crane Potain

Manitowoc

NATIONAL CRANE
by Manitowoc

OPERATOR MANUAL

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

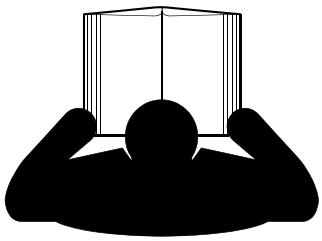
NBT40 Series Cranes

This Manual is divided into the following sections:

NOTICE

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

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



⚠DANGER

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

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

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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.

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

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.

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SECTION 1
INTRODUCTION

SECTION CONTENTS

GENERAL

This manual has been compiled to assist you in properly operating and maintaining your Model NBT40 SERIES National Crane (Figure 1-1). The NBT40 series includes crane models NBT36, NBT40, and NBT45.

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

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

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

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

The NBT40 SERIES 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 National Crane 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 National Crane distributor's service management to coordinate the contact on your behalf.

Supplemental Information

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

Whenever a question arises regarding your National 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 crane.

A Safety Compact Disc or a USB flash drive 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 National Crane 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 1-2. This nomenclature is used throughout this manual.

FIGURE 1-1

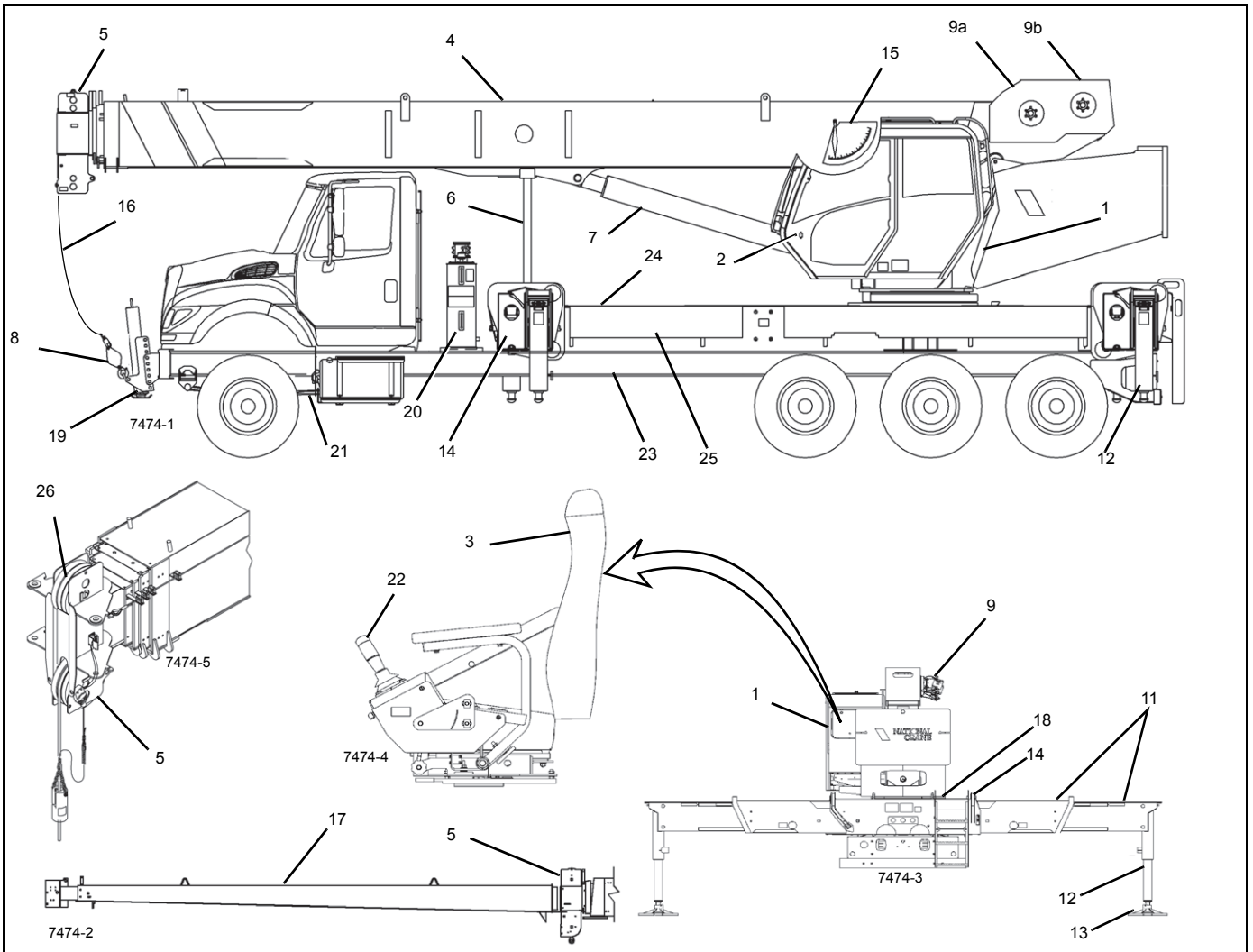


FIGURE 1-2

Item	Component
1	Crane Cab
2	Crane Cab console
3	Operator's Seat
4	Boom
5	Boom Nose
6	Boom Rest
7	Lift Cylinder
8	Downhaul Weight, Hook Block
9	Hoist, Hoist (9a Auxiliary, 9b Main)
11	Outrigger Beam
12	Outrigger Jack
13	Out Rigger Float
14	Outrigger Box

Item	Component
15	Boom Angle Indicator
16	Hoist Cable, Wire Rope
17	Jib
18	Turret
19	Stabilizer Front Outrigger (SFO), Front Outrigger Jack
20	Hydraulic Tank
21	Hydraulic Pump (not shown)
22	Hydraulic Remote Controller (HRC)
23	Truck Frame
24	Truck Bed
25	Torsion Box Frame, T-Box Frame
26	Sheave

NOTICE TO OWNER/USER

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

SECTION 2
SAFETY PRECAUTIONS

SECTION CONTENTS

SAFETY MESSAGES

General

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

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

Safety Alert Symbol

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

Signal Words

DANGER

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

WARNING

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

CAUTION

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

CAUTION

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

NOTE: Emphasizes operation or maintenance procedures.

GENERAL

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

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

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

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

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

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

ACCIDENTS

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

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

The Manitowoc Company, Inc.
1565 East Buchanan Trail
Shady Grove, PA 17256-0021

Phone: 888-777-3378 (888-PSR.DEPT)
Fax: 717-593-5152
E-mail: product.safety@manitowoc.com

OPERATOR INFORMATION

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

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

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

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

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

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

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

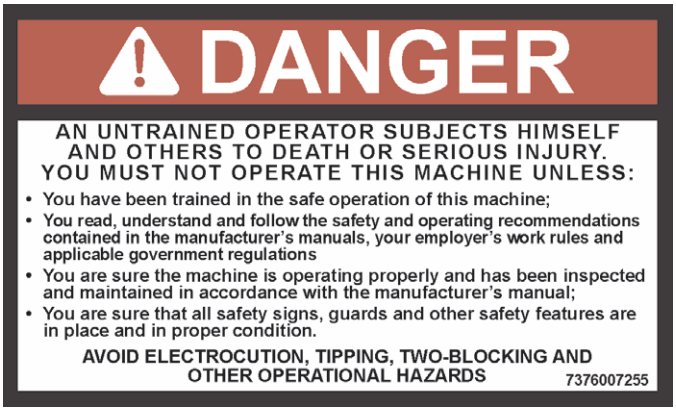
OPERATOR QUALIFICATIONS

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

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

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

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



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

You must not operate this machine unless:

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

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

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

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

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

OPERATIONAL AIDS

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

National Crane remains committed to providing reliable products that enable users and operators to safely lift and position loads. National Crane has been an industry leader in the incorporation of operational aids into the design of its cranes. Federal law requires that cranes be properly maintained and kept in good working condition. The manuals that National Crane provides that are specific for each crane and the manufacturer's manuals for the operational aids shall be followed. If an operational aid should fail to work properly, the crane user or owner must assure that repair or recalibration is accomplished as soon as is reasonably possible. If immediate repair or recalibration of an operational aid is not possible and there are exceptional circumstances which justify continued short-term use of the crane when operational aids are inoperative or malfunctioning, the following requirements shall apply for continued use or shutdown of the crane:

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

Rated Capacity Limiter (RCL) Systems (If Equipped)

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

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

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

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

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

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

Anti-Two-Blocking Device

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

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

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

boom extension nose respectively. An operator, concentrating on the specific line being used, may telescope or lower the boom allowing the other hoist line attachment to contact the boom or boom extension nose, thus causing damage to the sheaves, or causing the rope to fail, dropping the lifting device to the ground and possibly injuring personnel working below.

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

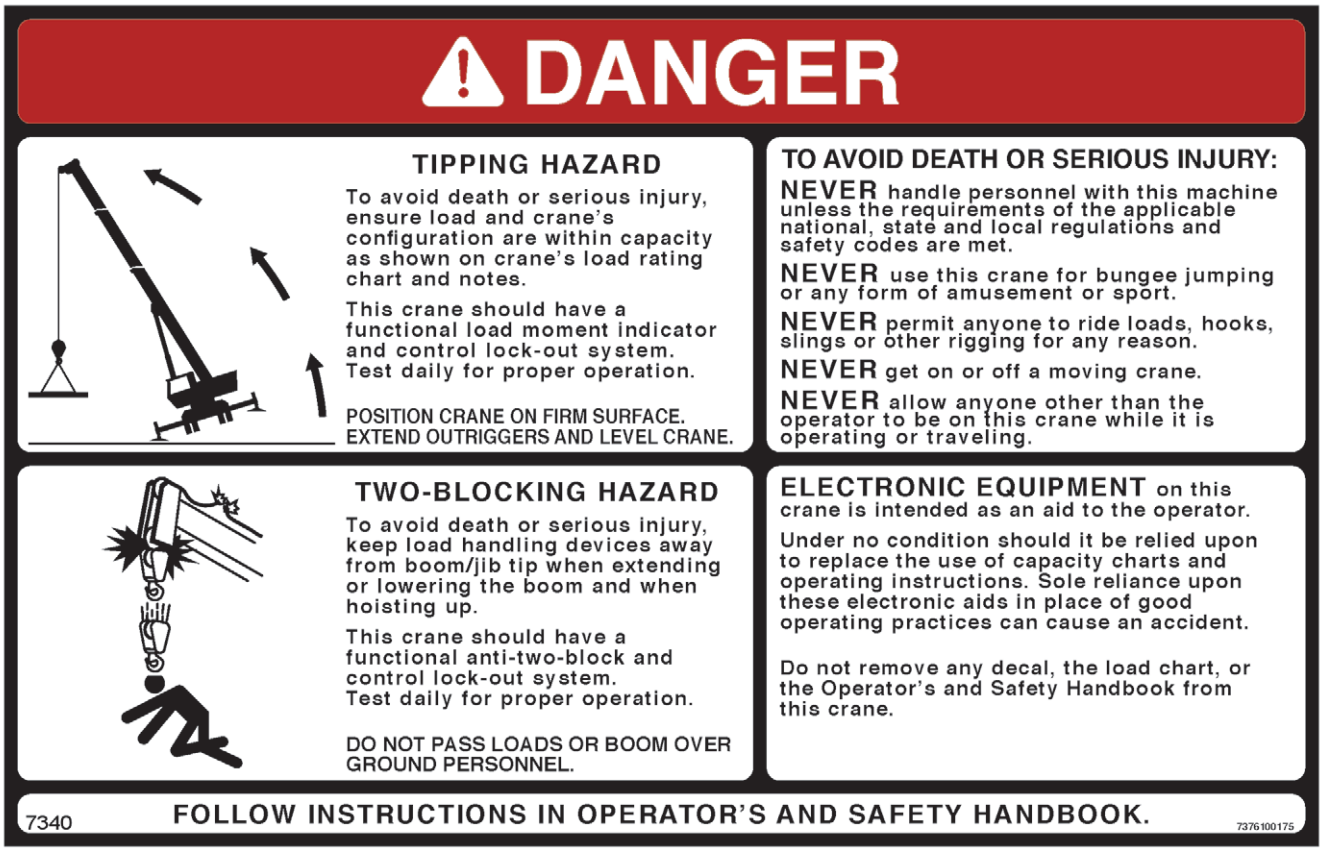
Two-blocking can be prevented. Operator awareness of the hazards of two-blocking is the most important factor in preventing this condition. An Anti-Two-Block System is intended to assist the operator in preventing dangerous two-block conditions. It is not a replacement for operator awareness and competence.

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

Working Area Limiter (If Equipped)

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

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



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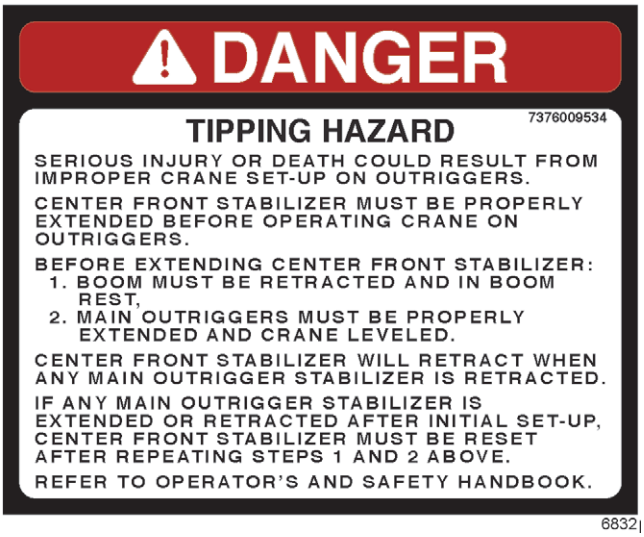
CRANE STABILITY/STRUCTURAL STRENGTH

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

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

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

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



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

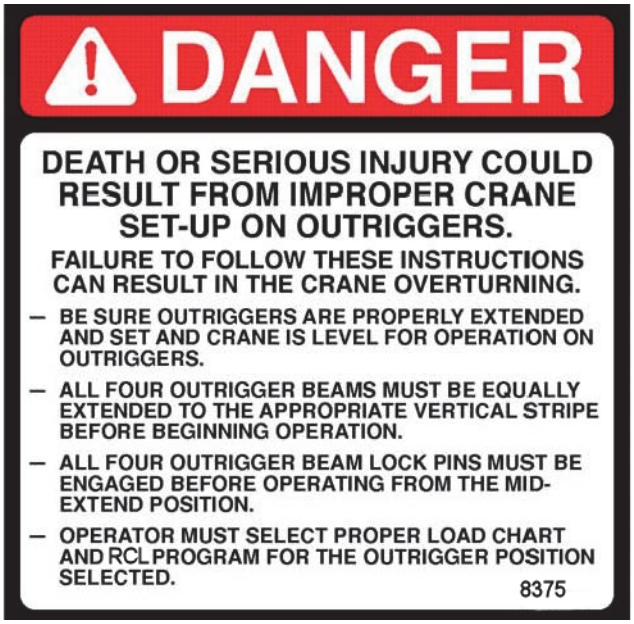
The operator must select the proper *Load Chart* and Rated Capacity Limiter (RCL) System program for the outrigger position selected.

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

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

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

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



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

Load Charts

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

Load Chart capacities are based on freely suspended loads.

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

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

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

Work Site

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

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

WIND FORCES

There are basic principles that must be followed while operating in windy conditions. This information has been

provided to assist in determining safe operation in windy conditions.

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

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

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

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

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

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

Table 2-1 Beaufort Wind Scale

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

Wind Speeds

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

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

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

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

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

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

In both cases **a**) and **b**) above, the lift may also be limited by the projected wind area of the load ***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.

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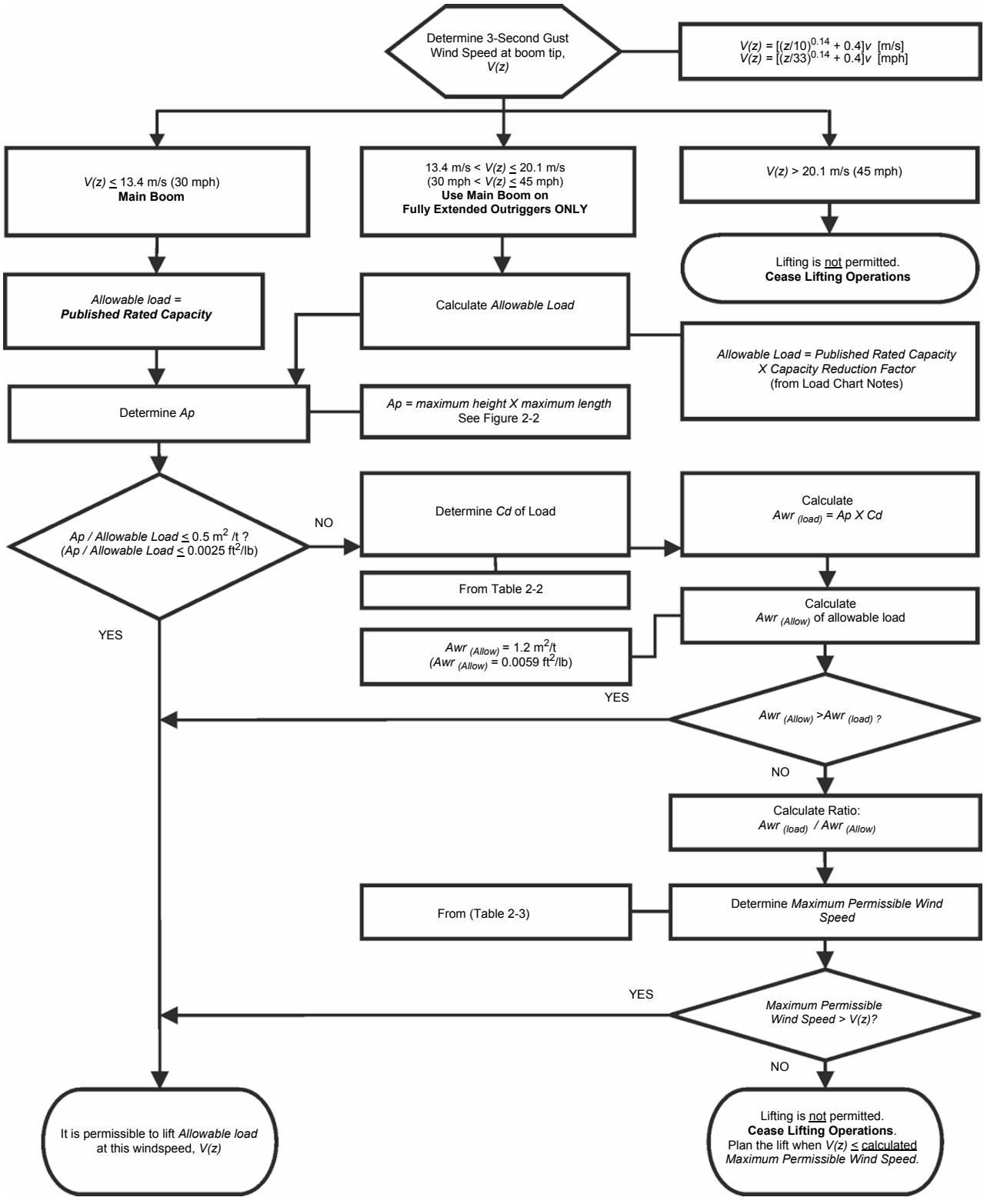
Simplified Method to Determine Maximum Permissible Wind Speed



V(z) = 3 second gust wind speed at boom tip, m/s (mph)
Ap = Projected Wind Area of Load, m^2 (ft^2)

Awr (load) = Actual Wind Resistance Area for the Load, m^2(ft)
Awr (Allow) = Allowable Wind Resistance Area of the Load, m^2 (ft2
Cd = air drag coefficient of load

FIGURE 2-1

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

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

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

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

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

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

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

where:

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

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

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

V = 7.9 m/s (17.7 mph)

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

then:

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

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

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

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

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

Size and Shape of the load:

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

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

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

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

where:

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

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

Cd - wind drag coefficient.

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

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

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

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

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

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

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

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

Calculation of Projected Wind Area (Ap):

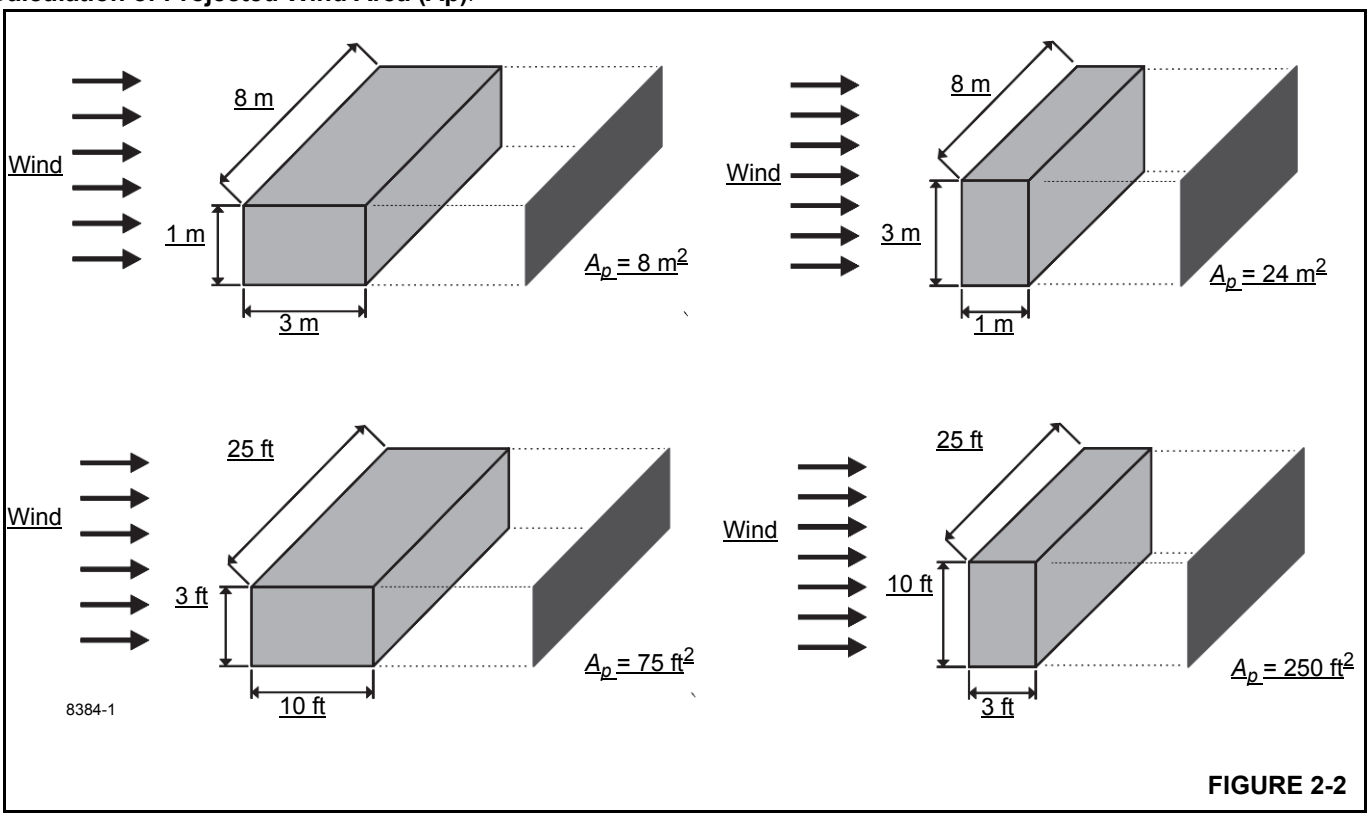


FIGURE 2-2

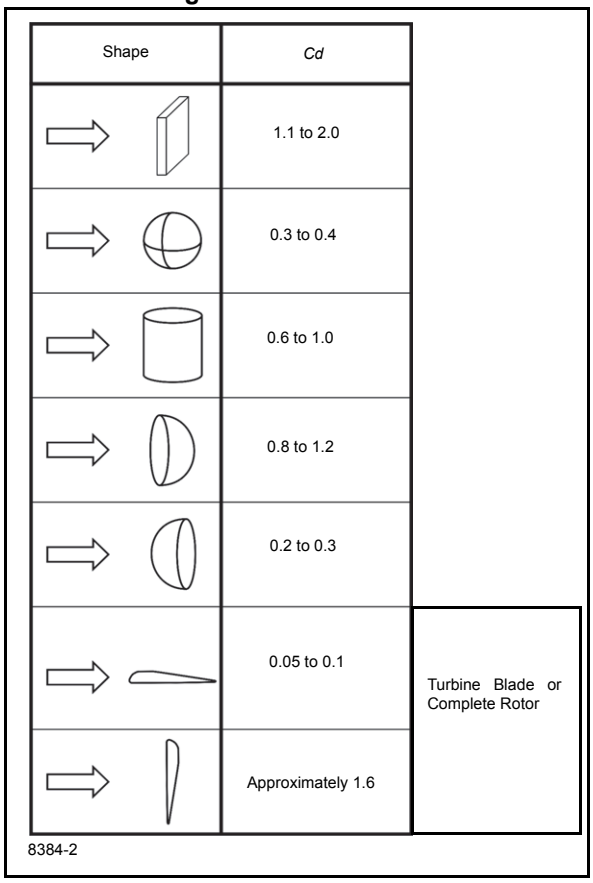
Determining Wind Drag Coefficient (Cd)

Table 2-2 shows the typical Shapes and corresponding Wind Drag Coefficient ***(Cd)*** 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 ***(Cd)*** = 2.4.

Table 2-2 Wind Drag Coefficient



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 (60)	18,225 (69.5)	16,575 (72)	16,575 (72)	15,250 (74.5)	11,400 (76)
9	20,600 (16.5)	20,550 (33.5)	20,375 (49.5)	20,225 (58)	18,225 (63)	16,575 (67)	15,050 (70)	13,875 (72.5)	11,400 (74.5)
10		17,200 (20.5)	17,200 (43)	17,175 (54)	17,325 (60)	15,175 (64.5)	13,725 (67.5)	12,700 (70.5)	11,400 (72.5)
12			13,025 (30.5)	13,025 (45.5)	12,575 (53.5)	12,575 (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)	7,175 (37.5)	7,575 (47)	7,920 (53)	7,980 (57.5)	7,470 (61.5)
18					5,525 (29)	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)	4,545 (48.5)
24							3,435 (23.5)	3,620 (36)	3,780 (43.5)
26								2,975 (28)	3,150 (37.5)
28								2,400 (16)	2,620 (31)
30									2,135 (22)
Minimum boom angle (°) for indicated length (no load)									0
Maximum boom length (m) at 0° boom angle (no load)									33.5

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

Lifting Capacities at Zero Degree Boom Angle									
Boom Angle	Main Boom Length in Meters								
	10.9	12.2	15.2	**18.4	21.3	24.4	27.4	30.5	33.5
0°	13,775 (9.2)	11,675 (10.4)	8,145 (13.5)	5,930 (16.6)	4,565 (19.6)	3,535 (22.6)	2,860 (25.7)	2,220 (28.7)	1,770 (31.8)

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

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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 m/s ≤ 20.1 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 m/s ≤ 20.1 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, $Awr_{(allow)}$ = 0.0012 x calculated reduced capacity in kg.
Wind resistance area of load, $Awr_{(load)}$ = projected wind area ***Ap*** x wind drag coefficient ***Cd*** for the load.

For wind resistance Area of load, $Awr_{(load)}$ > maximum allowable wind resistance area, $Awr_{(allow)}$ refer to crane Operator Manual.

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

Note: Permissible and rated wind speeds in this table are the 3-second gust wind speeds at boom tip height.					
Ratio:	1.2	1.4	1.6	1.8	2
	Maximum Permissible Wind Speed (m/s)				
For Rated Capacity at 13.4 m/s	12.2	11.4	10.6	10.0	9.5
For Allowable Capacity at 20.1 m/s	18.3	17.0	15.9	15.0	14.2

Example and Sample Calculations (metric)

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

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

Example 1: Crane Configuration:

- boom length = 27.4 m,
- load radius = 9 m,
- wind speed is measured at ***V(z)*** ≤ 20.1 m/s.

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

The maximum allowable wind resistance area of load is

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

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

Lifting Limits at wind speed V(z) ≤ 13.4 m/s at this configuration:

- Maximum load 15,050 kg
- Maximum wind resistance area of load 18.06 m^2

For the allowable wind speed > 13.4 m/s and ≤ 20.1 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 m/s **and ≤ 20.1 m/s,** at this configuration:

- Maximum load 12,040 kg
- Maximum wind resistance area of load 14.45 m^2

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

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

Load example 1.1:

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

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

wind resistance area of load can be estimated as

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

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 m^2 ≤ 14.45 m^2 YES

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

Load example 1.2:

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

- Load to be lifted of 10,000 kg,
- Projected Wind Area ***Ap*** = 5.45 m^2,
- 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 $Awr_{(load)} = Ap \times Cd = 5.45 \times 2.4 = 13.08\ m^2$

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 m^2 ≤ 14.45 m^2 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 m^2,
- Wind Drag Coefficient ***Cd*** = 1.2

the wind resistance area of load can be estimated as:

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

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 m^2 ≤ 18.06 m^2 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 m^2,
- Wind Drag Coefficient ***Cd*** = 1.3

the wind resistance area of load can be estimated as

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

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

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

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

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

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

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

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)	[illegible]	32,750 (69.5)	30,200 (72)	25,150 (74)
35			33,550 (40)	33,700 (51.5)	34,700 (58)	[illegible]	[illegible]	26,400 (69)	24,700 (71.5)
40			25,800 (28)	26,150 (44.5)	[illegible]	[illegible]	25,200 (62.5)	23,300 (66)	21,800 (68.5)
45				[illegible]	[illegible]	22,300 (54)	22,400 (59)	20,700 (62.5)	19,400 (65.5)
50				[illegible]	17,400 (41)	18,25[illegible] (49.5)	19,100 (55)	18,550 (59.5)	17,350 (62.5)
55					14,300 (33.5)	[illegible] (44)	16,000 [illegible]51)	16,400 (56)	15,600 (60)
60					[illegible]	12,700 (38.[illegible]	13,550 (46.5)	13,950 (52.5)	14,100 (56.5)
65						[illegible]00 (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.

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FIGURE 2-4

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

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

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

	Main Boom Length in Feet								
Wind Speed *Vz*> 30 mph ≤ 45 mph	36	40	50	[illegible]	70	80	90	100	110
Factor	0.9	0.9	0.8	[illegible]	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 ft^2, ***Awr*** $_{(allow)}$ = 0.0059 x calculated reduced capacity in lb.

Wind resistance area of load, ***Awr*** $_{(load)}$ = projected wind area ***Ap*** x wind drag coefficient ***Cd*** for the load.

For wind resistance area of load, ***Awr*** $_{(load)}$ > maximum allowable wind resistance, **Awr** $_{(allow)}$, refer to crane Operator Manual.

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

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

Example and Sample Calculations (Non-metric)

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

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

Example 2:

A crane is configured with:

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

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

The maximum allowable wind resistance area of load is:

$$\mathbf{Awr}_{(allow)} = 0.0059 \times \mathbf{m}_{(load)} \quad (2.5)$$

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

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

- Maximum load 25,200 lb
- Maximum wind resistance area of load 149 ft^2

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:

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

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

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

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 ft^2

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

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

Load example 2.1:

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

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

then the wind resistance area of load can be estimated as

$Awr_{(load)}$ = ***Ap*** x ***Cd*** = 70 x 1.5 = 105 ft^2

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

- Is the load to be lifted less than allowable load?
  19,500 lb ≤ 20,160 lb YES
- Is $Awr_{(load)}$ less than $Awr_{(allow)}$?
  105 ft^2 ≤ 119 ft^2 YES

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

Load example 2.2:

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

- Load to be lifted of 18,000 lb,
- Projected Wind Area ***Ap*** = 45 ft^2,
- 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*** x ***Cd*** = 45 x 2.4 = 108 ft^2

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

- Is the load to be lifted less than allowable load?
  18,000 lb ≤ 20,160 lb YES
- Is $Awr_{(load)}$ less than $Awr_{(allow)}$?
  108 ft^2 ≤ 119 ft^2 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 ft^2,
- Wind Drag Coefficient ***Cd*** = 1.2

the wind resistance area of load can be estimated as:

$Awr_{(load)}$ = ***Ap*** x ***Cd*** = 180 x 1.2 = 216 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 ft^2 ≤ 149 ft^2 . . . . . NO

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

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

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

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

Load example 2.3b:

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

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

the wind resistance area of load can be estimated as:

$Awr_{(load)}$ = ***Ap*** x ***Cd*** = 125 x 1.3 = 162 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 ft^2 ≤ 119 ft^2 NO

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

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

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

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

Lifting Operations

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

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

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

Verify the crane's capacity by checking the *Load Chart* against the weight of the load. Then, lift the load slightly at first to ensure stability before proceeding with the lift.

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

Measure the load radius before making a lift and stay within approved lifting areas based on the range diagrams and working area diagrams on the crane's *Load Chart*.

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

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

The crane can tip over or fail structurally if:

- The load and crane's configuration is not within the capacity as shown on the applicable *Load Chart* and notes.
- The ground is soft and/or the surface conditions are poor.
- Outriggers are not properly extended and set. On models equipped with outriggers that can be pinned at the mid-extend position, the outriggers must also be pinned when operating from the mid-extend position.
- Cribbing under the outrigger pads is inadequate.
- The crane is improperly operated.

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

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

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

If you should encounter a tipping condition, immediately lower the load with the hoist line and retract or elevate the boom to decrease the load radius. Never lower or extend the boom; this will aggravate the condition.

Use tag lines whenever possible to help control the movement of the load.

When lifting loads, the crane will lean toward the boom and the load will swing out, increasing the load radius. Ensure the crane's capacity is not exceeded when this occurs.

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

Never push or pull with the crane boom.

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

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

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

Counterweight

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

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

Outrigger Lift Off

Regarding "lifting" of an outrigger pad during craning activities, be advised that the rated loads for these cranes, as indicated on the crane's *Load Chart*, do not exceed 85% of the tipping load on outriggers as determined by SAE J765 JUNE2017 "Cranes Stability Test Code." An outrigger pad may lift off the ground during operation of the crane within the capacity limits of the *Load Chart*, yet the crane will not have reached instability. The "balance point" for stability testing according to SAE and National Crane criteria is a condition of loading wherein the load moment acting to overturn the crane is equal to the maximum moment of the crane available to resist overturning. This balance point or point of instability for a crane does not depend on "lifting" of an outrigger but rather on comparison of the "opposing" load moments.

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

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

Multiple Crane Lifts

Multiple crane lifts are not recommended.

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

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

Tilt-Up Panel Lifting

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

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

- The crane must be set up and operated in accordance with Grove's instructions in the Operator and Safety Handbook, Load Capacity Chart, and decals affixed to the crane.
- The hoist rope from the main hoist shall be reeved over the main boom nose reeved for two parts of line.
- The hoist rope from the auxiliary hoist shall be reeved over the auxiliary boom nose reeved for one part of line.
- The load shall be connected with the main hoist line connected to the end closest to crane and the auxiliary hoist line connected to the end farthest from the crane.
- The anti-two block system shall be installed and inspected to confirm that it is active to monitor both hoist lines.
- The RCL hoist selection shall be set to main hoist and two parts of line.
- The wire rope and sheaves shall be inspected prior to and following the lifting operations for chaffing or scrubbing.
- The total gross load shall not exceed 80% of the standard load chart. The operator shall be responsible to control this as the RCL does not have a feature to set reduced lifting limits.
- The auxiliary hoist line shall be considered part of the deducts to determine net allowable load.

- The panel shall be lifted so that the hoist lines are in line with the crane.
- The load shall be controlled to prevent rotation of the load and to ensure the load stays in line with the boom.
- The load must be balanced with the auxiliary: load line not taking more than half the load at any time during the lift. The RCL will not be providing coverage for the line pull of the auxiliary hoist line.
- The effect of wind loads on the crane and panel shall be taken into consideration. Operations shall be halted if the wind can cause a loss of control in handling the load.
- The main hoist line shall be used to raise the panel into the vertical position.

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

PILE DRIVING AND EXTRACTING

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

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

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

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

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

Crane Equipment

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

Crane Inspection

- In addition to the crane's frequent and periodic inspections, dated daily records shall be maintained showing inspections were performed on the crane during the time it was used for pile driving or extraction.
- All anti-two block warning devices and RCL systems shall be inspected daily and verified to be functional.
- All areas of the crane subject to fatigue shall be inspected monthly, and before the crane is to return to lifting service.
- The boom shall be inspected daily to ensure all wear pads remain in place. Cranes which utilize pinned boom sections shall be inspected daily to ensure the pinning mechanism operates properly and to check for undue wear at the pins and pinning plates.
- The hoist cable shall be inspected daily to ensure no chafing or wear is occurring.

ELECTROCUTION HAZARD

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

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

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

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

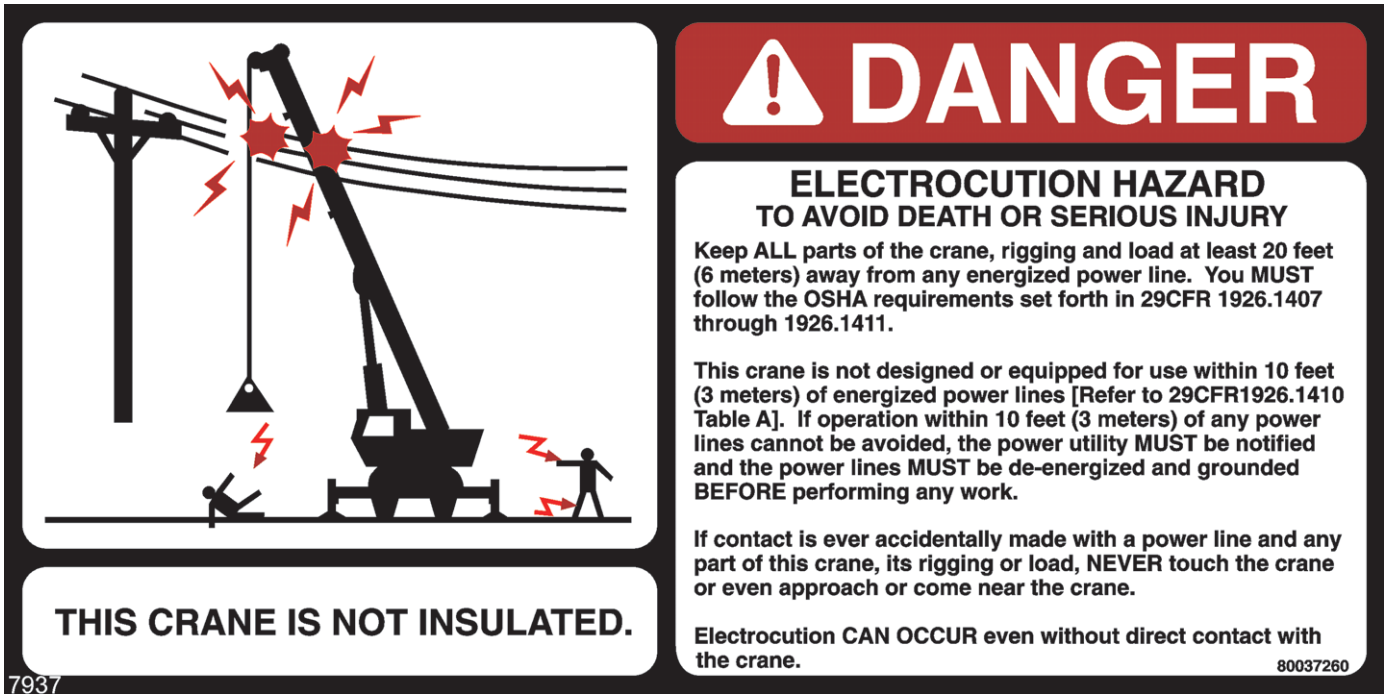
WARNING

Electrocution Hazard!

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

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

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



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

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

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

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

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

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

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

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

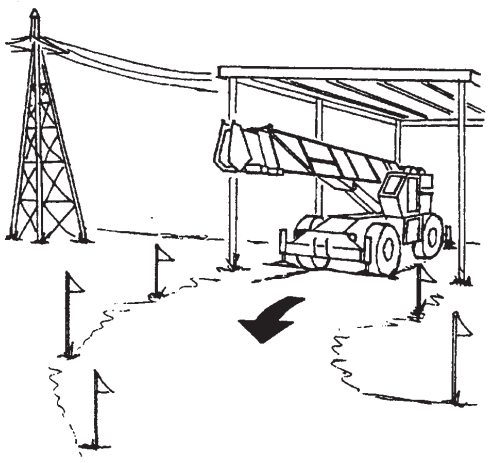
Set-Up and Operation

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

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

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

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



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

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

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

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

Electrocution Hazard Devices

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

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

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

Boom cages and boom guards afford limited protection from electrocution hazards. They are designed to cover only the boom nose and a small portion of the boom. Performance of boom cages and boom guards is limited by their physical size, insulating characteristics, and operating environment (e.g. dust, dirt, moisture, etc.). The insulating characteristics of these devices can be compromised if not kept clean, free of contamination, and undamaged.

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

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

Some variables you must know and understand are:

- Proximity devices are advertised to detect the existence of electricity and not its quantity or magnitude.

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

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

Electrical Contact

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

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

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

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

Special Operating Conditions and Equipment

Never operate the crane during an electrical thunderstorm.

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

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

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

Grounding the Crane

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

WARNING

Risk of accidents due to electric shock!

Ground the crane before you start to work with it

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

Use electrically conducting material for grounding.

1. Hammer a metal rod (3, Figure 2-5) (length of approximately 2.0 m (6.6 ft)) at least 1.5 m (5 ft) into the ground.
2. Moisten the soil around the metal rod (3) for better conductivity.
3. Clamp an insulated cable (2) to the metal rod (3), cross-section of at least 16 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.

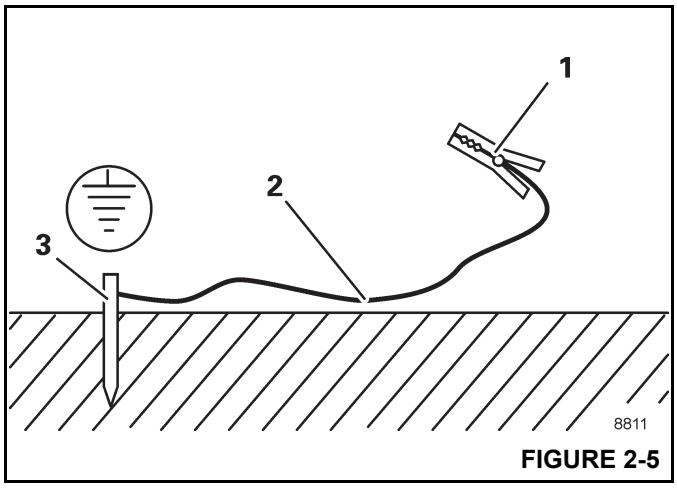


FIGURE 2-5

WARNING

Risk of accidents due to electric shock!

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

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

PERSONNEL HANDLING

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

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

This standard is consistent with the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) regulations for Construction that state, in 29CFRI926.1431:

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

Additional requirements for crane operations are stated in *ASME B30.5, Mobile and Locomotive Cranes*, ASME B30.8, *Floating Cranes and Floating Derricks,* and in *OSHA regulations 29CFRI910.180 for General Industry* and *29CFRI926.1431 for Construction*.

Use of a National crane to handle personnel is acceptable provided:

- The requirements of the applicable national, state and local regulations and safety codes are met.
- A determination has been made that use of a crane to handle personnel is the least hazardous means to perform the work.
- The crane operator shall be qualified to operate the specific type of hoisting equipment used in the personnel lift.
- The crane operator must remain at the crane controls at all times when personnel are off the ground.
- The crane operator and occupants have been instructed in the recognized hazards of personnel platform lifts.
- The crane is in proper working order.
- The crane must be equipped with a boom angle indicator that is visible to the crane operator.
- The crane's *Load Chart* is affixed at the operator's station and readily accessible to the operator. The total weight of the loaded personnel platform and related rigging shall not exceed 50 percent of the rated capacity for the radius and configuration of the crane.
- The crane is level within one percent of level grade and located on a firm footing. Cranes with outriggers shall have them all deployed following manufacturer's specifications.
- The crane's *Operator's Manual* and other operating manuals are at the operator's station and readily accessible to the operator.
- The platform meets the requirements as prescribed by applicable standards and regulations.
- For rope suspended platforms:
  - The crane is equipped with a hook that can be closed and locked, eliminating the throat opening.
  - The crane is equipped with a functional Anti-Two-Block Device.

- The platform is properly attached and secured to the load hook.

- For boom mounted platforms:
  - On cranes equipped with a boom mounted personnel platform, use only a platform approved by National Crane.
  - The platform is properly attached and secure.

To avoid death or serious injury:

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

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

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

  - or -

  online at: www.asme.org/kb/standards
- *US DOL/OSHA Rules and Regulations* are available by mail from the Superintendent of Documents, PO Box 371954, Pittsburgh, PA, 15250-7954.

ENVIRONMENTAL PROTECTION

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

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

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

When filling and draining crane components, observe the following:

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

MAINTENANCE

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

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

Shut down the crane while making repairs or adjustments.

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

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

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

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

Service and Repairs

WARNING

Fall Hazard!

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

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

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

specifications, contact your National Crane distributor for assistance.

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

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

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

Hydraulic Fluid:

- Do not use your hand or any part of your body to check for hydraulic fluid leaks when the engine is running or the hydraulic system is under pressure. Fluid in the hydraulic system can be under enough pressure that it will penetrate the skin, causing serious injury or death. Use a piece of cardboard, or piece of paper, to search for leaks. Wear gloves to protect your hands from spraying fluid.
- If any hydraulic fluid is injected into the skin, obtain medical attention immediately or gangrene may result.
- Do not attempt to repair or tighten any hydraulic hose or fitting while the engine is running, or when the hydraulic system is under pressure.
- Never disconnect any hydraulic lines unless the boom is fully lowered, the engine is shut off, and the hydraulic pressure is relieved. To relieve hydraulic pressure, stop the engine and move the hydraulic controls in both directions several times.
- Hot hydraulic fluid will cause severe burns. Wait for the fluid to cool before disconnecting any hydraulic lines.
- Hydraulic fluid can cause permanent eye injury. Wear appropriate eye protection.

Moving Parts:

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

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

- The boom should be fully retracted and lowered and the load placed on the ground.
- Do not get under a raised boom unless the boom is blocked up safely. Always block up the boom before doing any servicing that requires the boom to be raised.
- Stop the engine and disconnect the battery.
- Controls should be properly tagged. Never operate the crane if it is **tagged-out** nor attempt to do so until it is restored to proper operating condition and all tags have been removed by the person(s) who installed them.

After maintenance or repairs:

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

Lubrication

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

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

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

Tires

WARNING

Possible equipment damage and/or personal injury!

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

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

Ensure all lug nuts are properly torqued.

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

HOIST ROPE

Synthetic Hoist Rope

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

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

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

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

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

Wire Rope

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

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

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

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

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

- Wire ropes wear out. The strength of a rope begins to decrease when the rope is put to use and continues to decrease with each use. Rope will fail if worn-out, overloaded, misused, damaged or improperly maintained.
- The nominal strength, sometimes called catalog strength, of a rope applies only to a new, unused rope.
- The nominal strength of a rope should be considered the straight line pull which will actually break a new unused rope. The nominal strength of a rope should never be used as its working load.
- Each type of fitting attached to a rope has a specific efficiency rating which can reduce the working load of the rope assembly or rope system.
- Never overload a rope. This means never use the rope where the load applied to it is greater than the working load determined by the rope manufacturer.

- Never “shock load” a rope. A sudden application of force or load can cause both visible external and internal damage. There is no practical way to estimate the force applied by shock loading a rope. The sudden release of a load can also damage a rope.
- Lubricant is applied to the wires and strands of a wire rope when it is manufactured. The lubricant is depleted when the rope is in service and should be replaced periodically. Refer to the *Service Manual* for more information.
- In the U.S.A., regular inspections of the rope and keeping of permanent records signed by a qualified person are required by OSHA for almost every rope application. The purpose of the inspection is to determine whether or not a rope may continue to be safely used on the application. Inspection criteria, including number and location of broken wires, wear and elongation, have been established by OSHA, ANSI, ASME and similar organizations. See the *Service Manual* for inspection procedures.

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

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

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

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

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

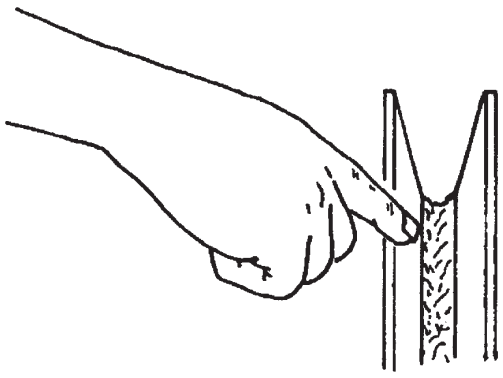
When installing a new rope:

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

When using a wedge socket:

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

Sheaves



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

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

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

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

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

Batteries

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

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

- Wear safety glasses when servicing batteries.
- If equipped, disconnect battery with the battery disconnect switch before disconnecting the ground battery cable.
- Do not break a live circuit at the battery terminal. Disconnect the ground battery cable first when removing a battery and connect it last when installing a battery.
- Do not short across the battery posts to check charge. Short circuit, spark, or flame could cause battery explosion.
- Maintain battery electrolyte at the proper level. Check the electrolyte with a flashlight.
- If applicable to your crane, check battery test indicator on maintenance-free batteries.
- Check battery condition only with proper test equipment. Batteries shall not be charged except in an open, well-ventilated area that is free of flame, smoking, sparks, and fire.

Engine

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

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

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

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

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

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

TRANSPORTING THE CRANE

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

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

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

Ensure the crane is adequately secured to the transporting vehicle.

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

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

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

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

exercised anytime any crane function is being performed while the cable is hooked into the hookblock tie down.

TRAVEL OPERATION

Only the crane operator shall occupy the crane when traveling.

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

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

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

WARNING

Crushing Hazard!

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

Keep Clear of revolving tires.

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

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

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

When driving the crane, ensure the cab is level, if equipped with a tilting cab.

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

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

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

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

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

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

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

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

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

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

Stay alert at the wheel.

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

Slopes:

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

WORK PRACTICES

Personal Considerations

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

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

Crane Access

WARNING

Fall Hazard!

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

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

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

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

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

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

Do not step on surfaces on the crane that are not approved or suitable for walking and working. All walking and working surfaces on the crane should be clean, dry, slip-resistant, and have adequate supporting capacity. Do not walk on a surface if slip-resistant material is missing or excessively worn.

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

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

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

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

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

Job Preparation

Before crane use:

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

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

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

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

Working

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

Know the location and function of all machine controls.

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

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

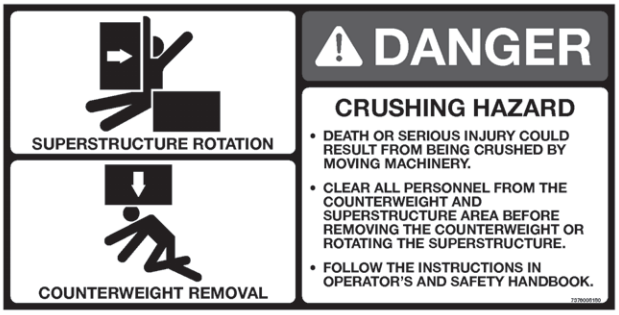
Carbon monoxide fumes from the engine exhaust can cause suffocation in an enclosed area. Good ventilation is very important when operating the crane.

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

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

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

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



Keep unauthorized personnel clear of the working area during operation.

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

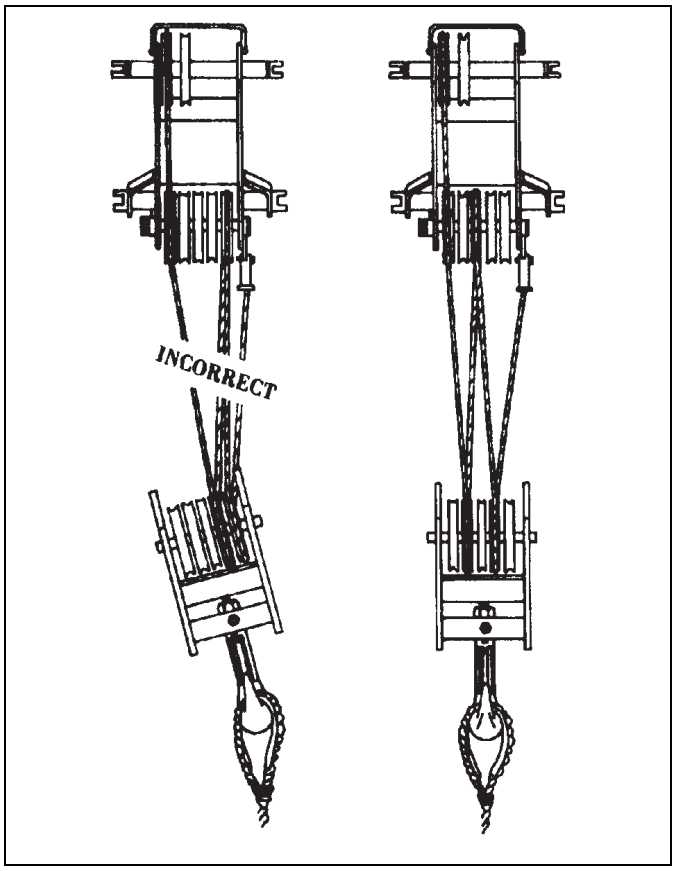
You must always be aware of everything around the crane while lifting or traveling. If you are unable to clearly see in the direction of motion, you must post a look out or signal person before moving the crane or making a lift. Sound the horn to warn personnel

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

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

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

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



Lifting

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

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

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

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

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

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

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

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

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

Watch the path of the boom and load when swinging. Avoid lowering or swinging the boom and load into ground personnel, equipment, or other objects.

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

Never leave the crane with a load suspended. Should it become necessary to leave the crane, lower the load to the ground and stop the engine before leaving the operator's station.

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

Stop the hook block from swinging when unhooking a load.

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

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

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

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

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

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

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

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

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

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

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

Hand Signals

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

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

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

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

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

Obey a signal to stop from anyone.

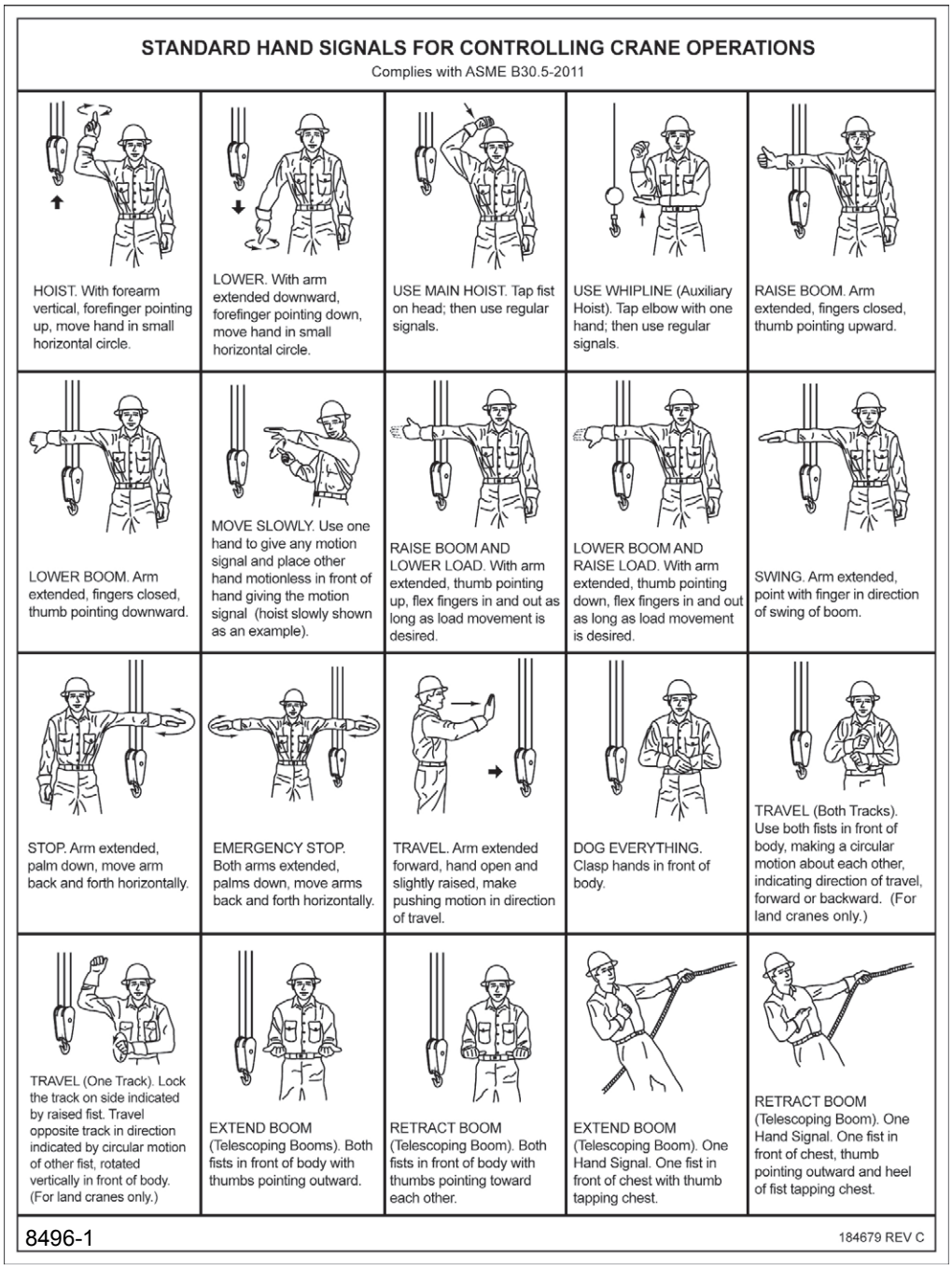

STANDARD HAND SIGNALS FOR CONTROLLING CRANE OPERATIONS
Complies with ASME B30.5-2011
HOIST. With forearm vertical, forefinger pointing up, move hand in small horizontal circle.
LOWER. With arm extended downward, forefinger pointing down, move hand in small horizontal circle.
USE MAIN HOIST. Tap fist on head; then use regular signals.
USE WHIPLINE (Auxiliary Hoist). Tap elbow with one hand; then use regular signals.
RAISE BOOM. Arm extended, fingers closed, thumb pointing upward.
LOWER BOOM. Arm extended, fingers closed, thumb pointing downward.
MOVE SLOWLY. Use one hand to give any motion signal and place other hand motionless in front of hand giving the motion signal (hoist slowly shown as an example).
RAISE BOOM AND LOWER LOAD. With arm extended, thumb pointing up, flex fingers in and out as long as load movement is desired.
LOWER BOOM AND RAISE LOAD. With arm extended, thumb pointing down, flex fingers in and out as long as load movement is desired.
SWING. Arm extended, point with finger in direction of swing of boom.
STOP. Arm extended, palm down, move arm back and forth horizontally.
EMERGENCY STOP. Both arms extended, palms down, move arms back and forth horizontally.
TRAVEL. Arm extended forward, hand open and slightly raised, make pushing motion in direction of travel.
DOG EVERYTHING. Clasp hands in front of body.
TRAVEL (Both Tracks). Use both fists in front of body, making a circular motion about each other, indicating direction of travel, forward or backward. (For land cranes only.)
TRAVEL (One Track). Lock the track on side indicated by raised fist. Travel opposite track in direction indicated by circular motion of other fist, rotated vertically in front of body. (For land cranes only.)
EXTEND BOOM (Telescoping Booms). Both fists in front of body with thumbs pointing outward.
RETRACT BOOM (Telescoping Boom). Both fists in front of body with thumbs pointing toward each other.
EXTEND BOOM (Telescoping Boom). One Hand Signal. One fist in front of chest with thumb tapping chest.
RETRACT BOOM (Telescoping Boom). One Hand Signal. One fist in front of chest, thumb pointing outward and heel of fist tapping chest.
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FIGURE 2-6

BOOM EXTENSION

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

Install and secure all pins properly.

Control movement of boom extension at all times.

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

DANGER

Boom Extension Hazard!

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

Do not remove all the pins from both front and rear stowage brackets unless the boom extension is pinned to the right side of the boom nose.

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

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

Stay outside of boom extension sections and lattice work.

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

PARKING AND SECURING

WARNING

Tipping Hazard!

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

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

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

The Controls and Operating Procedures section of this manual provides instructions for parking and securing a crane when it is to be left unattended. These instructions are intended to allow the crane to be placed in the most stable and secure position. However, National Crane recognizes that certain jobsite conditions may not permit the boom and boom extension of a crane to be fully lowered to the ground. When a qualified person at a jobsite determines that it is not practical to lower the boom to the ground, we recommend the following additional instructions be followed:

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

SHUT-DOWN

Use the following steps when shutting down the crane:

- Engage the parking brake.
- Fully retract and lower the boom.
- Engage the swing lock pin and/or 360 degree swing lock.
- Place controls in neutral position.
- Shut down the engine and remove the ignition key.
- Chock the wheels, if not on outriggers.
- Lock the operator’s cab (if applicable) and install vandal guards, if used.

COLD WEATHER OPERATION

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

Check operating procedures in this manual for cold weather starting.

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

Clean the crane of all ice and snow.

Allow ample time for hydraulic oil to warm up.

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

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

Never store flammable materials on the crane.

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

TEMPERATURE EFFECTS ON HOOK BLOCKS

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

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

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

TEMPERATURE EFFECTS ON HYDRAULIC CYLINDERS

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

The change in the length of a cylinder is proportional to the extended length of the cylinder and to the change in temperature of the oil in the cylinder. For example, a cylinder extended 7.6 m (25 ft) in which the oil cools 15.5°C (60°F) would retract approximately 196 mm (7 3/4 in) [see Table 2-8]. A cylinder extended 1.5 m (5 ft) in which the oil cools 15.5°C (60°F) would only retract approximately 38 mm (1 1/2 in). The rate at which the oil cools depends on many factors and will be more noticeable with a larger difference in oil temperature verses the ambient temperature.

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

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

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

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

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

Table 2-8: 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. (in^3/in^3/ °F) X 12 in/ft										

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

Coeff. =	0.000774	(1/ °C)	***Metric***								
STROKE	Temperature Change (°C)										
(m)	5	10	15	20	25	30	35	40	45	50	55
1.5	6	12	17	23	29	35	41	46	52	58	64
3	12	23	35	46	58	70	81	93	104	116	128
4.5	17	35	52	70	87	104	122	139	157	174	192
6	23	46	70	93	116	139	163	186	209	232	255
7.5	29	58	87	116	145	174	203	232	261	290	319
9	35	70	104	139	174	209	244	279	313	348	383
10.5	41	81	122	163	203	244	284	325	366	406	447
12	46	93	139	186	232	279	325	372	418	464	511
13.5	52	104	157	209	261	313	366	418	470	522	575
15	58	116	174	232	290	348	406	464	522	581	639
16.5	64	128	192	255	319	383	447	511	575	639	702
18	70	139	209	279	348	418	488	557	627	697	766
Length change in mm = Stroke (m) X Temperature Change (°C) X Coeff. (1/ °C) X 1000 mm/m											

OVERLOAD INSPECTION

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

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

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

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

WARNING

Overload Hazard!

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

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

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

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

Boom Inspection

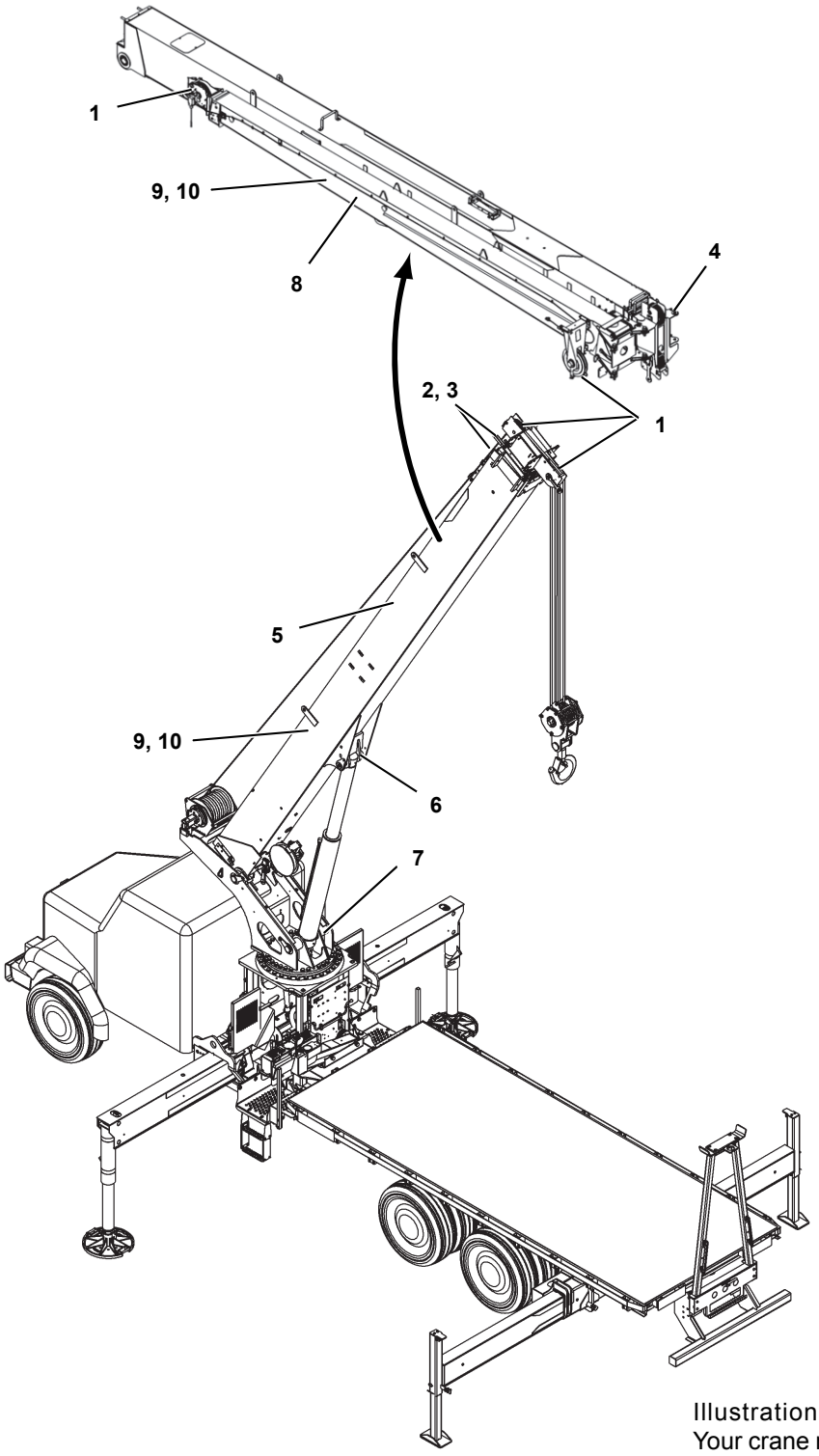


Illustration for reference only.
Your crane may be different.

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

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

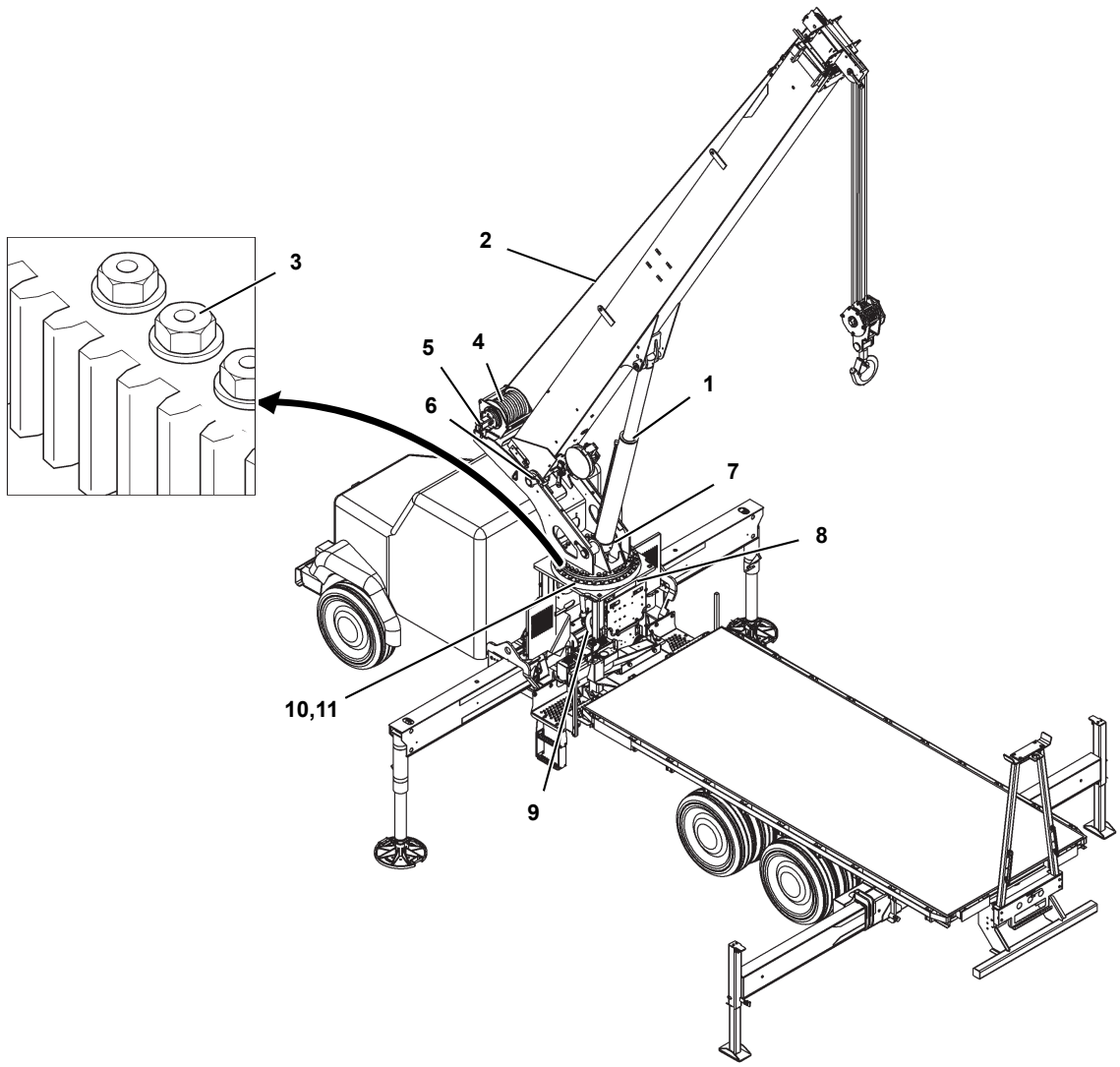


Illustration for reference only.
Your crane may be different.

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

Overload less than 25%			
1	Lift Cylinder	Inspect for leaks.	
2	Wire Rope	Inspect all for damage.	See topic in Introduction section of Service Manual.
3	Turntable Bearing	Check bolts for proper torque.	See topic in Swing section of Service Manual.
Overload from 25% to 49%			
1	Lift Cylinder	Inspect for leaks.	
2	Wire Rope	Inspect all for damage.	See topic in Introduction section of Service Manual.
3	Turntable Bearing	Check bolts for proper torque.	See topic in Swing section of Service Manual.
4	Hoist/Drums	Inspect each for damage.	
5	Hoist Brakes	Brakes must hold rated line pull.	
6	Bearing Main Boom Pivot Pin	Inspect for deformation, cracked welds.	
7	Lift Cylinder-Lower Mount	Inspect pin and welds.	
8	Turret Area	Inspect for deformation, cracked welds.	
9	Mounting Studs	Check bolts for proper torque.	
10	Welds	Inspect for cracks.	
11	Paint	Inspect for cracked paint which could indicate twisted, stretched, or compressed members.	

Carrier Inspection

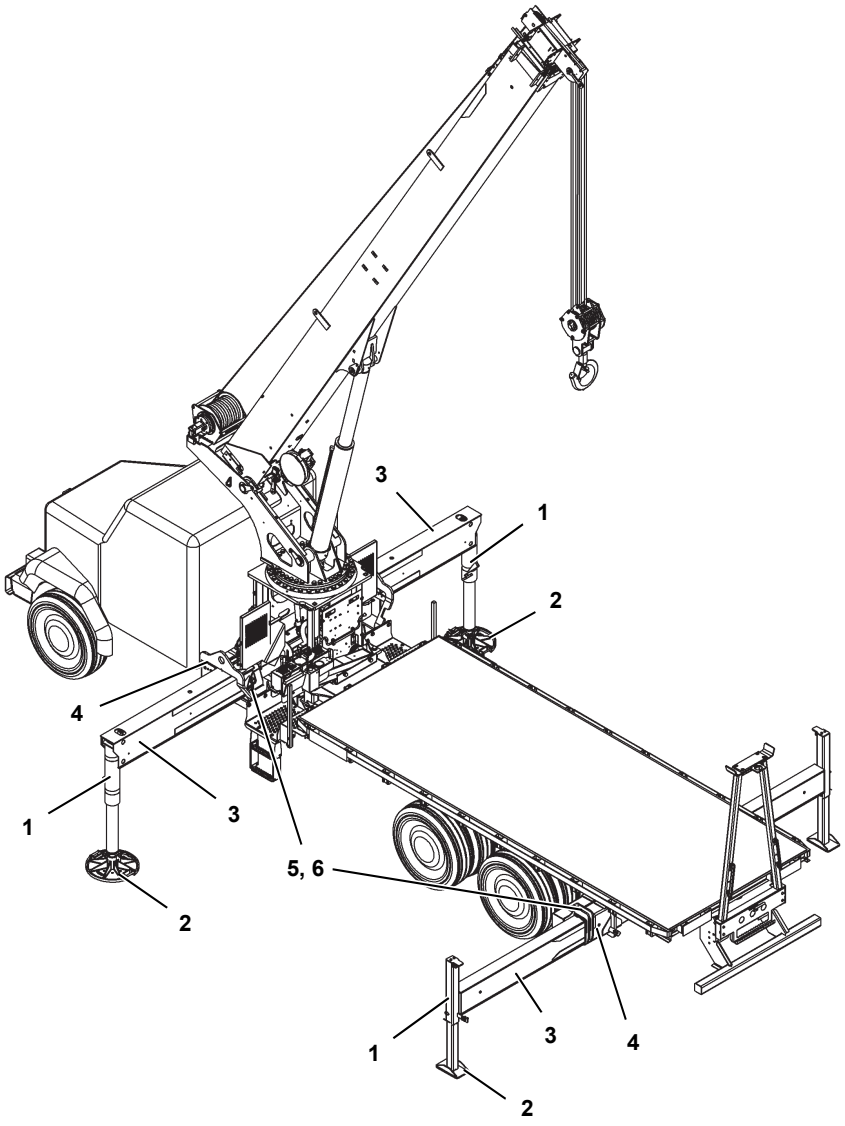


Illustration for reference only.
Your crane may be different.

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

Overload less than 25%			
1	Stabilizer Cylinders	Inspect for leaks.	
2	Outrigger Pads	Inspect for deformation and cracked welds.	
Overload from 25% to 49%			
1	Stabilizer Cylinders	Inspect for leaks.	
2	Outrigger Pads	Inspect for deformation and cracked welds.	
3	Outrigger Beams	Inspect for deformation and cracked welds.	
4	Outrigger Boxes	Inspect for deformation and cracked welds.	
5	Welds	Inspect for cracks.	
6	Paint	Inspect for cracked paint which could indicate twisted, stretched, or compressed members.	

SECTION 3
CONTROLS AND OPERATING PROCEDURES

SECTION CONTENTS

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

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

TRUCK CAB CONTROLS

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

Truck Cab Ignition Switch

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

Power Take Off

Manual Shift Control

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

Air Shift Control

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

Electric Shift Control

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

Park Brake

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

Engine Speed Governor

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

Neutral Start/Safety Switch

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

OUTRIGGERS

Outrigger Controls

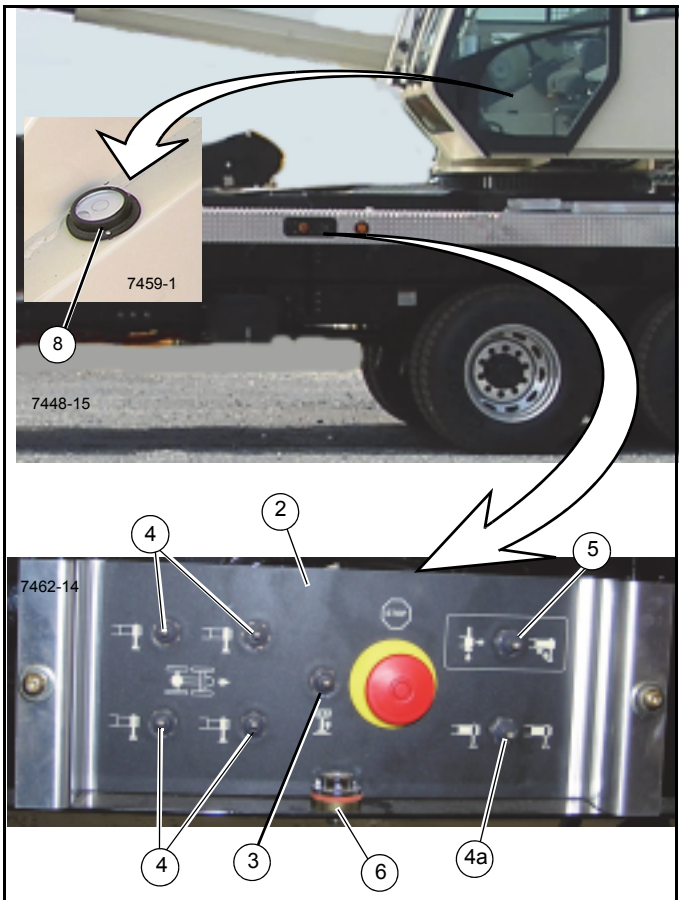
The outrigger has two controls units, a hand-help controller (1, Figure 3-1) located in the crane cab and a ground station control box (2, Figure 3-1) located on the carrier frame. Each controller contains the control switches for extending and retracting the outrigger beams, for raising and lowering the outrigger stabilizer (jack) cylinders and for raising and lowering the center front stabilizer. The cab hand held controller may be optional for some NBT40 series models.

Crane Level Indicators

The crane has one primary, two secondary level indicators. An optional secondary level indicator is available for the crane cab. The primary level indicator is used to verify the accuracy of the secondary level indicators.

The primary level indicator (7, Figure 3-1) is located behind the turret bearing. The secondary level indicators are located in the outrigger control boxes (6, Figure 3-1).

The secondary level indicator is located in the crane cab (38, Figure 3-4)



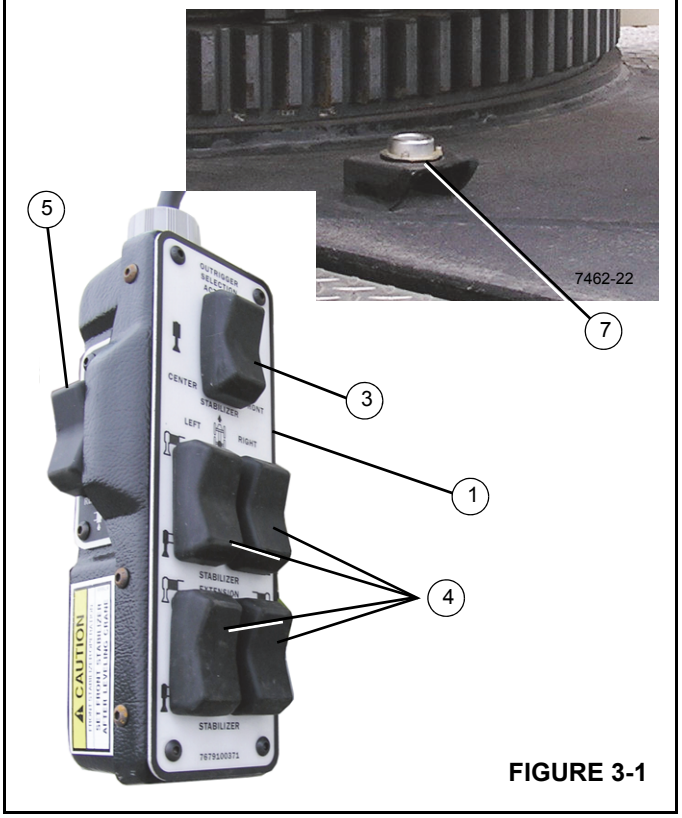


FIGURE 3-1

Item	Description
1	Hand Held Outrigger Control
2	Outrigger Control Box
3	Front Center Stabilizer Switch
4	Outrigger Selector Switches
4a	Outrigger Bean Selector
5	Extend/Retract Switch
6	Frame Level Indicator
7	Level Indicator
8	Cab Level Indicator

Outrigger Controls

The outrigger component controls are used to set the outriggers. Check the load chart located in the crane cab for the proper outrigger configuration.

Outrigger Control Boxes

The outrigger control boxes (2) are located on the side of the crane (Figure 3-1) and contain the outrigger controls.

Handheld Outrigger Control

The handheld outrigger control (1, Figure 3-1) is available for the crane cab.

Extend/retract Switch

The extend/retract switch (5, Figure 3-1) is used in conjunction with the outrigger selector switches to control the outrigger functions.

Outrigger Selector Switches

The outrigger selector switches (4, Figure 3-1) are used to select the outrigger component. To extend or retract an outrigger component, first select the component with the outrigger selector switch, then select extend or retract with the extend/retract switch.

The ground station outrigger beam selector switch (4a, Figure 3-1) is used to operation the front or rear outrigger beam on the same side of the crane the ground control is on.

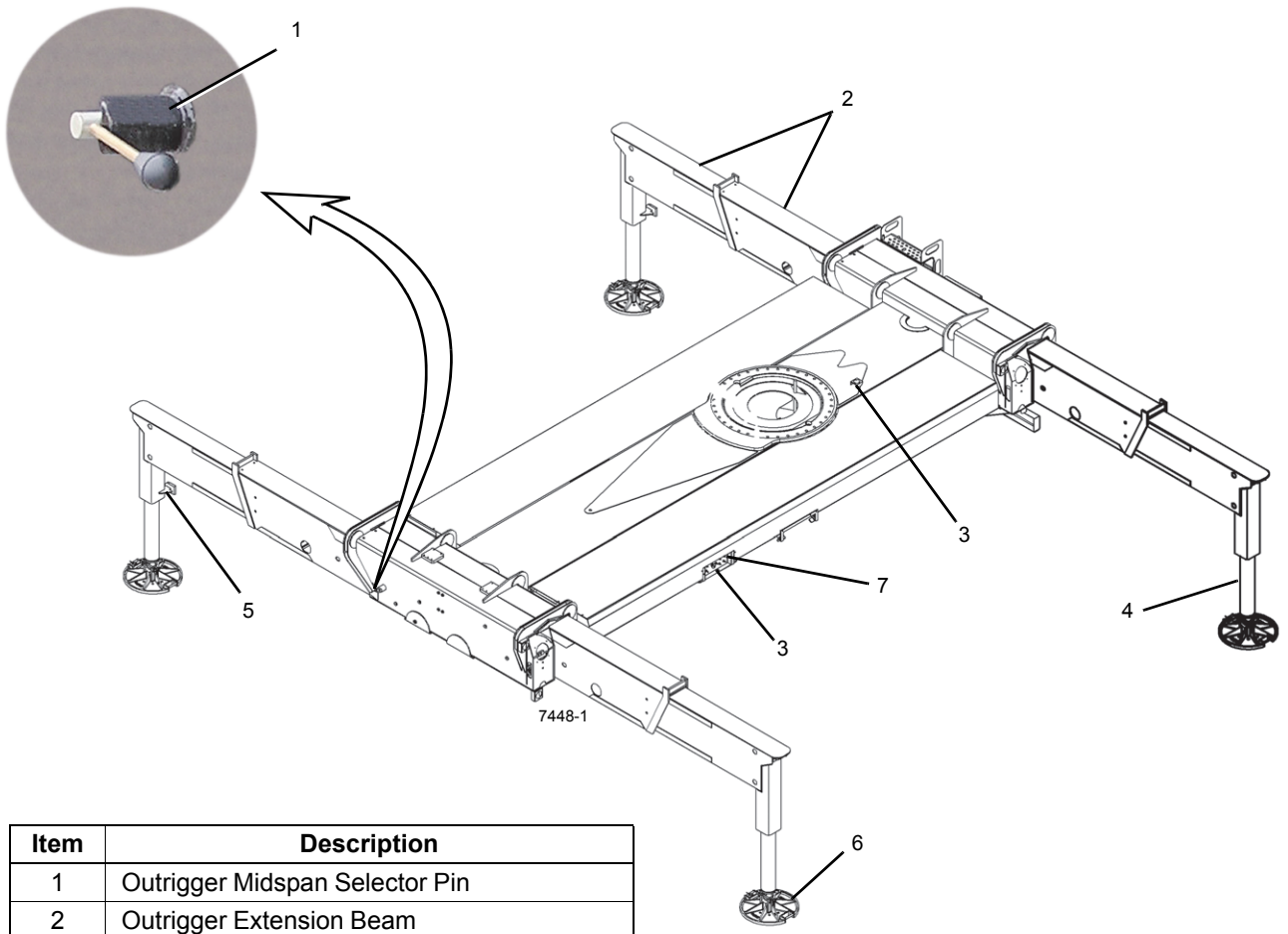
NOTE: Dependent on the carrier wheelbase, it may be necessary to remove the rear outrigger pads prior to retracting the outrigger beam.

3

Front Center Stabilizer Switch

The center front stabilizer switch (3, Figure 3-1) is used to lower and raise the center front stabilizer. To operate the center front stabilizer, press the center front stabilizer switch and then press extend/retract switch.

NOTE: The center front stabilizer automatically retracts if any of the other components are adjusted and must be reset if lifting is to be continued.



Item	Description
1	Outrigger Midspan Selector Pin
2	Outrigger Extension Beam
3	Level Indicators
4	Outrigger Jack
5	Outrigger Float Stow Peg
6	Outrigger Float
7	Ground Station O/R Controller

FIGURE 3-2

CRANE CONTROLS

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

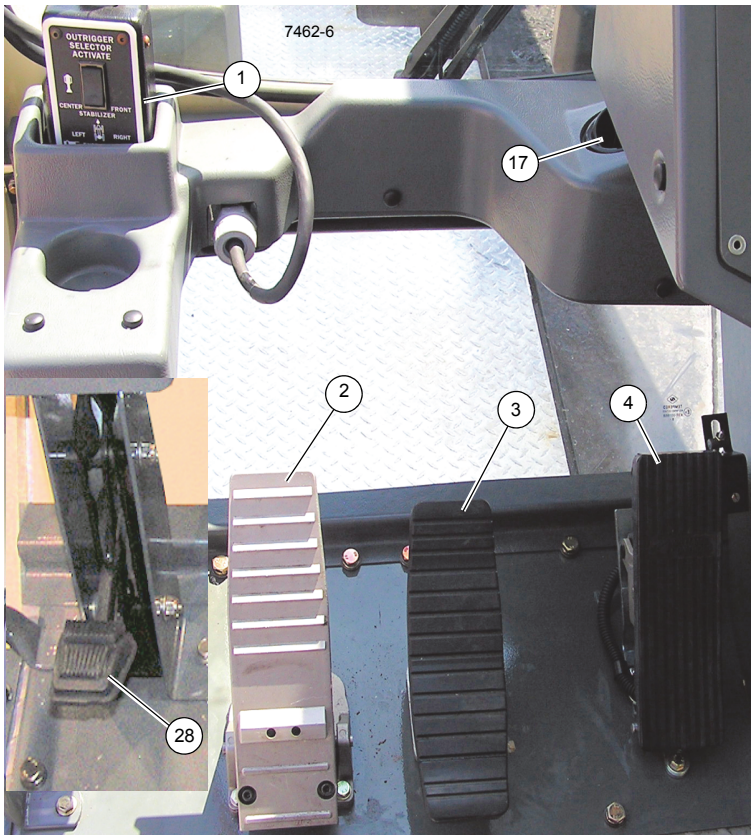
NOTE: The operator must be in the crane cab seat and the armrest must be lowered for the crane controls to operate properly.

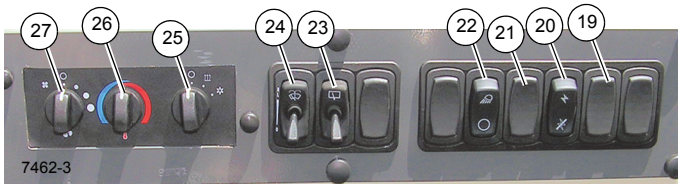
Load Chart

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

Handheld Outrigger Controls

The handheld outrigger controls (1, Figure 3-3) are stored in the crane cab and are used for outrigger operation from the crane cab. Crane Power switch must be on, operator in seat with armrest lowered.





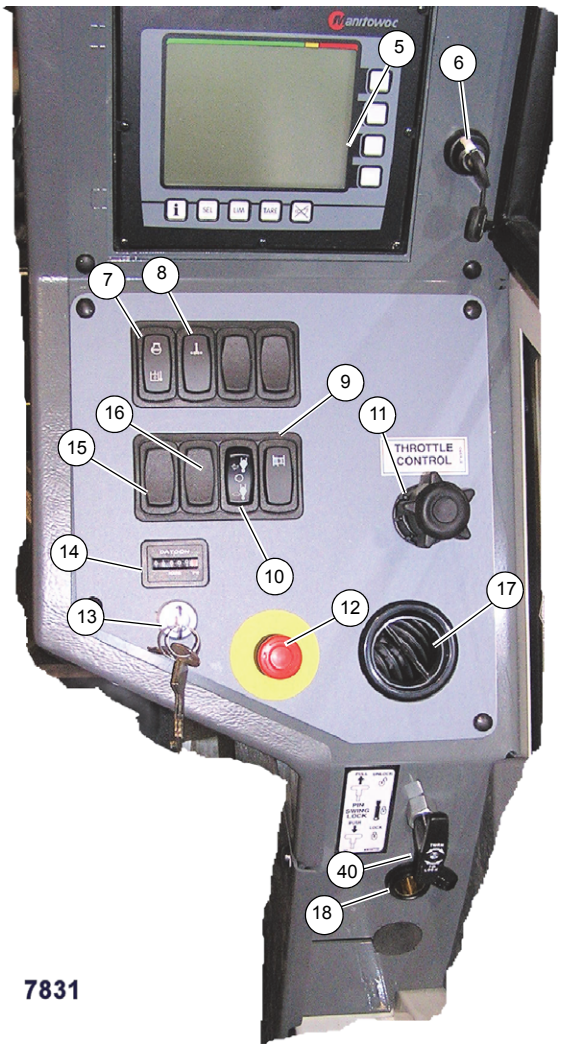
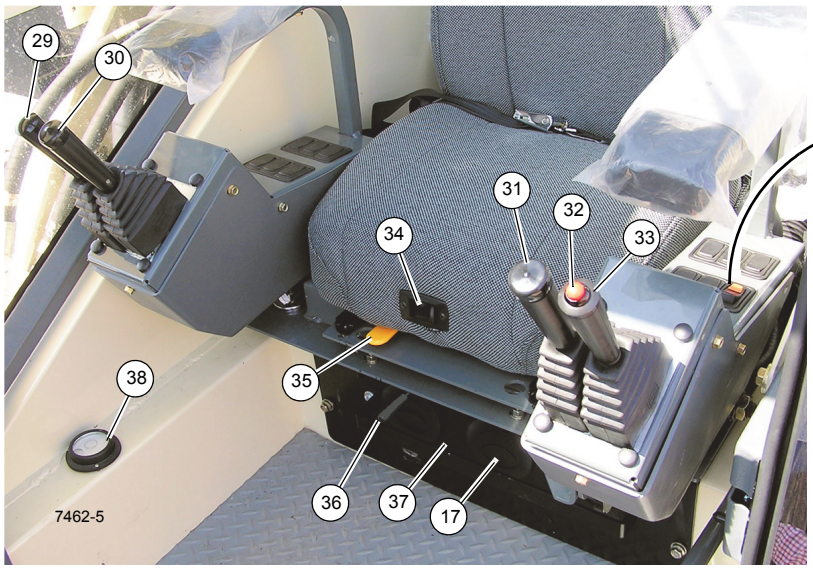


FIGURE 3-3

Item	Description
1	Handheld Outrigger Control
2	Swing Brake Pedal
3	Boom Telescope Pedal (Optional)
4	Foot Throttle Pedal
5	Display Panel
6	RCL Bypass Switch (Momentary)
7	Hydraulic Oil Indicator/Engine Warning
8	Swing Brake Indicator
9	Main Hoist Minimum Wrap Indicator
10	Main Hoist Speed Switch
11	Hand Throttle Control
12	Emergency Stop Switch
13	Crane Ignition Switch
14	Hourmeter
15	Auxiliary Hoist Switch (Optional)

Item	Description
16	Auxiliary Hoist Minimum Wrap Indicator
17	AC/Heater Vent
18	Receptacle (12V)
19	Remote Power Switch (Optional)
20	Crane Power Switch
21	Boom Worklight Switch (Optional)
22	Cab Worklight Switch
23	Skylight Wiper Switch
24	Windshield Wiper Switch
25	Heater/Air Conditioner Function Switch
26	Heater/Air Temperature Control
27	Heater/Air Fan Speed
28	360° Swinglock Pedal



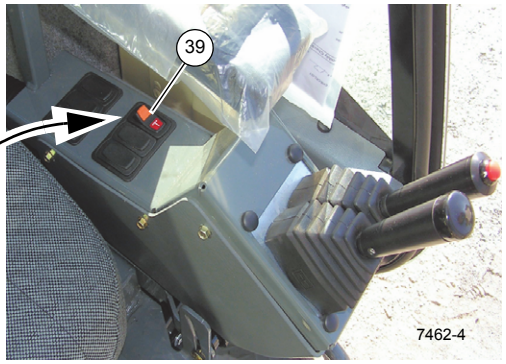


FIGURE 3-4

Item	Description	Item	Description
29	Boom Lift Control Lever	35	Seat Slide Handle
30	Hoist Up & Down Control (Rotate Indicator)	36	Seat Frame Slide Handle
31	Telescope Boom (Auxiliary Hoist Control)	37	Climate Control Unit
32	Warning Horn Button	38	Level
33	Turret Swing Control Lever	39	Swing Lock Control Switch
34	Seat Back Adjustment	40	House Lock (Figure 3-3)

Swing Brake Pedal

CAUTION

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

The swing brake pedal (2, Figure 3-3) is located on the left side of the crane cab floor. The brake pedal is used to activate the swing brake and momentarily hold the turret in position.

Boom Telescope Pedal (Optional)

The telescope foot pedal (3, Figure 3-3) is used to extend and retract the boom when the crane is equipped with an auxiliary hoist. Rock the pedal forward to extend the boom and rock back to retract the boom.

Foot Throttle Pedal

The foot throttle (4, Figure 3-4) is located on the crane cab floor and is used to control the engine speed. Depress the foot throttle to accelerate the engine speed and release to return to idle.

The hand throttle (11, Figure 3-4) must be positioned as shown in Figure 3-6 to operate the foot throttle properly.

Display Panel

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

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

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

DANGER

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

RCL and Minimum Wrap Bypass Switch

The RCL Bypass Switch (6, Figure 3-3) is a *momentary* on-off switch, turn the key to the On position (right) to disengaged the RCL controls and minimum wrap lockout controls. Releasing the key allows the RCL and minimum wrap controls to re-engage.

The RCL and 3 wrap system will be bypassed only as long as the switch (6, Figure 3-3) is in the On position.

Turning the key switch (6, Figure 3-3) to the On position re-engages the boom down, telescope out and hoist controls. These functions were disabled when an overload condition was sensed by the Rated Capacity Limiter (RCL). It is important to read and understand the RCL Override Warning information in the RCL Operator's Manual before using the RCL Bypass switch (6) or the RCL on/off switch.

The bypass switch (6, Figure 3-3) will also re-engage the main and auxiliary hoist controls disabled by the minimum wrap indicator sensor system.

The RCL control can be turned completely off and back on using the switch (1, Figure 3-5) located behind the cab seat.

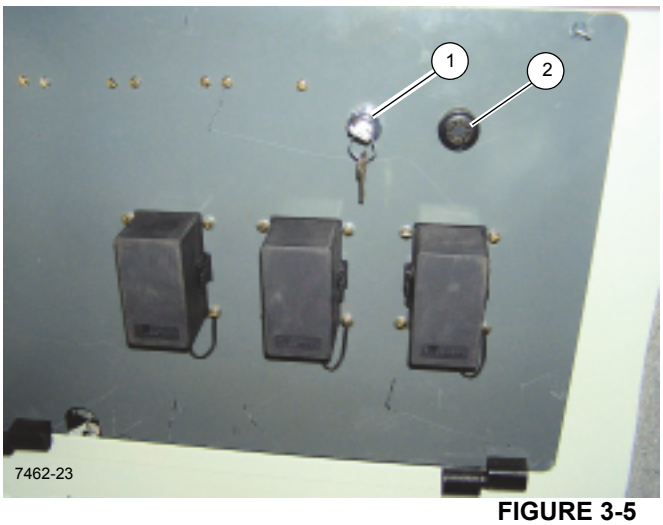


FIGURE 3-5

Hydraulic Oil Indicator

The hydraulic oil temperature warning light (7, Figure 3-3) is located on the crane cable console and illuminates when the hydraulic oil overheats. If overheating occurs, run the crane at idle with the controls in neutral until the light goes out.

NOTICE

Do not operate the crane with overheated hydraulic oil or damage to seals in the hydraulic components may result.

Swing Brake Indicator

The swing brake indicator (8, Figure 3-3) is located on the crane cab console. The indicator light is on when the swing brake is activated.

Main Hoist Minimum Wrap Indicator

When the main hoist is down to the last cable wrap the minimum wrap indicator (9, Figure 3-3) will flash intermittent and the minimum wrap buzzer (2, Figure 3-5) will sound intermittently.

When the amount of cable left on the hoist reaches the minimum wrap; the indicator light will be constant, the buzzer will be constant and the hoist will be disabled by the minimum wrap sensor system.

Main Hoist Speed Switch

The main hoist speed selector switch (10, Figure 3-3) is located on the right seat armrest. It is a three position switch (on-off-on), placarded as rabbit (fast) hoist motor speed and turtle (slow) hoist motor speed.

Hand Throttle Control

The push/pull hand throttle (11, Figure 3-4) is located on the crane cab console and has the following functions.

Increase Engine Speed - Push in and hold the center button (1, Figure 3-6); pull out on the knob (2) to accelerate the engine. Releasing button (1) will lock knob in place and maintain engine speed.

Decrease Engine Speed - Push in and hold the center button (1, Figure 3-6); push the knob (2) in to slow the engine speed.

Incremental Speed Adjustment - Rotate knob (2, Figure 3-6) clockwise to increase speed and counterclockwise to decrease engine speed.

The hand throttle must be positioned as shown in Figure 3-6 to operate the foot throttle (4, Figure 3-4) properly.

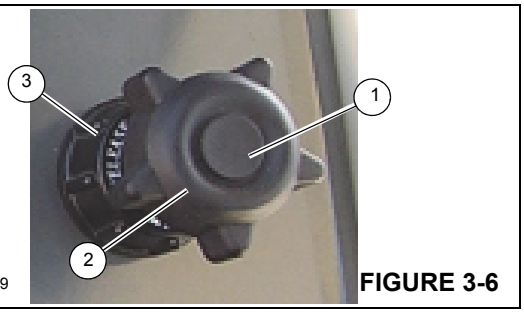


FIGURE 3-6

Emergency Stop Switch

The crane emergency stop switch (12, Figure 3-3) is located on the cab console and is used to shut down the truck engine. Push the red button in to shut down the engine, rotate the knob and pull out to resume normal operation.

Crane Ignition Switch

The crane ignition switch (13, Figure 3-3) is located on the crane cab console and controls the truck engine and crane cab power. The igniton switch has four positions. OFF shuts down engine and cab power, ON activates truck engine ignition as well as all cab power, ACC is crane cab power and Start is truck engine start.

The truck ignition key must be OFF before the truck engine can be started from the crane cab.

Aux Hoist Speed (Optional)

The auxiliary hoist speed selector switch (15, Figure 3-3) is located on the left seat armrest. It is a three position switch (on-on-on), placarded as rabbit (fast) hoist motor speed and turtle (slow) hoist motor speed.

Auxiliary Hoist Minimum Wrap Indicator (Optional)

When the auxiliary hoist is down to the last cable wrap the minimum wrap indicator (16, Figure 3-3) will flash intermittent and the minimum wrap buzzer (2, Figure 3-5) will sound intermittently.

When the amount of cable left on the hoist reaches the minimum wrap; the indicator light will be constant, the buzzer will be constant and the hoist will be disabled by the minimum wrap sensor system.

AC/Heater Vent

The cab has air conditioner and heating vents (17, Figure 3-3), located on the control panel, behind the panel. and to the left of the operator.

Receptacle

This 12 volt accessory outlet (18, Figure 3-3) is located on the lower part of the front control panel and is designed to mate with most 12 volt adapter plugs.

Radio Remote Switch (Optional)

The radio remote switch (19, Figure 3-4) is used to enable the radio remote controls. The crane function power switch, crane ignition (13) and truck igniton must all be OFF before the crane can be operated with a radio remote control.

Crane Power Switch

The crane function power switch (20, Figure 3-3) is located on the right overhead console. The switch has two positions: OFF takes all power from the joy stick controllers on the arm rest, cab outrigger, and from the swing brake unlock (assuring the brake stays locked). The OFF position prevents inadvertent operation of these functions and assures the swing brake is set when the crane is not powered. The ON position will restore power to the joy stick controllers, the swing brake and the cab O/R hand controller.

Boom Work Light Switch (Optional)

The work light switch (21, Figure 3-3) is a two position rocker switch, ON and OFF, located on the right overhead console. It turns the cab outside working lights on.

Cab Work Light Switch

The work light switch (22, Figure 3-3) is a two position rocker switch, ON and OFF, located on the right overhead console. It turns on custom mounted boom lights.

Skylight Wiper Switch

The skylight wiper switch (23, Figure 3-3) is located in the overhead console. This is Hi - Lo toggle type switch with 6 intermitting positions, intermitting timing is 2-15 seconds.

Windshield Wiper Switch

The windshield wiper switch (24, Figure 3-3) is located in the overhead console. This is Hi - Lo toggle type switch with 6 intermitting positions, intermitting timing is 2-15 seconds, wiper washer timing is 3 seconds.

Crane Cab Climate Controls

The cab climate controls (25, 26, 27, Figure 3-3) are used to adjust the heating and air conditioning for operator comfort.

360°Swinglock Pedal (Optional)

The swinglock pedal (28) is located on the left side of the crane cab floor. Apply the pedal to lock the turret, release the pedal to unlock the turret.

Boom Lift Control Lever

The boom lift control lever (29, Figure 3-4) is located on the right armrest and is used to raise and lower the boom. Push the lever forward to lower the boom and pull back to raise the boom.

Hoist Control Lever

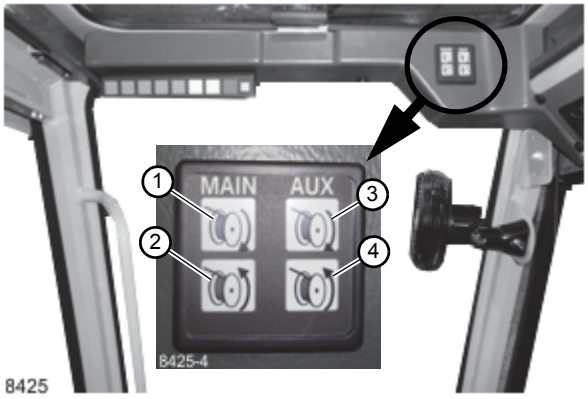
The hoist control lever (30, Figure 3-4) is located on the right armrest. Push forward to lower the load and pull the lever back to raise the load.

⚠ DANGER

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

Hoist Rotation Indicator Display

The display is located in the front overhead panel Figure 3-7. The LED display illuminates to indicate the current hoist in operation and which direction the hoist is rotating.



8425
8425-6

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

FIGURE 3-7

Hoist Rotation Indicator

The hoist rotation indicator (RDI) is located on top of the hoist control lever (30, Figure 3-3). The indicator is electronically driven by a signal from an electronic transmitter and sensor attached to the hoist. A pulsating signal is sensed by the operator's thumb during hoist operation.

Telescope Control Lever

When equipped *without* the auxiliary hoist the telescope boom control lever (31, Figure 3-4) is on the left armrest. Push the lever forward to extend the boom and pull back to retract the boom.

Auxiliary Hoist (Optional)

If equipped *with* an auxiliary hoist the control lever (31, Figure 3-4) is on the left armrest, positioning the lever forward lets out hoist cable. Pulling the lever back reels the cable in.

Warning Horn Button

The warning horn button (32, Figure 3-4) is located on the swing joy stick. Push the switch to sound the horn to warn fellow workers of pending movement of crane.

Swing Control Lever

CAUTION

Do not actuate the Swing Control Lever while the Swing Brake is engaged, as the turret may push thro8ugh the brake. Damage to the swing brake can occur.

The swing control lever (33, Figure 3-4) is located on the left armrest and controls turret rotation. Push the lever forward to rotate the turret clockwise and pull back to rotate the turret counterclockwise.

The swing control lever can be used to slow and stop the swing by moving the control lever to the opposite direction of the swing. For example, if the lever is pushed forward for a clockwise swing, pull the lever back to slow and stop the swing.

Seat Back Adjustment

To adjust the back of the seat press the adjustment knob (34, Figure 3-4) and then adjust the seat as needed.

Seat & Seat Frame Lever

Moving the seat slide lever (35, Figure 3-4) will slide the seat either forward or backward, moving the seat frame lever (36) slides the seat and seat frame at the same time.

Climate Control Unit

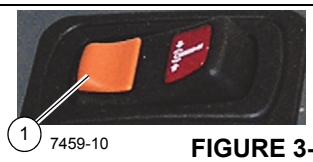
Air Conditioner and Heating of the crane cab is provided by the climate control unit (37, Figure 3-4) located under the cab seat.

Swing Brake Switch

The swing brake switch (39, Figure 3-4) is located on the crane cab console and is used to activate the swing brake

and park the turret in position. Press the switch to activate the swing brake to keep the turret from rotating. The swing brake indicator (8, Figure 3-3) is illuminated when the swing brake switch is applied.

The back half of the switch (1, Figure 3-8) is designed with a locking mechanism to secure the swing brake in the locked position and prevent accidental movement of the cab & superstructure.



7459-10 **FIGURE 3-8**

House Lock

The house lock control (40, Figure 3-3) is a manually operated mechanical lock that when engaged prevents rotation of the crane superstructure.

To engage the lock center the boom over the front of the cab turn the T handle clockwise and push the knob back into the locked position and move the superstructure left to right to align the lock pin with the lock pin hole. To disengage, pull out on the T handle and turn counter clockwise to lock the T handle and pin in position.

Heater

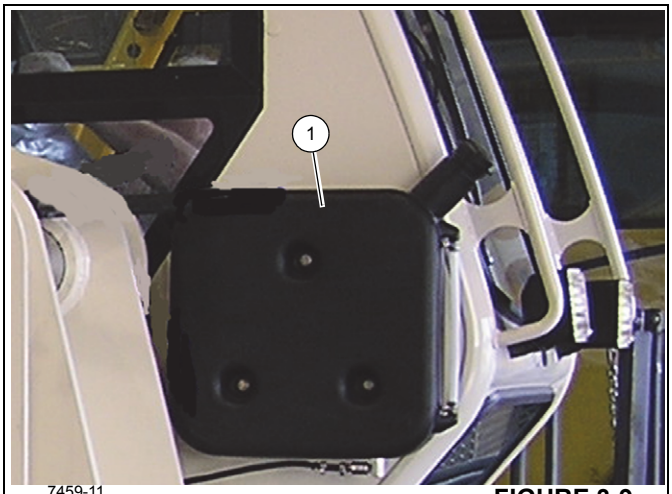
The diesel powered supplemental heater is stowed under the cab support frame and supplies heat to the crane cab (36, Figure 3-4). The heater controls the temperature of the crane cab by cycling coolant between the heater and the climate control unit located under the cab seat. Controls (25, 26, 27, Figure 3-3) for the heater are located on the overhead control panel in the crane cab.

⚠ WARNING

Do not mix gasoline with diesel fuel.

Heater Cold Weather Fuel Mixture

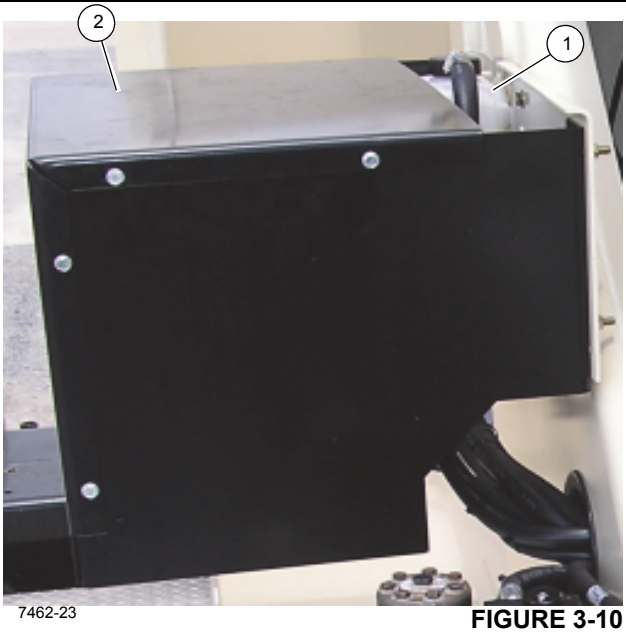
At temperatures below 20° F (-7° C), add a cold weather additive or mix kerosene with the diesel fuel at a 50/50 ratio, Add the mixture to the heater diesel fuel tank (1, Figure 3-9) located on the outside of the cab.



7459-11 **FIGURE 3-9**

Heater Coolant

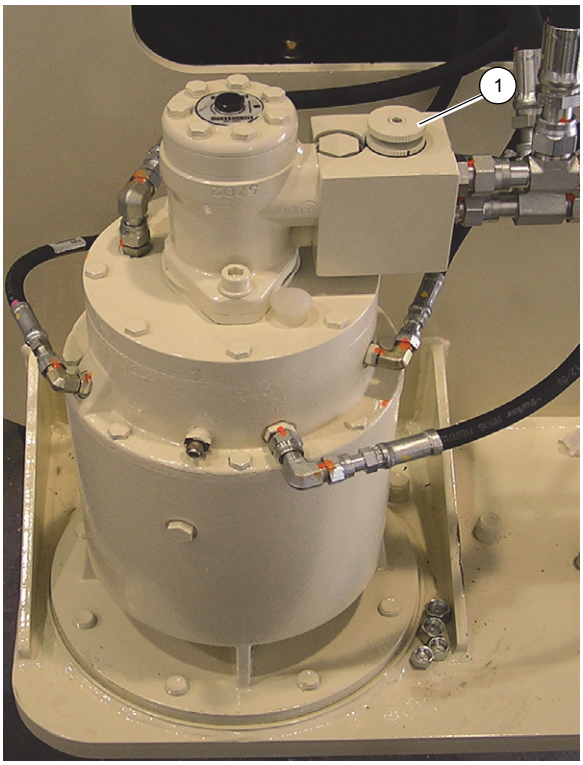
The heater coolant bottle (1, Figure 3-10) is mounted to the turret and located inside the a/c compressor enclosure (2). The coolant should contain at a minimum a mixture of water and enough antifreeze to prevent freezing or slushing.



7462-23 **FIGURE 3-10**

Adjustable Swing Speed Valve

The crane is equipped with an adjustable swing speed valve (1, Figure 3-11) that sets the maximum swing speed of the machine. Turn the valve knob clockwise to increase and counterclockwise to decrease speed.



7459-9 **FIGURE 3-11**

OPERATING PROCEDURES

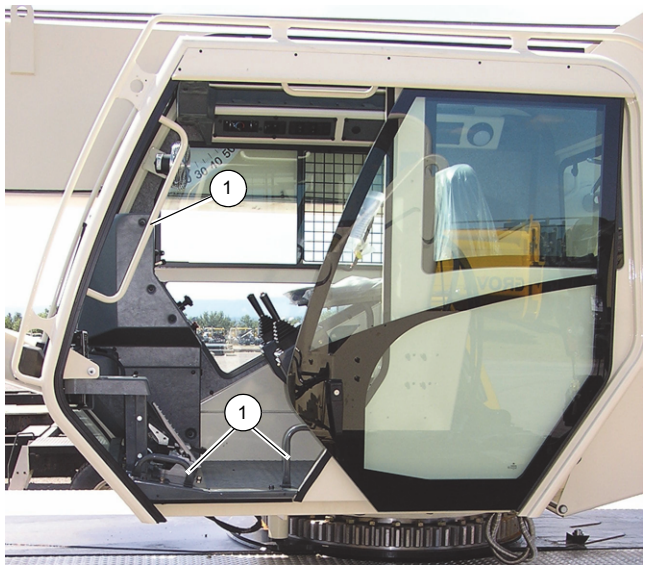
You need to be familiar with the safety precautions outlined in this manual before operating the crane.

Equipment Familiarization

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

Crane Cab Access

To enter the cab, pull the ladder out from under the crane cab door and use the grab handles (1, Figure 3-12) inside the cab to enter the cab. Take all precautions not to fall off the crane. Falling from any elevation can cause serious injury or death.



7602-5 **FIGURE 3-12**

Equipment Checks

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

- for any unusual conditions such as pools of hydraulic fluid or lubricating oil under the chassis, any outrigger which may have crept down or up and any signs of damage or improper maintenance.
- the tires are inflated to the proper pressure.
- the level of the hydraulic reservoir.

- the operation of the “stop” and horn circuits.
- for missing and loose bolts.
- for damaged structural members and welds.
- all rope guides and cable keepers.
- all sheaves for free turning.
- the hoist cable for kinks, broken strands or other damage in accordance with instructions on *Hoist Cable Inspection and Maintenance*, page 6-3.
- to see that the hydraulic hoses and fittings are in good condition and show no signs of leaking. The hoses should be free from cuts and abrasions and there should be no evidence of binding. Any damage or leakage should be repaired immediately.
- the RCL and anti-two-block system for proper operation.
- the electrical wiring connecting the various parts of the system for physical damage.

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

Cold Weather Operation

The following recommendations are for operating National cranes in very low (i.e., sub-zero) temperatures.

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

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

Operation Below -40°C

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

Operation Below -40°F

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

CRANE WARM-UP PROCEDURES

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

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

Before starting the crane, ensure the appropriate lubricants are used to provide lubrication for the prevailing ambient temperatures in which the crane will operate in (a list of lubricants and their temperature ranges can be found in the Lubrication section of your crane’s *Operator Manual*, by contacting your local National distributor, or by contacting Manitowoc Crane Care directly).

CAUTION

Crane Damage Hazard!

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

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

Engine

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

Warm-up Procedures for All Temperature Ranges:

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

Transmission

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

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

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

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

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

Hoist

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

Warm-up Procedures:

1. Without operating the hoist function, warm the hydraulic oil (see *Hydraulic Oil System*, page 3-13).
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 National distributor.
- **From 10°C to 4°C (50°F to 40°F):** Crane operation with a load is allowed with medium engine RPM and medium function speed (joystick position) until the fluid reaches at least 10°C (50°F).
- **From 95°C to 10°C (200°F to 50°F):** Crane operation with a load is allowed with no restrictions.
- **Above 95°C (200°F):** No crane operation is allowed. Let the crane's hydraulic oil cool by running the engine at idle with no functions actuated.

Anti-two-block Check

⚠ DANGER

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

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

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

⚠ DANGER

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

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

RCL Check

Perform the following checks to verify proper RCL operation.

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

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

DANGER

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

OUTRIGGER SETUP

DANGER

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

Proper Leveling of the Crane

ASME B30.5 specifies that if a crane is not level within 1% of grade, the allowable capacities must be reduced. Therefore, when lifting on outriggers, it is essential that the crane is level to within 1% of grade. The bubble level that is provided on the crane is calibrated to be accurate within 1% of grade.

To properly level the crane, the boom must be positioned over the front of the crane, fully lowered to horizontal and fully retracted (for cranes fitted with a boom rest, the boom shall be stowed onto the rest). Raise and level the crane using the outriggers; refer to *Setting the Outriggers*, page 3-14.

A working crane may settle during lifting operations. Frequently check the crane for level. When rechecking the crane for level, the boom must be positioned over the front of the crane, fully lowered to horizontal and fully retracted (for cranes fitted with a boom rest, the boom shall be stowed onto the rest). If necessary, relevel the crane using the procedures under *Setting the Outriggers*, page 3-14.

Bubble Level Adjustment

The bubble level adjustment should be checked periodically; if it is suspected that the bubble level indicator is out of adjustment, verify and adjust the bubble level as follows:

1. Position the crane on a firm, level surface.
2. Extend and set the outriggers. Level the crane, as indicated by the bubble level indicator, using the outriggers.
3. Place a miracle pointer level, carpenter level, or similar type device on a machined surface such as the turntable bearing or bearing mounting surfaces.
4. Using the outriggers, level the crane as indicated on the leveling device used in step 3.
5. Using the bubble level indicator mounting screws, adjust the bubble level indicator to show level.

Setting the Outriggers

1. Position the outrigger floats directly out from each outrigger to where the outriggers will be properly extended.

CAUTION

Possible Equipment Damage!

Always depress one of the outrigger selector switches before positioning the outrigger extend/retract switch to extend or retract. Failure to do this may cause a hydraulic lock against the individual solenoid valves, preventing them from opening.

WARNING

Electrocution Hazard!

To avoid death or serious injury, keep all parts of this machine, the rigging, and materials being lifted at least 20 feet away from electrical power lines and equipment.

2. If extending the outrigger to the mid-extend or fully extended position, depress the desired outrigger selector switch and hold the outrigger extend/retract switch to EXTEND. The appropriate outrigger beam begins to extend.

WARNING

Tipping Hazard!

All four outrigger beams must be deployed to one of three positions before beginning operation, which include fully retracted, mid-extend, or fully extended; do not operate the crane with the outriggers in any other position.

NOTE: More than one outrigger beam can be extended at a time. However, to ensure that each outrigger is fully extended, repeat step 2 for each outrigger after a multi-outrigger extension.

3. After deploying the four outrigger beams to one of the three proper positions (fully retracted, mid-extend, fully extended), depress the desired Stabilizer Switch on the Outrigger Selector Panel and hold the Outrigger

Extension/Retraction Switch to EXTEND. The appropriate stabilizer begins to move.

Extend each jack, positioning the float as necessary, until the locking levers of the float engage the jack cylinder barrel.

NOTE: More than one stabilizer can be extended at a time.

4. With each jack float firmly touching the ground, extend the front stabilizers approximately 3 to 4 in (8 to 10 cm). Extend the rear stabilizers approximately 3 to 4 in (8 to 10 cm).

5. Repeat step 4 until all wheels are clear of the ground and the crane is level as indicated by the bubble level indicator (Figure 3-13). If it is suspected that the bubble level indicator is out of adjustment, verify and adjust the bubble level using the procedures under *Bubble Level Adjustment*, page 3-14.

Not Level

FIGURE 3-13

6. Lower the center front stabilizer (optional) only after all other outriggers are set. Press the front stabilizer switch to activate and the extend/retract switch to extend. Hold the extend/retract switch for two seconds after the stabilizer contacts the ground. The front stabilizer is automatically set at the correct ground pressure.

DANGER

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

WARNING

Tipping Hazard!

The mid-extend outrigger beam lock pin must be engaged before operating on any beam from the mid-extend position.

The proper load chart and RCL program must be selected for the current outrigger configuration.

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

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

Set up of the outriggers is the same for cranes equipped with OMS; refer to “Setting the Outriggers” on page 2-14.

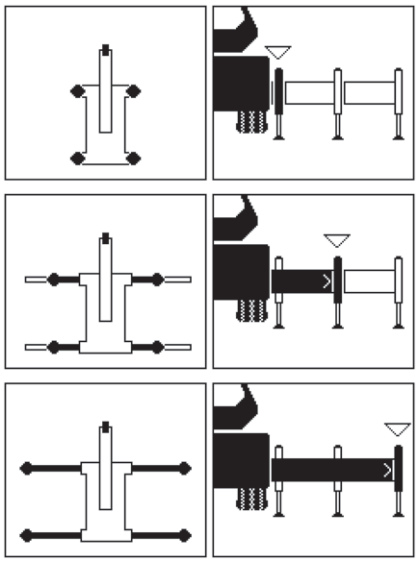
On cranes with OMS the symbols for the outriggers will display on the crane’s remote control LCD Display screen and also on the RCL screen (if equipped), refer to Figure 3-14.

If the crane is setup on outriggers and “On Outriggers” is chosen when programming the RCL, then the OMS indicates to the RCL the horizontal position of each of the four outrigger beams. Based on this information, the RCL will default to the most conservative outrigger beam configuration (i.e. If three outriggers are fully extended and one is retracted, the RCL will select retracted as the outrigger configuration). A confirmation of this configuration is all that is needed (see Figure 3-14). Refer to the *Rated Capacity Limiter Operator’s Manual* for detailed instructions.

Startup Graphic

8131-1

Operational Graphic



8131-2

FIGURE 3-14

HOIST SYSTEM OPERATION

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

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

Hoist Two Speed Operation

The high speed increases hoist line speed over normal operation. The high speed mode is activated by a switch (10, Figure 3-3) located on the crane cab console.

.

CAUTION

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

To start the high speed, depress the high speed switch and operate the hoist lever on the armrest. Refer to the load chart for more capacities

NOTE: Maximum Capacity with high speed on 5th layer.

- One Part Line - 5,000 lbs. (2272 kg)
- Two Part Line - 10,000 lbs. (4544 kg)
- Three Part Line - 15,000 lbs. (6818 kg)
- Maximum line speed on third layer - 351 FPM (107 mpm), fourth layer - 383 FPM (117 mpm)

WORK SITE LOCATION

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

Before Leaving the Truck Cab

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

DANGER

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

Stowing and Parking

WARNING

Tipping Hazard!

Never park the crane near holes, or on rocky or extremely soft surfaces. This may cause the crane to overturn.

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

When parking, the crane should be left in the smallest, most stable, valid operational configuration that the job site practically allows, do the following:

1. Park the crane on a stable surface.
2. Remove the load from the hook.
3. Stow the swingaway boom extension, if erected.
4. Fully retract the boom and position it in the normal travel position, then perform the following and proceed to Step 6:
   a. Engage the swing brake and/or swing lock pin.
   b. Retract all jack cylinders and outrigger beams.
5. If it is not practical to fully retract the boom and place it in the travel position, then perform the following and proceed to Step 6:
   a. Make the crane as stable as possible, including, boom angle, superstructure orientation, jib angle, etc. In high winds, the boom and jibs should be lowered or secured.
   b. Engage the swing brake and/or swing lock pin.
6. Apply the parking brake.
7. Put all operating controls in the neutral position.
8. Position the Crane Function switch to OFF.
9. Shut down the engine following the proper procedures specified in this manual and the applicable engine manual.
10. Remove the keys.

CAUTION

To avoid possible engine fault codes and undesirable operation, ensure the keyswitch has been off 2 minutes before disconnecting batteries.

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

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.

Before Making the Lift

- Set the outriggers as described in the Crane Set-up section in this manual.
- Prior to any fully retracted outrigger (0% extended) operation, extend jack cylinders with outriggers fully retracted and level crane. Engage swing brake and raise boom out of boom rest until the minimum boom angle for indicated boom length with no load is exceeded. DO NOT release swing brake with boom below minimum indicated boom angle.

DANGER

Tipping Hazard!

Serious injury or death could result from improper crane set-up on fully retracted outriggers.

In fully retracted outrigger configuration, before slewing:

Ensure outriggers are properly set and crane is level per operator manual.

Set swing brake to the locked position.

Raise boom to exceed minimum boom angle for given boom length at no load indicated on load chart

DO NOT release swing brake with boom below minimum indicated boom angle.

- Program the RCL as specified in the RCL Operator's Manual which is located in the crane cab.
- Check all controls for proper operation. If any abnormal operations are detected, the condition must be corrected before continuing.
- Check the work area for electric power lines.

LOAD CHART

Your unit is designed to provide satisfactory service if it is not loaded in excess of the maximum rated loads specified in the load chart. Overloading can create safety hazards, cause structural damage, and shorten the service life of the crane.

You must understand how to use the load charts located in the crane cab. Make sure the load, the working area, and the crane configuration are within the load limit specified in the load chart.

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

Using the Load Chart

NOTE: One of the most important tools of every crane is the load chart found in the crane operator's cab.

The load chart contains a large amount of information, which must be thoroughly understood by the operator.

The load chart contains outrigger capacity charts for fully extended, mid extended, outriggers for the main boom and boom extension, and fully retracted outrigger beams for main boom only.

Prior to any fully retracted outrigger (0% extended) operation, extend jack cylinders with outriggers fully retracted and level crane. Engage swing brake and raise boom out of boom rest until the minimum boom angle for indicated boom length with no load is exceeded. DO NOT release swing brake with boom below minimum indicated boom angle.

This condition is applicable when the load chart does not provide a maximum boom length at 0 degree boom angle in a no load situation. This is designated by "N/A".

DANGER

Tipping Hazard!

Serious injury or death could result from improper crane set-up on fully retracted outriggers.

In fully retracted outrigger configuration, before slewing:

Ensure outriggers are properly set and crane is level per operator manual.

Set swing brake to the locked position.

Raise boom to exceed minimum boom angle for given boom length at no load indicated on load chart

DO NOT release swing brake with boom below minimum indicated boom angle.

The capacity charts are divided into structural strength and stability limits. This is shown by the bold line across the chart. Capacities above the line are structural strength limits and capacities below the line are stability limits.

The left column is the load radius, which is the distance from the center of crane rotation to the load center of gravity. The top row lists various boom lengths ranging from fully retracted to fully extended or boom extension lengths and offsets. The number at the intersection of the left column and top row is the total load capacity for that load radius and boom length or boom extension lengths offset. The number in parentheses below the total load capacity is the required boom angle (in degrees) for that load. When the boom length or lift radius or both are between values listed, the smallest load shown at either the next larger radius or next longer or shorter boom length shall be used.

Another important section is the range diagram. The range diagram shows the operating radius and tip height that can be achieved at a given boom length and angle. If the operator knows the radius and tip height required for a specific lift, the angle and boom length can be quickly determined from the range diagram. Or, if the boom length and angle are known, the tip height and operating radius can be quickly determined.

A lifting diagram is included to describe over side, over rear, and over front lifting areas. The lifting area diagram shows that the locations of the outrigger stabilizer cylinders in the fully extended position are used to mark the boundaries of the lifting areas.

A boom extension capacity chart and notes are included to list the capacities for the extension length, load radius, and boom angle.

Another section contains the notes for lifting capacities. Be sure to read and understand all the notes concerning lifting capacities.

The load chart also gives weight reductions for load handling devices such as hook blocks, headache balls, boom extensions, etc., which must be taken into consideration as part of the load. Remember, the weight of any other load handling devices such as chains, slings, or spreader bars must be added to the weight of the load.

LIFTING THE LOAD

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

1. Position the crane in the work area and set the outriggers. See “Outrigger Setup” on page 2-14 for outrigger setup.
2. Program the RCL. Use the load chart to estimate the values.
3. Position the boom nose over the load. Do not try and drag the load with the boom or hoist.
4. Perform the lift. Meter the controls when moving the load to avoid sudden stops.
5. Retract and lower the boom after the lift is complete.

SHUT DOWN AND PREPARATION FOR ROAD TRAVEL

CAUTION

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

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

CAUTION

Machine Damage Hazard!

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

Fully retract the outrigger jacks and properly store the floats.

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

⚠ WARNING

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

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

2. Retract and place the boom in boom rest.
3. Ensure the center front stabilizer is fully retracted, if equipped.
4. Ensure the outrigger beams and jacks are fully retracted with the floats properly stowed.

⚠ CAUTION

Outrigger beams must be pinned for travel.

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

5. Engage the mechanical travel lock at each outrigger beam.
6. Engage the swing brake.
7. Engage the swing lock.
8. Either the hook block may be reeved over the main boom nose or the headache ball may be reeved over the main boom nose or auxiliary boom nose; the other must be removed and stowed securely before travelling. If the hook block or headache ball remains reeved on the boom, it must be secured at the tie down on the carrier provided for that purpose.
9. Secure the hook block and A2B weight:
   a. Slowly hoist up until there is a slight tension on the hoist cable. It may be necessary to override the A2B function to tension the cable.

b. The the A2B weight needs to be resting on the wedge socket so that there is slack in the anti-two-block-chain.

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

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

10. Turn off the ignition and all other switches in the crane cab.

11. Close and/or secure all windows and doors.

12. Exit the cab, lock the door, and stow the access ladder.

13. Secure any loads or lifting devices on truck bed or body.

14. Ensure tires are properly inflated.

15. Disengage the Power Take Off (PTO) and start truck from the truck cab.

Release the park brake before moving truck.

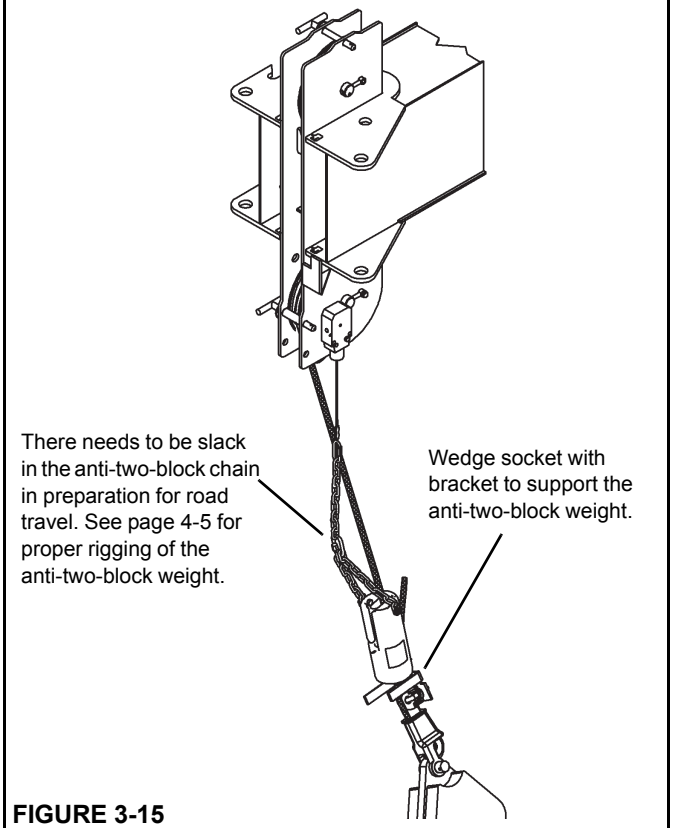


FIGURE 3-15

SECTION 4
SET-UP

SECTION CONTENTS

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

- Erect the jib
- Stow the jib
- Remove the jib
- Use multipart reeving
- Install the hoist cable
- Install the anti-two-block weight
- Install a wedge socket
- Counterweight

⚠ DANGER

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

JIB SAFETY INFORMATION

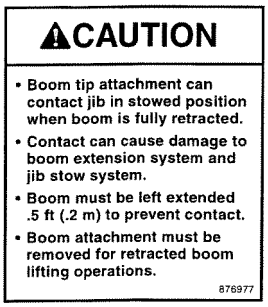
1. The anti-two-block switch weight and cord must be attached to the jib when deployed.
2. Operate with jib by radius when main boom is fully extended. If necessary, increase boom angle to maintain loaded radius.

   When radius is between points listed on capacity chart, the load shown at the next longer radius shall be used.
3. 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 capacity chart, the load shown at next lower boom angle shall be used.
4. Ensure jib is stowed correctly (Figure 4-1):
   a. Removal of swing around pins (C1, Figure 4-1), 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 (C1, Figure 4-1), will damage unit upon extension.
5. Only swing jib into working or stowed position when boom is horizontal, stow pin (A, Figure 4-1) and jib swing pin B, are removed and swing pins (C1) are in place. Jib could swing uncontrollably if boom is not horizontal.
6. Crane shall be fully set up according to proper set-up procedures outlined previously when stowing or unstowing jib.
7. Operate boom and turn functions very slowly and carefully when using jib since jibs can increase boom length by 50%.
8. Area where jib swings around must be clear of obstructions and power lines when stowing and unstowing jib.
9. Use safety glasses when pounding pins with hammer.
10. Do not extend/retract boom unless boom is horizontal when stow pin (A, Figure 4-1) and jib swing pin (B) are removed during stowing or unstowing procedures.

11. Always put spring clips in pins to ensure that they will stay in place.

12. When the jib is stowed, the boom can not be fully retracted if a boom tip attachment option is installed.



Also, on manually extendable jib options:

1. 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. Extendable section may slide out of 1st section jib when pin (E) is removed. Keep personnel clear of area.

JIB OPERATION

Deployment Procedure

1. Using boom telescope function, fully retract boom.

2. Using lift function, lower boom so that jib deployment pins (C1, Figure 4-1) and (C2, Figure 4-1) are easily accessible from the ground.

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

3. Install pins (C1, Figure 4-1) in upper and lower jib ears secure with retainer spring clips. These pins are used as a pivot point to swing jib into the deployed position.

4. Locate the stowed position of pins (C2, Figure 4-1). If in jib attachment holes or boom sheave case jib holes, remove pins from storage location.

5. Remove jib swing Pin (B, Figure 4-1) from top ear of jib.

6. Remove stow Pin (A, Figure 4-1) and stow in hook bracket (D), secure with spring clip.

7. Attach tag line to sheave case end of jib.

8. Using the lift function, raise the boom to the horizontal position.

9. Using telescope function, slowly extend boom approximately one foot. This procedure will pull the jib out of the jib stow bracket (H,Figure 4-1).

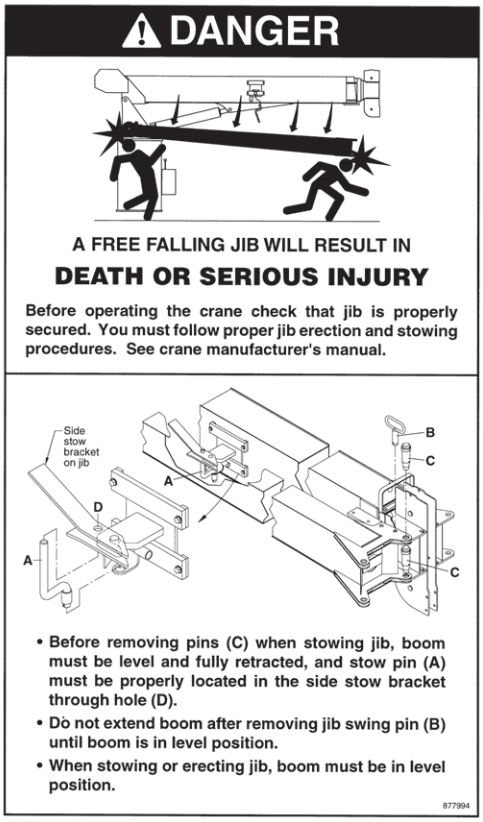
CAUTION

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, Figure 4-1) 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. Use the jib jack (F, Figure 4-1) to align lower (C2) pin.

a. Remove the jack handle (G, Figure 4-1) from the boom stowage bracket and check that the jack release valve is closed.

b. Extend the jack (F, Figure 4-1) so that the lower (C2) pin holes are aligned.

c. Install the lower (C2, Figure 4-1) pin and spring clip.

d. Open the jack release valve and retract the jack (F, Figure 4-1.

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 switch and weight/chain assembly and install on jib tip, see Figure 4-2. Be certain to use keeper provided with switch.

17. Disconnect 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, Figure 4-1) and spring clip into jib ears.

19. For manually extendable jibs, pull extension retaining pin (E, Figure 4-1), 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.

20. Make ATB cord connections as required.

Stowing Procedure

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

⚠ DANGER

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

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

- Side stow bracket completely engaged into stow hook with stow pin A properly in place.
- Both pins C1, Figure 4-1 in upper and lower jib holes properly in place through mating holes on boom tip.

1. Using lift function, lower boom so that jib deployment pins (C1, Figure 4-1) and (C2, Figure 4-1) are easily accessible from the ground.

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

2. Two section jib - For manually extendable jibs, pull extension retaining pin (E, Figure 4-1) and fully retract extendable 2nd section jib into the 1st section. Retraction of 2nd section may be facilitated by attaching loadline wedge socket to jib nose. Slowly activate the hoist up function until the 2nd section is fully retracted.

3. Two section jib - Reinstall extension retaining pin (E, Figure 4-1 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 anti-two-block wire connector at rear of the jib extension. Re-connect anti-two-block switch connector on boom tip. Move weight/chain assembly to boom tip see Figure 4-2.

6. Attach tag line to sheave case end of jib.

7. Remove spring clips from pins (C2, Figure 4-1) on both upper and lower jib ears.

8. Remove jib swing pin (B, Figure 4-1) from the boom nose.

9. Remove pins (C2, Figure 4-1) 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.

10. Raise the boom to the horizontal position.

11. Extend boom approximately 1 foot (.3m).

12. Using tag line attached to jib sheave case, slowly swing jib into stow position (parallel with 1st section boom), Pins (C1, Figure 4-1) are the jib pivot points during this operation.

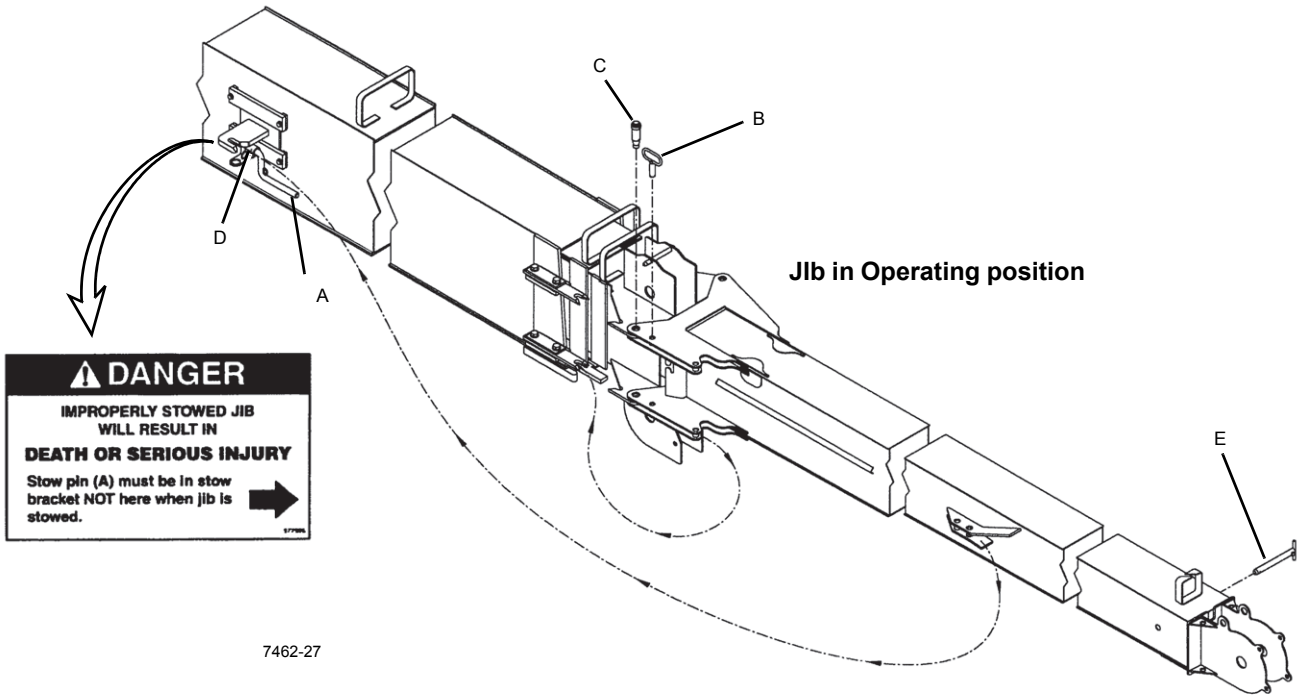
:

CAUTION

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

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

NOTE: Jib swing pin (B, Figure 4-1) does not retain the jib in its stowed position on the Ist section boom.



Jib in Operating position

A	Stow Pin
B	Jib Swing Pin
C	Jib Deployment Pins
D	Hook Bracket
E	Extension Retaining Pin
F	Jib Jack
G	Jack Handle
H	Jib Stowage Bracket

Jib in Stow Position

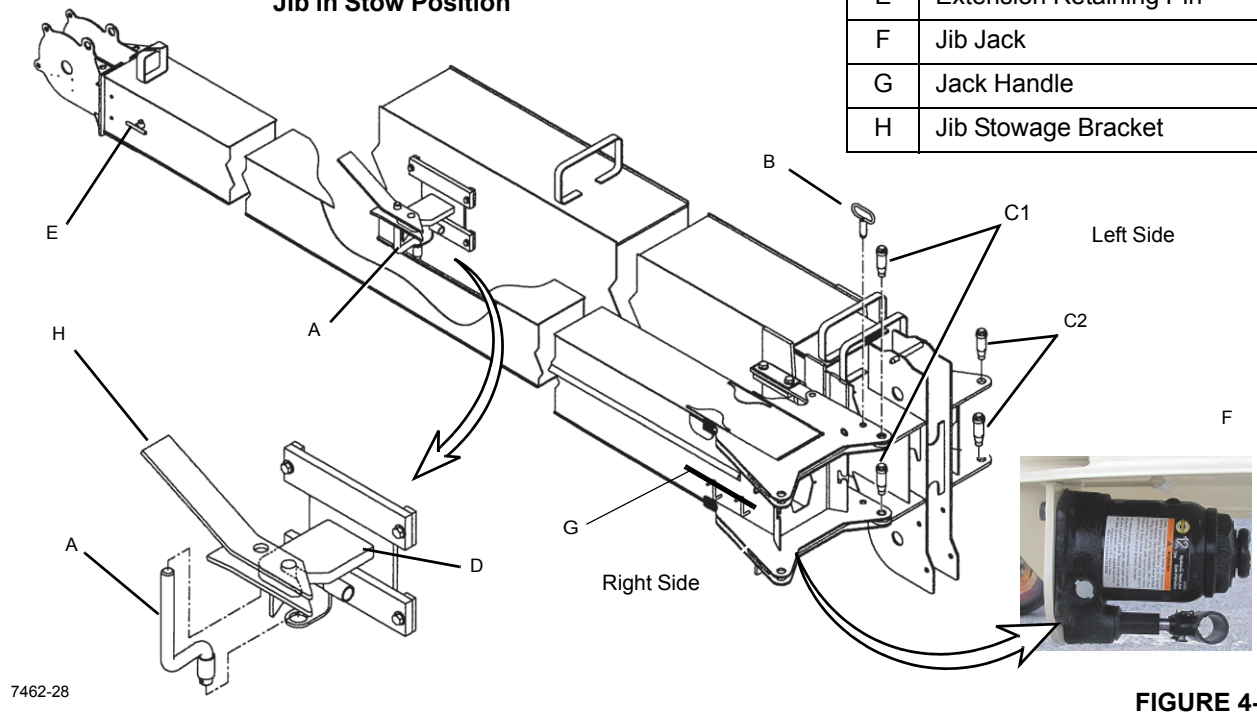


FIGURE 4-1

14. Using boom telescope function, slowly retract boom.

The jib stow bracket (H, Figure 4-1) on the side of the jib will engage the side stow bracket (D) on the side of the 1st section boom; first lifting the jib and then engaging the jib side stow bracket (H) and the stow bracket (D) completely upon full retraction of the boom.

15. Install stow pin (A, Figure 4-1) with spring clip into the jib stow bracket (H) on the jib. Complete engagement of stow brackets and proper installation of pin A is critical for secure jib stow attachment.

16. Remove pins (C1 Figure 4-1) from upper and lower jib ears. A slight hammer strike may be necessary to remove pins. Always use proper eye protection during this step.

17. Reinstall loadline over boom sheave case.

JIB REMOVAL

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

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.

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

Jib Maintenance

1. Lubricate as outlined in SECTION 5.

2. Check for free rotation of jib sheave daily when using jib.

ANTI-TWO BLOCK WEIGHT INSTALLATION

To prevent the hoist cable from slipping out of the ant-two-block weight, rig the weight as shown in Figure 4-2.

The A2B bracket is for single part line use only. Remove the A2B bracket shown in Figure 4-2 from the hoist cable when changing from a single part line to a multiple part line to allow the hoist cable and wedge socket to reeve through the sheaves on the boom nose and the hookblock. Re-install the clamp and nuts to the cable before performing a lift.

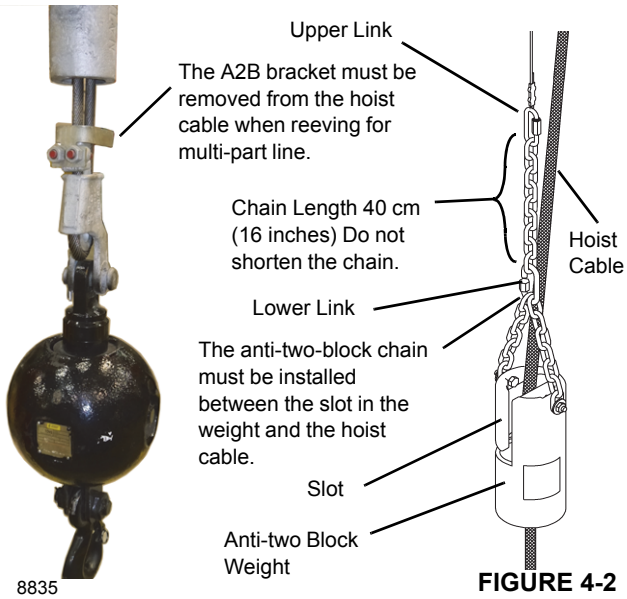


FIGURE 4-2

MULTI-PART LINE REEVING

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

Using Multiple Part Lines

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

The A2B bracket is for single part line use only. Remove the A2B bracket shown in Figure 4-2 from the hoist cable when changing from a single part line to a multiple part line to allow the hoist cable and wedge socket to reeve through the sheaves on the boom nose and the hookblock. Re-install the clamp and nuts to the cable before performing a lift.

STOW PEGS FOR HOIST CABLE

Stow pegs located on top of the boom keep the hoist cables secure when not reeved over the boom nose. The main hoist cable is stowed on the right peg and the auxiliary hoist cable is stowed on the left peg as viewed from the back of the boom.

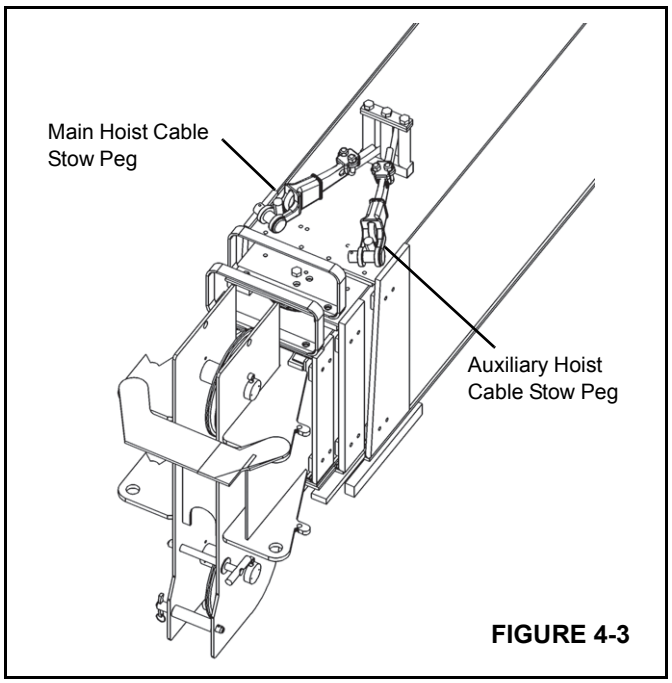


FIGURE 4-3

MULTI-PART LINE REEVING

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

Using Multiple Part Lines

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

The NBT36 is rated to lift 72,000 lbs (36 ton) at a 7 ft radius with all booms retracted with an seven part block

The NBT40 is rated to lift 80,000 lbs (40 ton) at a 7 ft radius with all booms retracted with an eight part block

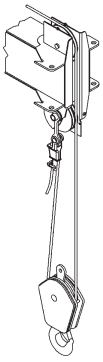
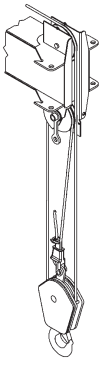
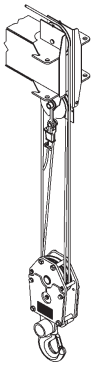
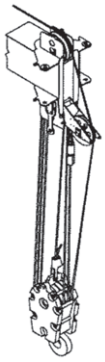
The NBT45 is rated to lift 90,000 lbs (45 ton) at a 7 ft radius with all booms retracted with an eight part block.

All pulls shown in the following table are on the fourth layer. The line pulls increase and the speed decreases on the third, second, and first layers.

NOTE: Keep at least three wraps of loadline on the drum at all times.

Do not deadhead hook block against boom tip when extending the boom.

Refer to load charts for all layers and wire rope capacities.

1 Part Line	2 Part Line	3 Part Line	4 Part Line	5 Part Line	6 Part Line	7 Part Line	8 Part Line
							
Maximum Pull Normal Speed 11,250 Lbs 191 fpm High Speed 5,000 Lbs 383 fpm	Maximum Pull Normal Speed 22,500 Lbs 95 fpm High Speed 10,000 Lbs 191 fpm	Maximum Pull Normal Speed 33,750 Lbs 63 fpm High Speed 15,000 Lbs 127 fpm	Maximum Pull Normal Speed 45,000 Lbs 47 fpm High Speed 20,000 Lbs 95 fpm	Maximum Pull Normal Speed 56,250 Lbs 38 fpm High Speed 25,000 Lbs 76 fpm	Maximum Pull Normal Speed 67,500 Lbs 31 fpm High Speed 30,000 Lbs 63 fpm	Maximum Pull Normal Speed 78,750Lbs 27 fpm High Speed 35,000 Lbs 54 fpm	Maximum Pull Normal Speed 90,000Lbs 23 fpm High Speed 40,000 Lbs 47 fpm
The hook block must be sized to the number of line parts. For example, do not use a six part line hook block on a three part line reeving. Contact your National Crane Distributor or Manitowoc Crane Care to order the proper hook block.							

INSTALLING CABLE ON THE HOIST

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

CAUTION

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

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

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

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

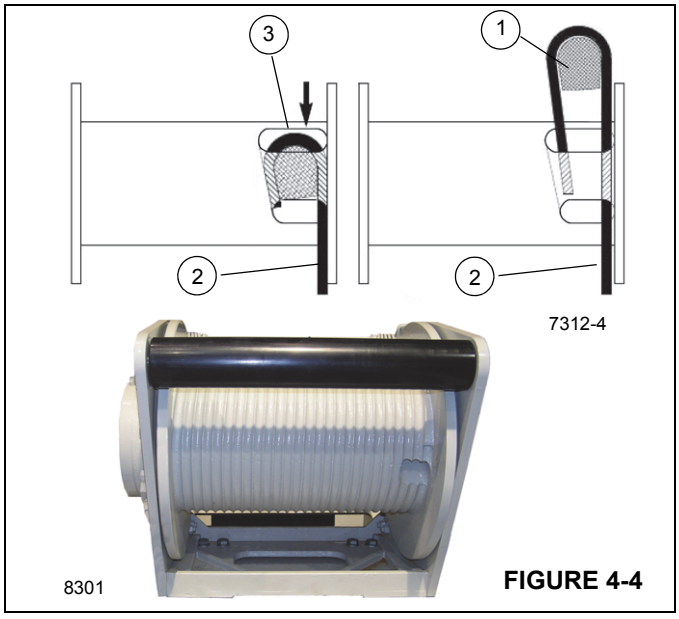


FIGURE 4-4

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

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

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7. Slowly rotate the drum, ensuring the first layer of cable is evenly wound onto the drum.
8. Install the remainder of the cable, as applicable.
9. Attach the wedge socket to the free end of the cable as shown in (Figure 4-6). If you are using a terminator wedge socket, see Figure 4-5.
10. Torque the clamp on the dead end of the cable to 95 ft-lb (128 Nm).

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

11. Start winding the cable onto the hoist drum. Maintain about 500 pounds (250 kg) of tension on the cable.
12. Keep the cable wraps tight against each other when the first half of the bare hoist is filling. The second half of the hoist should wrap tightly because the fleet angle of the cable tends to pull the cable to the center of the drum thus wrapping tightly.
13. Continue winding the cable on the second, third and fourth layer of the hoist. Keep the cable paying in straight to the boom to avoid side loading the boom. The preceding layers will wrap smoothly guided by the first layer wrapping.

WEDGE SOCKETS

To install a wedge socket:

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

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

Terminator Wedge Installation

The NBT40 SERIES is shipped with a terminator wedge socket which is National Crane's preferred type of socket (Figure 4-5). Other wedge socket types are shown on page 4-8.

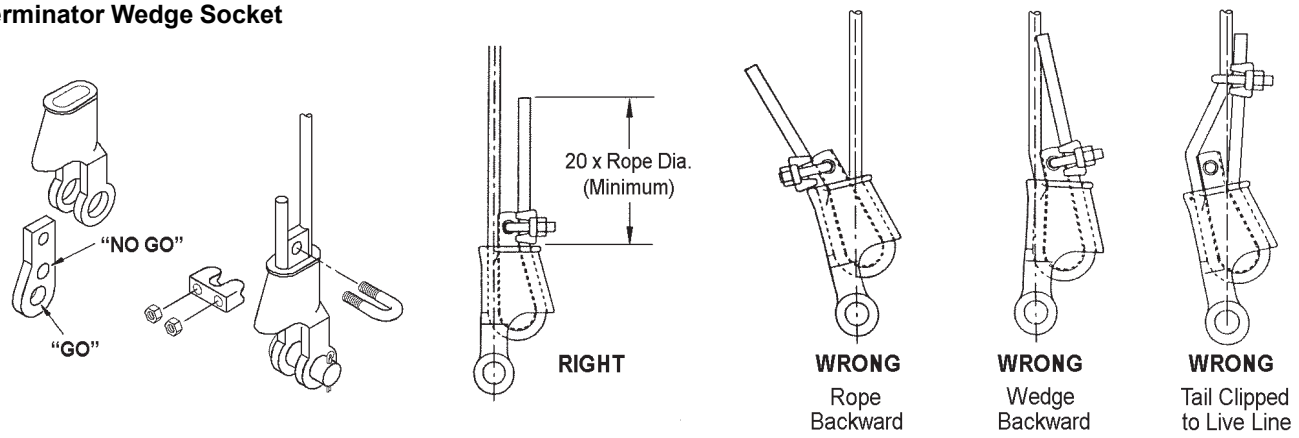
To attach a terminator wedge Figure 4-5, use the following procedure:

1. Match the socket, wedge, and clip to the wire rope and size the rope with the go and no go hole in the socket.
   - The wire rope must pass through the "go" hole and not pass through the "no go" hole.

- If the wire rope passes through the “no go” hole, the wedge is the wrong size.
- If the wire rope does not pass through the “go” hole, the wedge is the wrong size.

2. Align the live end of rope, with center line of pin.
3. Secure dead end section of rope.
4. Tighten nuts on clip to recommended torque.
5. Do not attach dead end to live end or install wedge backwards.
6. Use a hammer to seat Wedge and Rope as deep into socket as possible before applying first load.

Terminator Wedge Socket



Torque Value Table

Cable Size (inches)	3/8	7/16	1/2	9/16	5/8	3/4	7/8	1	1-1/8	1-1/4
Torque ft/lbs	45	65	65	95	95	130	225	225	225	360
Torque values shown are based upon clean dry threads free of lubrication.										

FIGURE 4-5

Wedge Socket Installation

1. Inspect the wedge and socket. Remove any rough edges and burrs.
2. The end of the wire rope should be seized using soft, or annealed wire or strand. If the end of the rope is welded, the welded end should be cut off. Do not weld on size 6X37 rope. This will allow the distortion of the rope strands, caused by the bend around the wedge, to adjust themselves at the end of the line. Refer to SECTION 1 - INTRODUCTION in the Service Manual for wire rope procedures.
3. Make sure the live-end (Figure 4-6) of the rope is directly in line with the ears of the socket and the direction of pull to which the rope will be subjected. If the rope is loaded into the socket incorrectly, under a load the rope will bend as it leaves the socket, and the edge of the socket will wear into the rope causing damage to the rope and eventual failure.

Wedge Socket

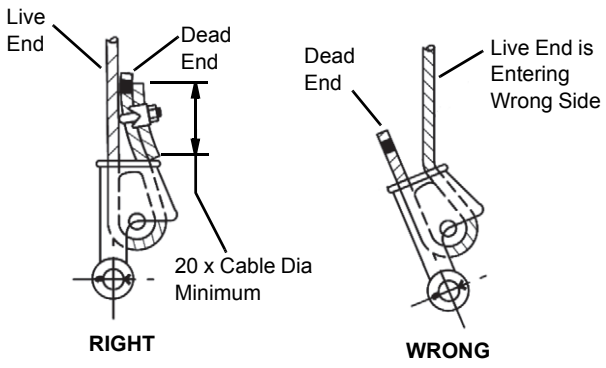


FIGURE 4-6

4. Insert the end of the wire rope into the socket, form a loop in the rope, and route the rope back through the socket allowing the dead-end (Figure 4-6) to protrude from the socket. Ensure the dead-end of the rope is of sufficient length to apply end treatment to the dead-end after the wedge has been seated.

5. Insert the wedge into the loop and pull the live-end of the rope until the wedge and rope are snug inside the socket. It is recommended that the wedge be seated inside the socket to properly secure the wire rope by using the crane's hoist to first apply a light load to the live-end.
6. After final pin connections are made, increase the loads gradually until the wedge is properly seated.
7. The wire rope and wedge must be properly secured inside the socket before placing the crane into lifting service. It is the wedge that secures the wire rope inside the socket. The dead-end treatment is used to restrain the wedge from becoming dislodged from the socket should the rope suddenly become unloaded due to the headache ball or hook block striking the ground, etc; refer to "Dead-end Rigging" on page 2-9.

Dead-end Rigging

Sketches A through F (Figure 4-7) illustrate various ANSI approved methods for treating the dead-ends of wire ropes which exit a wedge socket assembly. While use of the loop-back method is acceptable, care must be exercised to avoid the loop becoming entangled with tree branches and other components during crane transport and with the anti-two block system and other components during use of the crane.

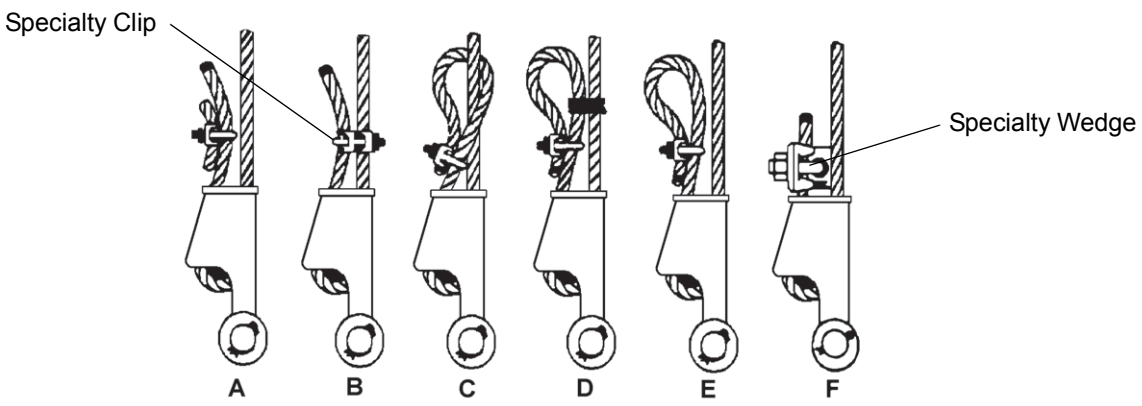
Of the methods shown below, Manitowoc prefers that method A or F be used, i.e., clipping a short piece of wire rope to the dead-end or using a commercially available specialty wedge. Typically, it is recommended that the tail length of the dead-end should be a minimum of 6 rope diameters but not less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

When using method A, place a wire rope clip around the dead end by clamping a short extra piece of rope to the rope dead end. DO NOT CLAMP THE LIVE END. The U-bolt should bear against the dead end. The saddle of the clip should bear against the short extra piece. Torque the U-bolts according to the table titled Wire Rope Clip Torque Values (Table 4-1).

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

Table 4-1

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



Wedge Socket

FIGURE 4-7

SECTION 5
LUBRICATION

SECTION CONTENTS

GENERAL

Following the designated lubrication procedure is important in ensuring maximum crane lifetime and utilization. The procedures and lubrication charts in this section include information on the types of lubricants used, the location of the lubrication points, the frequency of lubrication, and other information. The information included in this section does not include lubrication requirements for the truck chassis. Refer to appropriate truck manufacturer's manual for this information.

ENVIRONMENTAL PROTECTION

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

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

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

When filling and draining crane components, observe the following:

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

Immediately clean up any spills.

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

Lubricants

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

Arctic Conditions Below -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 Crane distributor or Manitowoc Crane Care.

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

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

Chassis Grease

CAUTION

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

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

CAUTION

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

Low Temperature Grease

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

Extreme Pressure Multipurpose Gear Lubricant (EPGL)

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

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

Open Gear Lubricant

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

Antifreeze/Coolant (for Cab Heater)

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

Anti-wear Additives

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

Hydraulic Oil

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

CAUTION

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

NOTE: When operating the crane in temperatures -9°C (15°F) and below, follow the procedures in the section titled “Arctic Conditions Below -9°C (15°F)” on page-2.

Standard Hydraulic Oil

Temperature Above -9°C (15°F)

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

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

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

CAUTION

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

Arctic Hydraulic Oil

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

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

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

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

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

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

Hydraulic Oil Inspection

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

Under normal operating conditions, it is recommended that hydraulic oil, filter and breathers be inspected at least every three to six months and more frequently for severe operating conditions. The inspections should be for air borne and/or ingested particles and water that deteriorate and contaminate the oil. For example, if oil appears “milky” or no longer has a transparent clear to amber color. The return filter by-pass indicator should be observed daily to determine if contaminant content is high. If the indicator reaches the red zone or indicates a by-pass condition, the hydraulic oil must be sampled. The hydraulic tank breather should also be inspected to assure that it is not restricting air flow into and out of the reservoir.

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

LUBRICATION

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

DANGER

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

CAUTION

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

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

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

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

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

CAUTION

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

NOTE:

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

Table 5-1

Symbol	Description	Manitowoc Lube Specification	
		Standard	Cold Weather - 40°C (-40°F)
AFC	Antifreeze/Coolant (for Cab Heater)	6829101130	6829104212
EP-MPG	Extreme Pressure Multipurpose Grease	6829003477	6829104275
GL-5	GL-5 Gear Lubricant	6829012964	6829014058
HYDO	Hydraulic Oil	6829006444	6829006993
EP-OGL	Open Gear Lubricant, CEPLATTYN 300 Spray, NLGI Grade 1-2	6829102971	6829102971
AGMA EP-4	Extreme Pressure Gear Lubricant.	6829100213	6829103636
WRL	Wire Rope Lubricant	6829015236	6829010993
EO-20W-20	Engine Oil (Light non-EP Oil), Mil-L-46152	6829005570	-
TES 295	TES295 Compliant Fluid	-	6829101690
NOTE: Cold weather lubricants are not sufficient for temperatures below 40° C (-40° F). Use hydraulic tank heaters and insulate where appropriate.			

Lubrication Points

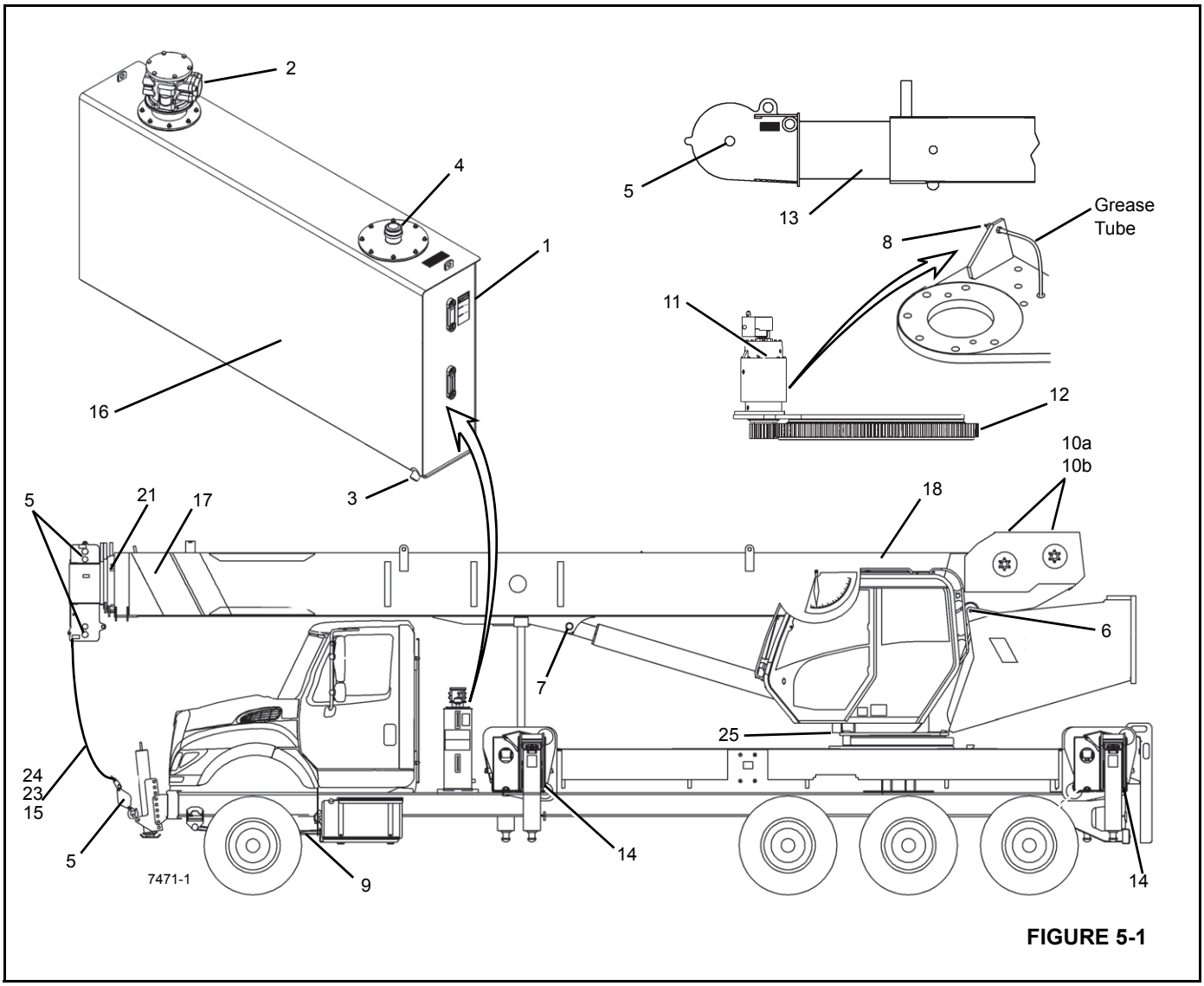


FIGURE 5-1

Table 5-2

Item	Application	Recommended Lubricant	Procedure	Frequency
1	Hydraulic oil reservoir	Hydraulic Oil	Check fill change	Weekly As Required Semi-Annually
2	Oil filter, Hydraulic oil reservoir		Change or clean	After first 40 Hrs. As indicated by gauge thereafter.
3	Magnetic Plug, Hydraulic oil reservoir		Clean	At oil filter service interval.
4	Breather, Hydraulic oil reservoir		Clean	Monthly
5	Sheave pins: boom nose (5 plcs), jib (1 pl), hook block (1 pl), Aux Boom Nose (1 pl)	EP-MPG	Grease gun	Weekly
6	Boom pivot pin	EP-MPG	Grease gun	Monthly
7	Lift cylinder pins - 2 ea.	EP-MPG	Grease gun	Monthly

Item	Application	Recommended Lubricant	Procedure	Frequency
8	Turntable bearing	EP-MPG	Grease gun	Weekly
9	Pump Drive U-Joint - 2 ea. (If Equipped) or Pump Spline Shaft (Direct Mount)	Chassis Grease Coupling Lube Spline Lubricant	Change Check and Fill Change	After First 100 Operating Hours Weekly Semi-Annually
10a	Main and Auxiliary Hoist gearbox.	GL-5	Change/check & fill	After First 100 Operating Hours Weekly Every 1000 hours or 6 months
10b	Hoist brake	EO-20W-20 or TES295	Change/check & fill	After First 100 Operating Hours Weekly Every 1000 hours or 6 months
11	Swing drive gearbox	GL-5	Change	After 100 operating hours
12	Swing gear teeth	EP-OGL	Spray Can	Monthly
13	Boom Jib	EP-MPG	Brush, roller, or grease gun	Monthly or as required
14	Outrigger beams, bottom, sides	EP-MPG	Brush or roller	Monthly or as Required
15	Wire rope	EP-OGL	Brush or spray	Semi-Annually
16	Diffuser strainer, Hydraulic oil reservoir		Clean	Semi-Annually with Oil Change
17a	Extend Sheaves: 2nd Section 127 ft and 142 ft booms each Side	Chassis Grease #200S Silver Streak Special Multi-Lube (light)	Grease Gun	Weekly
17b	Extend Sheaves: 4th Section 127 ft and 142 ft booms, each side	Chassis Grease #200S Silver Streak Special Multi-Lube (light)	Grease Gun	Weekly
18	Retract Sheaves - extend boom until retract sheave zerks are visible through access holes at center of boom.	Chassis Grease #200S Silver Streak Special Multi-Lube (light)	Grease Gun	Weekly
19	Wire Rope Jib Extension Cables (Not Shown)	WRL	Spray or Brush	Any Time Boom is Disassembled or 5 Years
20	Boom Wear Pads (Not Shown)	EP-MPG	See Boom Lubrication	Monthly or as Required
21	Wire or Hose Rollers	SAE 10	Oil Can	Quarterly
21	Wire or Hose Rollers	SAE 10	Oil Can	Quarterly
22	Cab Heater Reservoir	AFC	Check/Fill/Drain	Weekly/As Required/Semi-Annually
23	Hook Block Swivel Bearing	EP-MPG	Grease gun	Monthly
24	Hook Block Sheaves	EP-MPG	Grease gun	Monthly
25	Turntable Swing Lockpin	EP-MPG	Spray	Monthly

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

BOOM LUBRICATION

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.

Lubrication of the extend and retract sheaves is as follows:

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

Side and Bottom Boom Wear Pad Lubrication

DANGER

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

Recommended lubricant is EP-3MG grease.

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

Top Boom Wear Pad Lubrication

DANGER

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

Recommended lubricant is EP-3MG grease.

1. Fully extend and set the outriggers.
2. Lower the boom to horizontal.
3. Remove access plate at top rear of the base section.
4. Extend the boom until wear pads are centered in access opening and apply grease to all wear pads and contact surfaces at the top of all boom sections with a grease gun or a brush.
5. Raise the boom to 75°.
6. Extend and retract the boom several times until the grease is evenly spread.
7. Repeat as necessary.

Outrigger Beam Lubrication

DANGER

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

Recommended lubricant is EP-3MG grease.

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

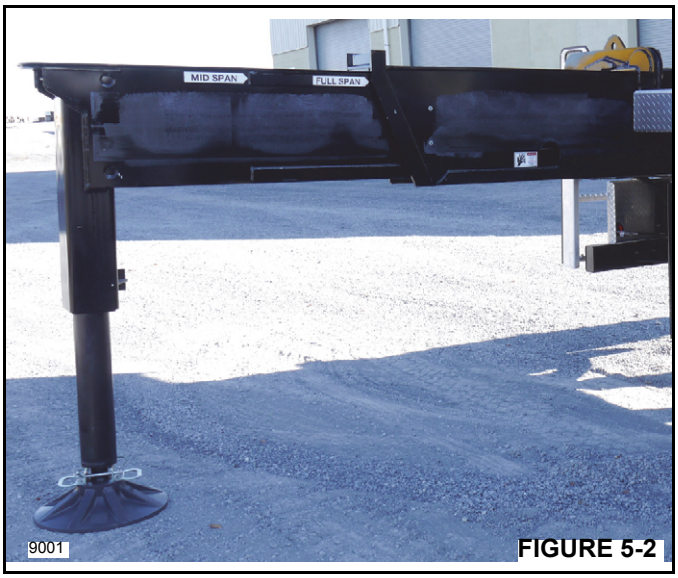


FIGURE 5-2

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

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

5

Drain /Add New Hoist Brake Oil

To drain and add new oil:

- Remove the drain plug (3, Figure 5-3), inspection plug (2) and vent plug (1).
- Drain the brake oil.
- Reinstall drain plug (3) and add oil at the brake oil vent hole (1) until oil is at the bottom level of the inspection hole (2). See Table 5-2. The hoist brake fill capacity is 0.23 liter (.25 quart).
- Install the inspection plug (2) and the oil vent and fill plug (1).

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.

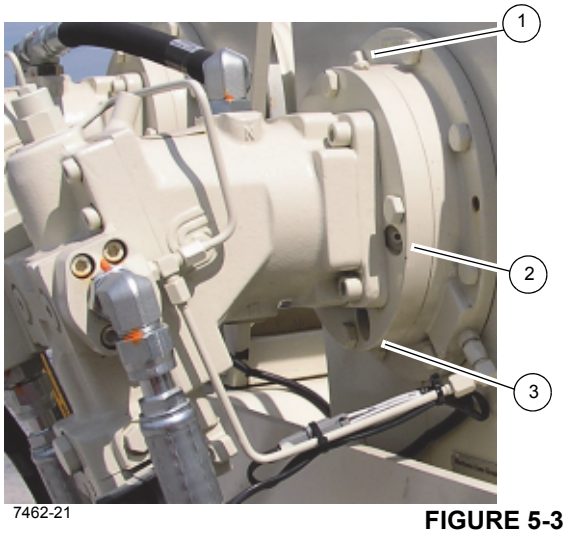


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FIGURE 5-3

DANGER

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

Hoist Gearbox Oil

Check Hoist Gearbox Oil Level:

- Rotate the drum until the oil fill/vent plug (1, (Figure 5-4) is visible in the inspection hole.
- Remove the fill/level plug (1) and visually inspect the oil level. The oil should be level with the bottom of the inspection/fill hole. If more oil is needed, add oil. (See Table 5-2).
- Re-install fill/level plug (1).

Fill Hoist Gearbox with Oil.

- To fill with oil, rotate the drum so the gearbox fill/level port (1, Figure 5-4) is visible through the upper hole.
- Remove fill/level plug (1) with a hex socket.
- Install a 1” pipe with elbow into the fill hole (1) to assist with adding oil.
- Remove the vent plug (3) to assist with adding the oil.
- Fill gear box with 3.3 l (3.50 qt) of oil or until oil is at the bottom level of the inspection hole with gear lube oil. See Table 5-2.

- ***Drain and Fill Hoist Gearbox with Oil.***
- To drain and add new oil, remove the vent plug (3, Figure 5-4) to assist with draining the oil.
- Remove fill/level plug (1) with a hex socket.
- Remove the drain plug (2) with a hex head socket.
- Screw a 1” pipe into the drain plug hole to assist with draining the oil.
- Drain the oil.
- Remove the 1” drain pipe.
- Install oil drain plug (2).
- Install a 1” pipe with elbow into the fill hole (1) to assist with adding oil.
- Fill gear box with 3.3 l (3.50 qt) of oil or until oil is at the bottom level of the inspection hole with gear lube oil. See (Table 5-2).
- Remove the 1” fill pipe.
- Install the inspection plug (1).
- Install the vent plug (3)

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

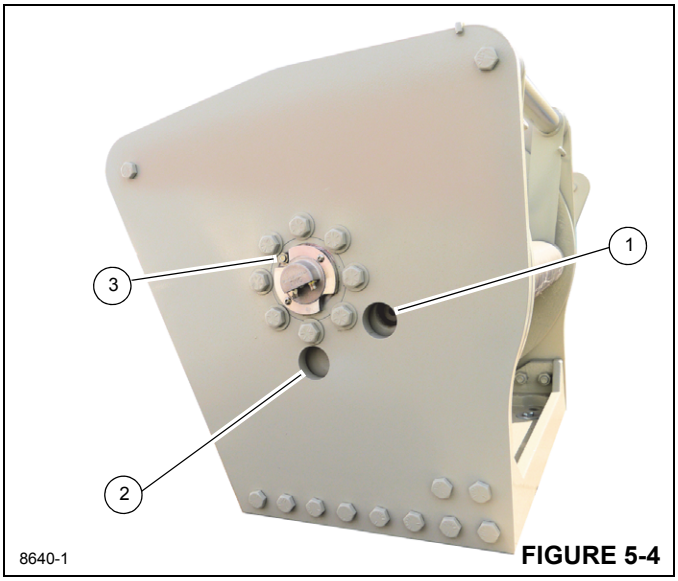


FIGURE 5-4

Swing Gearbox and Brake Oil

Check Swing Gearbox oil level:

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

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

Gearbox oil level inspection is achieved by removing the gearbox fill/vent plug and visually inspecting the oil level. Maximum oil level is to be 1" below the port for this gearbox with 3.3 l (3.50 qt) of gear lube oil.

Gearbox lubricants are satisfactory for standard operation in temperatures from -23° C to 82° C (-10° F to +180° F). For operation outside this range, contact Manitowoc Crane Care for recommendations.

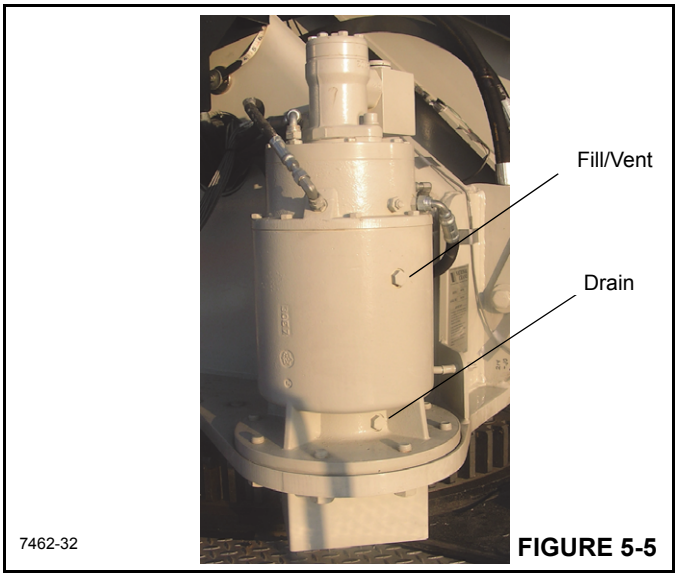


FIGURE 5-5

Hydraulic Oil Reservoir Level

The hydraulic oil reservoir has a sight gauge (1, Figure 5-6) located on the side of the reservoir. The oil in the hydraulic reservoir is sufficient when the level is between the High and Low marks on the sight gauge with the crane parked on a level surface in the transport position and the oil cold.

If the oil level is to low, add the recommended hydraulic oil until the oil level is even with the upper mark. If the oil level is high, drain oil until the oil level is even with the upper mark.

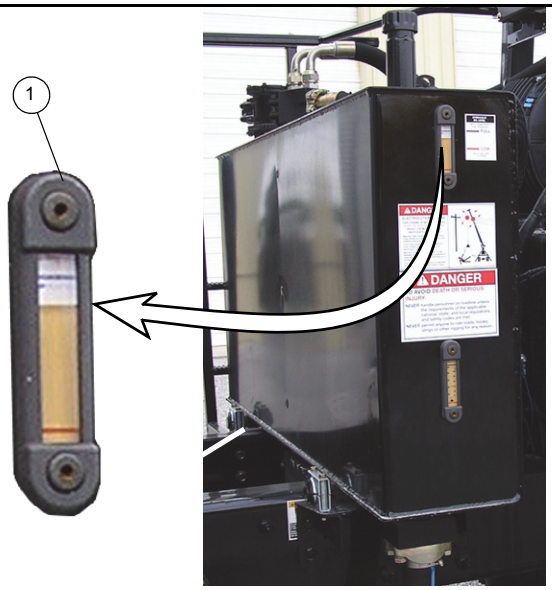


FIGURE 5-6

AIR CONDITIONING

When servicing air conditioner, evacuate system prior to disconnecting any components connected to the pressurized

lines. Follow the specifications listed on section titled *Air Conditioner*, page 9-32.

After servicing ensure air conditioning system is re-charged with refrigerant and oil according to specifications listed on (Table 5-2 on page 5-5).

WIRE ROPE LUBRICATION

Wire rope is lubricated during manufacture and the lubricant applied does not last the life of the rope. The wire rope must be lubricated as part of a regularly scheduled maintenance program. The lubricant applied must be compatible with the original lubricant and not hinder visual inspection of the rope. Consult the rope manufacturer for proper lubricant. The sections of rope which are located over sheaves or otherwise hidden during inspection and maintenance procedures require special attention.

The object of rope lubrication is to reduce internal friction and to prevent corrosion. The type and amount of lubrication applied during manufacture depends on the rope size, type, and anticipated use. This lubrication provides the finished rope with protection for a reasonable time if the rope is stored under proper conditions. When the rope is put into service, periodic applications of a suitable rope lubricant are necessary. Characteristics of a good wire rope lubricant are that it should be:

- free from acids and alkalis.
- have sufficient adhesive strength to remain on the rope.
- of a viscosity capable of penetrating the interstices between wires and strands.
- not be soluble in the medium surrounding it under the actual operating conditions (i.e. Water).
- have a high film strength.
- resistant to oxidation.

Before applying lubrication, accumulations of dirt or other abrasive material should be removed from the rope. Clean with a stiff wire brush and solvent, compressed air, or live steam. Lubricate the rope immediately after the rope is cleaned. Techniques that can be used include:

- bath
- dripping
- pouring
- swabbing
- painting
- pressure spray

Whenever possible, the lubricant should be applied at the top of a bend in the rope, because at that point the strands are spread by bending and are more easily penetrated. There should be no load on the rope while it is being lubricated. The service life of wire rope is directly proportional to the effectiveness of the method used and amount of lubricant that reaches the working parts of the rope.

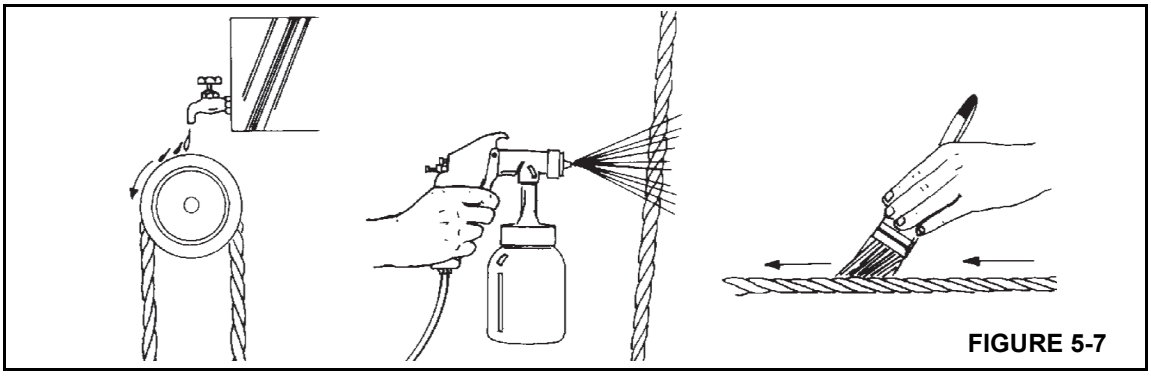


FIGURE 5-7

CARWELL® RUST INHIBITOR

Protecting Cranes From Rusting

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

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

Carwell® is a treatment, not a coating. It contains no silicones, solvents, CFCs or anything that would be classified as hazardous under OSHA Regulation 29 CFR 19 10.1200. The product is a liquid blend of petroleum derivatives, rust inhibitors, water-repelling and water-displacing agents.

Special equipment is used to spray a light film onto the entire undercarriage and various other areas of each new crane prior to shipment. When applied the product has a red tint to allow applicators to view coverage during application. This red tint will turn clear on its own within approximately 24 hours after application.

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

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

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

The most common causes of corrosion include the following:

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

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

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

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

Cleaning Procedures

DANGER

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

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

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

CAUTION

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

- Rinse the dirt and dust off before washing the crane. Dirt can scratch the crane's finish during washing/cleaning.

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

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

Inspection and Repair

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

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

CAUTION

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

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

For scratches and marks in areas of low visibility:

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

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

Application

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

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

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

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

NOTE: Unit must be completely dry before applying treatment.

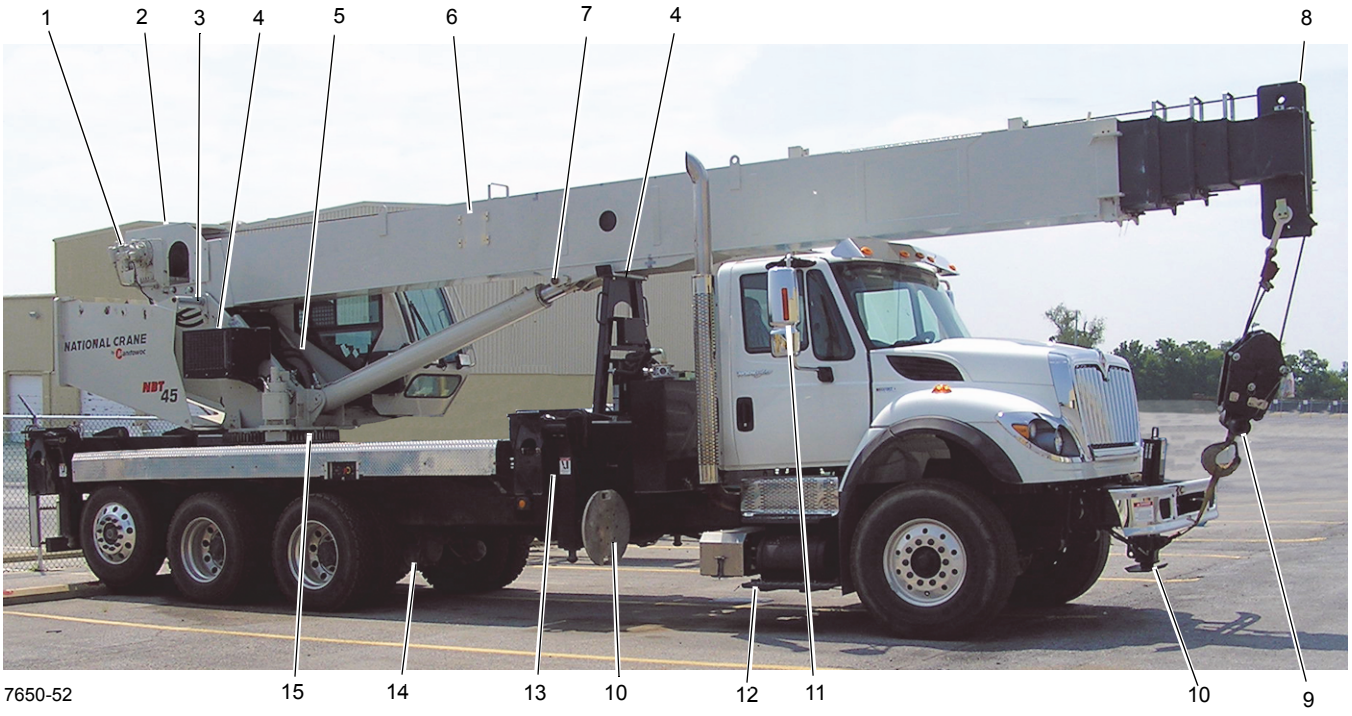
- Do not allow product to puddle or build-up on weather stripping, rubber gaskets, etc. Unit should not have puddles or runs evident anywhere.
- To ensure proper coverage of treatment, the product needs to be fogged on the unit.
- Use of pressure pots to apply the treatment to the unit being processed is recommended.
- Carwell® treatment is available in 16 ounce spray bottles from Manitowoc Crane Care (order part number 8898904099).
- After application of the treatment is complete, wash or clean film residue from lights, windshield, grab handles, ladders/steps and all access areas to crane, as necessary.

Please contact Manitowoc Crane Care should you have any questions.

Areas of Application

Refer to Figure 5-8

- 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, slew ring fasteners and all interior surfaces of the frame.
- Frame application areas are; hose ends and fittings, all unpainted fasteners and hardware, all bare metal surfaces, outrigger pads, and back up alarm hardware.
- Superstructure applications are; hose end and fittings, wire rope on hoist roller tensioning springs on hoists, all unpainted fasteners and hardware, valves, slew ring fasteners and all bare metal surfaces.
- Boom applications areas are; pivot pins, hose end and fittings, jib pins and shafts, all bare metal surfaces, headache ball pins/ hook block pins and fasteners.
- All hardware, clips, pins, hose connections not painted will have treatment applied.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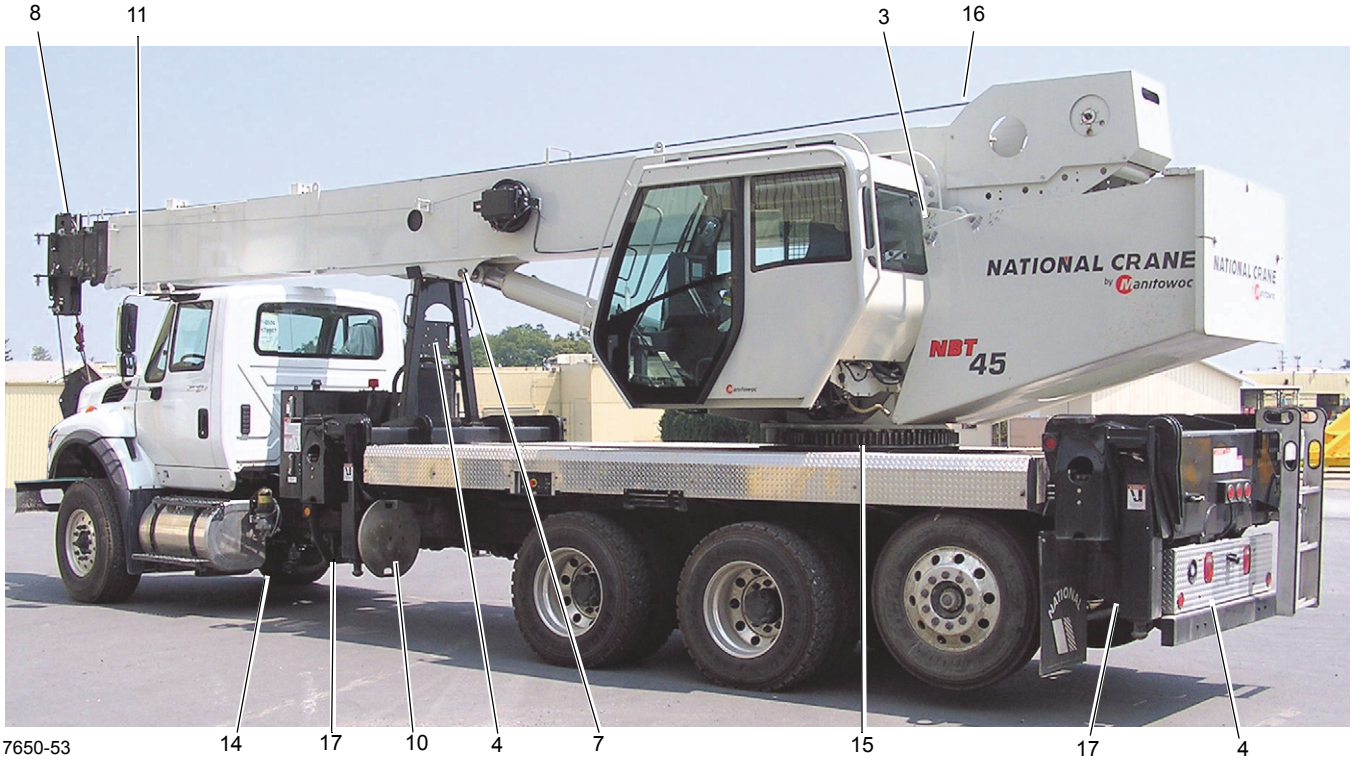
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FIGURE 5-8

Item	Description
1	Hoist Plumbing Connections
2	Tension Spring
3	Counterweight Pins
4	All Hardware, Clips, Pins, Hose Connections not painted O/R Pins, Clips
5	Valvebank, Hose Connections inside turntable
6	Boom Extension Hardware (Optional)
7	Pivot Shaft
8	Boom Nose Pins, Clips

Item	Description
9	Headache Ball/Hook block
10	O/R Pins, Clips
11	Mirror Mounting Hardware
12	Powertrain Hardware
13	O/R Hose Connections
14	Entire underside of unit
15	Turntable Bearing Fasteners
16	Wire Rope
17	Outrigger Beam Hardware

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SECTION 6
MAINTENANCE CHECKLIST

SECTION CONTENTS

CRANE INSPECTION AND MAINTENANCE

Regularly scheduled inspection and maintenance intervals are required to keep the crane in peak operating condition. The following pages outline the inspection and maintenance intervals.

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

⚠ WARNING

Fall Hazard!

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

Inspections

The inspection intervals listed below are to be conducted on the unit to ensure safe and proper operation. Refer to the *Service Manual* when installing missing or loose fasteners. Should a defect be found, a determination must be made as to whether the deficiency is a safety hazard or though not yet a safety hazard, needs to be monitored in the monthly inspections.

The inspections are separated into the following frequency classifications:

- Daily inspections - performed by the operator at the start of the day.
- Weekly inspections - performed by the operator.
- Monthly inspections - performed by maintenance personnel.
- Periodic inspections - performed by maintenance personnel at least every three months and includes all items listed under daily, weekly, and monthly inspections. Federal Laws through OSHA and ANSI B30.5 require that dated and signed records of these periodic inspections be kept. An inspection log book is available from your National Crane distributor or Manitowoc Crane Care.

⚠ WARNING

If any defect determined during the inspection is a safety hazard the machine must be removed from service and the defect corrected.

Daily Inspections/Pre-use

Check the following items:

1. Engine oil level.
2. Hydraulic oil level.
3. Radiator coolant level.
4. Loose parts or damage to structures or welds.
5. Operation of lights, safety equipment and gauges.
6. Condition of tires and suspension.
7. Condition of hoist cable and end attachment for corrosion, severe kinking, crushing, cutting, or slippage of cable clamps or wedge socket.
8. Loose parts or damage to cable centering hook blocks.
9. Position of cable with guides and on sheaves.
10. Free turning of sheaves.
11. Lubrication as specified by the *Lubrication*, Section 5.
12. Evidence of oil leaks from hoses, gearboxes, or swivel.
13. Hand and foot controls for malfunction or incorrect adjustment.
14. Truck parking brake operation.
15. Boom proportioning to insure that all boom sections extend and retract equally.
16. All securing hardware such as cotter pins, snap rings, hairpins, pin keepers, and capscrews for proper installation.
17. Proper condition and operation of RCL and anti-two-block systems to include the anti-two-block switch weight and chain at the boom tip (and extension tip if equipped), power cords, audible alarms, and indicator lights on the console.
18. Proper operation of the load hook safety latch.
19. Hooks and latches for excessive wear, cracks or damage from heat or chemicals.
20. Drain holes at rear of the first section of the boom are clear of all obstructions.
21. All fasteners retaining the cable centering block are in place and tight.
22. All safety covers for proper installation.
23. Boom lift and outrigger holding valves for proper operation.
24. Hoist brake for proper operation at hoist capacity load.
25. Control and drive mechanisms for excessive wear and/or contamination from lubricants, water or other foreign matter.

Weekly Inspections

Check the following items:

1. Battery water level.
2. Tire pressure.
3. Lubrication as specified by the *Lubrication*, Section 5.
4. Torque the T-box mounting bolts during the first month of operation and periodic inspections thereafter.
5. Torque the swing bearing mounting bolts during the first month of operation and periodic inspections thereafter.
6. Torque the boom wear pad retaining bolts during first month of operation, and monthly thereafter.
7. Check to see that this crane's *Operator's Manual* is with the crane. If the manual is missing, obtain the serial number of the crane and order an operator's manual immediately.

Monthly Inspections

Check the following items:

1. All cylinders and valves for improper operation or signs of leaks.
2. Lubrication as specified by the *Lubrication Points*, page 5-5.
3. Load hook for cracks or having more than 15 percent normal throat opening or 10 degree twist.
4. All structural members (boom, sub-base, frame, turret, and outriggers) for bends, cracks, or broken members.
5. All welds for breaks or cracks.
6. All pins for proper installation.
7. All control, safety, and capacity placards for readability and secure attachment.
8. Cable clip bolts above wedge socket at end of loadline should be properly torqued, refer to the *Service Manual*.
9. All boom wear pad retaining bolts.
10. Boom extension cables for proper tension or evidence of abnormal wear.
11. Sheaves and cable drums for wear and cracks.
12. Unwind the loadline and check according to cable maintenance procedure.

Periodic/Annual Inspection

Check the following items:

1. All items listed under daily, weekly, and monthly inspections.
2. Loose bolts and fasteners in all areas. Torque pin retainer bolts.

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

Special Boom Inspection

If the boom has not been disassembled and inspected in the last seven 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.

- Manitowoc recommends that boom extension cables be replaced every seven (7) years.

Stability

Stability of unit throughout working area. Check the stability procedure in Installation Section of the *Service Manual* annually or when any changes are made to crane or truck.

HOIST CABLE INSPECTION AND MAINTENANCE

⚠ WARNING

Worn or Damaged Equipment Hazard!

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

Wire rope should be inspected frequently/daily and periodically/yearly in accordance with the following information excerpted from a National Consensus Standard as referenced by Federal Government Agencies. Recommended inspection intervals may vary from machine to machine and may vary based on environmental conditions, frequency of lifts, and exposure to shock loads. The inspection time intervals may also be predetermined by state and local regulatory agencies.

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. Manitowoc recommends that boom extension cables be replaced every seven (7) years.

NOTE: Wire rope may be purchased through Manitowoc Crane Care.

Keeping Records

A signed and dated report of the wire rope's condition at each periodic inspection must be kept on file at all times. The report must cover all inspection points listed in this section. The information in the records can then be used to establish data which can be used to determine when a wire rope should be replaced.

It is recommended that the wire rope inspection program include reports on the examination of wire rope removed from service. This information can be used to establish a relationship between visual inspection and the rope's actual internal condition at the time of removal from service.

Environmental Conditions

The life expectancy of wire rope may vary due to the degree of environmental hostility and other conditions to which these mechanical devices are subjected. Variation in temperature, continuous excessive moisture levels, exposure to corrosive chemicals or vapors or subjecting the wire rope to abrasive material may shorten normal wire rope life. Frequent/periodic inspections and maintenance of wire rope is recommended for preventing premature wear and to insure long-term satisfactory performance.

NOTE: Refer to *Wire Rope Lubrication*, page 5-10 for wire rope lubrication requirements.

Dynamic Shock Loads

Subjecting wire rope to abnormal loads beyond the endurance limit will shorten the wire rope life expectancy. Examples of this type of loading are listed below.

- High velocity movement, for example; hoisting or swinging of a load followed by abrupt stops.
- Suspending loads while traveling over irregular surfaces such as railroad tracks, potholes, and rough terrain.
- Lifting a load that is beyond the rated capacity of the lifting mechanism, such as overloading.

Precautions and Recommendations During Inspection

- Always use safety glasses for eye protection.
- Wear protective clothing, gloves, and safety shoes as appropriate.
- Measure the rope's diameter across crowns of the strands when determining if rope has become damaged, refer to Figure 6-1.

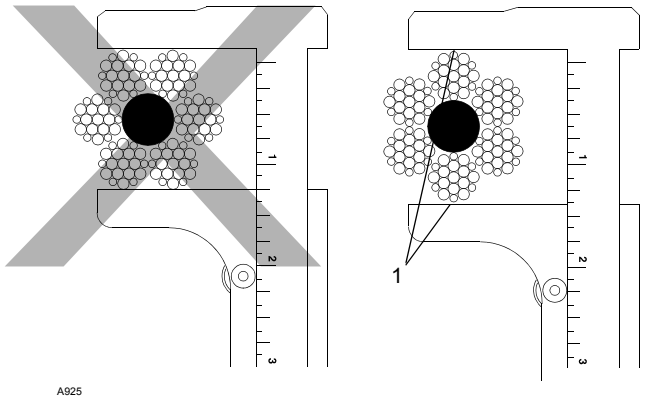


FIGURE 6-1

Inspection

All hoist cable in service needs to be inspected on a daily, monthly, and quarterly basis. Cable which has been idle for a period of a month or more must be given a thorough inspection before it is placed in service. These inspections should cover all types of deterioration including:

- Distortion such as kinking, crushing, un-stranding, bird caging, main strand displacement or core protrusion.
- Loss of cable diameter in a short cable length or unevenness of outer strands indicates the cable needs to be replaced.
- Significant corrosion.
- Broken or cut strands.
- Number, distribution and type of visible broken wires.
- Core failure in rotation resistant ropes.
- Prior electrical contact with a power line or other electric arc damage.
- Significantly corroded, cracked, bent, or worn end connections.

Only inspect the outer surface of a cable. Never attempt to open the cable.

Pay particular attention to areas of the rope where wear and other damage is likely to occur:

- Pick-up Points: Sections of wire rope that are repeatedly stressed during each lift, such as those sections in contact with sheaves.
- End Attachments: The point where a fitting is attached to the wire rope or the point where the wire rope is attached to the hoist drum.
- Abuse Points: The point where the wire rope is subjected to abnormal scuffing and scraping.

Daily Inspections

All cable in continuous service must be inspected at the beginning of each work day. Inspect the eye end and length of cable that is used in daily operation. The end should be inspected for abrasion, corrosion, broken wires, and loose or broken servings. Inspect the remainder of the cable length used for daily operations for points showing kinks, sharp bends, or any other evidences of damage or excessive wear.

Monthly Inspections

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

Periodic Inspections

Wire rope should be inspected periodically/annually, or at a shorter time interval, if necessitated by environmental or other adverse conditions, and shall cover the entire length of the wire rope. Periodic inspection should include all previous items listed under Inspection, plus the following:

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

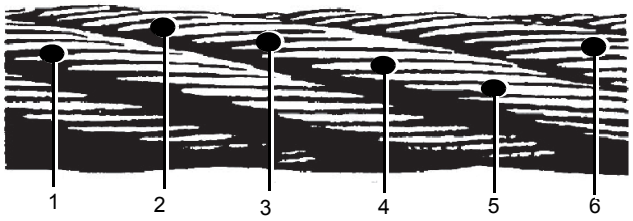
or hoist drums can accelerate wear and cause rapid deterioration of the wire rope.

Inspect the eye end of the cable for greater wear than the rest of the cable. If the cable is in good condition, reverse the cable on the drum so that the wear is equalized along the total length of the cable.

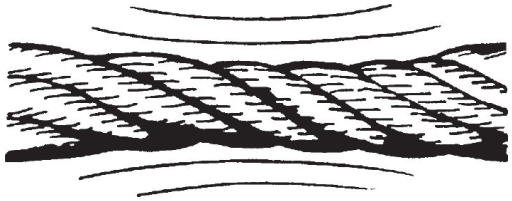
Wire Rope Replacement

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

- Six randomly distributed broken wires in one rope lay or three broken wires in one strand in one lay. The rope is unsafe for further use if there are either three broken wires in one strand (Breaks 2, 3, 4) or a total of six broken wires in all strands in any one lay.



- In rotation resistant ropes: two randomly distributed broken wires in six rope diameters or four randomly distributed broken wires in 30 rope diameters
- Wear of one-third the original diameter of outside individual wires. Worn rope, usually indicated by flat spots on the outer wires is unsafe for further use when less than two-thirds the thickness of the outer wire remains.
- Necking down of the rope indicates core failure.



- Kinking, crushing, bird caging, or any other damage resulting in distortion of the rope structure.
- Evidence of heat damage.
- Reductions from nominal diameter of more than:
  - 0.0156 in (.4 mm) for rope diameters to 0.313 in (8 mm)
  - 0.031 (.8 mm) for rope diameters 0.375 in (9.5 mm) to 0.50 in (12.7 mm)
  - 0.047 in (1.2 mm) for rope diameters 0.561 in (14.3 mm) to 0.75 in (19.1 mm)
  - 0.063 (1.6 mm) for rope diameters 0.875 in (22.2 mm) to 1.125 in (28.6 mm).
- One outer wire broken at its point of contact with the core of the rope which has worked its way out of, and protrudes or loops out from the rope structure.

Care of Wire Rope

Handle wire rope with care to prevent damage to the individual wires which affect the overall strength and performance of the rope. Do not allow the formation of kinks, because this displaces the strands of wire from their original position and relation to each other causing severe bending and unequal tensions in the strands. This distortion and wire displacement cannot be corrected even under high tension and a permanent weak point remains in the rope. Displaced or raised wires indicate a previous kink, but does not show the damaged condition of the inner rope wires.

Never pull wire rope over a non-rotating support such as a spindle bar, a pin, or an inoperative sheave. This practice causes severe abrasion to the outer strand wires. A properly operating sheave or snatch block is essential to safety and long service life of the rope.

Do not use worn sheaves or sheaves with flat grooves because they do not provide sufficient support to prevent the distortion and flattening of the rope. Sheaves with nicked or broken flanges can cut or otherwise damage the rope.

An even distribution of rope coils over the hoist drum is essential to smooth operation. This prevents the rope from cutting down through or crushing other coils on the drum resulting in damage to and difficulty in unwinding the rope.

REPLACEMENT CABLE

If the hoist cable needs to be replaced, care should be taken in selecting a suitable replacement cable. The cable strength requirements are shown on the crane load chart. The types of cable are optional with 6 x 25 and Dyform being the most common. A high strength, rotation resistant cable is preferred and is furnished as standard by National Cranes. This cable eliminates single part line load spin and prolongs cable life. It also eliminates load block spin up when multi-part reeving is used.

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

9/16 in. (14.3mm) Dia. Wire cable: 6X25 General Purpose 6X25 Nominal Breaking Strength: 16.8 tons (15,241 kg)

CRANE ADJUSTMENTS AND REPAIRS

Before adjustments and repairs are started on a crane, read and be familiar with the safety information outlined under *Maintenance*, page 2-27.

Boom Extension Cable

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

Jib Jack Service and Maintenance

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

Adding Oil to the Jib Jack

To add oil to the jib jack, do the following:

1. Set the jack in an upright level position.
2. Lower the saddle and make sure the piston is fully depressed.
3. Remove the oil filler plug.
4. Fill until the oil is level with the filler plug hole.

Changing the Jib Jack Oil

For best performance and longest life, replace the oil at least once a year. To change oil, do the following:

1. Remove the filler plug.
2. Lay the jack on its side and drain the oil into a suitable drain pan. The oil will run slowly because air must enter as oil drains out.
3. Be careful to prevent dirt or foreign matter from entering the system.
4. Replace with proper oil as described above.

Lubrication

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

Rust Prevention

Check the ram every three months for any sign of rust or corrosion. Clean as needed and wipe with an oil saturated cloth.

NOTE: When not in use, always leave the saddle and ram all the way down.

HYDRAULIC SYSTEM

Oil Cooler

The heat exchanger must be kept clean for efficient operation of the hydraulic cooler system. Wash the heat exchanger core frequently to eliminate oil film, road dirt, and other foreign object buildup on the heat exchanger fins.

Frequent inspection and tightening of hose clamp eliminates the possibility of end connection failure due to back pressure from a cold startup.

If the cooler system fails to provide adequate performance, reduced air or oil flow through the heat exchanger is the probable cause. Inspect the cooling fan for proper operation. Any obstructions to air flow should be corrected (cooler too close to other truck components, foreign matter in heat exchanger fins, etc.) All hydraulic lines should be periodically checked for obstructions, hose kinks or other flow restrictions.

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
No response to control	RCL system inoperative.	Insure the RCL system is working properly and the anti-two-block solenoid is powered.
	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.
	Boom holding valves out of adjustment.	Adjust or clean as required.
	Oil temperature too high.	Run engine at idle with controls in the neutral position until hydraulic oil light goes out.
	Hydraulic oil too cold or dirty.	Warm oil or use less viscous oil.
	Line restricted.	Check lines; clean and repair as required.
	Internal control valve crack.	Replace valve.
	Load too heavy.	Check load chart and reduce load.
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.
	Brake not holding properly.	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.

Condition	Possible Cause	Possible Solution
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 brake pilot pressure. Clean pilot line or adjust motor counterbalance valves.
	Swing speed adjustment set too low.	Adjust or clean brake for proper release.
		Adjust valve on turn motor.
Excessive pump noise during operation.	Excessive pump speed.	Adjust foot throttle or check for too high PTO ratio.
	Low oil temperature.	Allow unit to warm up.
	Low hydraulic oil supply.	Check and fill.
	Suction line kinked, collapsed or blocked.	Clear blockage.
	Hydraulic oil too thick.	Warm oil or use oil more applicable to environment.
	Relief valve chattering.	Dirt in relief valve or damaged relief.
	Hydraulic tubing vibration.	Check for loose tubing.
	Tank breather plugged.	Clean breather.
Cylinders drift	Not getting oil to cylinders.	Clean and replace as required.
	Worn or damaged piston seals.	Replace as required.
	Air in hydraulic oil.	Cycle crane cylinder to remove air.
	Loose holding valve.	Tighten valve.
	Dirt in holding or check valve.	Clean valve.
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, 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	Repair ATB if defective.

Condition	Possible Cause	Possible Solution
System is in a state of constant cut-out.	Blown fuse.	Check fuse at crane cab console. Replace if necessary.
	ATB switch open.	Ensure that ATB switch is closed.
System cuts out too early or too late.	RCL programmed wrong.	Reprogram RCL with correct lift values.
Jib Jack Troubleshooting		
Will not lift load.	No oil in system. Release valve not closed.	Add oil to reservoir. Turn handle clockwise tightly.
Will lift load only part way.	Oil level low.	Add oil to reservoir tank.
Will lift load but will not hold.	The following valve or valves leaking. a. Suction valve b. Delivery valve c. 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 non-flammable solvent.
Poor lifting.	Dirty oil. Air in hydraulic system.	Change oil. 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 SIZE DESIGNATION	USAGE	TIRE LOAD LIMITS (kg/lbs.) AT VARIOUS COLD INFLATION PRESSURES (kPa/psi)											
		450 *65*	480 *70*	520 *75*	550 *80*	590 *85*	620 *90*	660 *95*	690 *100*	720 *105*	760 *110*	790 *115*	830 *120*
295/60R22.5	DUAL	1750 *3860*	1830 *4040*	1930 *4245*	2000 *4410*	2030 *4480*	2120 *4665*	2240 *4940*	2280 *5025*	2360 *5195*	2430 *5355*	2510 *5535*	**2575**(H) 141 ***5675***(H)
	SINGLE	1850 *4080*	1950 *4300*	2050 *4515*	2120 *4675*	2230 *4925*	2330 *5125*	2430 *5355*	2500 *5520*	2590 *5710*	2650 *5840*	2760 *6085*	**2800**(H) 144 ***6175***(H)
225/70R19.5	DUAL	**1180**(D) 114 ***2600***(D)	1230 *2720*	1300 *2860*	**1360**(E) 119 ***3000***(E)	1410 *3115*	1470 *3245*	**1550**(F) 123 ***3415***(F)	1580 *3490*	1640 *3615*	**1700**(G) 126 ***3750***(G)		
	SINGLE	**1250**(D) 116 ***2755***(D)	1310 *2895*	1380 *3040*	**1450**(E) 121 ***3195***(E)	1500 *3315*	1570 *3450*	**1650**(F) 125 ***3640***(F)	1690 *3715*	1740 *3845*	**1800**(G) 128 ***3970***(G)		
245/70R19.5	DUAL				1550 *3415*	1590 *3515*	1660 *3655*	**1750**(F) 127 ***3860***(F)	1790 *3940*	1850 *4075*	**1950**(G) 131 ***4300***(G)	1970 *4345*	**2060**(H) 133 ***4540***(H)
	SINGLE				1650 *3640*	1700 *3740*	1770 *3890*	**1850**(F) 129 ***4080***(F)	1900 *4190*	1970 *4335*	**2060**(G) 133 ***4540***(G)	2095 *4620*	**2180**(H) 135 ***4805***(H)
265/70R19.5	DUAL				1700 *3750*	1780 *3930*	1860 *4095*	1950 *4300*	2000 *4405*	2000 *4415*	**2120**(G) 134 ***4675***(G)		
	SINGLE				1800 *3970*	1900 *4180*	1970 *4355*	2060 *4540*	2130 *4685*	2200 *4850*	**2300**(G) 137 ***5070***(G)		
305/70R19.5	DUAL				2060 *4540*	2120 *4670*	2200 *4860*	2300 *5070*	2370 *5230*	2450 *5410*	**2575**(H) 141 **5675**(H)	2620 *5770*	**2725**(J) 143 ***6005***(J)
	SINGLE				2240 *4940*	2330 *5130*	2420 *5340*	2500 *5510*	2610 *5745*	2700 *5945*	**2800**(H) 144 ***6175***(H)	2870 *6340*	**3000**(J) 146 ***6610***(J)

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

TABLE TBM-2R
Continued

TIRE SIZE DESIGNATION	USAGE	TIRE LOAD LIMITS (kg/lbs.) AT VARIOUS COLD INFLATION PRESSURES (kPa/psi)											
		450 *65*	480 *70*	520 *75*	550 *80*	590 *85*	620 *90*	660 *95*	690 *100*	720 *105*	760 *110*	790 *115*	830 *120*
255/70R22.5	DUAL				1800 *3970*	1860 *4110*	1940 *4275*	2000 *4410*	2020 *4455*	2090 *4610*	**2120(G)** [134] ***4675*(G)**	2230 *4915*	**2300(H)** [137] ***5070*(H)**
	SINGLE				1900 *4190*	1980 *4370*	2060 *4550*	2120 *4675*	2220 *4895*	2300 *5065*	**2360(G)** [138] ***5205*(G)**	2450 *5400*	**2500(H)** [140] ***5510*(H)**
305/75R22.5	DUAL				2360 *5205*	2440 *5375*	2540 *5595*	2560 *5840*	2730 *6025*	2830 *6235*	**3000(H)** [146] ***6610*(H)**	3010 *6640*	**3150(J)** [148] ***6940*(J)**
	SINGLE				2575 *5675*	2680 *5905*	2790 *6150*	2900 *6395*	3000 *6620*	3110 *6850*	**3250(H)** [149] ***7160*(H)**	3310 *7300*	**3450(J)** [151] ***7610*(J)**
315/80R22.5	DUAL				2575 *5675*	2650 *5840*	2750 *6070*	**2900(G)** [145] ***6395*(G)**	2970 *6545*	3070 *6770*	**3150(H)** [148] ***6940*(H)**	3270 *7210*	**3450(J)** [151] ***7610*(J)**
	SINGLE				2800 *6175*	2910 *6415*	3030 *6670*	**3150(G)** [148] ***6940*(G)**	3260 *7190*	3370 *7440*	**3450(H)** [151] ***7610*(H)**	3590 *7920*	**3750(J)** [154] ***8270*(J)**
305/85R22.5	DUAL				2430 *5355*	2520 *5550*	2620 *5780*	2725 *6005*	2820 *6215*	2920 *6435*	**3075(H)** [147] ***6780*(H)**	3110 *6860*	**3250(J)** [149] ***7160*(J)**
	SINGLE				2650 *5840*	2770 *6100*	2880 *6350*	3000 *6610*	3100 *6830*	3210 *7070*	**3350(H)** [150] ***7390*(H)**	3420 *7540*	**3550(J)** [152] ***7830*(J)**

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

TABLE TBM-1R

TIRE SIZE DESIGNATION	USAGE	TIRE LOAD LIMIT AT VARIOUS COLD INFLATION PRESSURES											
		kPa *psi*	480 *70*	520 *75*	550 *80*	590 *85*	620 *90*	660 *95*	690 *100*	720 *105*	760 *110*	790 *115*	830 *120*
245/75R22.5 235/80R22.5	DUAL	kg *lbs.*	1430 *3160*	1500 *3315*	1600 *3525*	1640 *3615*	1710 *3765*	1800 *3970*	1840 *4055*	1900 *4195*	**1950(G)** [131] ***4300(G)***		
	SINGLE	kg *lbs.*	1570 *3470*	1650 *3645*	1750 *3860*	1800 *3975*	1880 *4140*	1950 *4300*	2020 *4455*	2090 *4610*	**2120(G)** [134] ***4675(G)***		
265/75R22.5 255/80R22.5	DUAL	kg *lbs.*	1600 *3525*	1680 *3705*	1750 *3860*	1830 *4040*	1910 *4205*	2000 *4410*	2050 *4525*	2130 *4685*	**2180(G)** [135] ***4805(G)***		
	SINGLE	kg *lbs.*	1760 *3875*	1850 *4070*	1950 *4300*	2010 *4440*	2100 *4620*	2180 *4805*	2260 *4975*	2340 *5150*	**2360(G)** [138] ***5205(G)***		
295/75R22.5 275/80R22.5	DUAL	kg *lbs.*	1860 *4095*	1950 *4300*	2060 *4540*	2130 *4690*	2220 *4885*	**2300(F)** [137] ***5070(F)***	2390 *5260*	2470 *5440*	**2575(G)** [141] ***5675(G)***	2630 *5795*	**2725(H)** [143] ***6005(H)***
	SINGLE	kg *lbs.*	2040 *4500*	2140 *4725*	2240 *4940*	2340 *5155*	2440 *5370*	**2500(F)** [140] ***5510(F)***	2620 *5780*	2710 *5980*	**2800(G)** [144] ***6175(G)***	2890 *6370*	**3000(H)** [146] ***6610(H)***
285/75R24.5 275/80R24.5	DUAL	kg *lbs.*	1870 *4135*	1970 *4340*	2060 *4540*	2150 *4740*	2240 *4930*	**2360(F)** [138] ***5205(F)***	2410 *5310*	2490 *5495*	**2575(G)** [141] ***5675(G)***	2660 *5860*	**2800(H)** [144] ***6175(H)***
	SINGLE	kg *lbs.*	2060 *4545*	2160 *4770*	2240 *4940*	2360 *5210*	2460 *5420*	**2575(F)** [141] ***5675(F)***	2650 *5835*	2740 *6040*	**2800(G)** [144] ***6175(G)***	2920 *6440*	**3075(H)** [147] ***6780(H)***

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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	Tire Load Limits 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*
445/65R19.5	kg	3410	3610	3750	3960	4100	4250	4410	4540	**4750(J)**	162		
	lbs.	*7540*	*7930*	*8270*	*8680*	*9040*	*9370*	*9730*	*10100*	***10500(J)***			
385/65R22.5	kg	2880	3060	3150	3350	3470	3650	3740	3850	4000		4100	**4250(J)** 158
	lbs.	*6380*	*6720*	*6940*	*7350*	*7650*	*8050*	*8230*	*8510*	*8820*		*9050*	***9370(J)***
425/65R22.5	kg	3430	3640	3750	3980	4130	4250	4440	4580	**4750(J)**	162	4880	**5000(L)** 164
	lbs.	*7590*	*7990*	*8270*	*8740*	*9100*	*9370*	*9790*	*10100*	***10500(J)***		*10700*	***11000(L)***
445/65R22.5	kg	3720	3950	4125	4320	4470	**4625(H)** 161	4820	4960	5150		5290	**5600(L)** 168
	lbs.	*8230*	*8660*	*9090*	*9480*	*9870*	***10200(H)***	*10600*	*11000*	*11400*		*11700*	***12300(L)***

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

Hydraulic Pump.....75.5 gpm (286 1/min) at 2200 rpm, Variable displacement, axial piston with load sense
- Displacement.....8.54 in^3/rev (140 cc/rev)
- Pressure Rating (rated)..... 4600 psi (320 bar)
- Pressure Rating (peak .....5075 psi (350 bar)
- Case Refill Capacity.....37 gal (1.40 liter)
- Minimum Operating Speed .....600 rpm

Outrigger System .....3250 (+/-100) psi
Air Conditioner .....3500 (+/-100) psi
Boom Up .....35 gpm at 4550 psi
Boom Down .....17 gpm at 1000 psi
Telescope Extend .....35 gpm at 2900 psi
Telescope Retract .....17 gpm at 2250 psi
Aux/Main Hoist System & Relief.....35 gpm at 4300 psi
Swing .....18 gpm at 3100 (+200/-00) psi
Swing Park Brake.....Hydraulic released disc, released at 175 psi (12 bar)
Reservoir Capacity.....100 gal (351.3 L)
Reservoir Return Filter .....5 micron
Reservoir Suction Filter.....25 micron

Air Conditioner

Air Conditioner Hydraulic System .....3500 (+/-100) psi
Minimum Evacuation Time .....30 minutes
Refrigerant Charge Levels .....2.0 pounds (+/- 0.5 ounce)
Additional Pag Oil Required Above 6 ounces in Compressor 4.0 ounces

Hoist System

Wire Rope:
- Length.....450 ft (137 m)
- Diameter (Rotation Resistant).....5/8 in. (16 mm)
- Nominal Breaking Strength .....56,400 lb (25,582 kg)

Operating Pressure.....4300 (+/-100) psi (296.5 bar)
Flow .....35 gpm (2.21L/s)

Hoist Line Pull/Layer		
Layer	**Low Speed kN (lb)**	**High Speed kN (lb)**
1	66.7 (15,000)	33.4 (7,516)
2	60.2 (13,529)	30.1 (6,765)
3	54.7 (12.299)	27.4 (6,150)
4	50.2 (11,275)	25.1 (5,637)
5	46.3 (10,407)	23.1 (5,204)

Line Speed (no load at high engine idle speed)		
Layer	**Low Speed m/sec (ft/sec)**	**High Speed m/sec (ft/sec)**
1	43.9 (144)	87.5 (287)
2	48.5 (159)	97.2 (319)
3	53.3 (175)	107.0 (351)
4	58.2 (191)	116.7 (383)
5	63.1 (207)	126.5 (415)

Crane Operating Speeds

(Performance based on full governed RPM and 37.8° C (100° F) hydraulic reservoir temperature.)

Rotation 360° ..... 30 ± 7 sec (1.8 ± 0.2 rpm) Adjustment Knob Closed

Boom up -10° to 80° ..... 34 ± 5 sec

Boom Down 80° to -10° ..... 34 sec ± 5 sec

Boom Telescope .....

Boom Telescope Speed (Angle 60°- no load at high engine speed)		
Boom Length	**Extend**	**Retract**
9.44 - 31.39m (31 - 103ft)	105 sec (± 10 sec)	105 sec (± 10 sec)
9.44 - 38.70m (31 - 127ft)	120 sec (± 10 sec)	120 sec (± 10 sec)
10.36 - 43.28m (34 - 142ft)	135 sec (± 10 sec)	135 sec (± 10 sec)
11.88 - 49.07m (39 - 161ft)	150 sec (± 10 sec)	150 sec (± 10 sec)

Outrigger Beam Extend ..... 10 sec ±3 sec

Outrigger Beam Retract ..... 10 sec ±3 sec

Outrigger Jack Extend ..... 10 sec ±3 sec

Outrigger Jack Retract ..... 10 sec ±3 sec

Counterweight

NBT36

Standard ..... N/A

NBT40

Standard ..... 1000 lbs

NBT40 + 1000 Option ..... 2000 lbs

NBT45

Standard ..... 4500 lbs

NBT45 + 1000 Option ..... 5500 lbs

General

NBT36 ..... 36 tons (32.6 metric tons) at 7 ft (2.13 m) radius

NBT40 ..... 40 tons (36.3 metric tons) at 7 ft (2.13 m) radius

NBT45 ..... 45 tons (40.8 metric tons) at 7 ft (2.13m) radius

NBT36 127 ft Boom ..... 35,550 lbs (16,125.21 kg)

NBT40 127 ft Boom ..... 37,300 lbs (16,919 kg)

NBT45 127 ft Boom ..... 40,950 lbs (18,574.61 kg)

Boom Weight

103 ft Boom ..... 12,425 lbs (5,636 kg)

127 ft Boom ..... 12,985 lbs (5,890 kg)

142 ft Boom.....14,338 lbs (6,504kg)
161 ft Boom.....17,526 lbs (7,950kg)

DIMENSIONAL DRAWING

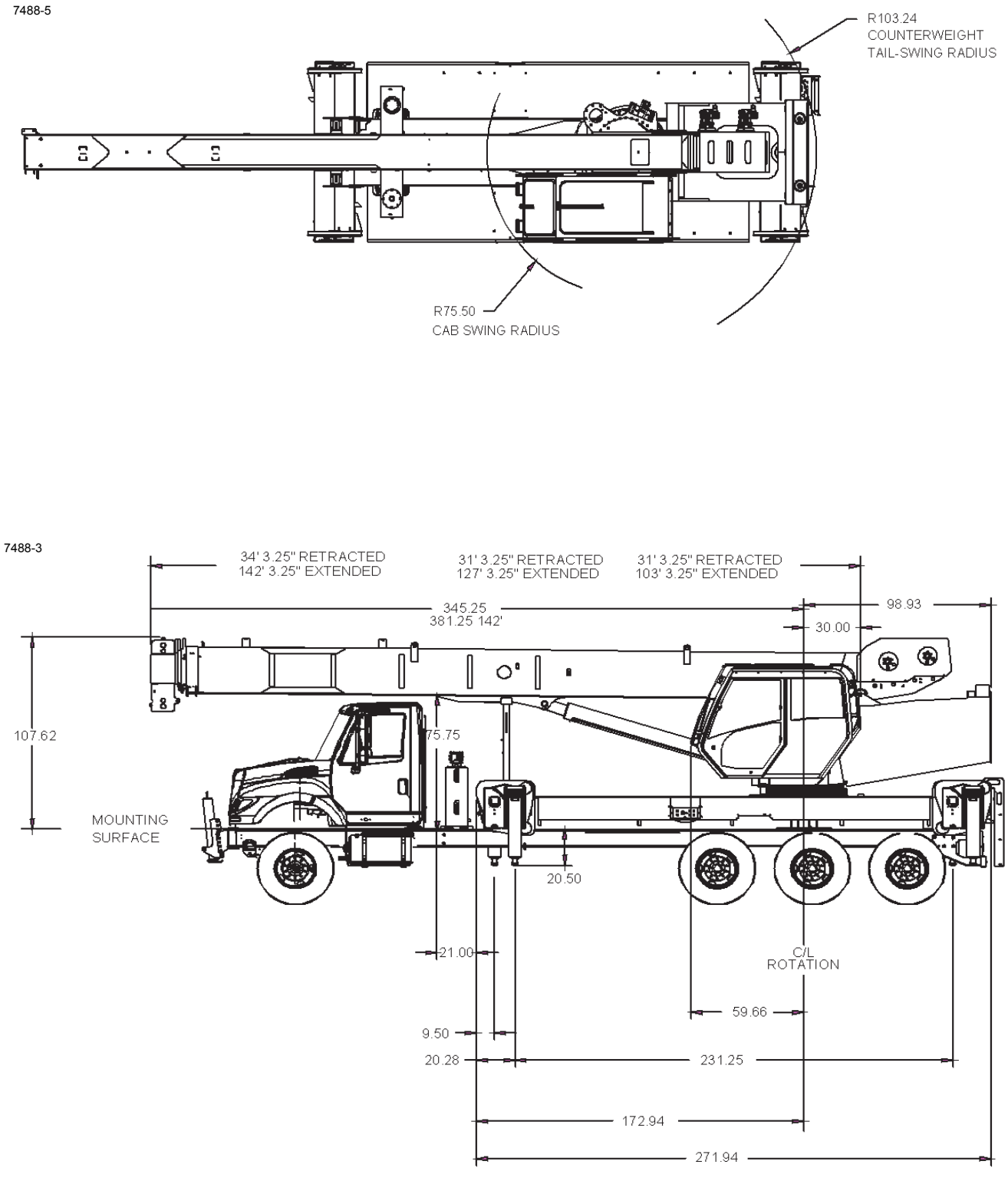
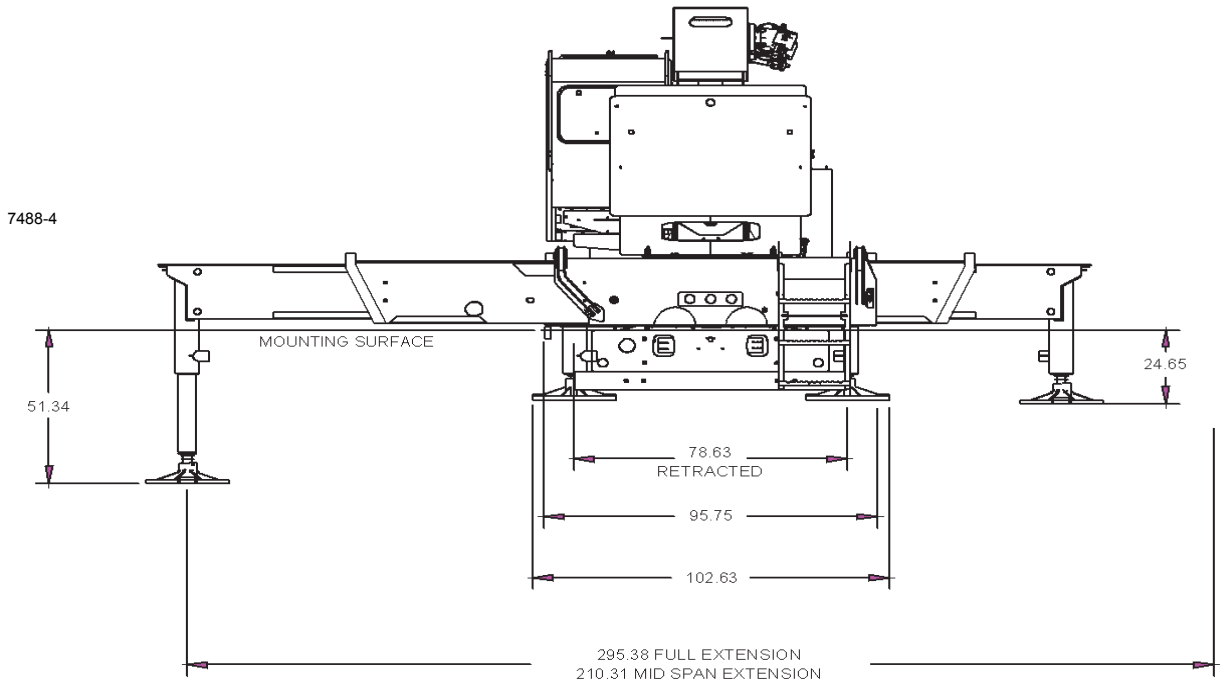
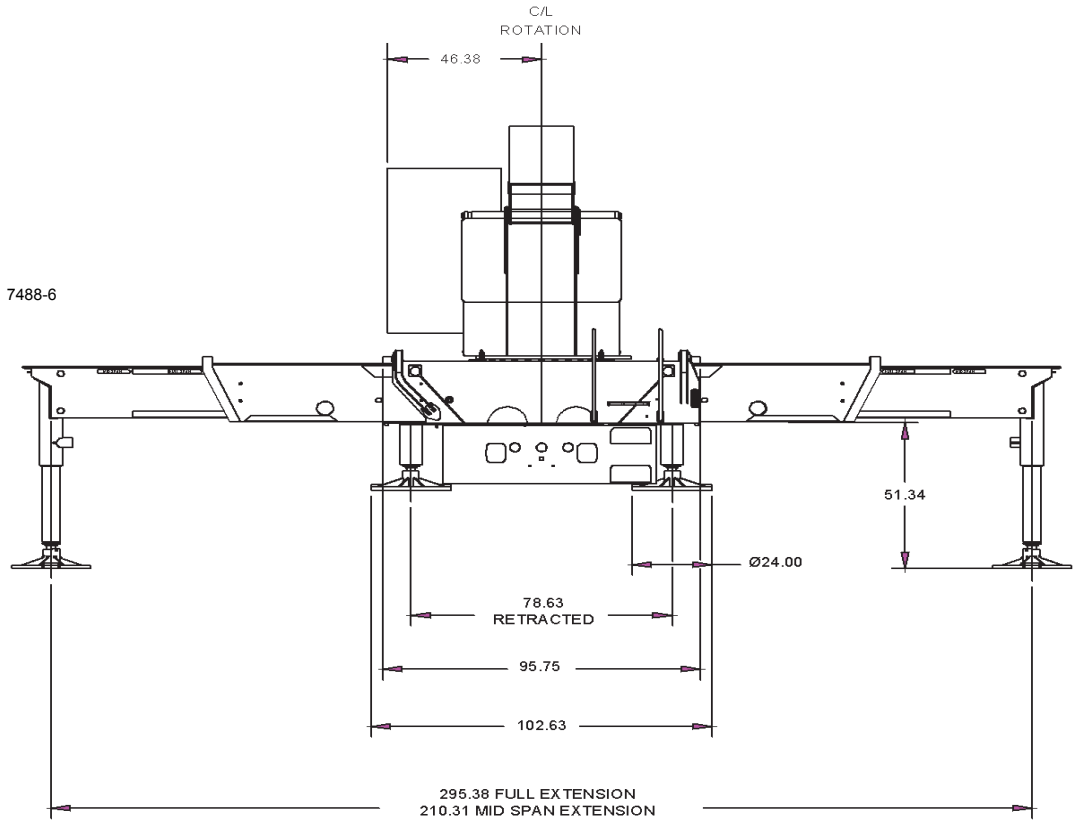


FIGURE 6-2


7488-4
MOUNTING SURFACE
51.34
24.65
78.63
RETRACTED
95.75
102.63
295.38 FULL EXTENSION
210.31 MID SPAN EXTENSION


C/L
ROTATION
46.38
7488-6
51.34
Ø24.00
78.63
RETRACTED
95.75
102.63
295.38 FULL EXTENSION
210.31 MID SPAN EXTENSION

6

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