

National Crane NBT30H-2

Operator Manual





WARNING

California Proposition 65

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

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

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

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

California Spark Arrestor

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

The original language of this publication is English.

OPERATOR MANUAL

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

NBT30H-2

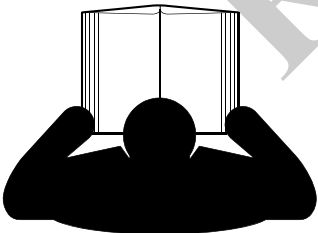
This Manual is divided into the following sections:

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

NOTICE

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

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



DANGER

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

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

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Reference
Only

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Table of Contents

See back of this manual for Alphabetical Index

SECTION 1	Introduction
General	1-1
Supplemental Information	1-2
Notice to Owner/User	1-2
Basic Nomenclature	1-2
SECTION 2	Safety Precautions
Safety Messages	2-1
General	2-1
Safety Alert Symbol	2-2
Signal Words	2-2
General	2-2
Accidents	2-2
Operator Information	2-2
Operator Qualifications	2-3
Operational Aids	2-4
Rated Capacity Limiter (RCL) Systems	2-4
Anti-Two-Blocking Device	2-5
Working Area Limiter (If Equipped)	2-5
Equipment Stability/Structural Strength	2-5
Load Charts	2-6
Work Site	2-6
Wind Forces	2-6
Wind Speeds	2-7
Lifting Operations	2-18
Counterweight	2-19
Outrigger Lift Off	2-19
Multiple Equipment Lifts	2-19
Tilt-Up Panel Lifting	2-20
Pile Driving and Extracting	2-20
Electrocution Hazard	2-20
Set-Up and Operation	2-22
Electrocution Hazard Devices	2-22
Electrical Contact	2-23
Special Operating Conditions and Equipment	2-23
Grounding the Equipment	2-23
Personnel Handling	2-24
Environmental Protection	2-25
Maintenance	2-25
Service and Repairs	2-26
Lubrication	2-26
Tires	2-27
Hoist Rope	2-27
Synthetic Hoist Rope	2-27
Wire Rope	2-27
Sheaves	2-29
Batteries	2-29
Engine	2-29
Transporting the equipment	2-29
Travel Operation	2-30
Work Practices	2-30
Personal Considerations	2-30
Equipment Access	2-31

Job Preparation	2-31
Working	2-31
Lifting	2-32
Hand Signals	2-33
jib	2-33
Parking and Securing	2-36
Shut-Down	2-36
Cold Weather Operation	2-36
Temperature Effects on Hook Blocks	2-36
Temperature Effects on Hydraulic Cylinders	2-36
Overload Inspection	2-38
Boom Inspection	2-39
Superstructure Inspection	2-41
Carrier Inspection	2-43
SECTION 3 Controls and Operating Procedures	
General	3-1
Jump Starting Hazard	3-2
Charging the Battery	3-2
Truck Cab Controls	3-2
Truck Cab Ignition Switch	3-2
Power Take Off	3-2
Park Brake	3-3
Engine Speed Governor	3-3
Neutral Start/Safety Switch	3-3
Crane Controls	3-3
Swing Speed Adjustment	3-3
Emergency Stop Switch	3-3
Anti-Two-Block Warning	3-3
Boom Angle Indicator	3-3
Boom Length Indicator	3-3
Outrigger Control Box (Pendent)	3-4
Crane Level Indicators	3-4
Crane Controls	3-6
Control Console	3-6
Stop/Run/Start Switch	3-6
Boom Telescope Control Lever	3-6
Hoist Control Lever	3-6
Hoist Speed Control	3-6
Warning Horn Switch	3-6
Swing Control Lever	3-6
Boom Lift Control Lever	3-6
Control Levers (Optional)	3-7
Foot Throttle	3-7
Load Charts	3-7
Rated Capacity Limiter (RCL) Display Module	3-7
Remote Control Enable Switch (Optional)	3-7
RCL Override Key Switch	3-7
Momentary RCL Override Switch	3-7
Hoist Jog Switch (Optional)	3-8
Diagnostic Connector	3-8
Fuse/Relay Panel	3-8
Operating Procedures	3-8
Equipment Familiarization	3-8
Equipment Checks	3-8
Cold Weather Operation	3-9
Crane Warm-up Procedures	3-9

Engine	3-9
Transmission	3-9
Hoist	3-9
Swing Drive and Turntable Bearing	3-10
Axles	3-10
Hydraulic Oil System	3-10
Anti-Two Block Check	3-10
RCL Check	3-10
Hoist System Operation	3-11
Work Site Location	3-11
Before Leaving the Truck Cab	3-11
Before Making the Lift	3-11
Load Chart	3-11
Using the Load Chart	3-12
Lifting the Load	3-12
Rated Capacity Limiter	3-15
RCL System Description	3-15
RCL Setup	3-18
Operating Mode	3-19
Operational Limits	3-20
Delete All Limits	3-22
Tools	3-22
Diagnostic	3-23
Shut Down and Preparation for Road Travel	3-25
Unattended Crane	3-26
Crane Remote Control (Optional)	3-27
Crane Remote Control Activation	3-30
SECTION 4	Set-Up
General	4-1
Outrigger Setup	4-1
Proper Leveling of the Crane	4-1
Bubble Level Adjustment	4-1
Site Selection	4-2
Setting the Outriggers	4-2
Outrigger Monitoring System (OMS) (Optional—Standard in North America)	4-2
Extension Safety Information	4-3
Side Folding Swing Around Extension Operation	4-4
Deployment Procedure	4-4
Stowing Procedure	4-6
Extension Removal	4-7
Extension Maintenance	4-7
Anti-two Block Weight Installation	4-8
Multi-part Line Reeving	4-8
Using Multiple Part Lines	4-8
Lifting a 30 Ton (60,000 lb) Load	4-8
Hoist Cable Installation	4-10
Wedge Sockets	4-10
Terminator Wedge Installation	4-10
Wedge Socket Installation	4-12
Dead-end Rigging	4-12
SECTION 5	Lubrication Procedure and Charts
General	5-1
Environmental Protection	5-1
Lubricants	5-1
Arctic Conditions Below -9°C (15°F)	5-1

Chassis Grease	5-2
Low Temperature Grease	5-2
Extreme Pressure Multipurpose Gear Lubricant (EPGL)	5-2
Open Gear Lubricant	5-2
Antifreeze/Coolant (for Cab Heater)	5-2
Anti-wear Additives	5-2
Hydraulic Oil	5-2
Standard Hydraulic Oil	5-2
Arctic Hydraulic Oil	5-3
Hydraulic Oil Inspection	5-3
Surface Protection for Cylinder Rods	5-3
Lubrication	5-3
Internal Cable Sheave Lubrication	5-7
Inner Boom Wear Pad Lubrication	5-7
Side and Bottom Boom Wear Pad Lubrication	5-7
Outrigger Beam Lubrication	5-8
Hoist Brake Oil	5-9
Hoist Gearbox Oil	5-9
Swing Gearbox and Brake Oil	5-9
Hydraulic Oil Reservoir Level	5-10
Wire Rope Lubrication	5-10
Carwell® Rust Inhibitor	5-11
Protecting Cranes From Rusting	5-11
Cleaning Procedures	5-11
Inspection and Repair	5-12
Application	5-12
Areas of Application	5-13
SECTION 6	Maintenance Checklist
Crane Inspection and Maintenance	6-1
Inspections	6-1
Special Boom Inspection	6-3
Stability	6-3
Hoist Cable Inspection and Maintenance	6-3
Keeping Records	6-3
Environmental Conditions	6-3
Dynamic Shock Loads	6-4
Precautions and Recommendations During Inspection	6-4
Inspection	6-4
Wire Rope Replacement	6-5
Care of Wire Rope	6-5
Replacement Cable	6-5
Crane Adjustments and Repairs	6-6
Boom Extension Cable	6-6
Extension Jack Service and Maintenance	6-6
Lubrication	6-6
Rust Prevention	6-6
Hydraulic System	6-6
Oil Cooler	6-6
Tire Load and Inflation Table	6-6
Specifications	6-10
Hydraulic Pump	6-10
Hydraulic System	6-10
Reservoir	6-10
Hoist System	6-10
Crane Operating Speeds	6-11
Outrigger Speeds	6-11

For
Reference
Only

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Reference
Only*

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SECTION 1
INTRODUCTION

SECTION CONTENTS

General	1-1	Notice to Owner/User	1-2
Supplemental Information	1-2	Basic Nomenclature	1-2

GENERAL

This manual has been compiled to assist you in properly operating and maintaining your Model NBT30H-2 Series National Crane (Figure 1-1).

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

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

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

The NBT30H-2 has been designed for maximum performance with minimum maintenance. With proper care, years of trouble-free service can be expected.

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

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



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 distributor.

Notice to Owner/User

IMMEDIATELY report all accidents, malfunctions, and equipment damages to your local National Crane distributor. Following any accident or damage to equipment, the local

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

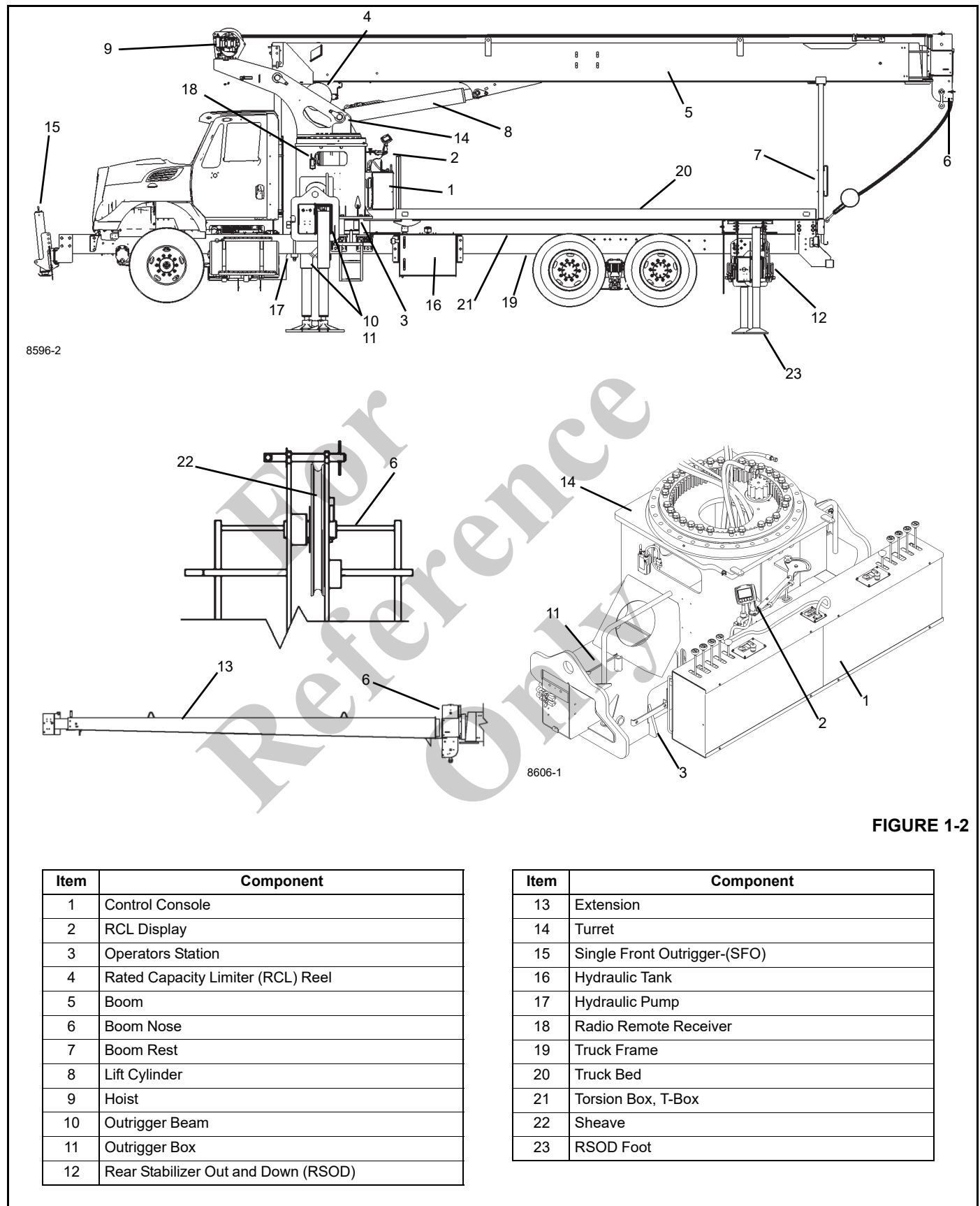
New Owners

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

Go to: 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.



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Reference
Only

SECTION 2

SAFETY PRECAUTIONS

SECTION CONTENTS

Safety Messages	2-1	Environmental Protection	2-25
General	2-1	Maintenance	2-25
Safety Alert Symbol	2-2	Service and Repairs	2-26
Signal Words	2-2	Lubrication	2-26
General	2-2	Tires	2-27
Accidents	2-2	Hoist Rope	2-27
Operator Information	2-2	Synthetic Hoist Rope	2-27
Operator Qualifications	2-3	Wire Rope	2-27
Operational Aids	2-4	Sheaves	2-29
Rated Capacity Limiter (RCL) Systems	2-4	Batteries	2-29
Anti-Two-Blocking Device	2-5	Engine	2-29
Working Area Limiter (If Equipped)	2-5	Transporting the equipment	2-29
Equipment Stability/Structural Strength	2-5	Travel Operation	2-30
Load Charts	2-6	Work Practices	2-30
Work Site	2-6	Personal Considerations	2-30
Wind Forces	2-6	Equipment Access	2-31
Wind Speeds	2-7	Job Preparation	2-31
Lifting Operations	2-18	Working	2-31
Counterweight	2-19	Lifting	2-32
Outrigger Lift Off	2-19	Hand Signals	2-33
Multiple Equipment Lifts	2-19	jib	2-33
Tilt-Up Panel Lifting	2-20	Parking and Securing	2-36
Pile Driving and Extracting	2-20	Shut-Down	2-36
Electrocution Hazard	2-20	Cold Weather Operation	2-36
Set-Up and Operation	2-22	Temperature Effects on Hook Blocks	2-36
Electrocution Hazard Devices	2-22	Temperature Effects on Hydraulic Cylinders ...	2-36
Electrical Contact	2-23	Overload Inspection	2-38
Special Operating Conditions and Equipment	2-23	Boom Inspection	2-39
Grounding the Equipment	2-23	Superstructure Inspection	2-41
Personnel Handling	2-24	Carrier Inspection	2-43

SAFETY MESSAGES

General

The importance of safe operation and maintenance cannot be overemphasized. Carelessness or neglect on the part of operators, job supervisors and planners, rigging personnel,

and job site workers can result in their death or injury and costly damage to the equipment and property.

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

Safety Alert Symbol



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

Signal Words



DANGER

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



WARNING

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



CAUTION

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

CAUTION

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

NOTE: Emphasizes operation or maintenance procedures.

GENERAL

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

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

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

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

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

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

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

ACCIDENTS

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

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

Grove U.S. L.L.C

1565 East Buchanan Trail
Shady Grove, PA 17256-0021

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

Fax: 717-593-5152

E-mail: product.safety@manitowoc.com

OPERATOR INFORMATION

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

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

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

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

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

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



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

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

If adjustments or repairs are necessary, the operator shall notify the next operator and personnel responsible for the maintenance and repair of the equipment.

OPERATOR QUALIFICATIONS

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

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

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

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



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

You must not operate this equipment unless:

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

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

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

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

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

OPERATIONAL AIDS

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

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

- Steps shall be taken to schedule repairs and recalibration immediately. The operational aids shall be put back into service as soon as replacement parts, if required, are available and the repairs and recalibration can be carried out. Every reasonable effort must be made to expedite repairs and recalibration.
- When a *Load Indicator*, *Rated Capacity Indicator*, or *Rated Capacity Limiter* is inoperative or malfunctioning, the designated person responsible for supervising the lifting operations shall establish procedures for determining load weights and shall ascertain that the weight of the load does not exceed the equipment ratings at the radius where the load is to be handled.

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

Rated Capacity Limiter (RCL) Systems

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

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

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

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

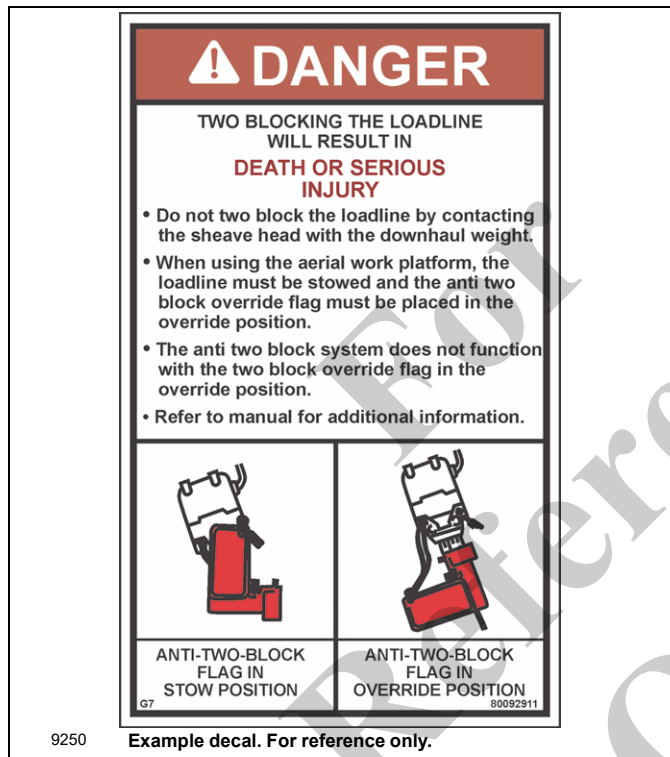
NEVER exceed the rated capacity shown on the *Load Chart*. Always check the *Load Chart* to make sure that the load to be lifted at the desired radius is within the rated capacity of the equipment.

For detailed information concerning the operation and maintenance of the RCL system installed on the equipment, see the appropriate section later in this manual, or the RCL manufacturer's manual supplied with the equipment. Manufacturers of rated capacity limiters may refer to them in their manuals as a load moment indicator (LMI), a hydraulic capacity alert system (HCAS), a safe load indicator (SLI) or an EKS5; National Crane refers to these systems as a rated capacity limiter (RCL) throughout its *Operator* and *Service manuals*.

Anti-Two-Blocking Device

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

Two-blocking occurs when the load block (hook block, downhaul weight, rigging, etc.) comes into physical contact with the boom (boom nose, sheaves, jib, etc.). Two-blocking can cause hoist rope (wire rope or synthetic 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 fall.



Two-blocking is more likely to occur when both the main and auxiliary hoist lines are reeved over the main boom nose and jib nose, respectively. An operator, concentrating on the specific line being used, may telescope or lower the boom allowing the other hoist line attachment to contact the boom or jib nose, thus causing damage to the sheaves, or causing the hoist rope to fail, dropping the lifting device to the ground and possibly injuring personnel working below.

Caution must be used when lowering the boom, extending the boom or hoisting up. Let out load line(s) simultaneously

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

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

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

Working Area Limiter (If Equipped)

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

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

EQUIPMENT STABILITY/STRUCTURAL STRENGTH

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

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

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

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



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

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

Before swinging the superstructure over the side when the outriggers are retracted, consult the *Load Chart* for any boom angle or boom length restrictions.

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

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

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

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

Load Charts

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

Load Chart capacities are based on freely suspended loads.

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

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

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

Work Site

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

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

WIND FORCES

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

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

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

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

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

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

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

Table 2-1 Beaufort Wind Scale

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

Wind Speeds

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

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

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

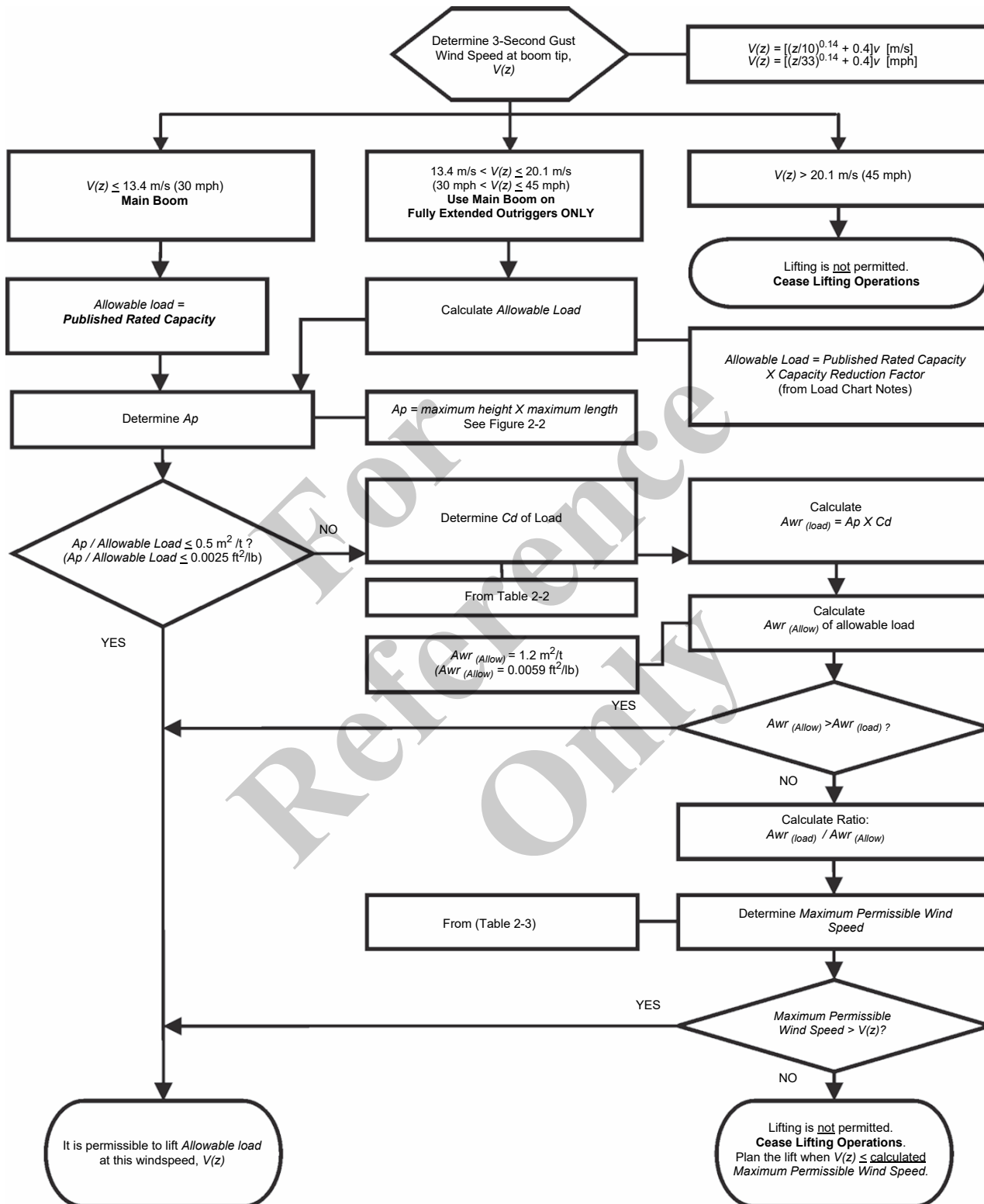
NOTE: This condition is limited to operation with the main boom on fully extended outriggers only.

- 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.

Simplified Method to Determine Maximum Permissible Wind Speed



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

$A_{wr}(\text{load})$ = Actual Wind Resistance Area for the Load, $\text{m}^2(\text{ft})$
 $A_{wr}(\text{Allow})$ = Allowable Wind Resistance Area of the Load, m^2 (ft^2)
 C_d = 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 equipment operation site:

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

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

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

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

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

where:

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

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

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

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

Boom tip height for this lift is **Z** = 30 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) [m²] [ft²] - Wind resistant area of the load

Ap [m²] [ft²] - projected wind area,

Cd - wind drag coefficient.

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

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

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

Metric, with **m_(load)** [kg] - Mass of the allowable load

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

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

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

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

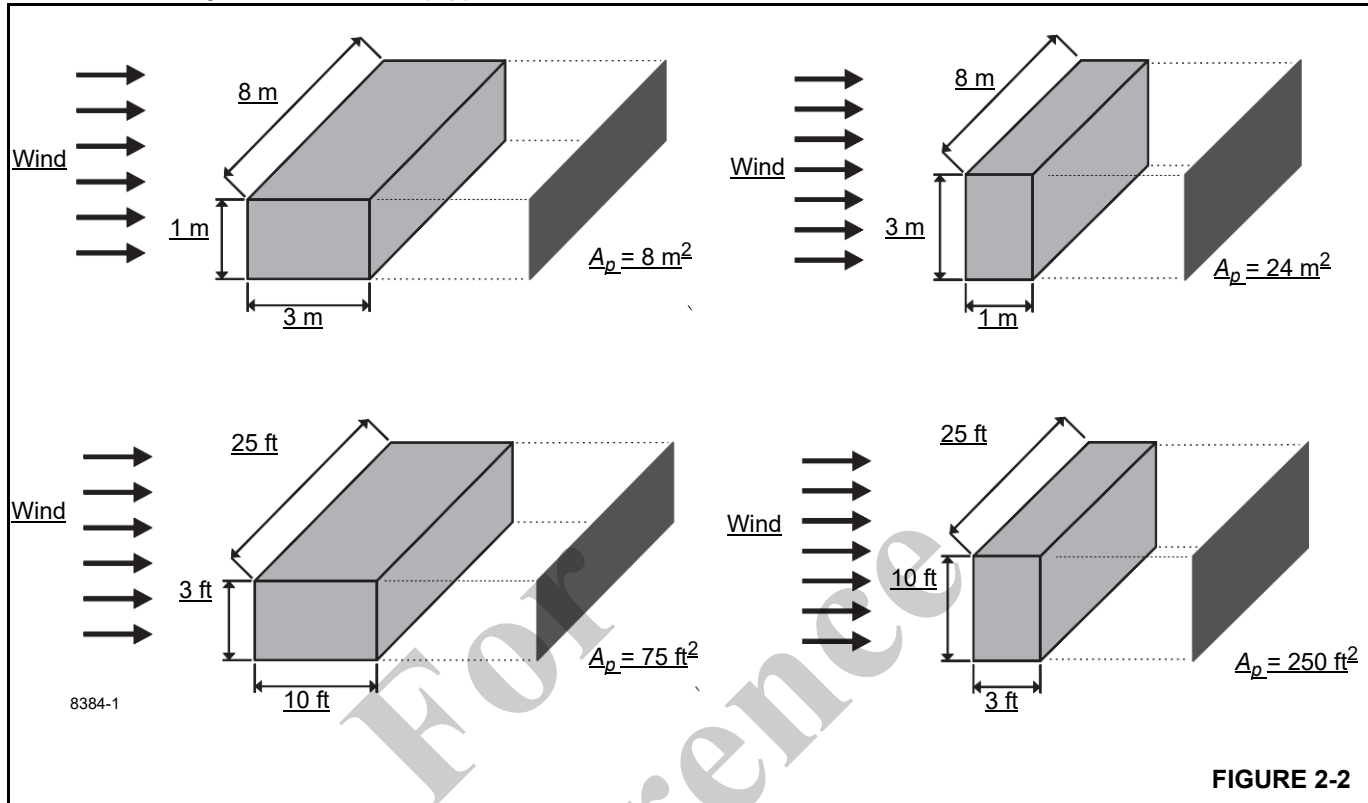

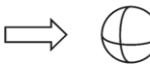


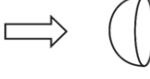
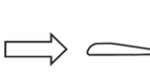

Calculation of Projected Wind Area (A_p):**Determining Wind Drag Coefficient (C_d)**

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

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

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

Table 2-2 Wind Drag Coefficient

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

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Maximum Permissible Wind Speed

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

Table 2-3 Awr Ratio and Permissible Wind Speed $V(z)$ - Imperial units

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 (66.5)	18,225 (69.5)	16,575 (72)	15,250 (74.5)	11,400 (76)
9	20,600 (16.5)	20,550 (33.5)	20,375 (49.5)	20,250 (55)	18,225 (63)	16,575 (67)	15,050 (70)	13,875 (72.5)	11,400 (74.5)
10		17,200 (20.5)	17,175 (41)	17,125 (54)	17,325 (60)	15,175 (64)	13,725 (67.5)	12,700 (70.5)	11,400 (72.5)
12			15,075 (38)	15,025 (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)	7,110 (37.5)	7,475 (47)	7,920 (53)	7,980 (57.5)	7,470 (61.5)
18					5,975 (27)	5,960 (39.5)	6,340 (47.5)	6,525 (53)	6,530 (57.5)
20						4,755 (30.5)	5,145 (41)	5,320 (48)	5,495 (53)
22						3,790 (16.5)	4,210 (33.5)	4,380 (42.5)	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.

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

(Only for lifting with main boom on fully extended outriggers, with or without stowed extension)									
For wind speed $V(z)$ (3-second gust speed at boom tip height) $V(z) > 13.4 \text{ m/s} \leq 20.1 \text{ m/s}$, the Reduced Capacity shall be calculated by multiplying the Published Rated Capacity by the following factors:									
	Main Boom Length in Meters								
Wind Speed $V(z) > 13.4 \text{ m/s}$ $\leq 20.1 \text{ m/s}$	10.9	12.2	15.2	18.4	21.3	24.4	27.4	30.5	33.5
Factor	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.7	0.6
Wind resistance area of load, $Awr_{(load)}$ shall not exceed maximum allowable wind resistance area $Awr_{(allow)}$. Maximum allowable wind resistance area, $[m^2] Awr_{(allow)} = 0.0012 \times \text{calculated reduced capacity in kg}$. Wind resistance area of load, $Awr_{(load)}$ projected wind area $Ap \times$ wind drag coefficient Cd for the load. For wind resistance Area of load, $Awr_{(load)} >$ maximum allowable wind resistance area, $Awr_{(allow)}$ refer to equipment Operator Manual.									

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

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

Example and Sample Calculations (metric)

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

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

Example 1: Equipment Configuration:

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

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

The maximum allowable wind resistance area of load is :

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

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

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

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

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

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

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

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

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

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

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

Load example 1.1:

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

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

wind resistance area of load can be estimated as

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

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

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

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

Load example 1.2:

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

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

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

- the wind resistance area of load can be estimated as

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

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

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

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

Load example 1.3a:

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

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

the wind resistance area of load can be estimated as:

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

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

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

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

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

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

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

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

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

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

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

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

Load example 1.3b:

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

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

the wind resistance area of load can be estimated as

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

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

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

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

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

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

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

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 **V_z** (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 V _z > 30 mph ≤ 45 mph	36	40	50	60	70	80	90	100	110
Factor	0.9	0.9	0.8	0.7	0.8	0.8	0.8	0.7	0.5

Wind resistance area of load, **A_{wr}**_(load), shall not exceed maximum allowable wind resistance area **A_{wr}**_(allow).

Maximum allowable wind resistance area in lb., **A_{wr}**_(allow) = 0.0059 x calculated reduced capacity in lb.

Wind resistance area of load, **A_{wr}**_(load) = projected wind area **A_p** x wind drag coefficient **C_d** for the load.

For wind resistance area of load, **A_{wr}**_(load) > maximum allowable wind resistance, **A_{wr}**_(allow), refer to equipment Operator Manual.

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

NOTE: () Boom angles are in degrees.

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

*This capacity is based on maximum boom angle.

NOTE: For allowable capacities while operating in 3-second wind gust speeds greater than 30 mph and up to 45 mph, refer to *Capacity Reduction Factors for wind speed (3-second gust speed) V(z) greater than 30 mph*.**Lifting Capacities at Zero Degree Boom Angle**

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

NOTE: () Reference radii in feet.

** Boom length is with inner-mid fully extended and outer-mid & fly fully retracted.

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FIGURE 2-4

Example and Sample Calculations (Non-metric)

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

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

Example 2:

Equipment is configured with:

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

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

The maximum allowable wind resistance area of load is:

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

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

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

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

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

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

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

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

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

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

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

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

Load example 2.1:

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

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

then the wind resistance area of load can be estimated as

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

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

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

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

Load example 2.2:

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

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

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

the wind resistance area of load can be estimated as

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

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

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

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

Load example 2.3a:

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

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

the wind resistance area of load can be estimated as:

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

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

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

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

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

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

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

- Is $Awr_{(load)}$ less than $Awr_{(allow)}$?

$$216 \text{ ft}^2 \leq 149 \text{ ft}^2 \dots\dots\dots \text{NO}$$

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

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

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

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

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

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

Load example 2.3b:

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

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

the wind resistance area of load can be estimated as:

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

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

- Is the load to be lifted less than allowable load?
12,000 lb \leq 20,160 lb YES
- Is $Awr_{(load)}$ less than $Awr_{(allow)}$?
162 ft² \leq 119 ft² NO

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

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

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

Lifting Operations

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

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

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

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

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

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

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

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

The equipment can tip over or fail structurally if:

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

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

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

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

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

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

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

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

Never push or pull with the boom.

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

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

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

Counterweight

On equipment that features removable counterweights, make sure that the appropriate counterweight sections are properly installed for the lift being considered.

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

Outrigger Lift Off

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

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

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

Multiple Equipment Lifts

Multiple equipment lifts are not recommended.

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

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

- Make sure that all signals are coordinated through the lift director or person in charge of the lift.
- Coordinate lifting plans with the operators, designated person, and signal person prior to beginning the lift.
- Maintain communication between all parties throughout the entire operation. If possible, provide approved radio equipment for voice communication between all parties engaged in the lift.
- Use outriggers on equipment so equipped.
- Calculate the amount of weight to be lifted by each equipment and attach slings at the correct points for proper weight distribution.
- Make sure that the load lines are directly over the attach points to avoid side loading and transfer of loading from one equipment to the other.
- Do not travel. Lift only from a stationary position.
- 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 equipment.
- The load shall be controlled to prevent rotation of the load and to make sure that the load stays in line with the boom.
- The load must be balanced with the auxiliary: load line not taking more than half the load at any time during the lift. The RCL will not be providing coverage for the line pull of the auxiliary hoist line.
- The effect of wind loads on the equipment and panel shall be taken into consideration. Operations shall be halted if the wind can cause a loss of control in handling the load.
- The main hoist line shall be used to raise the panel into the vertical position.

Tilt-Up Panel Lifting

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

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

- The equipment must be set up and operated in accordance with National Crane's instructions in the Operator Manual, Load Capacity Chart, and decals affixed to the equipment.
- The hoist rope from the main hoist shall be reeved over the main boom nose reeved for two parts of line.
- The hoist rope from the auxiliary hoist shall be reeved over the auxiliary boom nose reeved for one part-of-line, or up to two parts-of-line depending on the applicable load chart ratings.
- The load shall be connected with the main hoist line connected to the end closest to the equipment and the auxiliary hoist line connected to the end farthest from the equipment.
- The anti-two-block system shall be installed and inspected to confirm that it is active to monitor both hoist lines.
- The RCL hoist selection shall be set to main hoist and two parts-of-line.

Make sure that all personnel working on and around the equipment are properly trained and thoroughly familiar with operational functions of the equipment and safe operating and work practices. Personnel should be thoroughly familiar with regulations and standards governing equipment and 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

National Cranes are not approved and shall not be used in vibratory or pile driving applications. Vibratory or pile driving applications will significantly increase load cycle and promote early fatigue and/or premature failure of components.

ELECTROCUTION HAZARD

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

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

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

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



DANGER

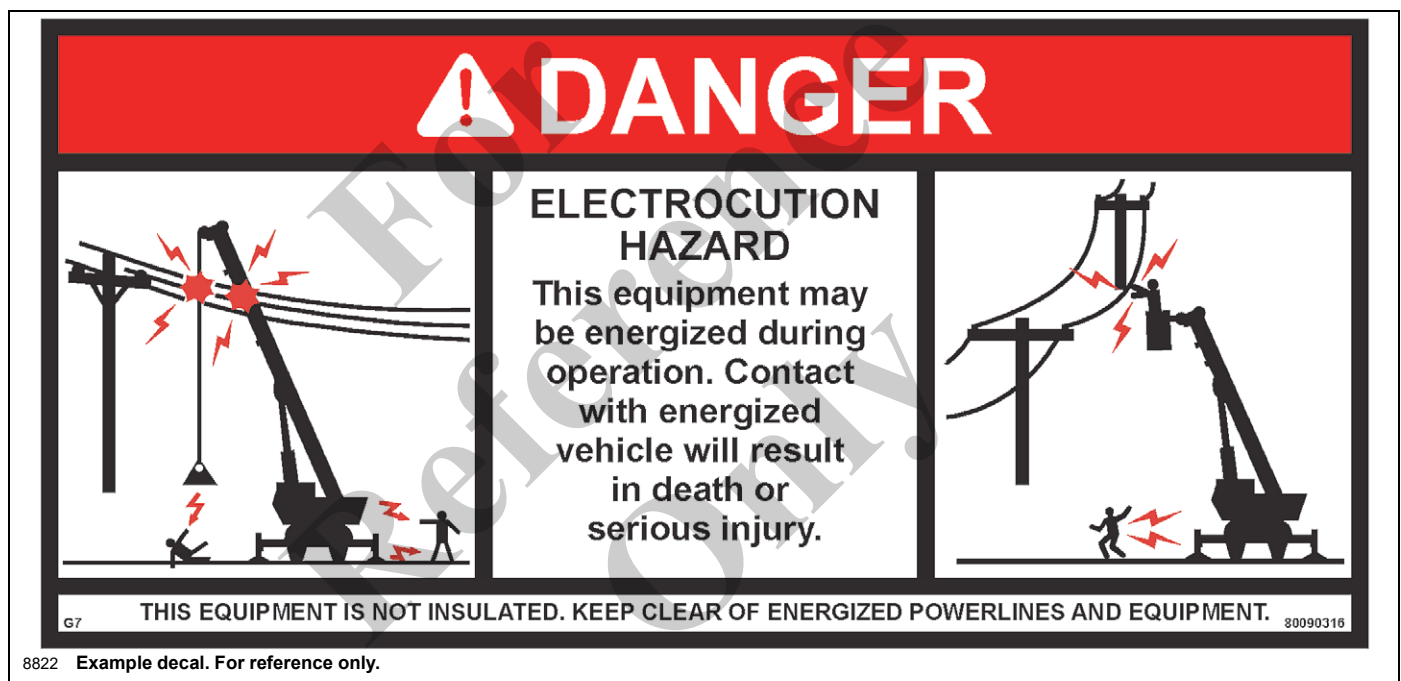
Electrocution Hazard!

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

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

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

2



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

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

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

lean against or touch the equipment. Permit no one, including riggers and load handlers, to hold the load, load lines, tag lines, or rigging gear.

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

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

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

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

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

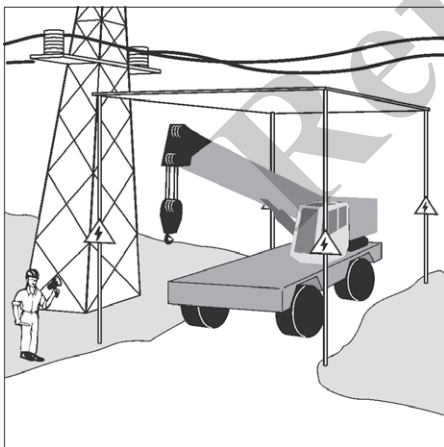
Set-Up and Operation

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

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

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

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



8823

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

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

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

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

Electrocution Hazard Devices

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

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

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

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

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

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

Some variables you must know and understand are:

- Proximity devices are advertised to detect the existence of electricity and not its quantity or magnitude.
- Some proximity devices may detect only alternating current (AC) and not direct current (DC).
- Some proximity devices detect radio frequency (RF) energy and others do not.

- Most proximity devices simply provide a signal (audible, visual, or both) for the operator; this signal must not be ignored.
- Sometimes the sensing portion of the proximity devices becomes confused by complex or differing arrays of power lines and power sources.

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

Electrical Contact

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

1. Stay in the equipment cab. **Do not panic.**
2. Immediately warn personnel in the vicinity to stay away.
3. Attempt to move the equipment away from the contacted power source using the equipment controls which may have remained functional.
4. Stay in the equipment until the power company has been contacted and the power source has been de-energized. **No one** must attempt to come close to the equipment or load until the power has been turned off.

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

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

Special Operating Conditions and Equipment

Never operate the equipment during an electrical thunderstorm.

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

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

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

Grounding the Equipment

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



WARNING

Risk of accidents due to electric shock!

Ground the equipment before you start to work with it

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

Use electrically conducting material for grounding.

1. Hammer a metal rod (3, Figure 2-5) (length of approximately 2.0 m (6.6 ft)) at least 1.5 m (5 ft) into the ground.
2. Moisten the soil around the metal rod (3) for better conductivity.
3. Clamp an insulated cable (2) to the metal rod (3), cross-section of at least 16 mm² (0.025 in²) (AWG 5).
4. Connect the free end of the cable with a clamp (1) to a good electrically conductive location on the frame.

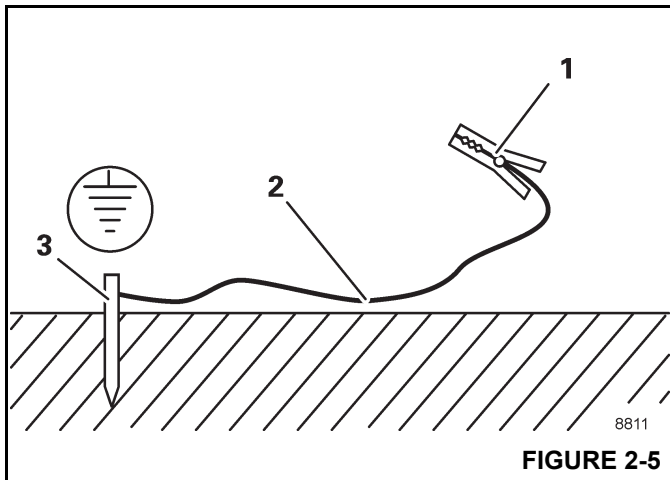


FIGURE 2-5

**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

For equipment that is Dual-Rated as both a crane and an aerial lift, refer to the Safety Precautions - Aerial Lift section. Also see the optional equipment manual titled Personnel Basket Manual which addresses safety, inspection, testing, operation, installation, and lubrication.

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

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

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

requirements of this volume have been met.

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

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

Use of National Crane equipment 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 the equipment to handle personnel is the least hazardous means to perform the work.
- The equipment operator shall be qualified to operate the specific type of hoisting equipment used in the personnel lift.
- The equipment operator must remain at the equipment controls at all times when personnel are off the ground.
- The equipment operator and occupants have been instructed in the recognized hazards of personnel platform lifts.
- The equipment is in proper working order.
- The equipment must be equipped with a boom angle indicator that is visible to the equipment operator.
- The equipment's *Load Chart* is affixed at the operator's station and readily accessible to the operator. The total weight of the loaded personnel platform and related rigging shall not exceed 50 percent of the rated capacity for the radius and configuration of the equipment.
- The equipment is level within one percent of level grade and located on a firm footing. Equipment with outriggers shall have them all deployed following manufacturer's specifications.
- The equipment's *Operator 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 hoist rope suspended platforms:
 - The equipment is equipped with a hook that can be closed and locked, eliminating the throat opening.
 - The equipment 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 equipment that features 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 equipment 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 moving equipment.
- NEVER allow anyone on the hoist access platform while 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, 07007-2900
 - or - check online at:
<https://www.asme.org/codes-standards/find-codes-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 Crane equipment includes, but is not limited to, oil, fuel, grease, coolant, air

conditioning refrigerant, filters, batteries, and cloths which have come into contact with these environmentally harmful substances.

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

When filling and draining equipment components, observe the following:

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

MAINTENANCE

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

National Crane continues to recommend that equipment be properly maintained, regularly inspected and repaired, as necessary. National Crane reminds equipment owners to make sure that all safety decals are in place and legible. National Crane continues to urge equipment owners to upgrade their equipment with a Rated Capacity Limiter (RCL) and control lever lockout systems for all lifting operations.

Shut down the equipment while making repairs or adjustments.

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

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

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

Routine maintenance and inspection of the equipment must be performed by a qualified person(s) according to the recommendations in the *Inspection and Lubrication Service Log*. Any questions regarding procedures and specifications should be directed to your National Crane distributor.

Service and Repairs



WARNING

Fall Hazard!

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

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

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

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

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

All replacement parts must be National Crane approved.

Any modification, alteration, or change to equipment which affects its original design and is not authorized and approved by National Crane is **strictly prohibited**. 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, turn the ignition switch to RUN, 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 the equipment.
- Pinch points, which result from relative motion between mechanical parts, are areas of the equipment that can cause personal injury or death. Do not place limbs or your body in contact with pinch points either on or around the equipment. 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 maintenance or repairs:

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

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

After maintenance or repairs:

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

Lubrication

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

Exercise care when servicing the hydraulic system of the equipment, as pressurized hydraulic oil can cause serious

injury. The following precautions must be taken when servicing the hydraulic system:

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

Tires



WARNING

Possible equipment damage and/or personal injury!

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

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

Make sure that all lug nuts are properly torqued.

Make sure that pneumatic tires are inflated to the proper pressure (refer to the *Load Chart*). When inflating tires, use a tire gauge, clip-on inflator, and extension hose which will permit standing clear of the tire while inflating.

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 make sure that equipment surfaces, such as wear pads, sheaves, etc., have not been damaged in a manner that can then damage the synthetic hoist rope.

NOTE: 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.

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

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

Wire Rope

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

- For rotation-resistant running wire 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 (e.g., 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 wire 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.
- If an operator hoists the hook block up or down too fast when reeved with multiple parts-of-line and no hook load, the wire rope can bird cage and damage the rope.
- 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 wire 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.***

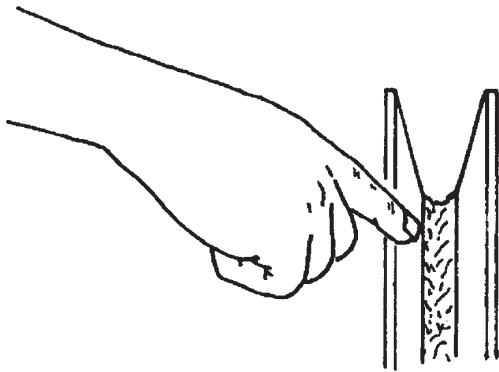
Installing a new rope:

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

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

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

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

Batteries

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

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

- Wear safety glasses when servicing batteries.

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

Engine

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

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

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

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

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

Do not use ether to start the engine on equipment that features intake manifold grid heaters.

TRANSPORTING THE EQUIPMENT

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

Check load limits of bridges on the travel route and make sure that they are greater than the combined weight of the equipment and transporting vehicle.

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

Make sure that the equipment is adequately secured to the transporting vehicle.

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

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

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

When using hook block 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 hook block tie down, the cable should be merely "snugged-up" with adequate slack provided at the center line of sheave to anchor point. Do not draw cable taut. Care must be exercised anytime any equipment function is being performed while the cable is hooked into the hook block tie down.

TRAVEL OPERATION

Only the equipment operator shall occupy the equipment when traveling.

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

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

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

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

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

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

When driving the equipment, make sure that the cab is level, if equipped with a tilting cab.

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

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

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

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

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

On equipment that features air-operated brakes, do not attempt to move the equipment until brake system air pressure is at operating level.

Check load limit of bridges. Before traveling across bridges, make sure that they will carry a load greater than the equipment's weight.

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

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

Always drive the equipment carefully, obeying speed limits and highway regulations.

Stay alert at the wheel.

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

Slopes:

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

WORK PRACTICES

Personal Considerations

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

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

Equipment Access



WARNING

Fall Hazard!

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

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

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

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

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

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

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

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

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

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

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

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

Job Preparation

Before equipment use:

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

You must make sure that the outriggers and jack cylinders are properly extended and set before performing any lifting operations. On models equipped with outriggers that can be pinned at the mid-extend position(s), 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 equipment set up on outriggers.

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

Working

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

Know the location and function of all equipment controls.

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

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

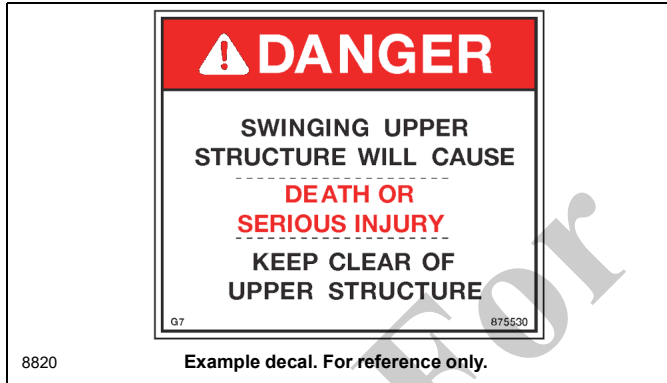
Carbon monoxide fumes from the engine exhaust can cause suffocation in an enclosed area. Good ventilation is very important when operating the equipment.

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

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

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

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



Keep unauthorized personnel clear of the working area during operation.

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

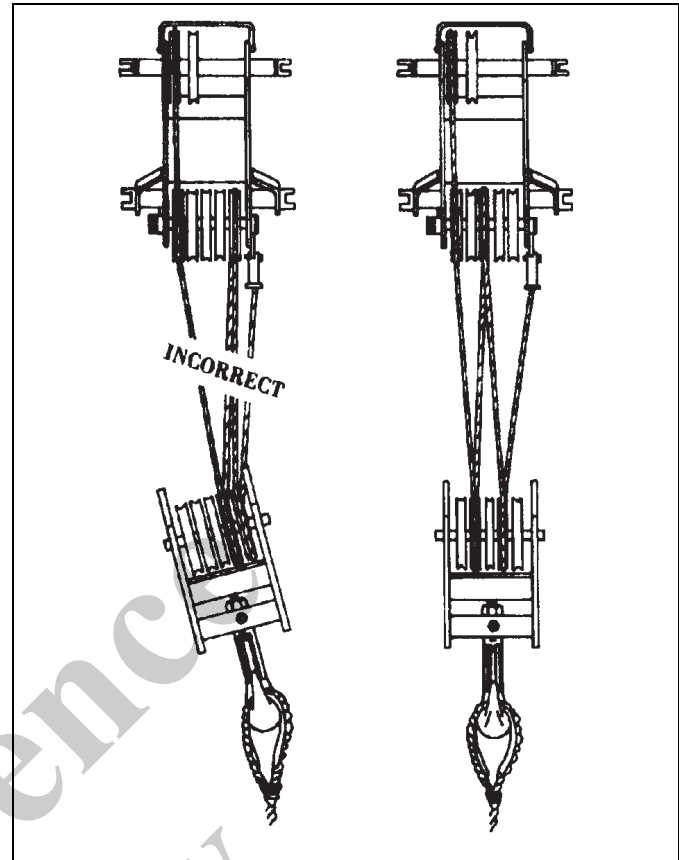
You must always be aware of everything around the equipment while lifting or traveling. If you are unable to clearly see in the direction of motion, you must post a look out or signal person before moving the equipment or making a lift. Sound the horn to warn personnel.

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

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

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

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

Make sure that 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.

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

If using a clam bucket, do not exceed 80% of the equipment 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.

Make sure that 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. Make sure that the hoist brake is working correctly before continuing the lift.

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

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

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

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

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

Stop the hook block from swinging when unhooking a load.

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

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

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

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

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

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

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

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

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

Make sure that everyone is clear of the equipment and work area before making any lifts.

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

Hand Signals

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

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

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

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

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

Obey a signal to stop from anyone.

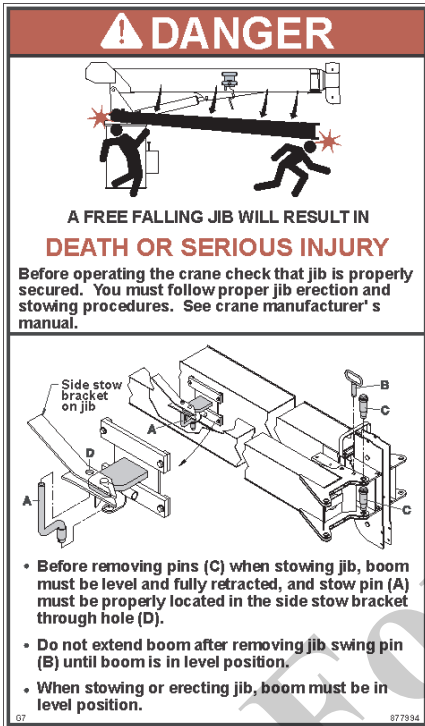
JIB

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

Install and secure all pins properly.

Control movement of the jib at all times.

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



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Example decal. For reference only.

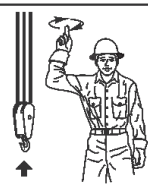
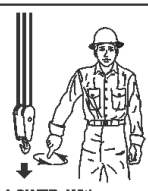

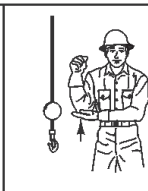
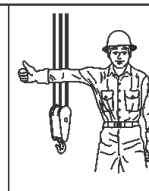
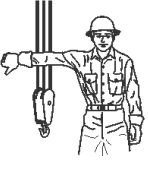


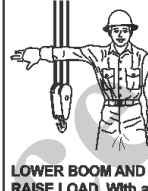
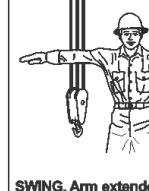
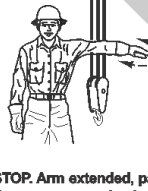
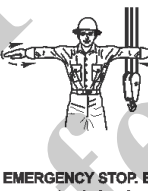
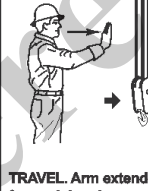
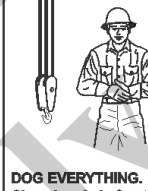
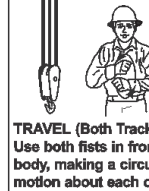
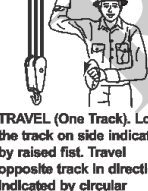
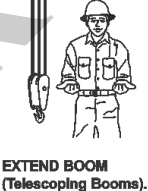
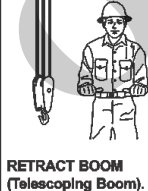
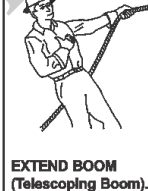
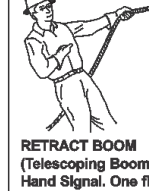
Do not remove the pins from the front stowage bracket unless the jib is pinned to the right side of the boom nose.

Properly inspect, maintain, and adjust jib and mounting.

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

Stay outside of jib sections and lattice work.

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

STANDARD HAND SIGNALS FOR CONTROLLING CRANE OPERATIONS				
Complies with ASME B30.5-2014				
				
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

PARKING AND SECURING



WARNING

Tipping Hazard!

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

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

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

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

- The equipment should be left in the smallest, most stable, valid operational configuration that the job site practically allows.
- The equipment cannot be left running, with a load on the hook, or with the jib deployed, or in wind conditions in excess of allowed values.
- The boom should be retracted as far as is practical, the equipment configured in as stable a configuration as possible (boom angle, superstructure orientation, jib angle, etc.)
- In high winds the boom and jib 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 the equipment when it is to be left unattended.

SHUT-DOWN

Use the following steps when shutting down the equipment:

- Engage the parking brake.
- Fully retract and lower the boom.
- Engage the swing lock pin or 360 degree swing lock.
- Place controls in neutral position.
- Shut down the engine and remove the ignition key.

- Chock the wheels, if not on outriggers.
- Lock the operator's cab (if applicable) and install vandal guards, if used.

COLD WEATHER OPERATION

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

Check operating procedures in this manual for cold weather starting.

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

Clean the equipment of all ice and snow.

Allow ample time for hydraulic oil to warm up.

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

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

Never store flammable materials on the equipment.

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

TEMPERATURE EFFECTS ON HOOK BLOCKS

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

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

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

TEMPERATURE EFFECTS ON HYDRAULIC CYLINDERS

Hydraulic oil expands when heated and contracts when cooled. This is a natural phenomena that happens to all liquids. The coefficient of expansion for API Group 1 hydraulic oil is approximately 0.00077 cm³ per cm³ of volume for 1°C of temperature change (0.00043 in³ per in³ 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 the equipment is set up in the morning with cool oil and the daytime ambient temperature heats the oil, the cylinders will extend in similar proportions.

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

NOTE: Operators and service personnel must be aware that load movement, as a result of this phenomena, can be easily mistaken as leaking cylinder seals or faulty holding valves.

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

Coeff. = 0.00043 (in ³ /in ³ / °F)										
STROKE	Temperature Change (°F)									
(FT.)	10	20	30	40	50	60	70	80	90	100
5	0.26	0.52	0.77	1.03	1.29	1.55	1.81	2.06	2.32	2.58
10	0.52	1.03	1.55	2.06	2.58	3.10	3.61	4.13	4.64	5.16
15	0.77	1.55	2.32	3.10	3.87	4.64	5.42	6.19	6.97	7.74
20	1.03	2.06	3.10	4.13	5.16	6.19	7.22	8.26	9.29	10.32
25	1.29	2.58	3.87	5.16	6.45	7.74	9.03	10.32	11.61	12.90
30	1.55	3.10	4.64	6.19	7.74	9.29	10.84	12.38	13.93	15.48
35	1.81	3.61	5.42	7.22	9.03	10.84	12.64	14.45	16.25	18.06
40	2.06	4.13	6.19	8.26	10.32	12.38	14.45	16.51	18.58	20.64
45	2.32	4.64	6.97	9.29	11.61	13.93	16.25	18.58	20.90	23.22
50	2.58	5.16	7.74	10.32	12.90	15.48	18.06	20.64	23.22	25.80
55	2.84	5.68	8.51	11.35	14.19	17.03	19.87	22.70	25.54	28.38
60	3.10	6.19	9.29	12.38	15.48	18.58	21.67	24.77	27.86	30.96
Length change in inches = Stroke (Ft.) X Temperature Change (°F) X Coeff. (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)		<i>Metric</i>									
STROKE		Temperature Change (°C)									
(m)	5	10	15	20	25	30	35	40	45	50	55
1.5	6	12	17	23	29	35	41	46	52	58	64
3	12	23	35	46	58	70	81	93	104	116	128
4.5	17	35	52	70	87	104	122	139	157	174	192
6	23	46	70	93	116	139	163	186	209	232	255
7.5	29	58	87	116	145	174	203	232	261	290	319
9	35	70	104	139	174	209	244	279	313	348	383
10.5	41	81	122	163	203	244	284	325	366	406	447
12	46	93	139	186	232	279	325	372	418	464	511
13.5	52	104	157	209	261	313	366	418	470	522	575
15	58	116	174	232	290	348	406	464	522	581	639
16.5	64	128	192	255	319	383	447	511	575	639	702
18	70	139	209	279	348	418	488	557	627	697	766
Length change in mm = Stroke (m) X Temperature Change (°C) X Coeff. (1/ °C) X 1000 mm/m											

OVERLOAD INSPECTION

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

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

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

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



WARNING

Overload Hazard!

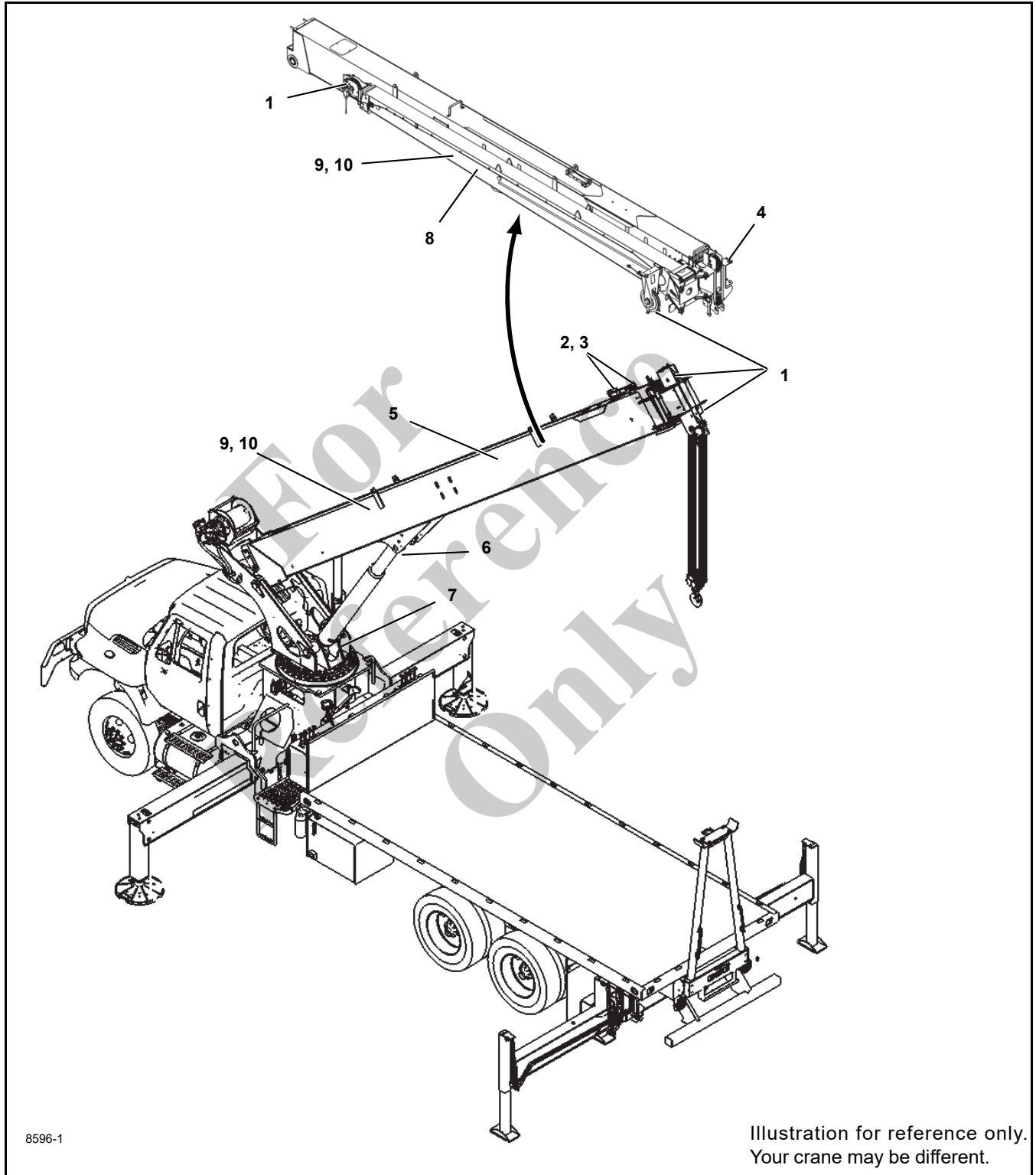
To avoid an accident caused by overload damage to your crane:

- 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.

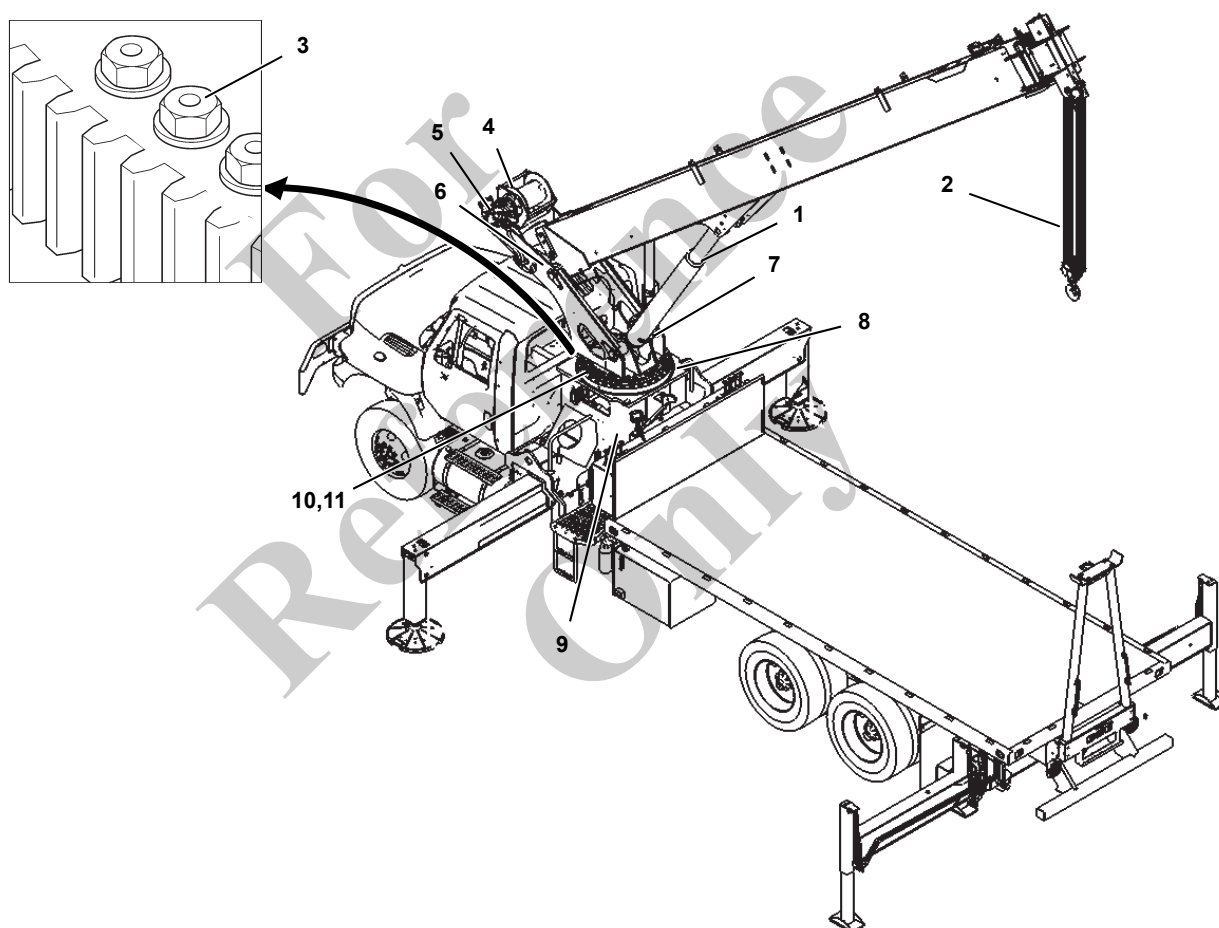
Boom Inspection



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

2

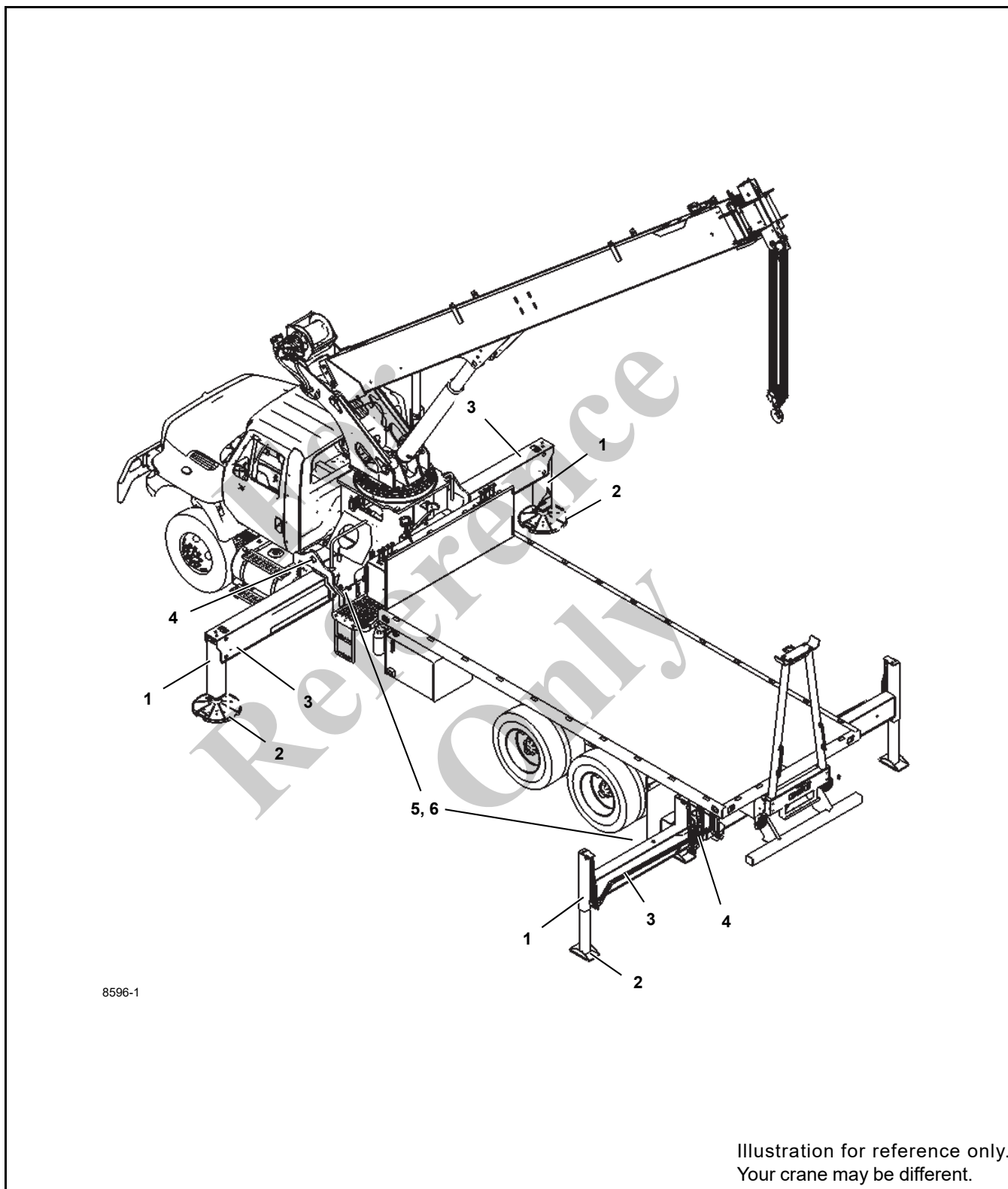
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Illustration for reference only.
Your crane may be different.

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



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

General	3-1	Diagnostic Connector	3-8
Jump Starting Hazard	3-2	Fuse/Relay Panel	3-8
Charging the Battery	3-2	Operating Procedures	3-8
Truck Cab Controls	3-2	Equipment Familiarization	3-8
Truck Cab Ignition Switch	3-2	Equipment Checks	3-8
Power Take Off	3-2	Cold Weather Operation	3-9
Park Brake	3-3	Crane Warm-up Procedures	3-9
Engine Speed Governor	3-3	Engine	3-9
Neutral Start/Safety Switch	3-3	Transmission	3-9
Crane Controls	3-3	Hoist	3-9
Swing Speed Adjustment	3-3	Swing Drive and Turntable Bearing	3-10
Emergency Stop Switch	3-3	Axles	3-10
Anti-Two-Block Warning	3-3	Hydraulic Oil System	3-10
Boom Angle Indicator	3-3	Anti-Two Block Check	3-10
Boom Length Indicator	3-3	RCL Check	3-10
Outrigger Control Box (Pendent)	3-4	Hoist System Operation	3-11
Crane Level Indicators	3-4	Work Site Location	3-11
Crane Controls	3-6	Before Leaving the Truck Cab	3-11
Control Console	3-6	Before Making the Lift	3-11
Stop/Run/Start Switch	3-6	Load Chart	3-11
Boom Telescope Control Lever	3-6	Using the Load Chart	3-12
Hoist Control Lever	3-6	Lifting the Load	3-12
Hoist Speed Control	3-6	Rated Capacity Limiter	3-15
Warning Horn Switch	3-6	RCL System Description	3-15
Swing Control Lever	3-6	RCL Setup	3-18
Boom Lift Control Lever	3-6	Operating Mode	3-19
Control Levers (Optional)	3-7	Operational Limits	3-20
Foot Throttle	3-7	Delete All Limits	3-22
Load Charts	3-7	Tools	3-22
Rated Capacity Limiter (RCL) Display Module	3-7	Diagnostic	3-23
Remote Control Enable Switch (Optional)	3-7	Shut Down and Preparation for Road Travel ...	3-25
RCL Override Key Switch	3-7	Unattended Crane	3-26
Momentary RCL Override Switch	3-7	Crane Remote Control (Optional)	3-27
Hoist Jog Switch (Optional)	3-8	Crane Remote Control Activation	3-30

GENERAL

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

- Truck Cab Controls
- Control Console
- Outrigger Controls
- Crane Controls
- Operating Procedures

- Hoist System Operation
- Work Site Location
- Load Chart
- Lifting the Load
- Shutdown and Preparation for Travel

JUMP STARTING HAZARD

Do not attempt to jump start the crane.

CAUTION

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

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

The batteries should be completely disconnected from the crane electrical system and charged using a battery charger of appropriate voltage level or replace the batteries with fully charged batteries. Refer to *Charging the Battery*, page 3-2.

CHARGING THE BATTERY

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

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

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 ON in order for the crane ignition switch to be operable.

NOTE: All ignition switches (truck key switch and both crane console switches must be in the RUN/ON position before the truck can be started from either the truck cab or the control console.

Power Take Off

CAUTION

Disengage the hydraulic pump when crane is not in active use. Leaving the PTO engaged will cause batteries to drain.

The PTO must be disengaged when crane is not being operated to prevent power drain to the battery. Power is supplied by the truck battery even when the truck ignition is in the OFF position.

PTO is recommended to be disengaged when starting for ease of cranking engine.

Manual Shift Control

The Power Take Off (PTO) switch varies by truck chassis. 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 the PTO and disengaged when the switch is in the off position. The truck gear shift lever must be in neutral and clutch depressed when the switch is moved. The transmission selector lever must be returned to “N” for stationary vehicle operation. The PTO can be disengaged while in any transmission range provided that the load has been removed from the PTO.

Electric Shift Control

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

Power Shift Control

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

Park Brake

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

Engine Speed Governor

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

Neutral Start/Safety Switch

The truck must be equipped with a Neutral/Start Safety Switch on the truck transmission. Check occasionally to ensure that the switch is working correctly and repair if it is not.

CRANE CONTROLS

The crane is equipped with control stations on each side of the main frame. Symbols on the control knobs indicate the direction to actuate the controls for the various crane functions. Each station provides control of boom rotation, boom elevation, boom extension, hoist, engine foot throttle, engine emergency stop switch, and horn switch. All control handles are positioned in the same order at both left and right control stations. Outrigger controls are pendant controlled and accessible from both sides.

Swing Speed Adjustment

The Swing Speed Adjustment is located on swing drive motor inside of turntable turret. Turn knob **IN** to increase

maximum swing speed. Turn knob **OUT** to decrease maximum swing speed.

Emergency Stop Switch

Operate the Emergency Stop Switch to kill the truck engine under emergency conditions. Switch must be reset to the "**ON**" position to operate truck from cab.

Anti-Two-Block Warning

Indicator light illuminates and an audible alarm sounds when a two-block or extension overload condition is detected. When the anti-two-block system is activated, the Boom Telescope, Boom Down and Hoist Up function will cease operation. To restore normal functioning, the Boom Up Function, Hoist Down function or Boom Retract function must be operated until the loadline block allows the anti-two-block sensing weight at the sheave case to hang freely.

Boom Angle Indicator

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

Boom Length Indicator

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

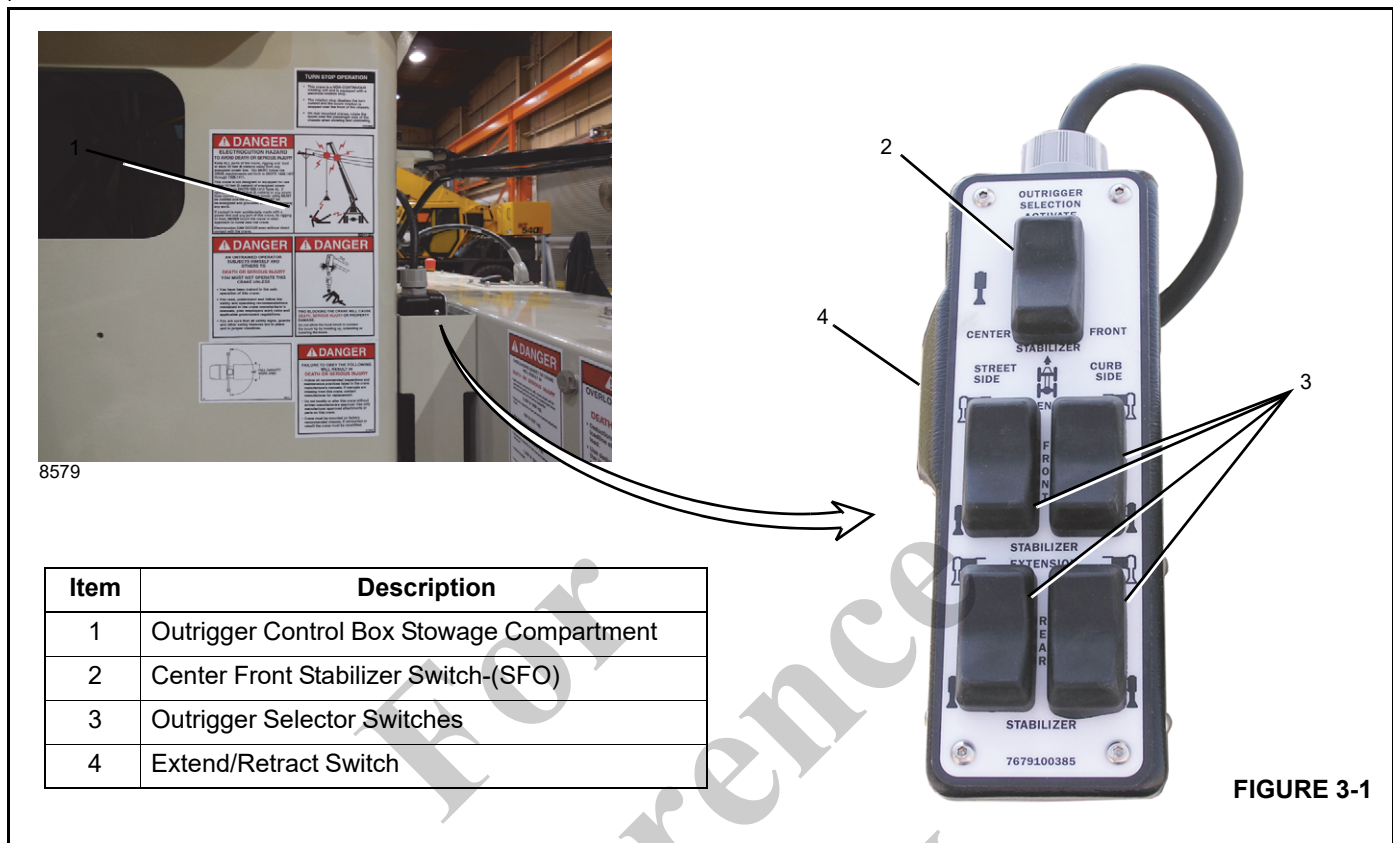


FIGURE 3-1

Outrigger Control Box (Pendent)

The hand-held Outrigger Control Box (13) is stowed in a compartment on the front of the control console station (Figure 3-1) and is used to control the outriggers.

Extend/Retract Switch

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

Outrigger Selector Switches

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

Center Front Stabilizer (SFO) Switch

The Center Front Stabilizer Switch (SFO) 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 jacks are retracted and must be reset if lifting is to be continued.

Crane Level Indicators

The crane has two Level Indicators (18) on either side of the turntable turret that is used to level the crane with the outriggers (Figure 3-2). Adjust the outrigger jacks until the bubble is in the center of the Level Indicator.

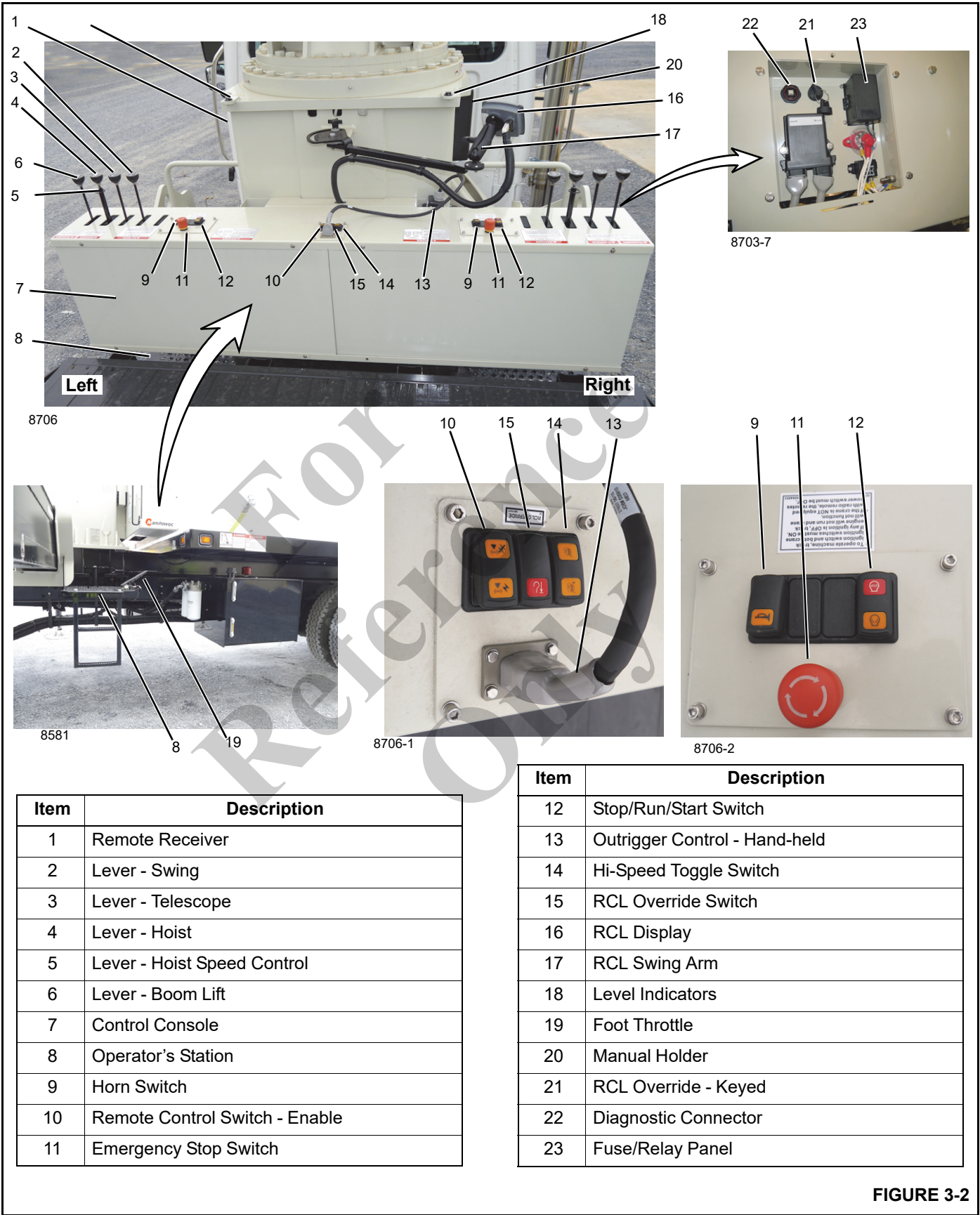


FIGURE 3-2

CRANE CONTROLS

See Figure 3-2 for item number identification.

Control Console

The Control Console (7) is located at the operator's station and contains the crane controls. The display symbol on control levers indicate direction of crane function relative to control lever actuation.

Stop/Run/Start Switch

The crane's power switch, Stop/Run/Start Switch (12) is located on the operator control console and controls the truck engine and crane power. The switch has three positions. STOP shuts down engine and crane power, RUN activates truck engine ignition and crane power, and START to start the truck engine.

NOTE: The truck cab ignition and both console switches must be in the ON position, set to RUN, before the engine can be started using the Stop/Run/Start Switch.

NOTE: If one switch does not engage the truck starter, check and make sure the other switches are ON and there are no active E-stops.

When all crane ignition switches are ON and the PTO engaged, the throttle pedal in the operators station overrides the truck cab throttle, the RCL system is powered, and the crane functions can be activated.

Boom Telescope Control Lever

The Telescope Control Lever (3) is located on the control console. Push the lever forward to extend the boom and pull back to retract the boom.



DANGER

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

Hoist Control Lever

The Hoist Control Lever (4) is located on the control console. Push forward to lower the load and pull the lever back to raise the load.



DANGER

Crushing Hazard!

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

Hoist Speed Control

The hoist operates at two speeds; the Hoist Speed Control (5), located on the Hoist Control Lever (4) and the Hi Speed Hoist Toggle Switch (14). Both are located on the console, are used to select the hoist speed.

Warning Horn Switch

The Warning Horn Switch (9) is located on the control console. Push the switch to sound the horn button to warn personnel of impending movement of the crane.

NOTE: An amber LED is illuminated when the switch is on.

Swing Control Lever

The Swing Control Lever (2) is located on the control console and controls turret rotation. Push the lever forward to rotate the turret counterclockwise and pull back to rotate the turret clockwise. When the swing control lever is moved to the neutral position, the swing brake is automatically applied.

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

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

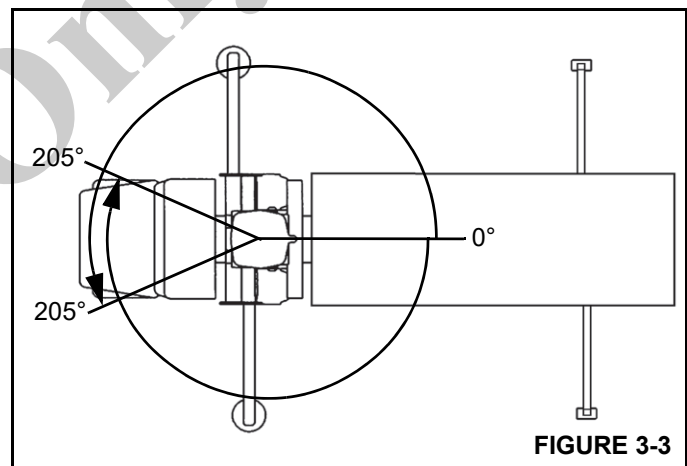


FIGURE 3-3

Boom Lift Control Lever

The Boom Lift Control Lever (6) is located on the right side of the control console and is used to raise and lower the boom. Push the lever forward to lower the boom and pull back to raise the boom.

Control Levers (Optional)

When installed, the control levers are used for optional hydraulic equipment such as an auger, auxiliary hoist or hydraulic hose reel. Move the lever forward or pull the lever backward to perform the required function of the option on your machine.

Foot Throttle

The Foot Throttle (19) is located on the floor of the operator's station and is used to control the engine speed. Depress the foot throttle to accelerate the engine speed and release to return to idle. The throttle pedal in the operator station overrides the truck cab throttle.

Load Charts

The Load Charts are contained in a binder and are stored in a manual holder (20) located on the right side of turret. This chart shows capacities of crane at various operating areas and hoist capacities with appropriate reeving in allowable lifting configurations. Refer to See "Load Chart" on page 11.

Rated Capacity Limiter (RCL) Display Module

The RCL provides the crane operator with information to assist the operator in operation of the crane within its design parameters. The RCL Console (16) 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. Refer to RCL Communication Overview in the Service Manual. The display is mounted on a swinging arm (17) that can be positioned to either left or right operator's station. The RCL display is not intended for frequent removal as damage may occur to the electrical connector. Removing the display will

result in a check engine light illuminating in the truck dash. This display will not effect truck function or performance. A cycle of the ignition switch off and on may be required if light does not turn off when the display is replaced.

Remote Control Enable Switch (Optional)

The Remote Control Enable Switch (10) is located on the control console and is used to activate the optional remote controller. Push the switch to the **ON** position to enable the controllers.

NOTE: The red LED in the switch is illuminated when the switch is in the **ON** position.

Refer to *Crane Remote Control (Optional)*, page 3-27.

RCL Override Key Switch

RCL Override key switch (21) is located behind an access panel on passenger side operator station. To enable or disable RCL and ATB device, remove cover and turn ATB override key switch.

NOTE: The RCL memory always has power supplied by the truck battery even when the truck ignition is in the OFF position.

Momentary RCL Override Switch

The Momentary RCL Override Switch (15) overrides the RCL system while the switch is pressed in. The RCL is active when the switch is released. Do Not use the override to continue lifting operations in an overload or two-blocked condition.

DANGER

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

Hoist Jog Switch (Optional)

CAUTION

When activated, the hoist jog switch overrides the A2B switch. Be careful not to damage the load line when taking in load line.

The hoist jog switch is located at the right rear corner (standard) or front bumper (tractor mount) of the truck. Use the hoist jog switch as an aid to stow and unstow the hook block. The following configuration conditions must be met to use the hoist jog switch:

- RCL Configured (Operating mode selected in RCL)
- Boom angle less than 10°
- Boom length within 10-ft of retracted
- Slew angle within 10° of centered over rear (or front)

The switch activates the hoist for a 2 second interval in either direction to take up or let out the load line. After the 2-second interval, the switch must be released and activated again to continue

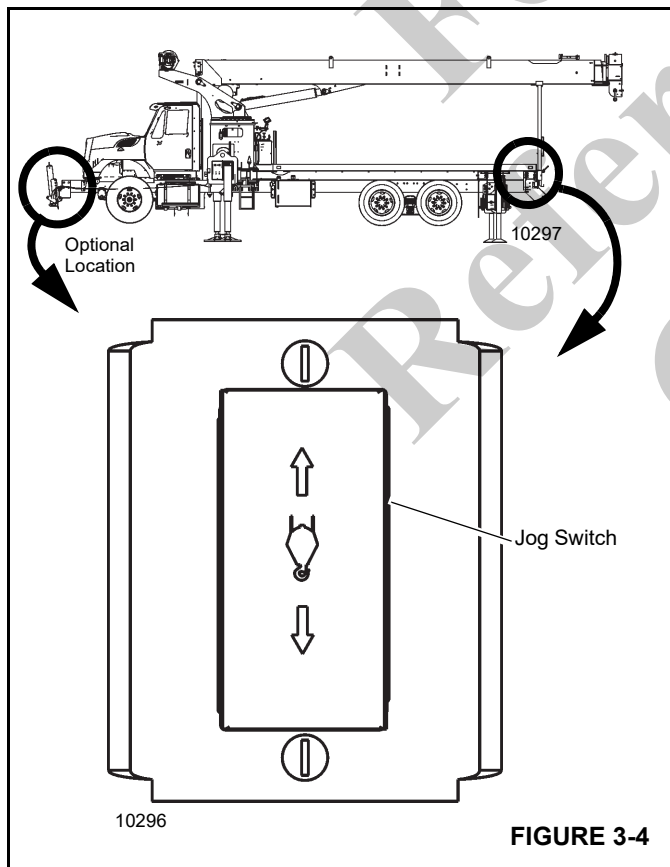


FIGURE 3-4

Diagnostic Connector

The Diagnostic Connector (22) is located behind the access panel on the right side of the console. It is used to connect to the crane/RCL CANbus network.

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



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

Fuse/Relay Panel

The crane electrical system is a standard 12 volt DC automotive type protected by a 30 amp fuse and supplies power for all crane functions. The Fuse/Relay Panel (23) is located behind the access panel on the right side of the console.

OPERATING PROCEDURES

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

Equipment Familiarization

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

Equipment Checks

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

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

- all sheaves for free turning.
- the hoist cable for kinks, broken strands or other damage in accordance with instructions in *Hoist Cable Inspection and Maintenance*, page 6-3.
- to see that the hydraulic hoses and fittings are in good condition and show no signs of leaking. Repair damaged or leaking hoses immediately.
- the RCL and anti-two-block system for proper operation.
- the electrical wiring connecting the various parts of the system for physical damage.

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

Cold Weather Operation

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

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

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

Operation Below -40°C

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

Operation Below -40°F

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

CRANE WARM-UP PROCEDURES

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

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

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

CAUTION

Crane Damage Hazard!

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

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

Engine

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

Warm-up Procedures for All Temperature Ranges:

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

Transmission

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

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

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

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 3-10).
2. Once the hydraulic system is warm, operate the unloaded hoist, in both directions, at low speeds several times to prime all hydraulic lines with warm hydraulic oil and to circulate gear lubricant through the planetary gear sets.

Swing Drive and Turntable Bearing

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

1. Setup the crane on fully extended outriggers, with the boom fully retracted and near maximum lift angle with no load applied.
2. Rotate the superstructure at a speed of less than one RPM for at least one complete revolution in one direction, then rotate the superstructure at a speed of less than one RPM for at least one complete revolution in the opposite direction.

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

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

Axles

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

Hydraulic Oil System

Operating Limits and Warm-up Procedures:

- **From 4°C to -10°C (40°F to 15°F):** Crane operation without a load is allowed with medium engine RPM and medium function speed (joystick position) until the fluid reaches at least 10°C (50°F). It is then recommended that all crane functions be cycled to remove cold fluid from all components and cylinders of the hydraulic system. If there is any unusual sound coming from the crane's hydraulic pumps or motors, stop the operation and engine immediately and contact a Manitowoc distributor.
- **From 10°C to 4°C (50°F to 40°F):** Crane operation with a load is allowed with medium engine RPM and medium function speed (joystick position) until the fluid reaches at least 10°C (50°F).
- **From 95°C to 10°C (200°F to 50°F):** Crane operation with a load is allowed with no restrictions.
- **Above 95°C (200°F):** No crane operation is allowed. Let the crane's hydraulic oil cool by running the engine at idle with no functions actuated.

Anti-Two Block Check



DANGER

Crushing Hazard!

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

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

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



DANGER

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

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

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

RCL Check



DANGER

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

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

Lifting personnel is not permitted with a malfunctioning RCL.

Perform the following checks to verify proper RCL operation:

- Check that the display of the main boom length agrees with the actual boom length.
- Check that the display of the main boom angle agrees with the actual boom angles.
- Check that the display of the operating radius of the crane agrees with the actual radius.
- Check that the outrigger monitoring system is functioning at all outrigger positions—retracted, mid-extend and full extend. Refer to *Outrigger Monitoring*

System (OMS) (Optional—Standard in North America), page 4-2.



DANGER

Tipping Hazard!

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

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



DANGER

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

HOIST SYSTEM OPERATION

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

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

WORK SITE LOCATION

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

Before Leaving the Truck Cab

- Position the truck so that the outriggers can be extended with no obstructions.
- Put the truck transmission in neutral.
- Set the truck park brake. Wheel chocks may also be required.
- Engage the power takeoff.
- Ensure the truck ignition switch is in the **ON/RUN** position.

NOTE: PTO engaged and truck ignition in the **ON/RUN** position will power up the Crane/RCL system. The engine does not need to be shut off before moving from the truck cab to the crane platform.

To operate crane, both truck ignition switch and crane ignition switch must be **ON**. If any ignition is **OFF**, truck engine will not run and crane will not function.

If the crane is **NOT** equipped with a radio remote, the remotes power switch must be **OFF**.



WARNING

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

Before Making the Lift

- Set the outriggers as described in *Outrigger Setup, page 4-1*.
- Program the RCL as specified in the RCL Operator Manual which is located in the document case.
- Check all controls for proper operation. If any abnormal operations are detected, the condition must be corrected before continuing.
- Check the work area for electric power lines.

LOAD CHART

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

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

Using the Load Chart

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

- **Load Radius** - The horizontal distance from the centerline of rotation, before loading, to the center of the vertical load line or block. This distance is slightly greater with a loaded boom due to deflection.
- **Loaded Boom Angle** - The loaded boom angle is the angle between the first section boom and the horizontal with the load. The loaded boom angle combined with the boom length approximates the operating radius.
- **Working Area** - The area measured in a circular arc above the center line of rotation to the suspended load.

NOTE: The standard work area for the NBT30H-2-2 is 180°. With a center front stabilizer (SFO) the work area is 360°.

- **Freely Suspended Load** - The load hanging free with no direct external force applied except by the loadline.
- **Side Load** - Horizontal side force applied to the lifted load either on the ground or in the air.
- **Boom Length** - The length from boom pivot pin to the boom nose. Decals on either side of the boom shows when specific boom lengths are reached.
- **Range Diagram** - The range diagram (Figure 3-6) shows the operating radius and height of the unloaded boom nose at all boom lengths and angles. It should be used as a guide to position unloaded loadline and to determine to approximate height to which the load can be lifted.

The load chart contains the lifting capacities of the crane in all allowable lifting configurations. The information is presented in three parts, one for outriggers fully retracted, one for outriggers at mid point, and one for the outriggers fully extended. Each part contains the load chart, range diagram, and hoist data sheet. In the examples shown here, the information for the outriggers fully extended is used.

- The load chart (Figure 3-5) is used to determine the weight limit of the load based on the load radius and boom angle. All lifting devices must be included when determining the weight of the load.
- The range diagram (Figure 3-6) shows the operating radius and the height from horizontal of the unloaded boom.

- The hoist data chart (Figure 3-7) shows hoist capacity and multi-part line reeving. The correct reeving for all loads listed in the load chart is also shown.

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

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

To determine the safe operating parameters you need to:

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

LIFTING THE LOAD

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

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

RATED LIFTING CAPACITIES IN POUNDS WITH STOWED EXTENSION 32 FT. - 110 FT. BOOM

ON OUTRIGGERS FULLY EXTENDED

Radius in Feet	#002					
	Main Boom Length in Feet					
	32	46-A	62-B	78-C	94-D	110
6	*59,200 (75.8)					
8	42,200 (72.1)	28,500 (77.8)				
10	35,100 (68.2)	28,400 (75.3)				
12	31,200 (64.3)	27,400 (72.7)	27,550 (77.8)			
15	26,200 (58.1)	23,400 (68.7)	22,550 (74.9)	19,150 (78.7)		
20	18,700 (46.5)	17,700 (61.8)	17,050 (70)	17,150 (75.1)	16,000 (78.8)	
25	14,100 (31.9)	13,900 (54.3)	13,600 (64.9)	13,650 (71.2)	13,400 (75.7)	10,200 (78.5)
30		11,400 (46.1)	11,150 (59.6)	11,150 (67.2)	11,050 (72.4)	8,900 (75.9)
35		8,850 (36.4)	9,350 (54)	9,350 (63)	10,300 (69.3)	8,700 (73.5)
40		6,650 (24.7)	7,600 (47.9)	7,900 (58.7)	8,150 (65.7)	7,450 (70.8)
45			6,100 (41.7)	6,400 (54.5)	6,600 (62.4)	6,700 (68)
50			4,850 (33.9)	5,150 (49.7)	5,350 (58.7)	5,550 (64.9)
55			3,850 (23.9)	4,200 (44.4)	4,400 (54.8)	4,550 (61.8)
60				3,350 (38.7)	3,500 (50.8)	3,750 (58.5)
65				2,650 (32)	2,800 (46.4)	3,000 (55.2)
70				2,000 (23.7)	2,250 (41.8)	2,450 (51.7)
75					1,750 (36.7)	1,950 (48)
80					1,350 (30.9)	1,500 (44.1)
85					950 (23.7)	1,150 (39.9)
90					600 (12.9)	800 (35.3)
95						500 (30)
100						250 (23.7)
Minimum boom angle (°) for indicated length (no load)						0
Maximum boom length (ft.) at 0° boom angle (no load)						94

NOTE: () Boom angles are in degrees.

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

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

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

NOTE: () Reference radii in feet.

80085127

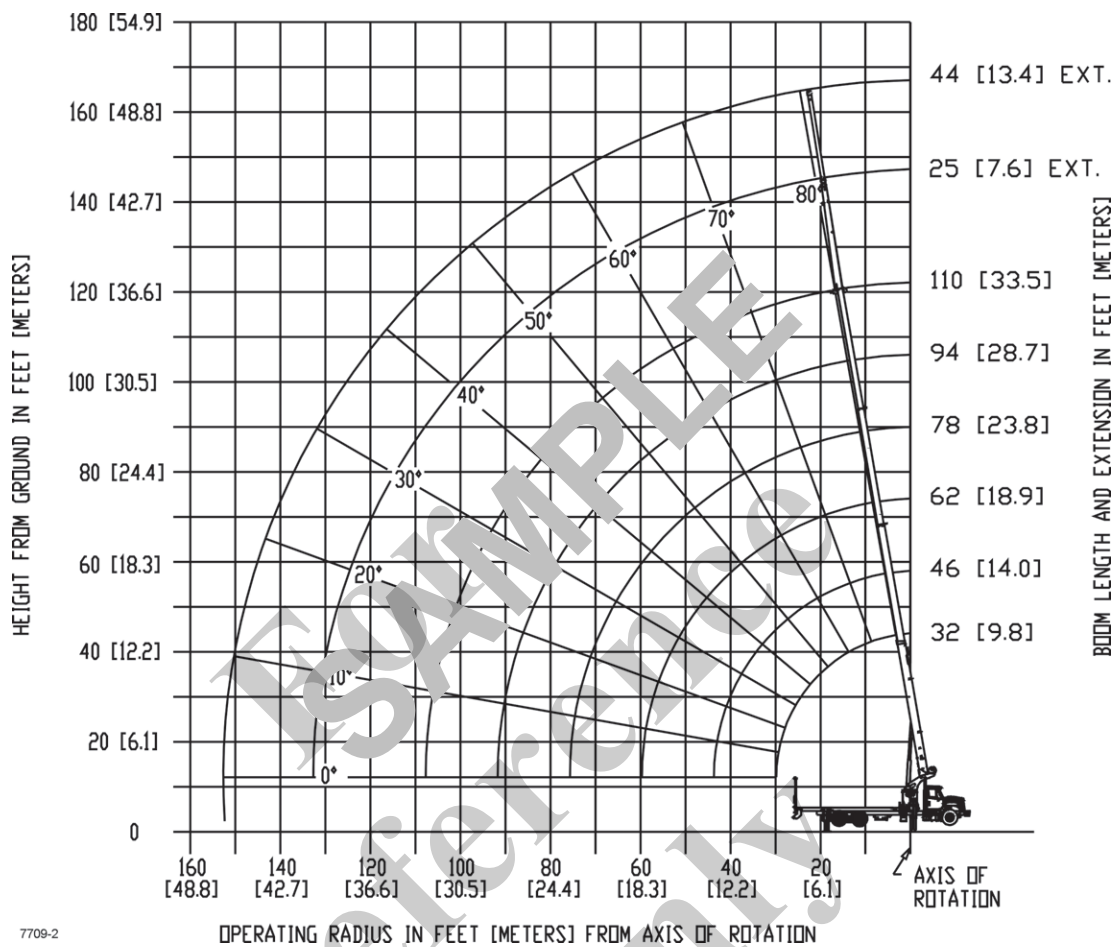


FIGURE 3-6

Parts of line	1	2	3	4	5	6	7
Max. boom length (ft.) at max. elevation with stated rigging and load block at ground level	154	110	74	78	62	46	32
Low speed lift (lb)	7700	15400	23100	30800	38500	46200	53900
High speed lift (lb)	3000	6000	9000	12000	15000	18000	21000

7709-1

FIGURE 3-7

RATED CAPACITY LIMITER



FIGURE 3-8

RCL System Description

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

The RCL is not a substitute for good operator judgment, experience, and safe operating procedures. The

responsibility for safe crane operation remains with the operator.

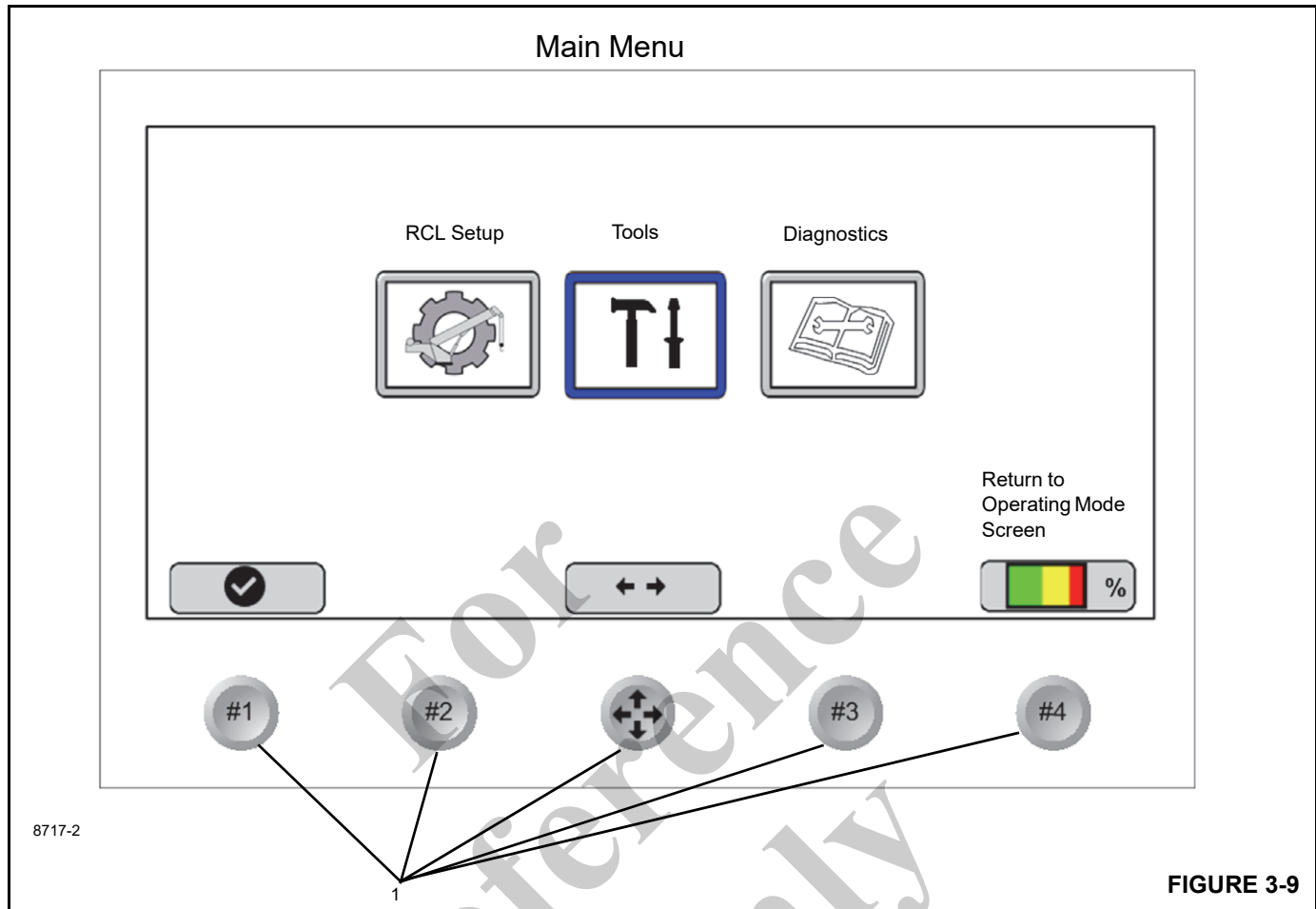
The Manitowoc RCL system consists of an operator's console, anti-two block switch, length sensor, angle sensor, slew potentiometer, four outrigger length sensors and two lift cylinder pressure transducers. The maximum load/actual load is displayed on the operator screen and the load part number is displayed on the error codes screen. When a load is picked, the RCL compares the actual conditions with the load chart. If an overload condition is sensed, audible and visual warnings are generated and the Boom Down, Telescope Out, and Hoist Up controls are disabled. These are the functions that worsen the overload condition.

Components:

- RCL display is mounted on an adjustable arm that can be positioned to either the passenger-side or the driver-side of the operator's control console.

NOTE: The RCL display is not intended for frequent removal as damage may occur to the electrical connector. Removing the display will result in a check engine light illuminating in the truck dash.

- Length/angle sensor with cable reel mounted on the under side of boom.
- Lift cylinder pressure transducers located inside the turret.
- Anti-two block (A2B) switch on the boom nose.
- Slew sensor inside the frame mounted to the bearing.
- Outrigger length string potentiometer mounted inside each outrigger beam.



RCL Display

The **Main Menu** screen should display when:

- The display first powers up or
- If the 2-hour resume configuration timer has expired.

This screen should not display when:

- Crane was shut down while operating in Radio Remote Control State and was configured with a man-basket during first machine set-up-regardless of the above (2) conditions. In this case, the display should power up and display the last known operating mode screen (with basket).

The **Main Menu** screen (Figure 3-9) is divided into the following three major sections which are used to set-up, operate, calibrate and troubleshoot the Rated Capacity Limiter (RCL) system.

The RCL display will show available button functions based on the current screen and the current system status. An icon showing the available functions for each button will appear above each button.

Buttons 1-4 can be used to select/confirm a highlighted item, go back/escape, return to operating screen or go to a specific menu or function.











The Directional button is used to highlight and select applicable choices and navigate to multiple screens.

Use the directional pad to highlight the desired function, then select with button #1.

- **RCL Set-Up** - Highlight and press Select function key (Figure 3-9) to configure the RCL system. This screen includes configuration and establishing operational limits for the boom, outrigger, hoist, and reeving. The RCL Set-Up screen also includes the RCL operating mode screen, see page 3-17.
- **Tools** - Highlight and Select function key (Figure 3-9) to access the tools screen, see page 3-22. This screen includes:
RCL Setup and Sensor Calibration Screens and Measurement Display Information.
- **Diagnostic** - Highlight and press the Select function key #3 (Figure 3-9) to access the RCL diagnostic menu, see page 3-23. This menu includes:

Machine Information and Warnings, Crane Electrical Fault Monitoring, Hour Meter, Load Chart Part Number, Calibration Chart Part Number and Module Input/Output screens with Software Versions and Real-Time Sensor information.

The **Main Menu** screen has *function keys* (Figure 3-9) that are used to highlight and select the functions shown on the display screen.

-  The Return to Operating Mode Screen button is only displayed if the RCL has been through configuration and set-up. The image on the button displays the real-time Rated Capacity Bar Graphics status.
-  The Directional button is used to highlight and select applicable choices and navigate to multiple screens.
- For more choices, press the right arrow  function key.
- To go back to the previous choices, press the left arrow  function key. The Back function returns to the previous screen without saving inputs.
- The up  and down  arrow functions are used to increment or decrement through inputs or screen selections.
-  The Select function key confirms the choice that is highlighted.
-  The Escape function returns to the previous screen without saving inputs.

NOTE: On start up of the RCL, the Manitowoc splash screen and the National Crane logo screen will appear for a few seconds each before the Main Menu Screen appears (Figure 3-9).

NOTE: If the crane is powered up after sitting idle within a 2 hour time period, the Configuration Confirmation Screen 9 (page 3-19) will appear first.

NOTE: If one of the RCL sensors have not been calibrated, then the sensor calibration menu will display.

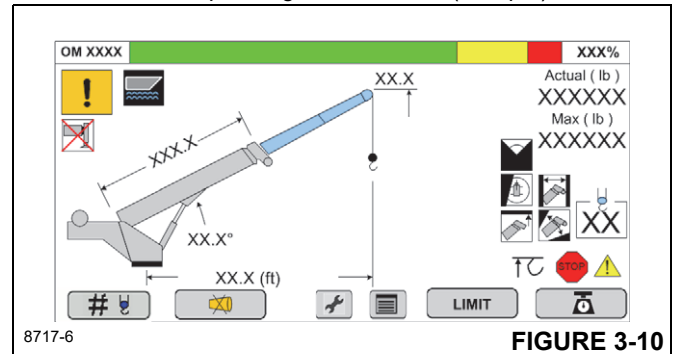
Alert and Limit Symbols




The left and right sides of the operating screen display active alert and/or limit symbols. Only those limits that are set are displayed. If there is a violation of a set limit, the symbol

flashes. In normal operation with no limits set and no alerts active, this portion of the screen is blank.

The warning cluster on the following sample screen shows all alert and limit symbols for illustration purposes only.



RCL Operating Mode Screen (Sample)



-  **RCL-Capacity Warning** - Continuous visual and audible warning that an overload condition is approaching. The operator can continue with extreme caution.
-  **RCL Capacity Lockout** - Continuous visual and audible warning that an overload condition exists. The following controls are locked out:
 - Hoist Up (Main and Auxiliary)
 - Boom Down
 - Telescope Out
-  **A2B Limit is Activated** - Continuous visual and audible warning that a two-block condition exists. The following controls are locked out:
 - Hoist Up (Main and Auxiliary)
 - Boom Down
 - Telescope Out



RCL Override Warning

The RCL override bypasses the RCL for both overload and A2B alerts.





-  **RCL Override Warning (Red)** - Indicates that the RCL is bypassed by the operator. Use extreme caution when the RCL is bypassed.
-  **A2B Override Warning (Red)** - Indicates that the A2B is bypassed by the operator. Use extreme caution when the A2B is bypassed.




DANGER

Use extreme caution when operating the crane with the RCL system overridden. Use of the RCL system override to operate the crane in a non-permissible range can result in death or injury to personnel and/or damage to equipment and property.



-  Horn Silence - Indicates the RCL warning horn is temporarily disabled.
-  Slew Angle Limit - The slew angle is measured from the centerline of the bearing with the boom in the boom rest to the present boom position. This is to alert the operator of a user set limit.

A positive slew angle is to the passenger side of the boom rest $+1^\circ$ to $+360^\circ$ or $+1^\circ > \text{angle} > 180^\circ$ negative slew angle is to the drivers side of the boom rest from -0.0° to -180° .

-  Tip Height Limit - The tip height is measured from the ground to the tip of the boom. This monitors the height of the boom tip to alert the operator of a user set limit.
-  RCL Angle Limit - The angle limit is measured by the boom angle. This is to alert the operator of user defined limits above or below these settings.
-  Radius Limit - The radius limit is measured from the center of rotation to the center of the load. This is to alert the operator of a user set limit.
-  RCL WADS Limit - The work area definition (WADS) limit is measured as a straight line from point A to point B anywhere in the work area. This sets up a virtual wall that alerts the operator of a user set limit. The WADS can be configured with three virtual walls.

-  General Warning - refer to MAIN Menu screen, option 3 Diagnostics to see the warning that is active.
-  Outrigger (O/R) Setup Overridden - Indicates that the operator has manually overridden the current O/R configuration determined by sensor data. No buzzer sounds and no functions are locked out when the outrigger setup is overridden.
-  Outrigger (O/R) Configuration Change - Indicates that the current O/R position has changed from the

previously configured O/R setup. Buzzer sounds to warn operator of discrepancy, but no functions are locked out.

-  3rd Wrap Indicator - Begins to flash to indicate that the minimum layer has been reached on the hoist drum.
-  Barge Mode icon is shown when Barge Mode is selected.

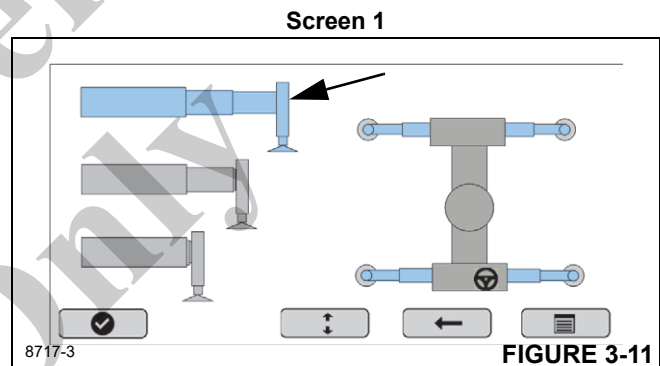
RCL Setup

The RCL setup is where the outrigger and reeving configurations of the crane are entered into the system. The RCL setup is required before the crane can be operated.

When the truck chassis ignition switch is activated, the PTO is engaged and the crane ignition is activated, the RCL will power up and displays the Manitowoc splash screen and National Crane logo screen for a few seconds followed by the Main menu during the RCL setup sequence.

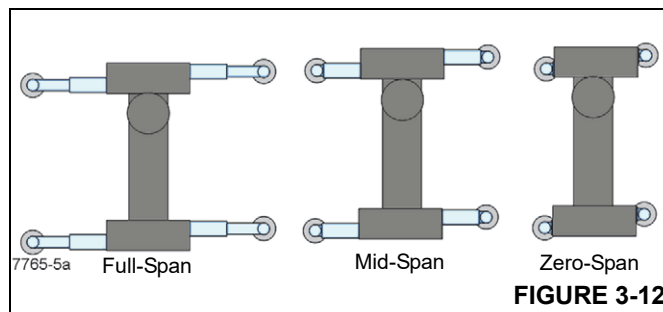
Outrigger Configuration (Optional)

The Outrigger Monitoring System screens displays the configurations of the deployed outriggers.



The detected current outrigger status will be pre-highlighted displaying the current outrigger setting in light blue, shown on the left side of Screen 1. The non-current span setting will be shown in gray.

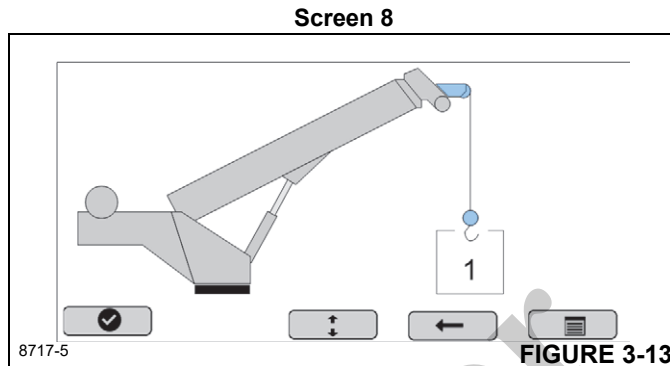
The position of each outrigger will be shown graphically on the right of the screen and will be either Full-Span, Mid-Span, Zero-Span, Figure 3-12.



The outrigger with the shortest span determines the chart that is to be used. For example:

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

Reeving Configuration



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

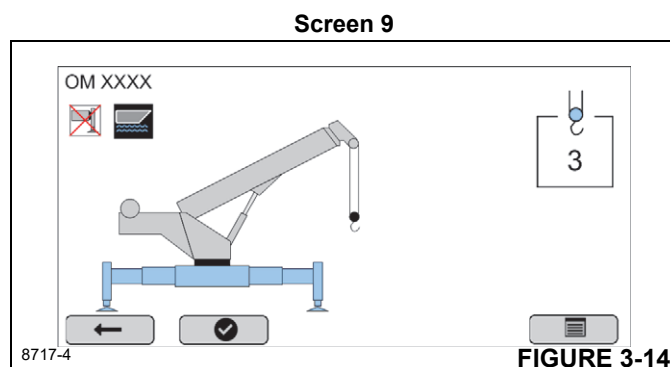
Configuration Confirmation

After the RCL crane configuration setup is complete, the crane configuration confirmation Screen 9 is displayed.

Check the configuration and press the Select function key to confirm the choice that is highlighted if the configuration is correct. This verifies the lift configuration of the crane.

If the confirmation Screen 9 is not correct, use the back arrow key to go back to Screen 8 and correct the configuration.

If the machine is shut down and restarted again within 2 hours, the operator can Press the Select button at Screen 9. Pressing the Select button will automatically return the RCL to the configuration used at shutdown. Re-configuration of the RCL will not be required.



TARE Function

The TARE function calculates the net weight of the load (Total Load – Hook Block). The TARE function must be activated before lifting. To use the TARE function :

- Rig the load to the hook block.
- Before lifting the load, press the TARE function.
- Lift the load. The net load is shown in the actual number display.

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

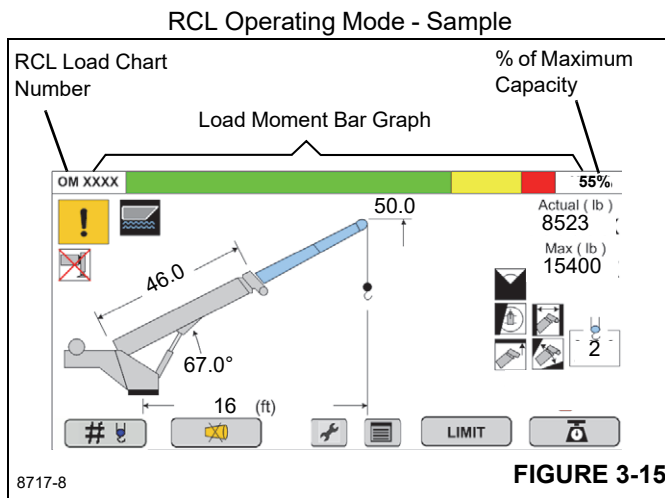
Operating Mode

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

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

- - Reeving selecting screen; pressing this button returns to the number of parts of line selection screen. This button does not appear if Man Basket is selected.
- - Horn Silence pressing disables the horn, if active for approximately 15 seconds per press. Button will flash BLUE when active.
- - Wrench - Pressing this key transitions to the diagnostics screen.
- - MAIN - Pressing this key returns to the MAIN Menu screen.
- LIMIT - Pressing this key transitions to the RCL Limits Menu screen (WADS).
- - Pressing TARE temporarily zeros out the Actual Load indicated on the screen to show the weight of the load only. If the boom angle changes more than 2 degrees or the boom length changes more than 2.5 inches, return to total actual load, non-Tare. Tare button icon will flash BLUE when active.

The following *example* RCL Operating Mode - Sample screen has been set up with all limits set and displays the following:

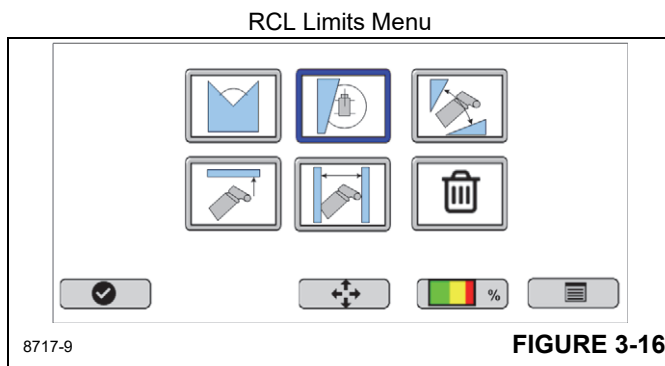


- Boom Length (BL) = 46.0 ft
- Boom Angle (BA) = 67.0°
- Load Radius (LR) = 16 ft
- Boom Tip Height (TH) = 50.0 ft
- # Parts of Line (#) = 2
- Maximum Allowable Load (ML) = 15,400 lbs.
- Actual Load (AL) = 8,523 lbs.
- All Active Limits

Operational Limits

Operational limits are set by the operator to limit crane operation to a defined area. The operational limit icons are displayed in the warning cluster on the RCL Operating Mode screen and flash when the operator violates the limits.

To set operational limits select the LIMIT function key on the RCL Operating Mode screen, the RCL Limits Menu screen will appear.



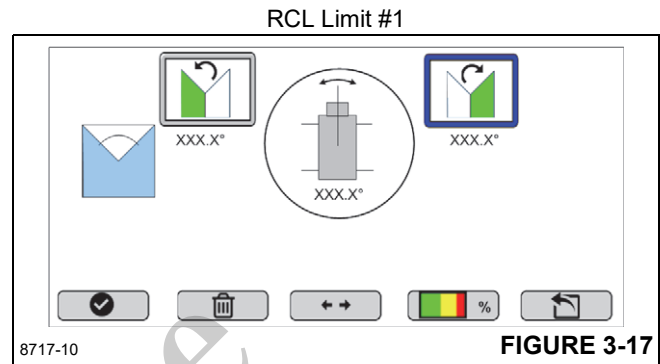
Select the desired operational limit, use the arrow keypad to highlight and select the desired operational limit.

Operational limit selections on the display are as follows:

1. Set a slew angle limit.
2. Set a wall (WADS) limit.

3. Set a boom angle limit.
4. Set a tip height limit.
5. Set a radius limit.
6. Delete all limits

Slew Angle Limit



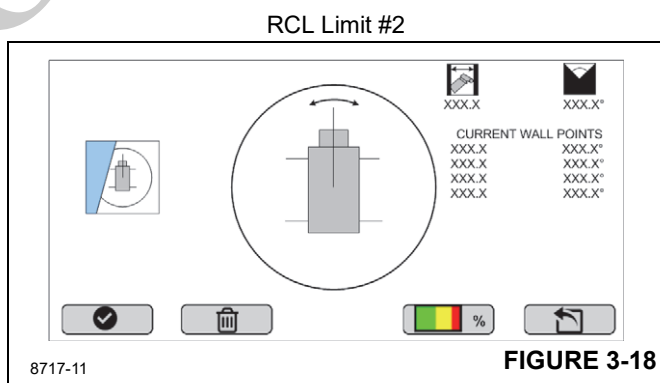
Rotate the crane superstructure to the desired position (the number will appear on the display screen) then:

- Highlight the desired direction and press the select function key to store the current slew angle.

The set slew angle will be displayed under the clockwise or counterclockwise directional icons shown in the limit #1 screen depending on which was highlighted when the limit was set. Once set, this value is fixed and does not change. The current/operating slew angle will appear below the center icon.

NOTE: Button #2 appears after a slew angle has been set and only erases the individual highlighted limit on this screen.

WADS Limit



The RCL Limit #2 screen will set the superstructure radius limit and slew angle limit to create a virtual wall.

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

- Press the Select function key to set the current radius and slew angle for the boom nose position.(Figure 3-18)

- Press select to store each position.

There can be up to four set points which form 3 virtual walls. The points are taken from the load position of the boom nose.

There needs to be at least two points for a virtual wall. Points are stored as distance in feet (RADIUS) from the center of rotation and angle (SLEW ANGLE) from the center line of truck with the boom in the boom rest, see Figure 3-19.

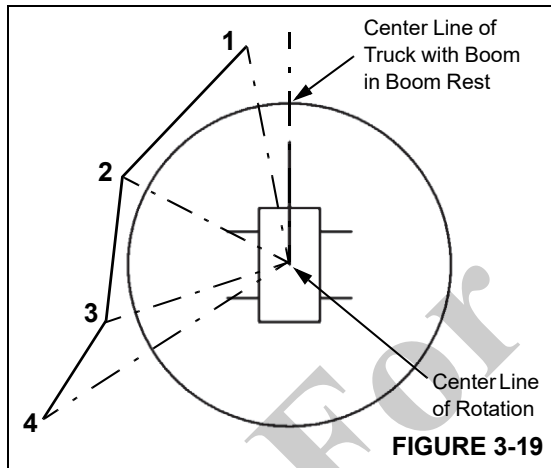


FIGURE 3-19

Boom Angle Limit

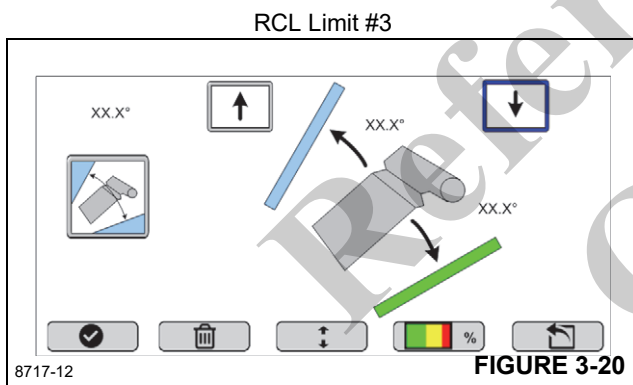


FIGURE 3-20

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

- Limit arrows, limit bars, and limit angles are only shown when that limit is defined.
- The Navigation Pad UP and Down buttons are used to select between upper and lower limits.
- The selected (blue highlight) switches between the upper and lower limit selection box. If a limit exists, the limit bar changes to the green color when selected.

Use this screen to set either the Max boom angle, the Min. boom angle or both Min. and Max.

The current boom angle is always shown in the upper left hand corner.

Tip Height Limit

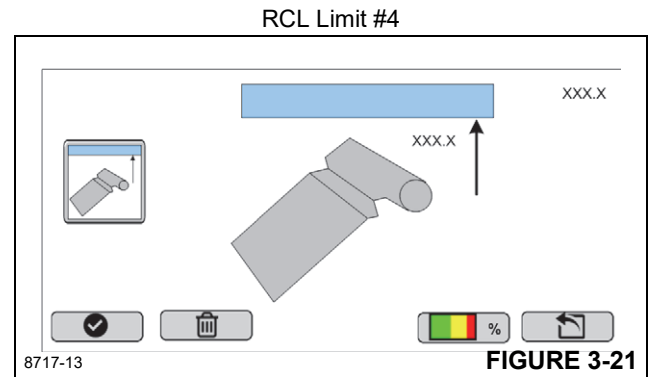


FIGURE 3-21

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

- Limit bar, and limit tip height are only shown when that limit is defined.
- Press Select button #1 (Figure 3-9) to store the current boom tip position as the set point.

The current boom tip height is always shown in the upper right hand corner.

Radius Limit

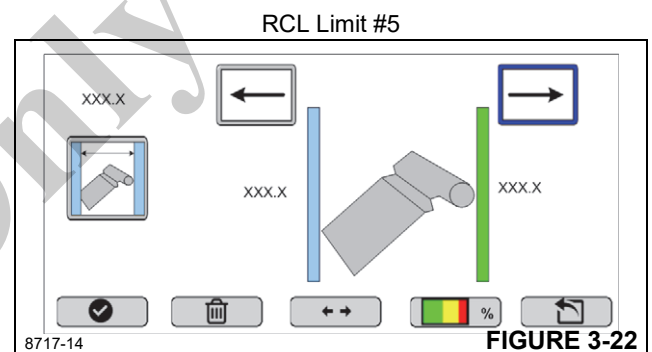


FIGURE 3-22

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

- Limit bar, and limit radius are only shown when that limit is defined.
- The Navigation Pad Left and Right buttons are used to select between MIN and MAX limits.
- The selected (blue highlight) switches between the min and max limit selection box. If a limit exists, the limit bar changes to the green color when selected.

Use this screen to set either the Max boom radius, the Min. boom radius or both the Min. and Max boom radius.

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

Delete All Limits

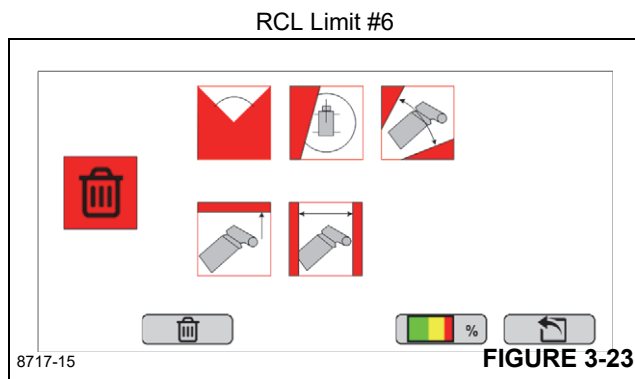


FIGURE 3-23

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

- Select Trash Can to delete all values.
- The Escape function goes back to the Main Limits menu screen without deleting any limit values.

TOOLS

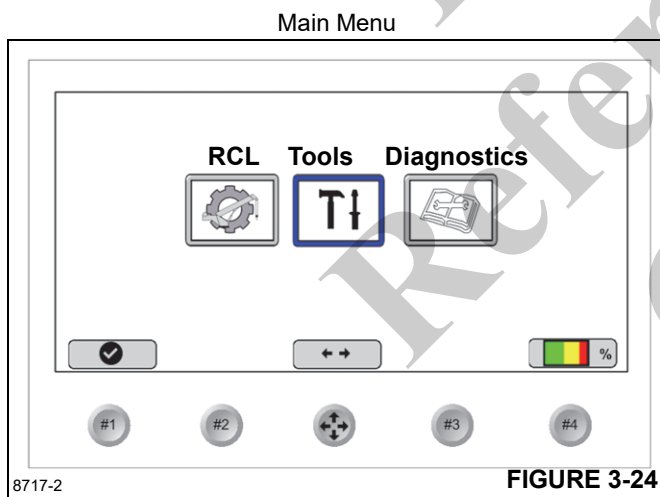
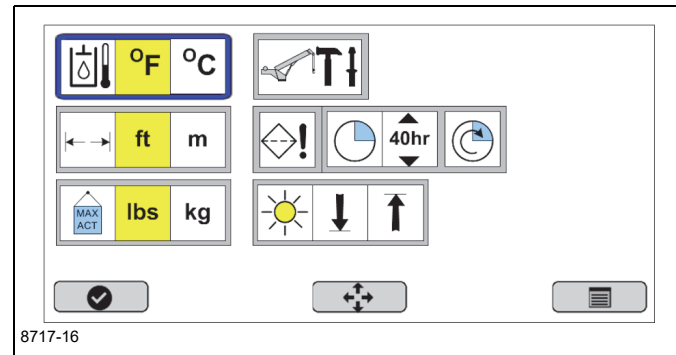


FIGURE 3-24

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

Tools Screen



The Tool Screen will contain the following set up, calibration, tools and measurement display information.

Each selection on the Tools Screen is made by using the arrow keys to scroll and make the selection; press Select button to accept the selection.

Units of Measure

	Temperature, select either °F (Fahrenheit) or °C (Celsius)
	Length, select either ft (feet) or m (meter)
	Weight, select either lbs (pounds) or kg (kilograms)

Yellow indicates the currently set value.

- RCL Sensor Calibration - Sensor calibration is password protected, refer to the *Service Manual*.
- Hydraulic Filter Reminder Setup - ON/OFF, reminder interval (40/250/500 hr.), reset reminder.
This display allows the operator to setup a reminder to check/replace the hydraulic return and suction filter on the crane. The operator can select three different intervals. When the timer expires, an indicator is turned on for the operator to indicate it is time to change the filter. To reset the timer select the far right icon.
- Screen Brightness - Allows adjustment of backlight over a range of 15 steps.
- Up and down arrows in the time and password boxes correspond to button #1 selection.
- Light GRAY background box highlights BLUE when selected, starts in upper left corner.

DIAGNOSTIC

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

Select the Main Menu.

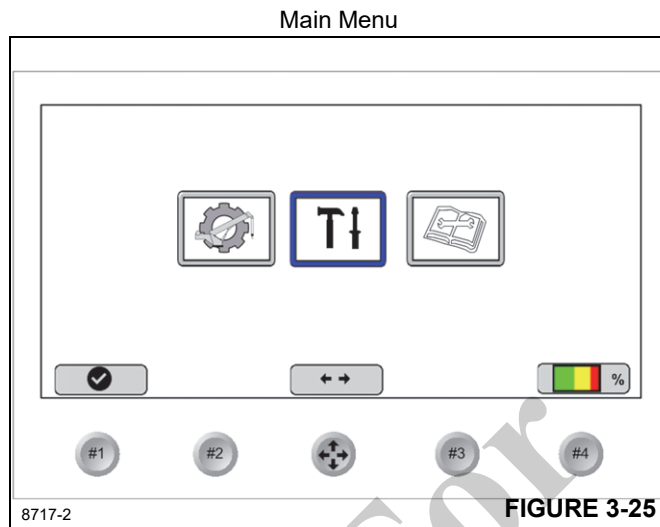


FIGURE 3-25

Select function key #3, Diagnostics.

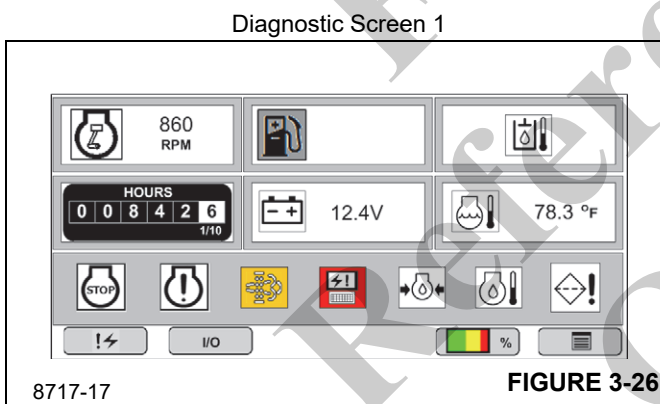




FIGURE 3-26

The first diagnostic screen will contain the following Machine Information Warnings:

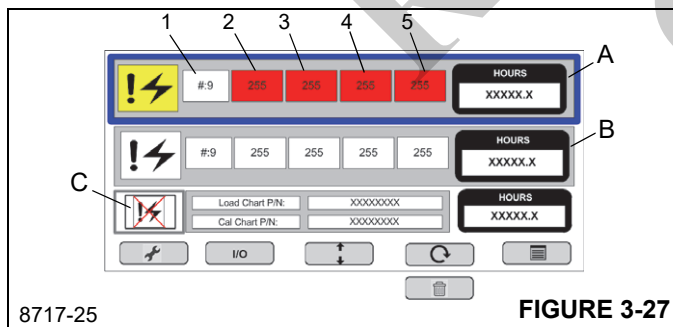
	<u>Truck Engine RPM</u> - Shows current engine RPM.
	<u>Truck Diesel Fuel Level</u> - The truck diesel fuel level is displayed as a percentage of maximum fuel level. If the truck diesel fuel level drops below 20% of maximum capacity, the general warning light is shown on the operating mode screen and the truck diesel fuel level icon is highlighted YELLOW on the diagnostics screen.

	<u>Hydraulic Oil Temp</u> - If the hydraulic oil temperature rises above 180°F, the general warning light is shown on the operating mode screen and this icon is highlighted RED. Fahrenheit is the default value.
	<u>Crane Hour meter</u> - Shows Real time crane hours.
	<u>Battery Voltage</u> - If the truck battery voltage drops below 10.5 Volts, the general warning light is shown on the operating mode screen and the truck battery voltage icon is highlighted RED on the diagnostics screen.
	<u>Engine Water Temperature</u> - If the engine water temperature rises above 220°F the general warning light is shown on the operating mode screen and this icon is highlighted RED. Fahrenheit is the default value.
	<u>Engine Stop Lamp</u> - Lamp turns RED when engine error is detected.
	<u>Engine Warning Lamp</u> - Lamp turns Yellow when engine warning is detected.
	<u>Truck Regeneration Needed</u> - When the truck is in need of regeneration (first stage and all subsequent stages), the general warning light is shown on the operating mode screen and the truck diesel particulate filter icon is highlighted YELLOW on the diagnostics screen.
	<u>Module Fault</u> - turns RED when any module is missing or has a fault which should be present or OK.
	<u>Engine Oil Pressure Warning</u> - If the truck engine oil pressure is below 5 psi, the general warning light is shown on the operating mode screen and the truck engine oil pressure icon is highlighted RED on the diagnostics screen.

	<p><u>Engine Oil Temperature</u> - If the truck engine oil temperature rises above 250°F, the general warning light is shown on the operating mode screen and the truck engine oil temperature icon is highlighted RED on the diagnostics screen. Temperature is displayed in degrees Fahrenheit (default value).</p>
	<p><u>Hydraulic Filter Reminder Warning</u> - If the hydraulic filter reminder limit (see "Tools" screen) has been reached, the general warning light is shown on the operating mode screen and the hydraulic filter reminder icon is highlighted RED on the diagnostics screen.</p>

NOTE:

1. Button #1 will navigate to Diagnostic Screen 2 when pressed.
2. Button #2 will navigate to real-time IO screen when pressed.
3. Button #4 is only displayed if the RCL has been through configuration and set-up.
4. Button #5 will navigate to Main Screen when pressed.
5. Crane Hour Meter - is ON when the PTO is engaged and the ignition is activated. The time is saved when the equipment is shutdown.

**FIGURE 3-27**

Active Fault Box (Red, A) - The crane control system will display up to 20 active faults or errors in the crane and RCL control system(s). Fault numbers only show when a fault occurs and clears to logged when the fault is corrected. The three digit numbers correspond to a specific fault for a specific module, connector and pin.

- (1) - # Block - Indicates the number of the active fault already in the control system, use the arrow keys to scroll. Numbers are 1 through 20, with maximum of 20 faults.
- (2) - Device Number
- (3) - Group Number
- (4) - Index
- (5) - Error Number

The hour meter in Active Fault Box (A) displays the hour meter time that the displayed error occurred.

Logged Fault Box (B) - Logged faults are not currently active, use the circular arrows to scroll through the codes. The crane control system will display up to 50 of the most recent logged faults or errors in the crane and RCL control system(s). The circular up/down arrows can be used to scroll through the active faults.

- The active fault codes box will be highlighted when navigating to this screen.
- To select the Active or Logged Fault Code box, push the up/down arrow button.
- To scroll through the faults for either the Active or Logged faults, select the circular arrow button #3.
- To navigate to the real-time diagnostic screen, press button #2.
- To navigate to the main menu, press button #5.
- Button #4 will change to a trashcan image when the erase the logged codes is highlighted. Selecting the trashcan will clear the logged codes.
- To navigate to the Diagnostic Screen 1, press button #1.

SHUT DOWN AND PREPARATION FOR ROAD TRAVEL

CAUTION

Disengage the hydraulic pump when crane is not in active use, for extended traveling, cold weather starting, or engine checks. Leaving the PTO engaged will cause batteries to drain.

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 overhaul ball from the hoist cable(s) and stow securely or make sure the hook block or overhaul ball is properly secured to the tie down provided for that purpose.

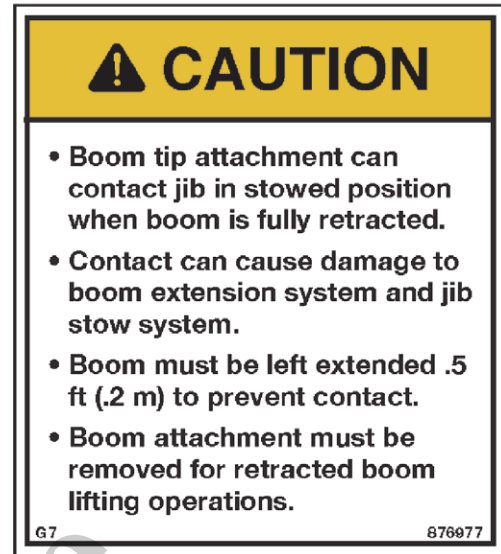
Fully retract the outrigger jacks and properly store the floats.

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 (SFO) 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. Secure the boom during travel using one of the following methods:
 - Either the hook block may be reeved over the main boom nose
 - or the overhaul ball may be reeved over the main boom nose or auxiliary boom nose. The other must be removed and stowed securely before traveling. If the hook block or overhaul ball remains reeved on the boom, it must be secured at the tie down on the carrier provided for that purpose.
- NOTE:** If the wire rope is not reeved over the boom nose, the boom must be secured to the boom rest to prevent sliding and bouncing.
7. 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.

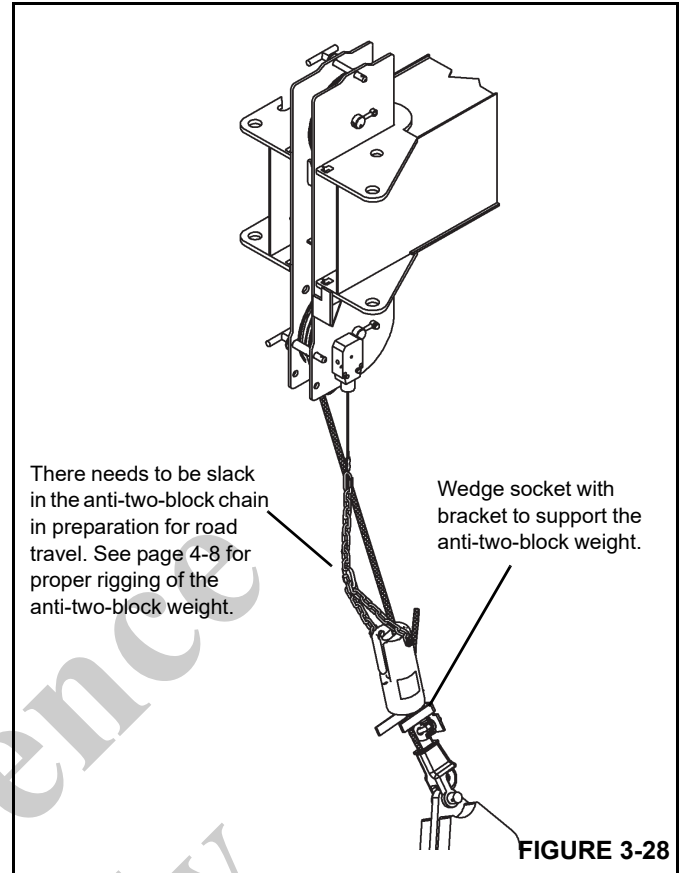
NOTE: There needs to be enough slack in the A2B chain so that the A2B switch does not switch between open and close during travel.

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

- 8. Ensure the stop/run switch is in the run position on the crane operating console.

NOTE: Operator is free to leave engine running when transitioning operation between crane and truck chassis.

- 9. Secure any loads or lifting devices on truck bed or body.
- 10. Ensure tires are properly inflated.
- 11. Disengage the Power Take Off (PTO) and start truck from the truck cab.
- 12. Release the park brake before moving truck.



Unattended Crane



WARNING

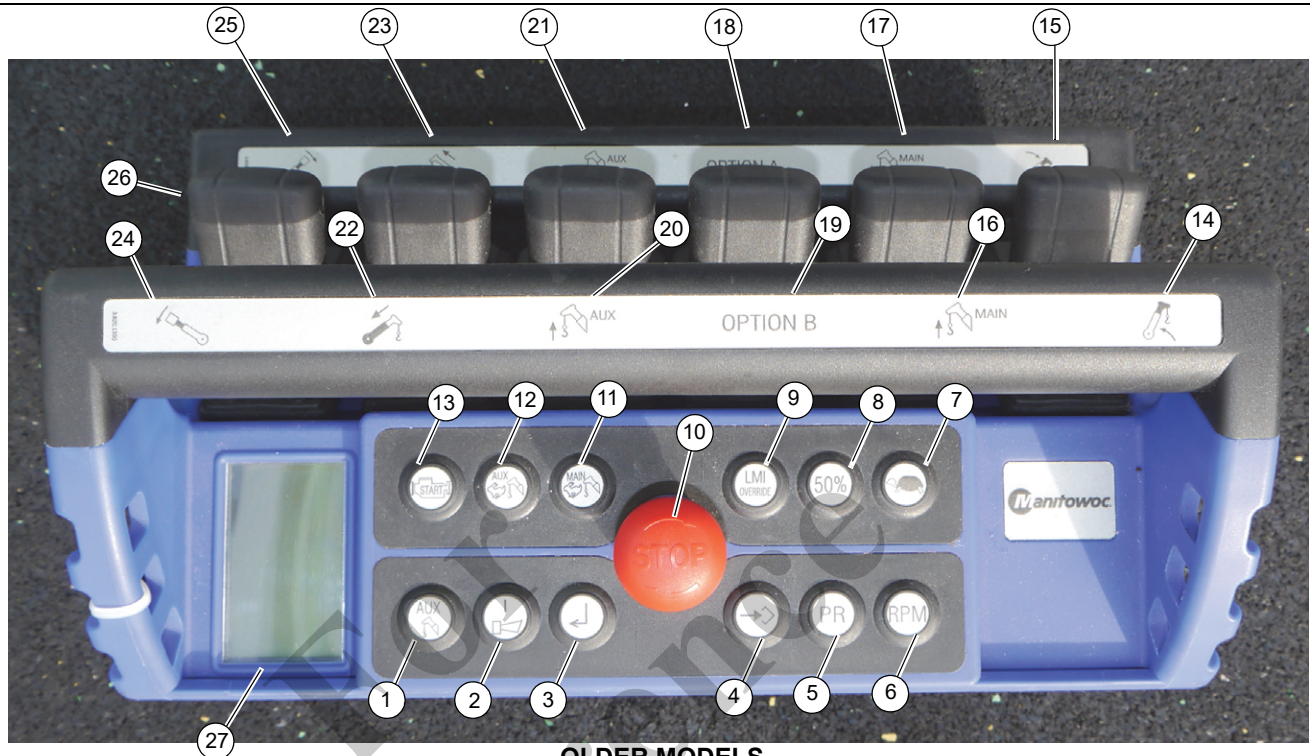
Tipping Hazard!

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

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

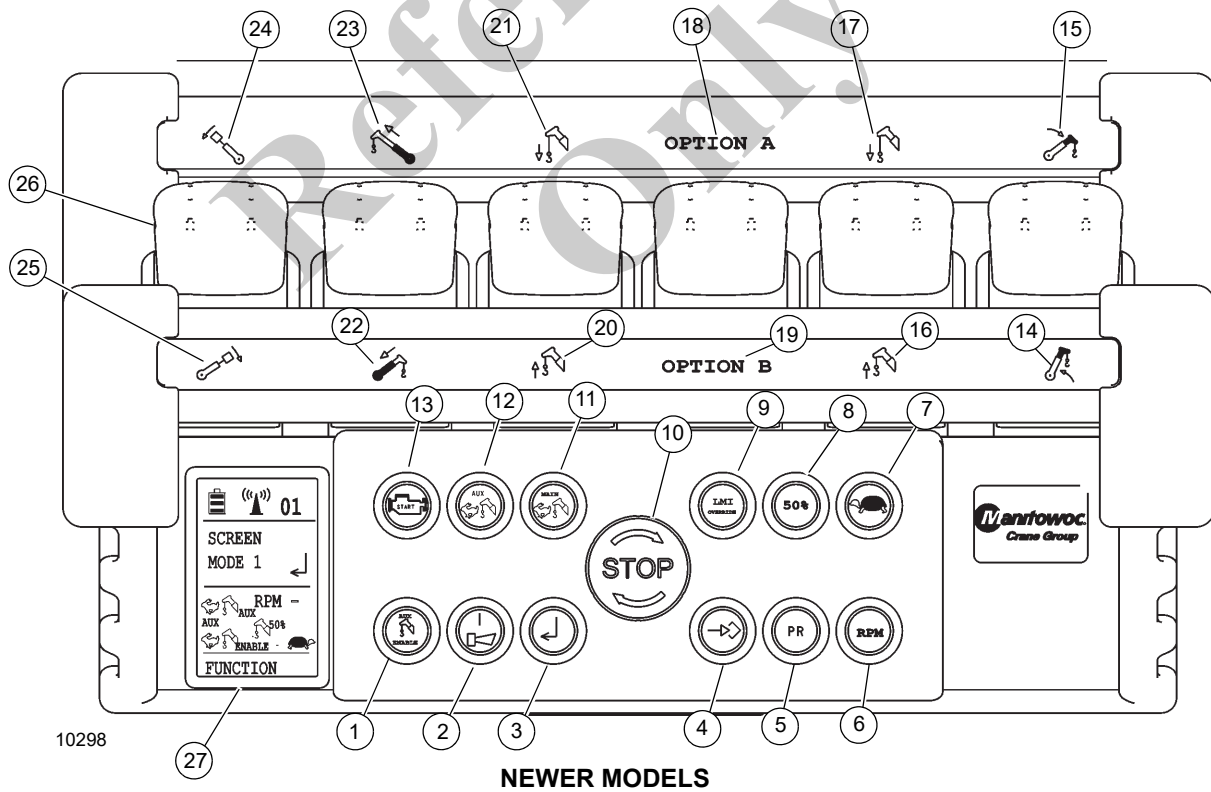
The configuration in which the crane should be left while unattended shall be determined by a qualified, designated individual familiar with the job site, configuration, conditions, and limitations.

CRANE REMOTE CONTROL (OPTIONAL)



7914-3

OLDER MODELS



10298

NEWER MODELS

FIGURE 3-29

The optional Crane Remote Control (Figure 3-29) will allow full remote control of the crane. Refer to the Crane Remote Control Operator Manual for operating instructions for this optional remote control.

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

Item	Description
1	Auxiliary Hoist Enable (Disabled is Default)
2	On/Horn Button
3	Advance Rated Capacity Limiter (RCL)
4	Remote Frequency Change
5	Not Used
6	RPM + (Default is RPM -)
7	Turtle Mode (Default is Normal)
8	50% (Default is 100%)
9	RCL Override
10	E-Stop
11	Main Hoist Hi-Speed
12	Auxiliary Hoist Hi-Speed (not used)
13	Engine Start
14	Boom Up
15	Boom Down
16	Main Hoist Up
17	Main Hoist Down
18	Optional A (not used)
19	Optional B (not used)
20	Auxiliary Hoist Up (not used)
21	Auxiliary Hoist Down (not used)
22	Boom Retract
23	Boom Extend
24	Swing Counter Clockwise

Item	Description
25	Swing Clockwise
26	Joystick Lever (6 levers, two position)
27	LCD Screen

The LCD Screen (27, Figure 3-29 and Figure 3-30) on the display is used to communicate signal strength, battery level, wireless channel, remote status, and the configuration of the crane based upon which buttons are depressed. RCL information is also displayed to the operator and can be toggled by pressing the Toggle Crane RCL Screen button (3). The following RCL information is available to the operator on the LCD screen:

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

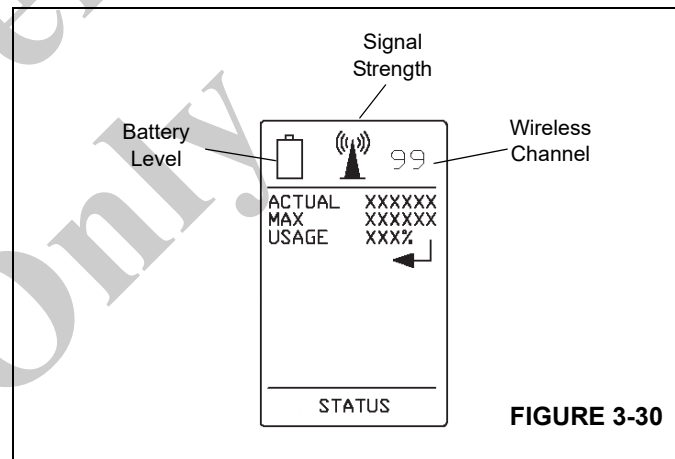
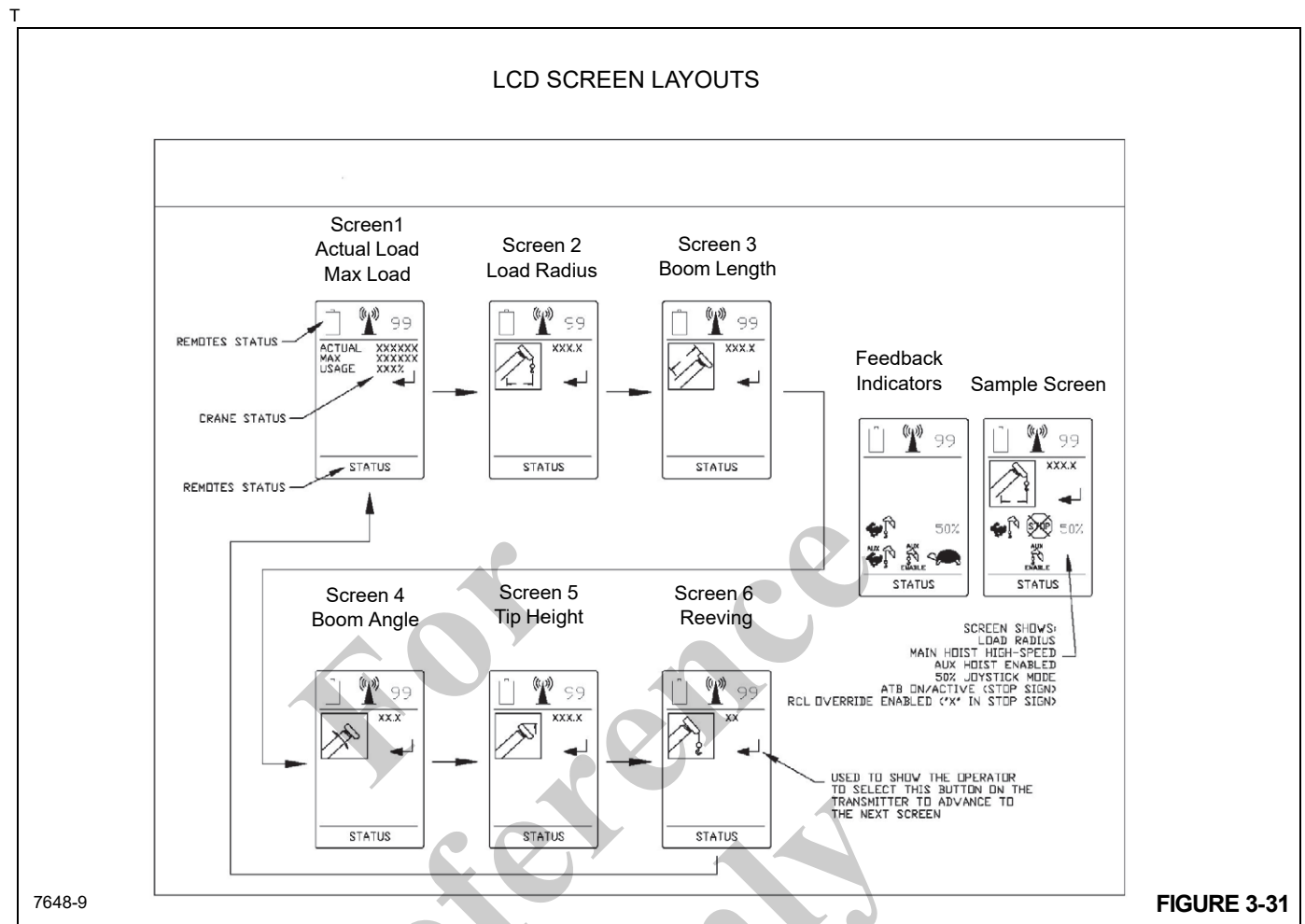


FIGURE 3-30

The Crane Remote can only be used when the crane Remote Enable Switch is activated in the ON position. After transmitter powers up, all outputs go to default.



Crane Remote Control Activation

To use this remote:

1. The red STOP button (10, Figure 3-29) must be twisted and released to turn ON the transmitter.
2. To control the crane, the ON/Horn button (2) must be pressed to activate the remote. The crane horn will sound as confirmation that the remote is now active.
3. The crane can now be started by pressing and holding the Engine Start button (13).
4. The remote can now be used to control the crane. To activate a function move lever (26) that corresponds to the desired movement to activate desired function.
5. When finished with the remote, press the red STOP button (10). This will shut off the machine.

NOTE: If the remote is left turned ON for more than 60 minutes, the remote will shut itself off.

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

NOTE: The console override key and switch (see Figure 3-2) must both be OFF to operate the remote controls. The remote control functions will be disabled and the remote buzzer will sound if either console override is activated in remote

mode. The remote transmitter has an override button (see Figure 3-29) for use when operating with the wireless remote control.

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

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

DANGER

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

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

SECTION 4
SET-UP

SECTION CONTENTS

General	4-1	Extension Removal	4-7
Outrigger Setup	4-1	Extension Maintenance	4-7
Proper Leveling of the Crane	4-1	Anti-two Block Weight Installation	4-8
Bubble Level Adjustment	4-1	Multi-part Line Reeving	4-8
Site Selection	4-2	Using Multiple Part Lines	4-8
Setting the Outriggers	4-2	Lifting a 30 Ton (60,000 lb) Load	4-8
Outrigger Monitoring System (OMS) (Optional—Standard in North America)	4-2	Hoist Cable Installation	4-10
Extension Safety Information	4-3	Wedge Sockets	4-10
Side Folding Swing Around Extension Operation	4-4	Terminator Wedge Installation	4-10
Deployment Procedure	4-4	Wedge Socket Installation	4-12
Stowing Procedure	4-6	Dead-end Rigging	4-12

GENERAL

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

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

 **WARNING**
Crushing Hazard!

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

OUTRIGGER SETUP

Proper Leveling of the Crane

ASME B30.5 specifies that if a crane is not level within 1% of grade, the allowable capacities must be reduced. Therefore, whether lifting outriggers, it is essential that the crane is level

to within 1% of grade. The bubble level that is provided on the crane is calibrated to be accurate within 1% of grade.

To properly level the crane, the boom must be positioned over the rear of the crane, fully lowered to horizontal and fully retracted (for cranes fitted with a boom rest, the boom shall be stowed onto the rest). Raise and level the crane using the outriggers; refer to *Setting the Outriggers*, page 4-2.

A working crane may settle during lifting operations. Frequently check the crane for level. When rechecking the crane for level, the boom must be positioned over the front of the crane, fully lowered to horizontal and fully retracted (for cranes fitted with a boom rest, the boom shall be stowed onto the rest). If necessary, re level the crane using the procedures under *Setting the Outriggers*, page 4-2.

Bubble Level Adjustment

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

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

- Using the bubble level indicator mounting screws, adjust the bubble level indicator to show level.

Site Selection

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

- uneven
- rocky
- muddy

Setting the Outriggers

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

The outrigger setup procedure is as follows:

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

WARNING Tipping Hazard!

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

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

- Extend all four jacks until the truck tires are about four inches off the ground.
- Adjust the jacks until the bubble in the level indicator is in the center of the bulls eye. Do not allow the tires to touch the ground. If it is suspected that the bubble level indicator is out of adjustment, verify and adjust the bubble level using the procedures under *Bubble Level Adjustment*, page 4-1.

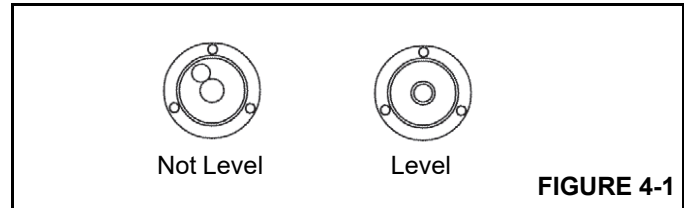


FIGURE 4-1

- Lower the center front stabilizer (SFO) only after all other jacks are set. Press the center front stabilizer (SFO) 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 center front stabilizer (SFO) is automatically set at the correct ground pressure.

WARNING Tipping Hazard!

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

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

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

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

The OMS indicates to the RCL the position of the four outrigger beams. Based on this information, the RCL will choose the most conservative outrigger beam configuration (i.e. If three outriggers are fully extended and one is retracted, the RCL will select retracted as the outrigger configuration). A confirmation of this configuration is all that is needed. Refer to the *Rated Capacity Limiter*, page 3-15 for detailed instructions.

EXTENSION SAFETY INFORMATION

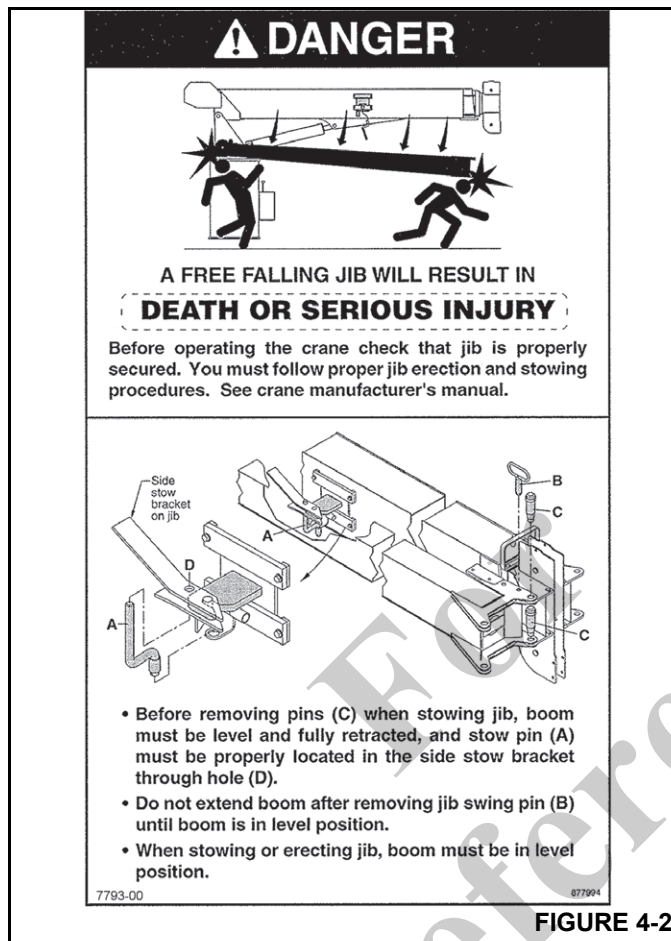


FIGURE 4-2

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

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

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

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

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

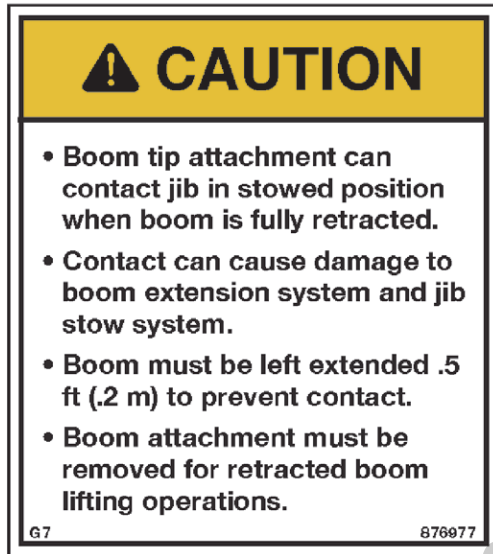
⚠ CAUTION
Eye Injury Hazard!

Use safety glasses when striking pins with a hammer.

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

Also, on manually extendable extension options:

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



SIDE FOLDING SWING AROUND EXTENSION OPERATION

Deployment Procedure

1. Using boom telescope function, fully retract boom.
2. Using lift function, lower boom so that extension deployment pins C1 (Figure 4-3) and C2 are easily accessible from the ground.

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

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

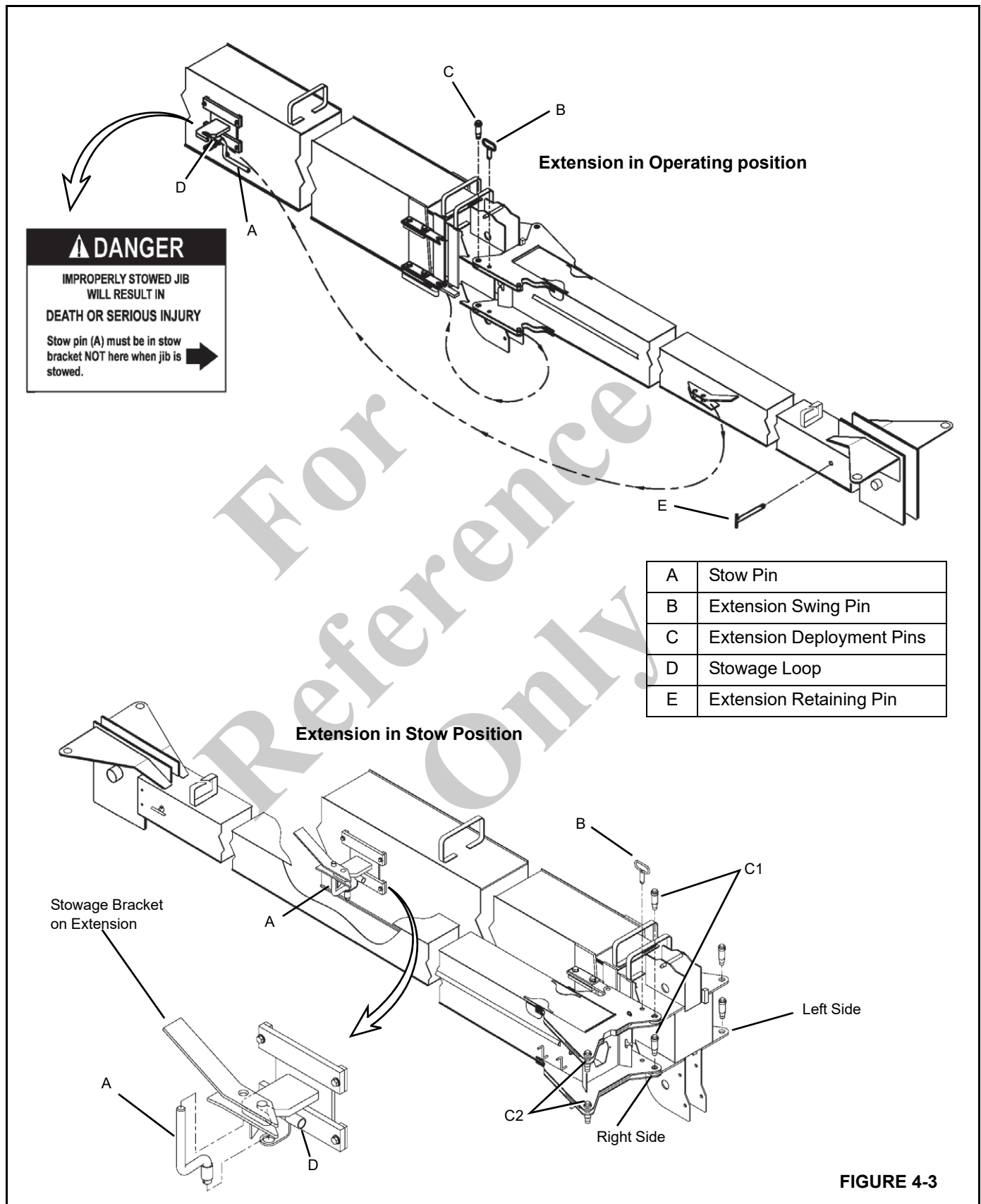


FIGURE 4-3

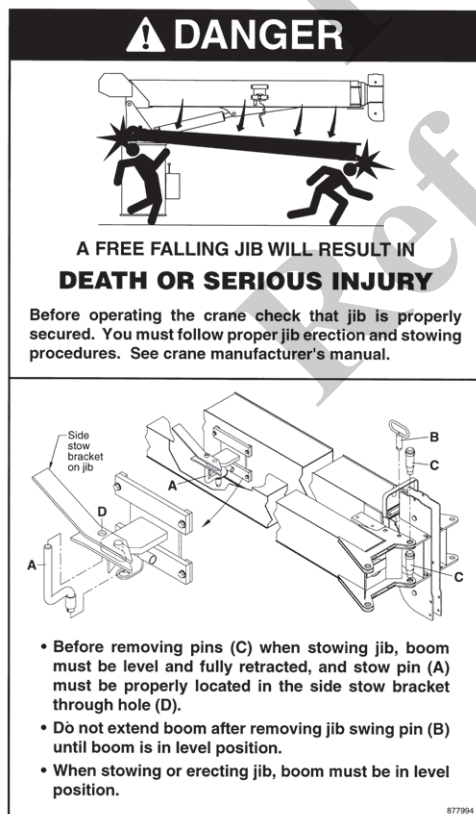
**WARNING****Crushing Hazard!**

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

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

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

Use safety glasses when striking pins with a hammer.



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

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

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

Stowing Procedure

1. Using lift function, lower boom so that extension deployment pins C1 and C2 are easily accessible from the ground.

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

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

5. Disconnect twist lock anti-two block wire connector at rear of 1st section extension. Connect twist lock connector to anti-two block switch connector on boom tip. Move weight/chain assembly to boom tip.
6. Attach tag line to sheave case end of extension.
7. Remove spring clips from pins C2 on both upper and lower extension ears.
8. Remove extension swing pin B from the boom nose.
9. Remove pins C2 from upper and lower extension ears. Do not remove C1 pins at this time. C1 pins will be used as a pivot point to swing extension into stow position. A slight hammer strike may be necessary to remove pins. Always use proper eye protection during this step.
10. Raise the boom to the horizontal position.
11. Extend boom approximately 0.3 m (1 ft).
12. Using tag line attached to extension sheave case, slowly swing extension into stow position (parallel with 1st section boom), Pins C1 are the extension pivot points during this operation.

CAUTION

Equipment Damage Hazard!

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

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



CAUTION

Eye Injury Hazard!

Use safety glasses when striking pins with a hammer.

17. Reinstall loadline over boom sheave case.



DANGER

Crushing Hazard!

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

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

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



CAUTION

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

EXTENSION REMOVAL

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

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

To install, proceed in reverse order of removal.

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

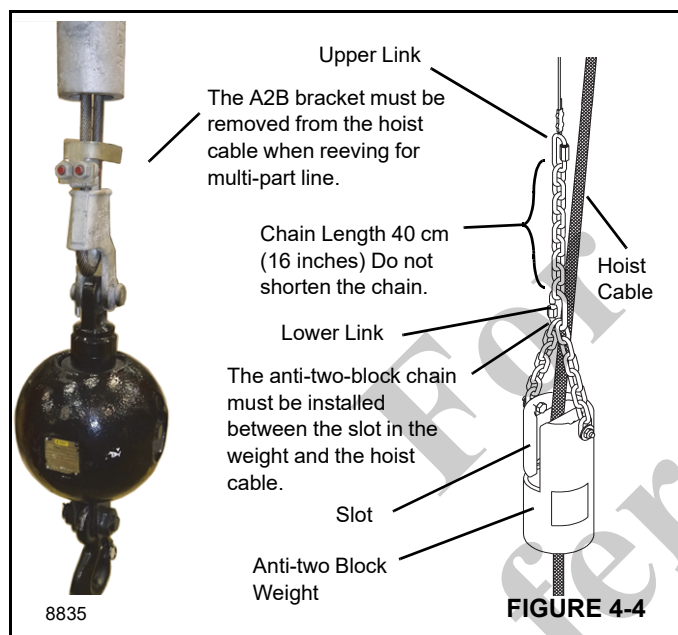
Extension Maintenance

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

ANTI-TWO BLOCK WEIGHT INSTALLATION

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

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



MULTI-PART LINE REEVING

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

Using Multiple Part Lines

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

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

Lifting a 30 Ton (60,000 lb) Load

The NBT30H-2-2 is rated to lift 27,216 kg (60,000 lbs) at a 1.83 m (6 ft) radius with all booms retracted with a seven part block. To make this lift the crane must be equipped with optional 6 x 25 IWRC wire rope with a rated breaking strength of 15,241 kg (33,600 lb). This rope is required to have the appropriate 3.5:1 safety factor.


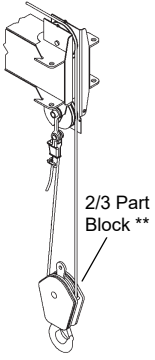
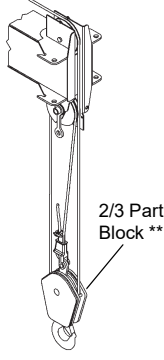
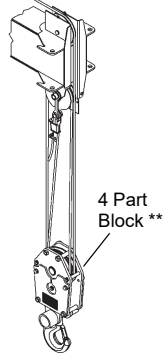
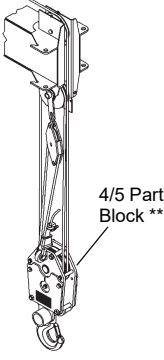
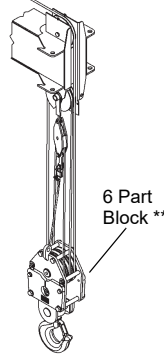
It is also necessary to increase the hoist system hydraulic pressure relief valve from 22,753 kPa (+690/-0) to 23,787 kPa (+690/-0) [3,300 psi (+100/-0) to 3,450 psi (+100/-0)]. See the *Service Manual*. This is required to increase the hoist pull to 3,901 kg (8,600 lbs) to achieve the 60,000 lbs lift with seven part rigging.

CAUTION

Equipment Damage Hazard!

All components on the crane are rated for intermittent operation under these conditions. After this lift is completed the hoist operating pressure must be reduced back to 22.7 kPa (3,300 psi).

Continuous operation of the hoist hydraulic system at nominal pressures greater than 22.7 kPa (3,300 psi) will shorten the life of hydraulic components and void their warranty.

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

7 Part Line (not shown) uses a 7/8 part block**, maximum pull 24,449 kg (53,900 lb)

* 42,180 kg (60,000 Lbs) load requires optional 9/16 in diameter 6 x 25 IWRC cable

** The hook block must be sized to the number of line parts. For example, do not use a six part line hook block on a three part line reeving. Contact your National Crane Distributor or Manitowoc Crane Care to order the proper hook block.

For Reference Only

HOIST CABLE INSTALLATION

To install wire rope, use the following procedure:

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

CAUTION

Equipment Damage Hazard!

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

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

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

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

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



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

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

10. Start winding the cable onto the hoist drum. Maintain about 500 lb (250 kg) of tension on the cable.

11. 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.

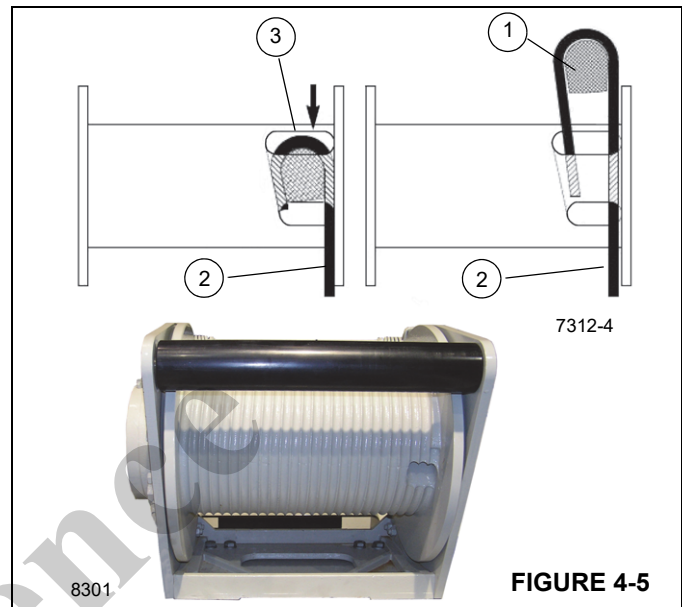


FIGURE 4-5

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

WEDGE SOCKETS

To install a wedge socket:

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

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

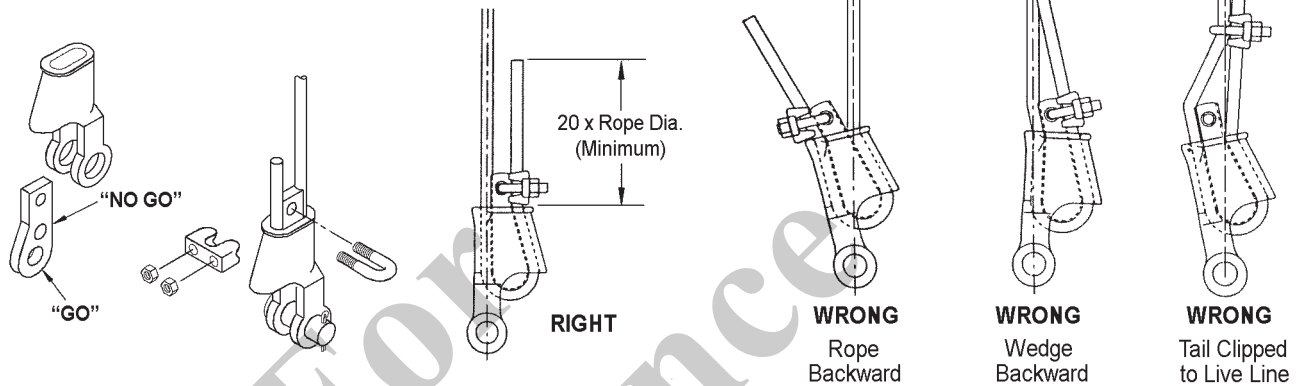
Terminator Wedge Installation

The NBT30H-2-2 is shipped with a terminator wedge socket which is National Crane's preferred type of socket (Figure 4-6). Other wedge socket configurations are shown in Figure 4-7.

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

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

Terminator Wedge Socket



Torque Value Table

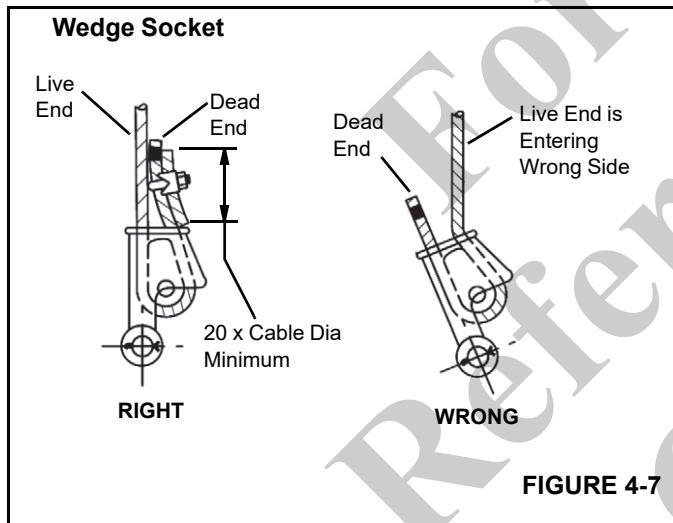
Cable Size (inches)	3/8	7/16	1/2	9/16	5/8	3/4	7/8	1	1-1/8	1-1/4
Torque lb-ft	45	65	65	95	95	130	225	225	225	360

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

FIGURE 4-6

Wedge Socket Installation

1. Inspect the wedge and socket. Remove any rough edges and burrs.
2. The end of the wire rope should be seized using soft, or annealed wire or strand. If the end of the rope is welded, the welded end should be cut off. Do not weld on size 6X37 rope. This will allow the distortion of the rope strands, caused by the bend around the wedge, to adjust themselves at the end of the line. Refer to SECTION 1 - INTRODUCTION in the Service Manual for wire rope procedures.
3. Make sure the live-end (Figure 4-7) of the rope is directly in line with the ears of the socket and the direction of pull to which the rope will be subjected. If the rope is loaded into the socket incorrectly, under a load the rope will bend as it leaves the socket, and the edge of the socket will wear into the rope causing damage to the rope and eventual failure.



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

6. After final pin connections are made, increase the loads gradually until the wedge is properly seated.
7. The wire rope and wedge must be properly secured inside the socket before placing the crane into lifting service. It is the wedge that secures the wire rope inside the socket. The dead-end treatment is used to restrain the wedge from becoming dislodged from the socket should the rope suddenly become unloaded due to the overhaul ball or hook block striking the ground, etc; refer to *Dead-end Rigging*, page 4-12.

Dead-end Rigging

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

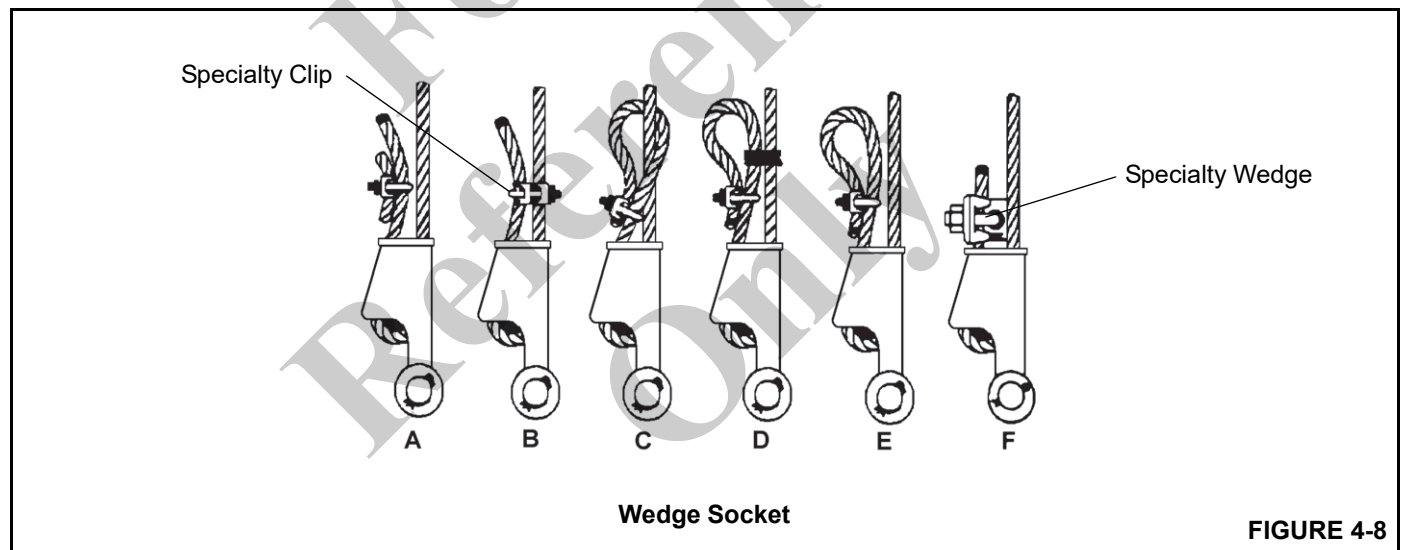
Of the methods shown below, Manitowoc prefers that method A or F be used, i.e., clipping a short piece of wire rope to the dead-end or using a commercially available specialty wedge. Typically, it is recommended that the tail length of the dead-end should be a minimum of 6 rope diameters but not less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

When using method A, place a wire rope clip around the dead end by clamping a short extra piece of rope to the rope dead end. **DO NOT CLAMP THE LIVE END.** The U-bolt should bear against the dead end. The saddle of the clip should bear against the short extra piece. Torque the U-bolts according to the table titled Wire Rope Clip Torque Values (Table 4-1).

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

Table 4-1

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



*For
Reference
Only*

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SECTION 5

LUBRICATION PROCEDURE AND CHARTS

SECTION CONTENTS

General	5-1	Lubrication	5-3
Environmental Protection	5-1	Internal Cable Sheave Lubrication.	5-7
Lubricants	5-1	Inner Boom Wear Pad Lubrication.	5-7
Arctic Conditions Below -9°C (15°F).....	5-1	Side and Bottom Boom Wear Pad Lubrication ...	5-7
Chassis Grease	5-2	Outrigger Beam Lubrication.	5-8
Low Temperature Grease.....	5-2	Hoist Brake Oil.	5-9
Extreme Pressure Multipurpose Gear		Hoist Gearbox Oil	5-9
Lubricant (EPGL)	5-2	Swing Gearbox and Brake Oil	5-9
Open Gear Lubricant	5-2	Hydraulic Oil Reservoir Level	5-10
Antifreeze/Coolant (for Cab Heater).....	5-2	Wire Rope Lubrication	5-10
Anti-wear Additives	5-2	Carwell® Rust Inhibitor.	5-11
Hydraulic Oil	5-2	Protecting Cranes From Rusting	5-11
Standard Hydraulic Oil	5-2	Cleaning Procedures.....	5-11
Arctic Hydraulic Oil	5-3	Inspection and Repair	5-12
Hydraulic Oil Inspection	5-3	Application	5-12
Surface Protection for Cylinder Rods	5-3	Areas of Application.....	5-13

GENERAL

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

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

Environmental Protection

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

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

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

When filling and draining crane components, observe the following:

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

Lubricants

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

Arctic Conditions Below -9°C (15°F)

In general, petroleum based fluids developed especially for low temperature service may be used with satisfactory results. However, certain fluids, such as halogenated hydrocarbons, nitro hydrocarbons, and phosphate ester

hydraulic fluids, might not be compatible with hydraulic system seals and wear bands. If you are in doubt about the suitability of a specific fluid, check with your authorized National Cranes distributor or Manitowoc Crane Care.

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

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

Chassis Grease

CAUTION

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

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

CAUTION

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

Low Temperature Grease

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

Extreme Pressure Multipurpose Gear Lubricant (EPGL)

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

SAE Viscosity Number	Minimum Ambient Temperature C (F)	
75W	-40°C	(-40°F)
80W	-26°C	(-15°F)
85	-12°C	(+10°F)
90	-7°C	(+20°F)
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 Hydraulic Oil" on page 5-3.

Standard Hydraulic Oil

Temperature Above -9°C (15°F)

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

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

CAUTION

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

Arctic Hydraulic Oil

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

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

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

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

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

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

Hydraulic Oil Inspection

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

Under normal operating conditions, it is recommended that hydraulic oil, filter and breathers be inspected at least every three to six months and more frequently for severe operating conditions. The inspections should be for air borne and/or ingested particles and water that deteriorate and contaminate the oil. For example, if oil appears “milky” or no longer has a transparent clear to amber color. The return filter by-pass indicator should be observed daily to determine if contaminant content is high. If the indicator reaches the red zone or indicates a by-pass condition, the hydraulic oil must be sampled. The hydraulic tank breather should also be inspected to assure that it is not restricting air flow into and out of the reservoir.

To inspect the hydraulic oil, fill a small glass container with a sample of the reservoir oil and another glass container with fresh oil. Let the samples stand, undisturbed, for one or two hours. Then, compare the samples. If the reservoir oil is heavily contaminated with water, the sample will appear “milky” with only a small layer of transparent oil on top. If the

“milky” appearance is due to air foaming, it will dissipate and the oil should closely match the fresh oil. Remember, replacement oil must meet ISO 17/14 or better cleanliness level and must meet John Deere Standard JDM J20C. Contact your National Crane distributor or Manitowoc Crane Care if you have any questions.

Surface Protection for Cylinder Rods

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

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

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

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

LUBRICATION

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



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

CAUTION

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

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

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

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

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

CAUTION

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

NOTE:

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

Table 5-1

Symbol	Description	Manitowoc Lube Specification	
		Standard	Cold Weather - 40°C (-40°F)
AFC	Antifreeze/Coolant (for Cab Heater)	6829101130	6829104212
EP-MPG	Extreme Pressure Multipurpose Grease	6829003477	6829104275
GL-5	GL-5 Gear Lubricant	6829012964	6829014058
HYDO	Hydraulic Oil	6829006444	6829001559
EP-OGL	Open Gear Lubricant, CEPLATTYN 300 Spray, NLGI Grade 1-2	6829102971	6829102971
AGMA EP-4	Extreme Pressure Gear Lubricant	6829100213	6829103636
WRL	Wire Rope Lubricant	6829015236	6829010993
EO-20W-20	Engine Oil (Light non-EP Oil), Mil-L-46152	6829005570	-
TES 295	TES295 Compliant Fluid	-	6829101690
NOTE: Cold weather lubricants are not sufficient for temperatures below -40° C (-40° F). Use hydraulic tank heaters and insulate where appropriate.			

Lubrication Points

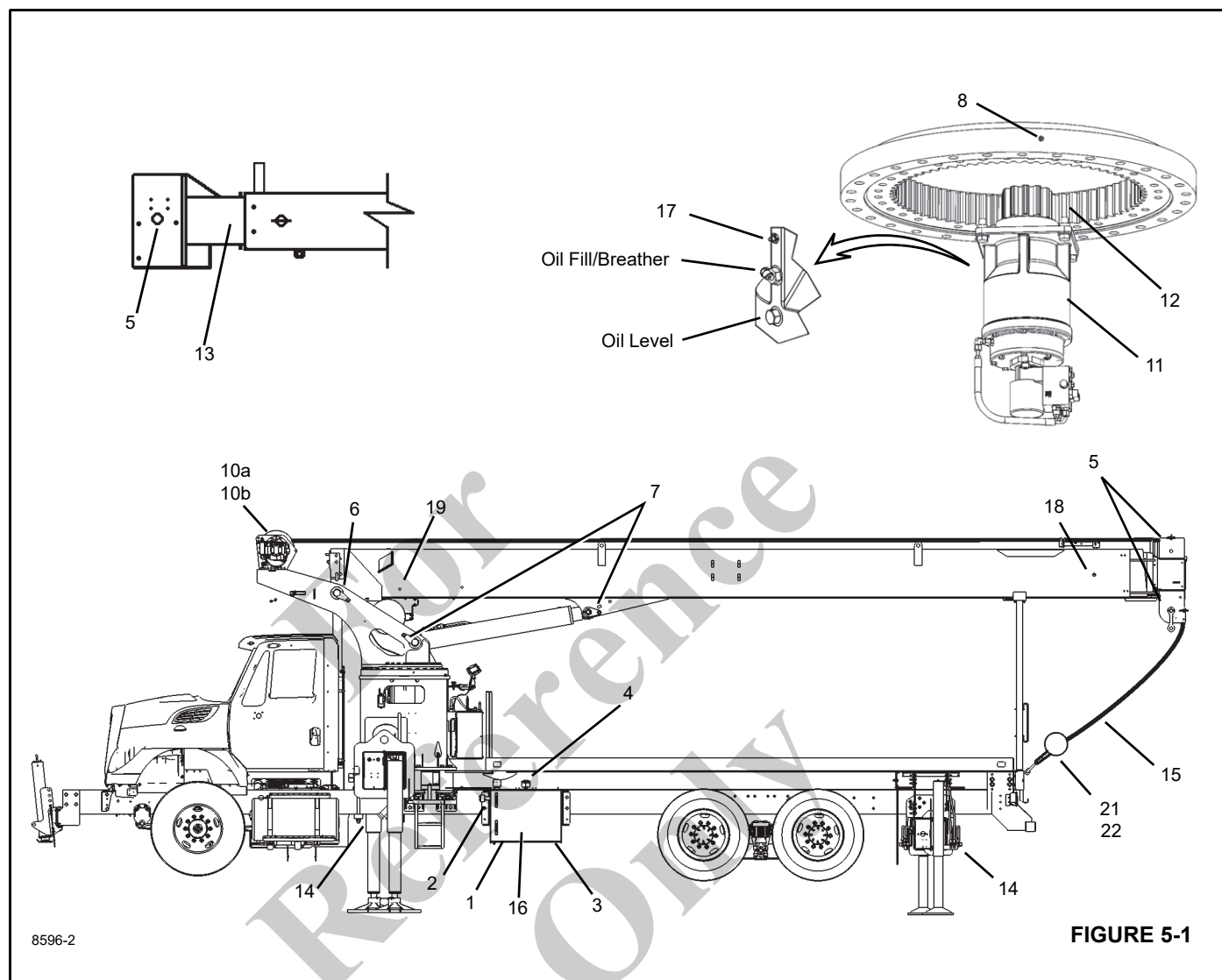


Table 5-2:

Item	Application	Recommended Lubricant	Procedure	Frequency
1	Hydraulic oil reservoir	HYDO	Check and Fill Change	Check and Fill: Weekly, Fill as required Change: Semi-Annually
2	Oil filter, Hydraulic oil reservoir		Change or clean	After first 40 Hrs. Quarterly thereafter
3	Magnetic Plug, Hydraulic oil reservoir		Clean	At oil filter service interval.
4	Breather, Hydraulic oil reservoir		Clean	Monthly
5	Sheave pins: boom (5 places), extension (1), block (1), rooster sheave (1)	EP-MPG	Grease gun	Weekly
6	Boom pivot pin	EP-MPG	Grease gun	Monthly
7	Lift cylinder pins - 2 ea.	EP-MPG	Grease gun	Monthly
8	Swing bearing	EP-MPG	Grease gun	Weekly

Table 5-2:

Item	Application	Recommended Lubricant	Procedure	Frequency
10a	Hoist gearbox.	GL-5	Check and Fill Change	Check and Fill: Every 500 operating hours, or 3 months. Change: After first 100 hours, then every 1000 hours or 6 months thereafter.
10b	Hoist brake	EO-20W-20 or TES295	Check and Fill Change	Check and Fill: Every 500 operating hours, or 3 months. Change: After first 100 hours, then every 1000 hours or 6 months thereafter.
11	Swing drive gearbox	GL-5	Check and Fill Change	Check and Fill: As part of daily crane inspection, check the gearbox for visible leaks. Change: After first 50 hours of operation, every 500 hours or 6 months thereafter.
12	Swing gear teeth	EP-OGL	Spray can	Monthly
13	Boom inner, side and bottom wear pads	LTG	See page 5-7	Monthly or as required
14	Outrigger beams, bottom, sides	LTG	Brush or roller	Monthly or as Required
15	Wire rope (hoist cable)	EP-OGL	Brush or spray	Semi-Annually
16	Diffuser strainer, hydraulic oil reservoir		Clean	Semi-Annually with oil change
17	Swing motor pinion bearing	EP-MPG	Grease gun	Sparingly every 50 hours
18	Extend sheaves	EP-3MG	Grease gun	Weekly
19	Retract sheaves: Extend the boom until the retract sheave grease holes are visible through the access holes along side of boom.	EP-3MG	Grease gun	Weekly
20	Extension cables (Not Shown)	WRL	Spray or brush	Any time boom is disassembled or 5 years
21	Hook Block Swivel Bearing	EP-MPG	Grease gun	Monthly
22	Hook Block Sheaves	EP-MPG	Grease gun	Monthly
NOTE: Lubricate items more frequently than interval indicated in table if environmental conditions and/or operating conditions necessitate.				

Gearbox Vent

Internal Cable Sheave Lubrication



WARNING

Fall Hazard!

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

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

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

Lubrication of the extend and retract sheaves is as follows:

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

Inner Boom Wear Pad Lubrication

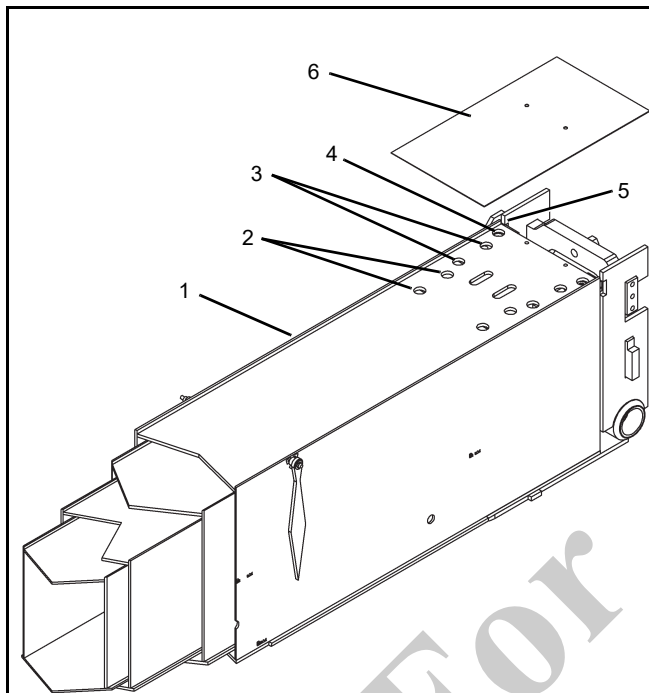
1. Fully extend and set the outriggers.
2. With the boom fully retracted, remove the access plate (6) located on the top rear of the 1st section (Figure 5-2).

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

Side and Bottom Boom Wear Pad Lubrication

Recommended lubricant is EP-3MG grease.

1. Fully extend and set the outriggers.
2. Lower the boom to horizontal.
3. Fully extend the boom and apply grease to the side and bottom of the 2nd, 3rd, and 4th sections with a brush.
4. Raise the boom to 75° and retract the boom.
5. Extend and retract the boom several times until the grease is evenly spread.
6. Repeat as necessary.



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

FIGURE 5-2

Outrigger Beam Lubrication

DANGER

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

Recommended lubricant is EP-3MG grease.

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

4. Repeat as necessary.



FIGURE 5-3

Hoist Brake Oil

DANGER

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

Check Hoist Brake Oil

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

Drain /Add New Hoist Brake Oil

To drain and add new oil, remove the drain plug (Figure 5-4), inspection plug and vent plug and drain the brake oil. Reinstall drain plug and add fluid until the fluid is visible to the bottom of the inspection hole. Reinstall the vent plug and the inspection plug. See "Lubrication" on page 5-3. The hoist brake fill capacity is 0.23 liter (.25 quart).

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

DANGER

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

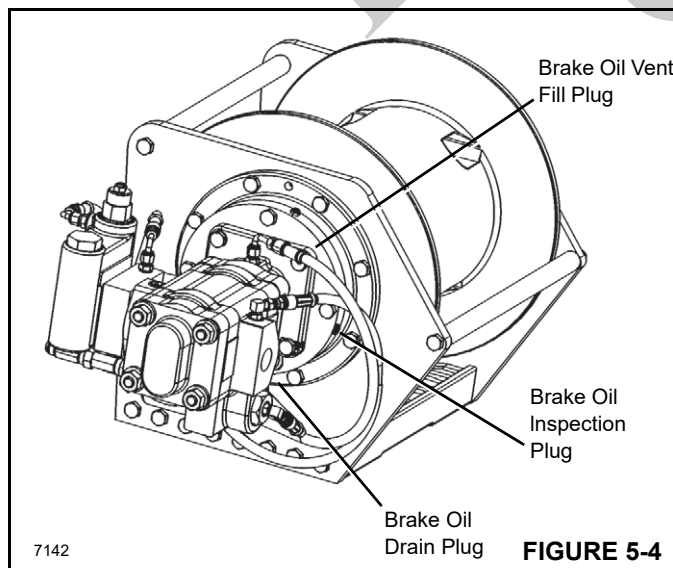


FIGURE 5-4

Hoist Gearbox Oil

Check hoist gearbox oil level

- Rotate the drum until the oil fill/level plug (Figure 5-5) is visible in the inspection hole.
- Remove the fill/level plug and visually inspect the oil level. The oil should be level with the bottom of the inspection hole. If more oil is needed, add and reinstall fill/level plug.
- To drain and add new oil, remove the vent plug (Figure 5-5) and then screw a 1" pipe into the drain plug hole to allow the oil to drain. Remove the drain plug with a hex head socket and drain hydraulic oil. Remove the 1" drain pipe and install drain plug.

Fill hoist gearbox with oil

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

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

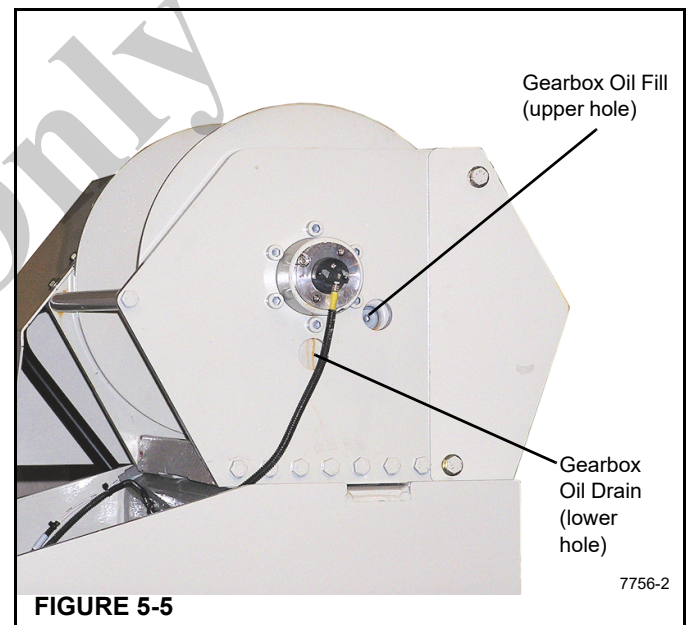


FIGURE 5-5

Swing Gearbox and Brake Oil

Check Swing Gearbox oil level

The oil in the gearbox and brake sections is recommended to be changed after first 50 hours of operation and every 1000 hours or 6 months of usage.

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

Hydraulic Oil Reservoir Level

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

If the oil level is too low, add the recommended hydraulic oil until the oil level is even with the upper mark. If the oil level is high, drain oil until the oil level is even with the upper mark.

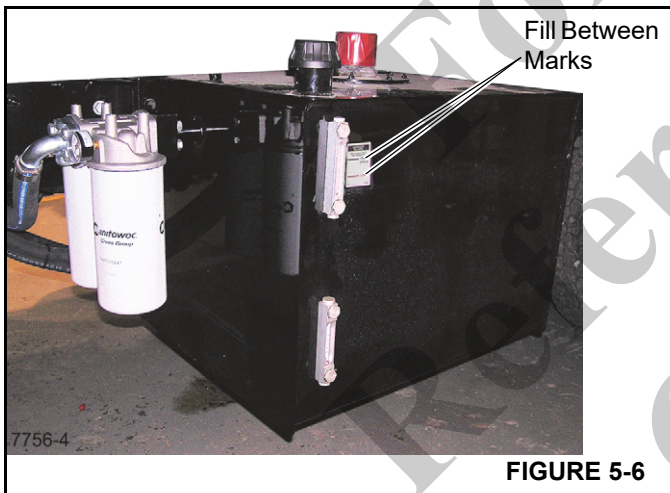


FIGURE 5-6

WIRE ROPE LUBRICATION

Wire rope is lubricated during manufacture and the lubricant applied does not last the life of the rope. The wire rope must be lubricated as part of a regularly scheduled maintenance program. The lubricant applied must be compatible with the original lubricant and not hinder visual inspection of the rope. Consult the rope manufacturer for proper lubricant. The

sections of rope which are located over sheaves or otherwise hidden during inspection and maintenance procedures require special attention.

The object of rope lubrication is to reduce internal friction and to prevent corrosion. The type and amount of lubrication applied during manufacture depends on the rope size, type, and anticipated use. This lubrication provides the finished rope with protection for a reasonable time if the rope is stored under proper conditions. When the rope is put into service, periodic applications of a suitable rope lubricant are necessary. Characteristics of a good wire rope lubricant are that it should be:

- free from acids and alkalis.
- have sufficient adhesive strength to remain on the rope.
- of a viscosity capable of penetrating the interstices between wires and strands.
- not be soluble in the medium surrounding it under the actual operating conditions (i.e. water).
- have a high film strength.
- resistant to oxidation.

Before applying lubrication, accumulations of dirt or other abrasive material should be removed from the rope. Clean with a stiff wire brush and solvent, compressed air, or live steam. Lubricate the rope immediately after the rope is cleaned. Techniques that can be used include:

- bath
- dripping
- pouring
- swabbing
- painting
- pressure spray

Whenever possible, the lubricant should be applied at the top of a bend in the rope, because at that point the strands are spread by bending and are more easily penetrated. There should be no load on the rope while it is being lubricated. The service life of wire rope is directly proportional to the effectiveness of the method used and amount of lubricant that reaches the working parts of the rope.

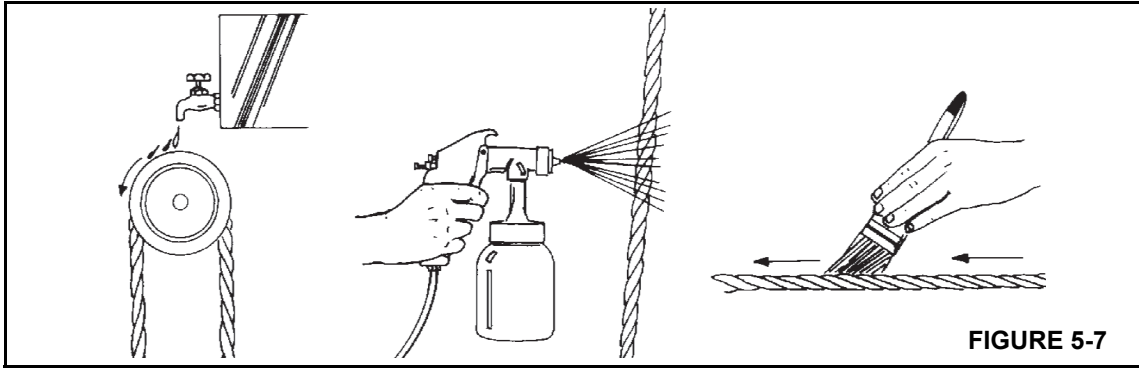


FIGURE 5-7

CARWELL® RUST INHIBITOR

Protecting Cranes From Rusting

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

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

Carwell® is a treatment, not a coating. It contains no silicones, solvents, CFCs or anything that would be classified as hazardous under OSHA Regulation 29 CFR 19 10.1200. The product is a liquid blend of petroleum derivatives, rust inhibitors, water-repelling and water-displacing agents.

Special equipment is used to spray a light film onto the entire undercarriage and various other areas of each new crane prior to shipment. When applied the product has a red tint to allow applicators to view coverage during application. This red tint will turn clear on its own within approximately 24 hours after application.

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

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

In addition to the factory-applied treatment, National Crane owners must provide proper maintenance and care to help ensure long-term protection of their crane against corrosion.

This procedure provides information and guidelines to help maintain the paint finish on National Cranes.

The most common causes of corrosion include the following:

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

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

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

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

Cleaning Procedures

To help protect against corrosion of National cranes, Manitowoc Crane Care recommends washing the crane at least monthly to remove all foreign matter. More frequent cleanings may be needed when operating in harsh

environmental conditions. To clean the crane, follow these guidelines:

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



CAUTION

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

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

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

Inspection and Repair

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

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



CAUTION

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

- For scratches and marks in highly visible areas:
- Sand to remove the scratch and feather outward from the mark to blend the repair into the original surface. Body putty may be applied as necessary to hide the defect; then sand smooth.
- Cover all bare metal with a primer that is compatible with the original paint finish and allow to dry thoroughly.
- Prepare the surface prior to applying the finish coat of paint.
- Apply a finish coat of 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 primed and painted areas for at least 48 hours after paint is properly dried and cured. For minor touch up areas a 24 hour period is needed for cure time before applying treatment.

NOTE: 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 ends and fittings, swivel, pumps, axles, drivelines, transmission, slew ring fasteners and all interior surfaces of the frame.
- Frame application areas are; hose ends and fittings, all unpainted fasteners and hardware, all bare metal surfaces, outrigger pads, and back up alarm hardware.
- Superstructure applications are; hose ends and fittings, wire rope on hoist roller tensioning springs on hoists, all unpainted fasteners and hardware, valves, slew ring fasteners and all bare metal surfaces.
- Boom applications areas are; pivot pins, hose ends and fittings, jib pins and shafts, all bare metal surfaces, overhaul ball pins/ hook block pins and fasteners.
- All hardware, clips, pins, hose connections not painted will have treatment applied.

For
Reference
Only



Item	Description
1	Hoist Plumbing Connections
2	All Hardware, Clips, Pins, Unpainted Hose Connections
3	Pivot Shaft
4	Hose Connections
5	Mirror Mounting Hardware
6	Wire Rope
7	Boom Nose Pins, Clips
8	Hook Block/Overhaul Ball
9	O/R Hose Connections
10	O/R Pins, Clips
11	Power Train Hardware
12	Entire Underside of Unit
13	Turntable Bearing Fasteners, Pins
14	Valve Bank, Hose Connections
15	Clips for Optional Jib
16	Hanger Hardware for Optional Jib

For Reference Only

For Reference Only

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SECTION 6

MAINTENANCE CHECKLIST

SECTION CONTENTS

Crane Inspection and Maintenance	6-1	Boom Extension Cable	6-6
Inspections	6-1	Extension Jack Service and Maintenance	6-6
Special Boom Inspection	6-3	Lubrication	6-6
Stability	6-3	Rust Prevention	6-6
Hoist Cable Inspection and Maintenance	6-3	Hydraulic System	6-6
Keeping Records	6-3	Oil Cooler	6-6
Environmental Conditions	6-3	Tire Load and Inflation Table	6-6
Dynamic Shock Loads	6-4	Specifications	6-10
Precautions and Recommendations During		Hydraulic Pump	6-10
Inspection	6-4	Hydraulic System	6-10
Inspection	6-4	Reservoir	6-10
Wire Rope Replacement	6-5	Hoist System	6-10
Care of Wire Rope	6-5	Crane Operating Speeds	6-11
Replacement Cable	6-5	Outrigger Speeds	6-11
Crane Adjustments and Repairs	6-6		

CRANE INSPECTION AND MAINTENANCE

Regularly scheduled inspection and maintenance intervals are required to keep the crane in peak operating condition. The following pages outline the inspection and maintenance intervals.

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

 **WARNING**

Fall Hazard!

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

Inspections

The inspection intervals listed below are to be conducted on the unit to ensure safe and proper operation. Refer to the *Service Manual* when installing missing or loose fasteners. Should a defect be found, a determination must be made as to whether the deficiency is a safety hazard or though not yet a safety hazard, needs to be monitored in the monthly inspections.

The inspections are separated into the following frequency classifications:

- Daily inspections - performed by the operator at the start of the day.
- Weekly inspections - performed by the operator.
- Monthly inspections - performed by maintenance personnel.
- Periodic inspections - performed by maintenance personnel at least every three months and includes all items listed under daily, weekly, and monthly inspections. Federal Laws through OSHA and ANSI B30.5 require that dated and signed records of these periodic inspections be kept. An inspection log book is available from your National Crane distributor or Manitowoc Crane Care.

 **WARNING**

If any defect determined during the inspection is a safety hazard the machine must be removed from service and the defect corrected.

Daily Inspections/Pre-use

Check the following items:

1. Engine oil level.
2. Hydraulic oil level.

3. Radiator coolant level.
4. Loose parts or damage to structures or welds.
5. Operation of lights, safety equipment and gauges.
6. Condition of tires and suspension.
7. Condition of hoist cable and end attachment for corrosion, severe kinking, crushing, cutting, or slippage of cable clamps or wedge socket.
8. Loose parts or damage to cable centering hook blocks.
9. Position of cable with guides and on sheaves.
10. Free turning of sheaves.
11. Lubrication as specified by the *Lubrication Procedure and Charts*, Section 5.
12. Evidence of oil leaks from hoses, gearboxes, or swivel.
13. Hand and foot controls for malfunction or incorrect adjustment.
14. Truck parking brake operation.
15. Boom proportioning to insure that all boom sections extend and retract equally.
16. All securing hardware such as cotter pins, snap rings, hairpins, pin keepers, and capscrews for proper installation.
17. Proper condition and operation of RCL and anti-two block systems to include the anti-two block switch weight and chain at the boom tip (and extension tip if equipped), power cords, audible alarms, and indicator lights on the console.
18. Proper operation of the load hook safety latch.
19. Hooks and latches for excessive wear, cracks or damage from heat or chemicals.
20. Drain holes at rear of the first section of the boom are clear of all obstructions.
21. All fasteners retaining the cable centering block are in place and tight.
22. All safety covers for proper installation.
23. Boom lift and outrigger holding valves for proper operation.
24. Hoist brake for proper operation at hoist capacity load.
25. Control and drive mechanisms for excessive wear and/or contamination from lubricants, water or other foreign matter.

Weekly Inspections

Check the following items:

1. Battery water level.
2. Tire pressure.
3. Lubrication as specified by the *Lubrication Procedure and Charts*, Section 5.
4. Torque the T-box mounting bolts during the first month of operation and periodic inspections thereafter.
5. Torque the swing bearing mounting bolts during the first month of operation and periodic inspections thereafter.
6. Torque the boom wear pad retaining bolts during first month of operation, and monthly thereafter.
7. Check to see that this crane's *Operator Manual* is with the crane. If the manual is missing, obtain the serial number of the crane and order an operator manual immediately.

Monthly Inspections

Check the following items:

1. All cylinders and valves for improper operation or signs of leaks.
2. Lubrication as specified by the *Lubrication Procedure and Charts*, Section 5.
3. Load hook for cracks or having more than 15 percent normal throat opening or 10 degree twist.
4. All structural members (boom, sub-base, frame, turret, and outriggers) for bends, cracks, or broken members.
5. All welds for breaks or cracks.
6. All pins for proper installation.
7. All control, safety, and capacity placards for readability and secure attachment.
8. Cable clip bolts above wedge socket at end of loadline should be properly torqued, refer to the *Service Manual*.
9. All boom wear pad retaining bolts.
10. Boom extension cables for proper tension or evidence of abnormal wear.
11. Sheaves and cable drums for wear and cracks.
12. Unwind the loadline and check according to cable maintenance procedure.

Periodic/Annual Inspection

Check the following items:

1. All items listed under daily, weekly, and monthly inspections.
2. Loose bolts and fasteners in all areas. Torque pin retainer bolts.

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

Special Boom Inspection

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

Stability

Stability of unit throughout working area. Check the stability procedure in Installation Section of the *Service Manual* annually or when any changes are made to crane or truck.

HOIST CABLE INSPECTION AND MAINTENANCE

WARNING

Worn or Damaged Equipment Hazard!

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

Wire rope should be inspected frequently/daily and periodically/yearly in accordance with the following information excerpted from a National Consensus Standard as referenced by Federal Government Agencies. Recommended inspection intervals may vary from machine to machine and may vary based on environmental conditions, frequency of lifts, and exposure to shock loads. The inspection time intervals may also be predetermined by state and local regulatory agencies.

NOTE: Wire rope may be purchased through Manitowoc Crane Care.

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

Keeping Records

A signed and dated report of the wire rope's condition at each periodic inspection must be kept on file at all times. The report must cover all inspection points listed in this section. The information in the records can then be used to establish data which can be used to determine when a wire rope should be replaced.

It is recommended that the wire rope inspection program include reports on the examination of wire rope removed from service. This information can be used to establish a relationship between visual inspection and the rope's actual internal condition at the time of removal from service.

Environmental Conditions

The life expectancy of wire rope may vary due to the degree of environmental hostility and other conditions to which these mechanical devices are subjected. Variation in temperature, continuous excessive moisture levels, exposure to corrosive chemicals or vapors or subjecting the wire rope to abrasive material may shorten normal wire rope life. Frequent/periodic inspections and maintenance of wire rope is recommended for preventing premature wear and to insure long-term satisfactory performance.

NOTE: Refer to *Wire Rope Lubrication*, page 5-10 for wire rope lubrication requirements.

Dynamic Shock Loads

Subjecting wire rope to abnormal loads beyond the endurance limit will shorten the wire rope life expectancy. Examples of this type of loading are listed below.

- High velocity movement, for example; hoisting or swinging of a load followed by abrupt stops.
- Suspending loads while traveling over irregular surfaces such as railroad tracks, potholes, and rough terrain.
- Lifting a load that is beyond the rated capacity of the lifting mechanism, such as overloading.

Precautions and Recommendations During Inspection

- Always use safety glasses for eye protection.
- Wear protective clothing, gloves, and safety shoes as appropriate.
- Measure the rope's diameter across crowns of the strands when determining if rope has become damaged, refer to Figure 6-1.

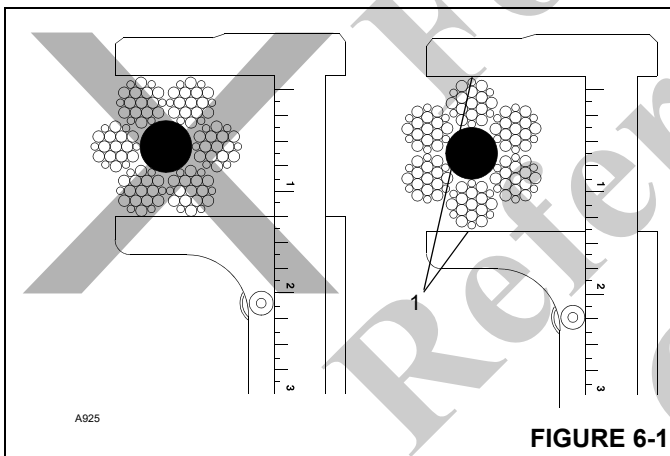


FIGURE 6-1

Inspection

All hoist cable in service needs to be inspected on a daily, monthly, and quarterly basis. Cable which has been idle for a period of a month or more must be given a thorough inspection before it is placed in service. These inspections should cover all types of deterioration including:

- Distortion such as kinking, crushing, un-stranding, bird caging, main strand displacement or core protrusion.
- Loss of cable diameter in a short cable length or unevenness of outer strands indicates the cable needs to be replaced.
- Significant corrosion.
- Broken or cut strands.
- Number, distribution and type of visible broken wires.

- Core failure in rotation resistant ropes.
- Prior electrical contact with a power line or other electric arc damage.
- Significantly corroded, cracked, bent, or worn end connections.

Only inspect the outer surface of a cable. Never attempt to open the cable.

Pay particular attention to areas of the rope where wear and other damage is likely to occur:

- Pick-up Points: Sections of wire rope that are repeatedly stressed during each lift, such as those sections in contact with sheaves.
- End Attachments: The point where a fitting is attached to the wire rope or the point where the wire rope is attached to the hoist drum.
- Abuse Points: The point where the wire rope is subjected to abnormal scuffing and scraping.

Daily Inspections

All cable in continuous service must be inspected at the beginning of each work day. Inspect the eye end and length of cable that is used in daily operation. The end should be inspected for abrasion, corrosion, broken wires, and loose or broken servings. Inspect the remainder of the cable length used for daily operations for points showing kinks, sharp bends, or any other evidences of damage or excessive wear.

Monthly Inspections

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

Periodic Inspections

Wire rope should be inspected periodically/annually, or at a shorter time interval, if necessitated by environmental or other adverse conditions, and shall cover the entire length of the wire rope. Periodic inspection should include all previous items listed under *Inspection*, plus the following:

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

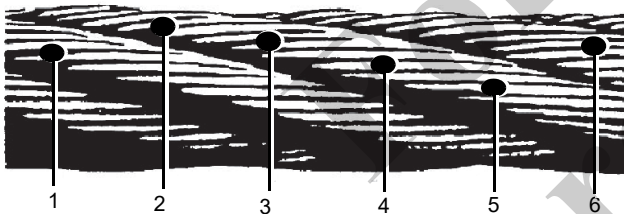
or hoist drums can accelerate wear and cause rapid deterioration of the wire rope.

Inspect the eye end of the cable for greater wear than the rest of the cable. If the cable is in good condition, reverse the cable on the drum so that the wear is equalized along the total length of the cable.

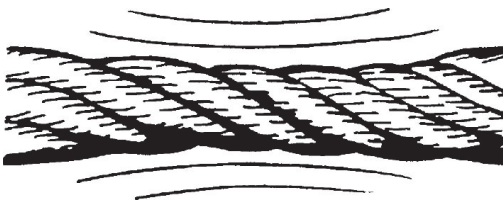
Wire Rope Replacement

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

- Six randomly distributed broken wires in one rope lay or three broken wires in one strand in one lay. The rope is unsafe for further use if there are either three broken wires in one strand (Breaks 2, 3, 4) or a total of six broken wires in all strands in any one lay.



- In rotation resistant ropes: two randomly distributed broken wires in six rope diameters or four randomly distributed broken wires in 30 rope diameters
- Wear of one-third the original diameter of outside individual wires. Worn rope, usually indicated by flat spots on the outer wires is unsafe for further use when less than two-thirds the thickness of the outer wire remains.
- Necking down of the rope indicates core failure.



- Kinking, crushing, bird caging, or any other damage resulting in distortion of the rope structure.
- Evidence of heat damage.
- Reductions from nominal diameter of more than:

- .4 mm (0.0156 in) for rope diameters to 8 mm (0.313 in)
- 0.031 (.8 mm) for rope diameters 9.5 mm (0.375 in) to 12.7 mm (0.50 in)
- 1.2 mm (0.047 in) for rope diameters 14.3 mm (0.561 in) to 19.1 mm (0.75 in)
- 1.6 mm (0.063 in) for rope diameters 22.2 mm (0.875 in) to 28.6 mm (1.125 in).
- One outer wire broken at its point of contact with the core of the rope which has worked its way out of, and protrudes or loops out from the rope structure.

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

CRANE ADJUSTMENTS AND REPAIRS

Before adjustments and repairs are started on a crane, read and be familiar with the safety information outlined under *Maintenance*, page 2-25.

Boom Extension Cable

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

Extension Jack Service and Maintenance

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

Adding Oil to the Extension Jack

To add oil to the extension jack, do the following:

1. Set the jack in an upright level position.
2. Lower the saddle and make sure the piston is fully depressed.
3. Remove the oil filler plug.
4. Fill until the oil is level with the filler plug hole.

Changing the Extension Jack Oil

For best performance and longest life, replace the oil at least once a year. To change oil, do the following:

1. Remove the filler plug.
2. Lay the jack on its side and drain the oil into a suitable drain pan. The oil will run slowly because air must enter as the oil drains out.

3. Be careful to prevent dirt or foreign matter from entering the system.
4. Replace with proper oil as described above.

Lubrication

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

Rust Prevention

Check the ram every three months for any sign of rust or corrosion. Clean as needed and wipe with an oil saturated cloth.

NOTE: When not in use, always leave the saddle and ram all the way down.

HYDRAULIC SYSTEM

Oil Cooler

The heat exchanger must be kept clean for efficient operation of the hydraulic cooler system. Wash the heat exchanger core frequently to eliminate oil film, road dirt, and other foreign object buildup on the heat exchanger fins.

Frequent inspection and tightening of hose clamps eliminates the possibility of end connection failure due to back pressure from a cold startup.

If the cooler system fails to provide adequate performance, reduced air or oil flow through the heat exchanger is the probable cause. Inspect the cooling fan for proper operation. Any obstructions to air flow should be corrected (cooler too close to other truck components, foreign matter in heat exchanger fins, etc.) All hydraulic lines should be periodically checked for obstructions, hose kinks or other flow restrictions.

TIRE LOAD AND INFLATION TABLE

Definite tire inflation pressures are established for each tire size depending upon the load imposed on the tires. For greater stability, riding comfort and prolonged tire life, tires should be inflated for the loads carried. The load and inflation table shown below indicates the proper inflation pressure.

NOTE: The values in the tables below are as published by the Tire and Rim Association, 2005. Your vehicle may be equipped with other tire sizes or the same size tires rated differently. Always check the tire sidewalls to verify the maximum capacity and inflation. Inflation pressure and loading must not exceed the values shown on the wheel or rim.

Tire and Load Inflation Tables

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

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

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

Radial Ply Tires Mounted on 15° Drop Center Rims

Tire and Rim Association Standard

TABLE TBM-2R		TIRE LOAD LIMITS (kg/lbs.) AT VARIOUS COLD INFLATION PRESSURES (kPa/psi)											
TIRE SIZE DESIGNATION	USAGE	450 65	480 70	520 75	550 80	590 85	620 90	660 95	690 100	720 105	760 110	790 115	830 120
295/60R22.5	DUAL	1750 3860	1830 4040	1930 4245	2000 4410	2030 4480	2120 4665	2240 4940	2280 5025	2360 5195	2430 5355	2510 5535	2575(H) ¹⁴¹ 5675(H)
	SINGLE	1850 4080	1950 4300	2050 4515	2120 4675	2230 4925	2330 5125	2430 5355	2500 5520	2590 5710	2650 5840	2760 6085	2800(H) ¹⁴⁴ 6175(H)
225/70R19.5	DUAL	1180(D) ¹¹⁴ 2600(D)	1230 2720	1300 2860	1360(E) ¹¹⁹ 3000(E)	1410 3115	1470 3245	1550(F) ¹²³ 3415(F)	1580 3490	1640 3615	1700(G) ¹²⁶ 3750(G)		
	SINGLE	1250(D) ¹¹⁶ 2755(D)	1310 2895	1380 3040	1450(E) ¹²¹ 3195(E)	1500 3315	1570 3450	1650(F) ¹²⁵ 3640(F)	1690 3715	1740 3845	1800(G) ¹²⁸ 3970(G)		
245/70R19.5	DUAL				1550 3415	1590 3515	1660 3655	1750(F) ¹²⁷ 3860(F)	1790 3940	1850 4075	1950(G) ¹³¹ 4300(G)	1970 4345	2060(H) ¹³³ 4540(H)
	SINGLE				1650 3640	1700 3740	1770 3890	1850(F) ¹²⁹ 4080(F)	1900 4190	1970 4335	2060(G) ¹³³ 4540(G)	2095 4620	2180(H) ¹³⁵ 4805(H)
265/70R19.5	DUAL				1700 3750	1780 3930	1860 4095	1950 4300	2000 4405	2000 4415	2120(G) ¹³⁴ 4675(G)		
	SINGLE				1800 3970	1900 4180	1970 4355	2060 4540	2130 4685	2200 4850	2300(G) ¹³⁷ 5070(G)		
305/70R19.5	DUAL				2060 4540	2120 4670	2200 4860	2300 5070	2370 5230	2450 5410	2575(H) ¹⁴¹ 5675(H)	2620 5770	2725(J) ¹⁴³ 6005(J)
	SINGLE				2240 4940	2330 5130	2420 5340	2500 5510	2610 5745	2700 5945	2800(H) ¹⁴⁴ 6175(H)	2870 6340	3000(J) ¹⁴⁶ 6610(J)

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

TABLE TBM-2R
Continued

TIRE SIZE DESIGNATION	USAGE	TIRE LOAD LIMITS (kg/lbs.) AT VARIOUS COLD INFLATION PRESSURES (kPa/psi)											
		450 65	480 70	520 75	550 80	590 85	620 90	660 95	690 100	720 105	760 110	790 115	830 120
255/70R22.5	DUAL				1800 3970	1860 4110	1940 4275	2000 4410	2020 4455	2090 4610	2120(G) ¹³⁴ 4675(G)	2230 4915	2300(H) ¹³⁷ 5070(H)
	SINGLE				1900 4190	1980 4370	2060 4550	2120 4675	2220 4895	2300 5065	2360(G) ¹³⁸ 5205(G)	2450 5400	2500(H) ¹⁴⁰ 5510(H)
305/75R22.5	DUAL				2360 5205	2440 5375	2540 5595	2560 5840	2730 6025	2830 6235	3000(H) ¹⁴⁶ 6610(H)	3010 6640	3150(J) ¹⁴⁸ 6940(J)
	SINGLE				2575 5675	2680 5905	2790 6150	2900 6395	3000 6620	3110 6850	3250(H) ¹⁴⁹ 7160(H)	3310 7300	3450(J) ¹⁵¹ 7610(J)
315/80R22.5	DUAL				2575 5675	2650 5840	2750 6070	2900(G) ¹⁴⁵ 6395(G)	2970 6545	3070 6770	3150(H) ¹⁴⁸ 6940(H)	3270 7210	3450(J) ¹⁵¹ 7610(J)
	SINGLE				2800 6175	2910 6415	3030 6670	3150(G) ¹⁴⁸ 6940(G)	3260 7190	3370 7440	3450(H) ¹⁵¹ 7610(H)	3590 7920	3750(J) ¹⁵⁴ 8270(J)
305/85R22.5	DUAL				2430 5355	2520 5550	2620 5780	2725 6005	2820 6215	2920 6435	3075(H) ¹⁴⁷ 6780(H)	3110 6860	3250(J) ¹⁴⁹ 7160(J)
	SINGLE				2650 5840	2770 6100	2880 6350	3000 6610	3100 6830	3210 7070	3350(H) ¹⁵⁰ 7390(H)	3420 7540	3550(J) ¹⁵² 7830(J)

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

TABLE TBM-1R

TIRE SIZE DESIGNATION	USAGE	TIRE LOAD LIMIT AT VARIOUS COLD INFLATION PRESSURES											
		kPa psi	480 70	520 75	550 80	590 85	620 90	660 95	690 100	720 105	760 110	790 115	830 120
245/75R22.5 235/80R22.5	DUAL	kg lbs.	1430 3160	1500 3315	1600 3525	1640 3615	1710 3765	1800 3970	1840 4055	1900 4195	1950(G) ¹³¹ 4300(G)		
	SINGLE	kg lbs.	1570 3470	1650 3645	1750 3860	1800 3975	1880 4140	1950 4300	2020 4455	2090 4610	2120(G) ¹³⁴ 4675(G)		
265/75R22.5 255/80R22.5	DUAL	kg lbs.	1600 3525	1680 3705	1750 3860	1830 4040	1910 4205	2000 4410	2050 4525	2130 4685	2180(G) ¹³⁵ 4805(G)		
	SINGLE	kg lbs.	1760 3875	1850 4070	1950 4300	2010 4440	2100 4620	2180 4805	2260 4975	2340 5150	2360(G) ¹³⁸ 5205(G)		
295/75R22.5 275/80R22.5	DUAL	kg lbs.	1860 4095	1950 4300	2060 4540	2130 4690	2220 4885	2300(F) ¹³⁷ 5070(F)	2390 5260	2470 5440	2575(G) ¹⁴¹ 5675(G)	2630 5795	2725(H) ¹⁴³ 6005(H)
	SINGLE	kg lbs.	2040 4500	2140 4725	2240 4940	2340 5155	2440 5370	2500(F) ¹⁴⁰ 5510(F)	2620 5780	2710 5980	2800(G) ¹⁴⁴ 6175(G)	2890 6370	3000(H) ¹⁴⁶ 6610(H)
285/75R24.5 275/80R24.5	DUAL	kg lbs.	1870 4135	1970 4340	2060 4540	2150 4740	2240 4930	2360(F) ¹³⁸ 5205(F)	2410 5310	2490 5495	2575(G) ¹⁴¹ 5675(G)	2660 5860	2800(H) ¹⁴⁴ 6175(H)
	SINGLE	kg lbs.	2060 4545	2160 4770	2240 4940	2360 5210	2460 5420	2575(F) ¹⁴¹ 5675(F)	2650 5835	2740 6040	2800(G) ¹⁴⁴ 6175(G)	2920 6440	3075(H) ¹⁴⁷ 6780(H)

Metric Wide Base Tires for Trucks, Busses, and Trailers Used in Normal Highway Service

Tires Used as Singles Mounted on 15° Drop Center Rims

Tire and Rim Association Standard

TABLE MWB-1

		Tire Load Limits at Various Cold Inflation Pressures										
TIRE SIZE DESIGNATION	kPa psi	480 70	520 75	550 80	590 85	620 90	660 95	690 100	720 105	760 110	790 115	830 120
445/65R19.5	kg lbs.	3410 7540	3610 7930	3750 8270	3960 8680	4100 9040	4250 9370	4410 9730	4540 10100	4750(J) 10500(J) 162		
385/65R22.5	kg lbs.	2880 6380	3060 6720	3150 6940	3350 7350	3470 7650	3650 8050	3740 8230	3850 8510	4000 8820	4100 9050	4250(J) 9370(J) 158
425/65R22.5	kg lbs.	3430 7590	3640 7990	3750 8270	3980 8740	4130 9100	4250 9370	4440 9790	4580 10100	4750(J) 10500(J) 162	4880 10700	5000(L) 11000(L) 164
445/65R22.5	kg lbs.	3720 8230	3950 8660	4125 9090	4320 9480	4470 9870	4625(H) 10200(H) 161	4820 10600	4960 11000	5150 11400	5290 11700	5600(L) 12300(L) 168

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

Radial Ply Tires Mounted on 15° Drop Center Rims

Tire and Rim Association Standard

TABLE TTB-3R

		TIRE LOAD LIMITS (kg/lbs.) AT VARIOUS COLD INFLATION PRESSURES (kPa/psi)										
TIRE SIZE DESIGNATION	USAGE	480 70	520 75	550 80	590 85	620 90	660 95	690 100	720 105	760 110	790 115	830 120
8R19.5	DUAL	1120 2460	1170 2570	1215(D) 2680(D) 115	1260 2785	1310 2890	1360(E) 3000(E) 119	1410 3100	1460 3200	1500(F) 3305(F) 122		
	SINGLE	1150 2540	1220 2680	1285(D) 2835(D) 117	1340 2955	1400 3075	1450(E) 3195(E) 121	1500 3305	1550 3415	1600(F) 3525(F) 124		
8R22.5	DUAL	1250 2750	1300 2870	1360(D) 3000(D) 119	1410 3100	1460 3200	1500(E) 3305(E) 122	1570 3455	1640 3605	1700(F) 3750(F) 126		
	SINGLE	1290 2840	1360 2990	1450(D) 3195(D) 121	1500 3305	1550 3415	1600(E) 3525(E) 124	1670 3675	1740 3825	1800(F) 3970(F) 128		
9R22.5	DUAL	1480 3270	1550 3410	1610 3550	1670 3690	1750(E) 3860(E) 127	1820 4005	1890 4150	1950(F) 4300(F) 131	2010 4425	2070 4550	2120(G) 4675(G) 134
	SINGLE	1530 3370	1610 3560	1690 3730	1760 3890	1850(E) 4080(E) 129	1920 4235	1990 4390	2060(F) 4540(F) 133	2120 4675	2180 4810	2240(G) 4940(G) 136
10R22.5	DUAL	1750 3860	1830 4045	1910 4230	2000(E) 4410(E) 132	2080 4585	2160 4760	2240(F) 4940(F) 136	2300 5075	2360 5210	2430(G) 5355(G) 139	
	SINGLE	1850 4080	1940 4280	2030 4480	2120(E) 4675(E) 134	2200 4850	2280 5025	2360(F) 5205(F) 138	2430 5360	2500 5515	2575(G) 5675(G) 141	
11R22.5	DUAL	1990 4380	2080 4580	2160 4760	2250 4950	2360(F) 5205(F) 138	2460 5415	2560 5625	2650(G) 5840(G) 142	2710 5895	2710 5950	2725(H) 6005(H) 143
	SINGLE	2050 4530	2160 4770	2260 4990	2370 5220	2500(F) 5510(F) 140	2600 5730	2700 5950	2800(G) 6175(G) 144	2870 6320	2940 6465	3000(H) 6610(H) 146
11R24.5	DUAL	2110 4660	2210 4870	2300 5070	2390 5260	2500(F) 5510(F) 140	2580 5675	2660 5840	2725(G) 6005(G) 143	2820 6205	2910 6405	3000(H) 6610(H) 146
	SINGLE	2190 4820	2300 5070	2410 5310	2520 5550	2650(F) 5840(F) 142	2770 6095	2890 6350	3000(G) 6610(G) 146	3080 6790	3160 6970	3250(H) 7160(H) 149
12R22.5	DUAL	2170 4780	2260 4990	2350 5190	2440 5390	2575(F) 5675(F) 141	2630 5785	2680 5895	2725(G) 6005(G) 143	2840 6265	2960 6525	3075(H) 6780(H) 147
	SINGLE	2240 4940	2360 5200	2470 5450	2580 5690	2725(F) 6005(F) 143	2820 6205	2910 6405	3000(G) 6610(G) 146	3120 6870	3240 7130	3350(H) 7390(H) 150
12R24.5	DUAL	2300 5080	2400 5300	2500 5520	2600 5730	2650(F) 5840(F) 142	2770 6095	2890 6350	3000(G) 6610(G) 146	3080 6790	3160 6970	3250(H) 7160(H) 149
	SINGLE	2380 5240	2500 5520	2630 5790	2740 6040	2900(F) 6395(F) 145	3020 6650	3140 6910	3250(G) 7160(G) 149	3350 7380	3450 7600	3550(H) 7830(H) 152

SPECIFICATIONS

Hydraulic Pump

Type Variable displacement, axial piston with load sense
 Total Flow 180 LPM (47.5 GPM) at 2400 RPM

Hydraulic System

Requirements:

Outrigger System 53 lpm (14 gpm)
 Boom Up 94 lpm (25 gpm)
 Boom Down 49 lpm (13 gpm)
 Telescope Extend 140 lpm (37 gpm)
 Telescope Retract 30 lpm (8 gpm)
 Hoist System 95 lpm (25 gpm)
 Swing 38 lpm (10 gpm)

Reservoir

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

Hoist System

Wire Rope - Standard:

Length 119 m (390 ft)
 Diameter (Rotation Resistant) 14 mm (9/16 in)
 Nominal Breaking Strength 17,463 kg (38,500 lb)
 Permissible Line Pulls 3493 kg (7700 lb)

Wire Rope - Optional:

Length 119 m (390 ft)
 Diameter 14 mm (9/16 in) 6X25 IWRC
 Nominal Breaking Strength 15,240 kg (33,600 lb)
 Permissible Line Pulls 3901 kg (8600 lb)

Low Speed Hoist Performance (1 part line)				
Layer	Hoist Pull			
	lbs	(kg)	fpm	(mpm)
1	10820	(4908)	99	(31)
2	9756	(4425)	110	(34)
3	8882	(4029)	121	(37)
4	8152	(3698)	131	(40)
5	7533	(3417)	143	(44)
NOTE: All ratings based on 34 gpm at 3500 psi (128.7 lpm at 24.1 MPa)				

High Speed Hoist Performance (1 part line)				
Layer	Hoist Pull			
	lbs	(kg)	fpm	(mpm)
1	5410	(2454)	199	(61)
2	4878	(3573)	220	(67)
3	4441	(2014)	242	(74)
4	4076	(1849)	264	(80)
5	3766	(1708)	285	(87)
NOTE: All ratings based on 34 gpm at 3500 psi (128.7 lpm at 24.1 MPa)				

Crane Operating Speeds

Rotation 360°	54 sec ±5
Boom up -10° to 80°	30 sec ± 5
Boom Down 80° to -10°	25 sec ± 5
Boom Extend/Retract 100 ft - (Angle 60°)	
Extend	70 sec ± 10
Retract.....	70 sec ± 10
Boom Extend/Retract 110 ft - (Angle 60°)	
Extend	80 sec ± 10
Retract.....	60 sec ± 10

Outrigger Speeds

Beam Extend-(Front)	12 sec ± 3
Beam Extend-(Rear).....	6 sec ± 3
Beam Retract-(Front).....	10 sec ± 3
Beam Retract-(Rear)	6 sec ± 3
Jack Extend - (Front)	14 sec ± 3
Jack Extend - (Rear/SFO)	6 sec ± 3
Jack Retract - (Front).....	11 sec ± 3
Jack Retract-(Rear/SFO).....	6 sec ± 3

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Alphabetical Index

Accidents	2-2
Anti-two Block Weight Installation	4-8
Carwell® Rust Inhibitor	5-11
Charging the Battery	3-2
Cold Weather Operation	2-36
Crane Adjustments and Repairs	6-6
Crane Controls.	3-3
Crane Controls.	3-6
Crane Inspection and Maintenance	6-1
Crane Remote Control (Optional)	3-27
Crane Warm-up Procedures	3-9
Diagnostic	3-23
Electrocution Hazard	2-20
Environmental Protection.	2-25
Equipment Stability/Structural Strength.	2-5
Extension Removal	4-7
Extension Safety Information.	4-3
Hoist Cable Inspection and Maintenance	6-3
Hoist Cable Installation	4-10
Hoist Rope.	2-27
Hoist System Operation.	3-11
Hydraulic System.	6-6
jib	2-33
Jump Starting Hazard	3-2
Lifting the Load	3-12
Load Chart.	3-11
Lubrication	5-3
Maintenance	2-25
Multi-part Line Reeving	4-8
Operating Procedures	3-8
Operational Aids	2-4
Operator Information	2-2
Operator Qualifications	2-3
Outrigger Setup	4-1
Overload Inspection.	2-38
Parking and Securing	2-36
Personnel Handling	2-24
Pile Driving and Extracting.	2-20
Rated Capacity Limiter	3-15
Replacement Cable	6-5
Safety Messages	2-1
Shut Down and Preparation for Road Travel.	3-25
Shut-Down.	2-36
Side Folding Swing Around Extension Operation	4-4
Specifications.	6-10
Temperature Effects on Hook Blocks	2-36
Temperature Effects on Hydraulic Cylinders	2-36
Tire Load and Inflation Table	6-6
Tools	3-22
Transporting the equipment.	2-29
Travel Operation	2-30
Truck Cab Controls	3-2
Wedge Sockets	4-10

Wind Forces 2-6

Wire Rope Lubrication 5-10

Work Practices 2-30

Work Site Location 3-11

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