National Crane NBT40-2 Series

Operator Manual

10354

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.

1565 Buchanan Trail East PO Box 21
Shady Grove, PA 17256-0021 T
717 597 8121 F 717 593 5999
www.manitowoc.com

CHANGE OF OWNERSHIP FORM

Constant improvements, engineering progress or manufacturing information may arise after this crane has been in the field for several years that will make it necessary for us to contact future owners of this machine. It is important to you that Manitowoc Crane have up-to-date records of the current owners of the crane should the need arise for us to contact you. Manitowoc Crane is interested in safe efficient operation of its cranes for their lifetime. Therefore, if you are the second, third, or subsequent owner of this crane, please fill out the form below relating the new owner, model of crane and crane serial number information and e-mail or send to the below address.

PREVIOUS COMPANY NAME: _____

CURRENT COMPANY NAME: _____

CONTACT NAME: _____

ADDRESS: _____

CITY/STATE:_____POSTAL CODE: _____

TELEPHONE NUMBER: _____

EMAIL ADDRESS: _____

DATE PURCHASED_____CRANE MODEL_____CRANE SERIAL NUMBER_____

Please e-mail to: warranty.team@manitowoc.com or visit
https://www.manitowoc.com/support/change-ownership

CHANGE OF OWNERSHIP REGISTRATION

Product Support strives to maintain up-to-date contact information for crane owners so that we can readily communicate information about improvements and/or engineering developments for cranes that have been in the field for several years.

Product Support is pleased to announce that we have developed a QR code to allow the customer to register their crane remotely or re-register their crane if it was purchased used.

To register your crane scan the QR code below or visit https://www.manitowoc.com/warranty-registration-form to register your crane.

NATIONAL CRANE®

OPERATOR MANUAL

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

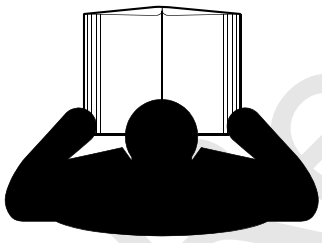
NBT40-2 Series Cranes

This manual is divided into the following sections:

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 in the crane cab (4, Appendix 1). ***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 have been trained in the safe operation of this crane. National Crane is not responsible for qualifying personnel
- You read, understand, and follow the safety and operating recommendations contained in the crane manufacturer's manuals and load charts, your employer's work rules, and applicable government regulations.
- You are sure that all safety signs, guards, and other safety features are in place and in proper condition.
- The Operator Manual and Load Chart are in the holder provided on crane.

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SECTION 1
INTRODUCTION

SECTION CONTENTS

GENERAL

This manual has been compiled to assist you in properly operating and maintaining your Model NBT40-2 Series National Crane (Figure 1-1). The NBT40-2 Series includes crane models NBT40-2, NTC40-2, NBT45-2, and NTC45-2.

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.

For detailed information concerning the operation and maintenance of the RCL system installed on the crane, see Section 7- Rated Capacity Limiter in this manual. Manufacturers of rated capacity limiters may refer to them in their manuals as a load moment indicator (LMI) or a hydraulic capacity alert system (HCAS). National Crane refers to these systems as a rated capacity limiter (RCL) throughout its *Operator* and *Service Manuals*.

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

The NBT40-2 Series cranes have been designed for maximum performance with minimum maintenance. With proper care, years of trouble-free service can be expected.

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

Supplemental Information

Supplemental Information regarding Safety & Operation, Specifications, Service & Maintenance, Installation, and parts for options such as remote controls, augers, varying control configurations, personnel platforms, 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.

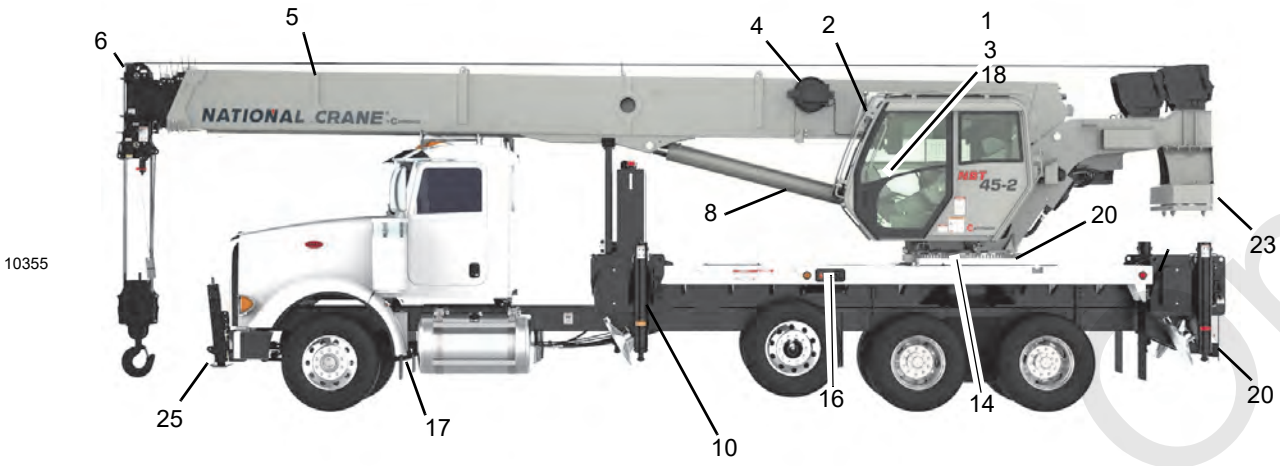
A Safety Compact Disc or a USB flash drive which includes sections on Operation, Service and a Safety Video for National Crane operators and owners is supplied when the equipment is purchased new. Additional copies are available from your local distributor.

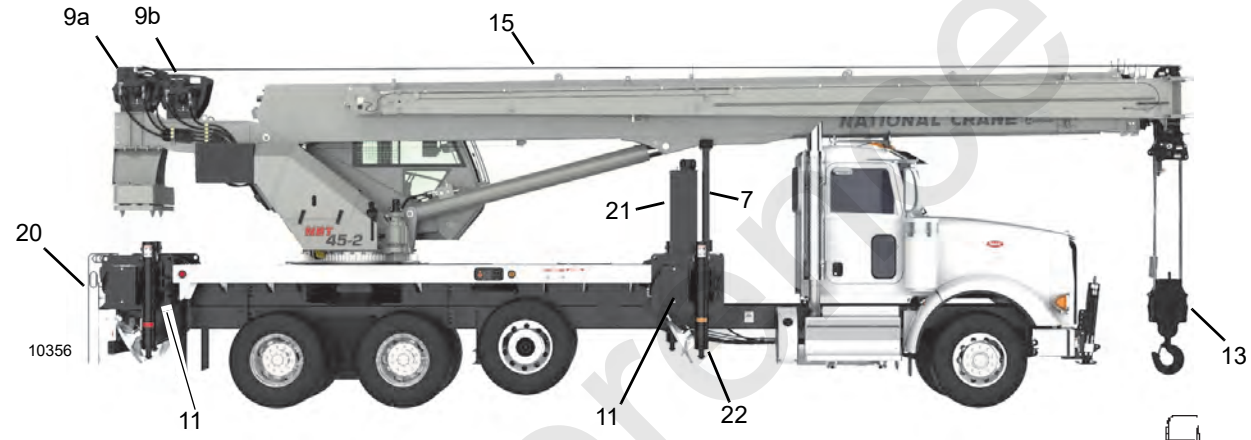
New Owner

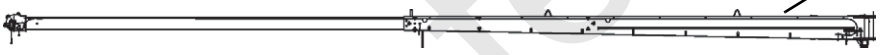
If you are the new owner of a National Crane, please register it with National Product Support so we have the ability to contact you if the need arises. Go to: https://www.manitowoccranes.com/en/services/crane-care/service-and-tech-support/Change-of-Ownership-Form

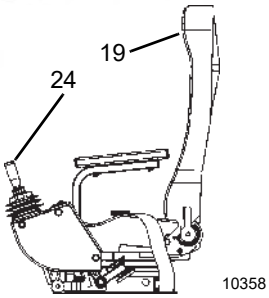
Basic Nomenclature

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









Item	Component
1	Cab Crane Controls (Inside Cab)
2	Cab
3	RCL, Display Screen (Inside Cab)
4	Rated Capacity Limiter (RCL) Reel
5	Boom
6	Boom Nose
7	Boom Rest
8	Lift Cylinder
9a	Main Hoist (rear)
9b	Auxiliary Hoist (front)
10	Outrigger Beam
11	Outrigger Box
12	Telescoping Jib
13	Hook Block

Item	Component
14	Superstructure Bearing
15	Hoist Rope
16	Ground Outrigger Control
17	Hydraulic Pump
18	Cab Outrigger Control (Inside Cab)
19	Cab Seat
20	Access Ladder
21	Hydraulic Tank
22	Outrigger Stabilizer
23	Counterweight
24	Cab Controllers
25	Single Front Outrigger (SFO) (Optional)

FIGURE 1-1

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 National Product Support. 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 National Product Support.

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SECTION 2
SAFETY PRECAUTIONS

SECTION CONTENTS

SAFETY MESSAGES

General

The importance of safe operation and maintenance cannot be overemphasized. Carelessness or neglect on the part of operators, job supervisors and planners, rigging personnel, and job site workers can result in their death or serious 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 National Product Support.

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.

Example decal. For reference only.
8819

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.

Example decal. For reference only.
8788

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.

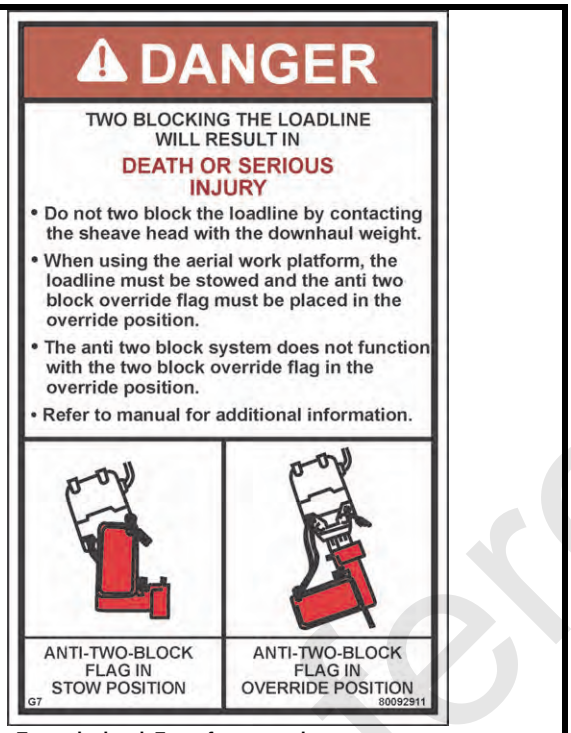
NEVER exceed the rated capacity shown on the *Load Chart*. Always check the *Load Chart* to make sure that the load to be lifted at the desired radius is within the rated capacity of the equipment.

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, 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.



9250 **Example decal. For reference only.**

Two-blocking is more likely to occur when both the main and auxiliary hoist lines are reeved over the main boom nose and jib nose, respectively. An operator, concentrating on the specific line being used, may telescope or lower the boom allowing the other hoist line attachment to contact the boom or jib nose, thus causing damage to the sheaves, or causing the 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 any intermediate position (vertical stripe, if applicable), the outriggers must also be pinned when operating from the intermediate position.

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

Read and follow the safety decal for equipment:

9120 **Example decal. For reference only.**

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 operating mode 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 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 crane.

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

Wind forces can exert extreme dynamic loads. Grove 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.

NOTE: Not all crane models allow lifting operations in all configurations or speeds of 20.1 m/s (45 mph). Refer to load chart notes for allowable configurations and maximum permissible wind speed.

Table 2-1 Beaufort Wind Scale

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

Wind Speeds

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

NOTE: Not all crane models allow lifting operations above 13.4 m/s (30 mph). Refer to load chart notes for maximum permissible wind speed.

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

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

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

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

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

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

the **Actual** wind resistance area with the **Allowable** wind resistance area.

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

NOTE: Not all crane models allow lifting operations in all configurations or speeds of 20.1 m/s (45 mph). Refer to load chart notes for allowable configurations and maximum permissible wind speed.

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

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

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

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

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

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

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

where:

V [m/s] [mph] - Mean wind speed at 10 m (33 ft) elevation (upper limit of Beaufort scale)

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

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

V = 7.9 m/s (17.7 mph)

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

then:

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

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

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

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

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

Size and Shape of the load:

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

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

NOTE: Not all crane models allow lifting operations in all configurations or speeds of 20.1 m/s (45 mph). Refer to load chart notes for allowable configurations and maximum permissible wind speed.

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

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

where:

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

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

Cd - wind drag coefficient.

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

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

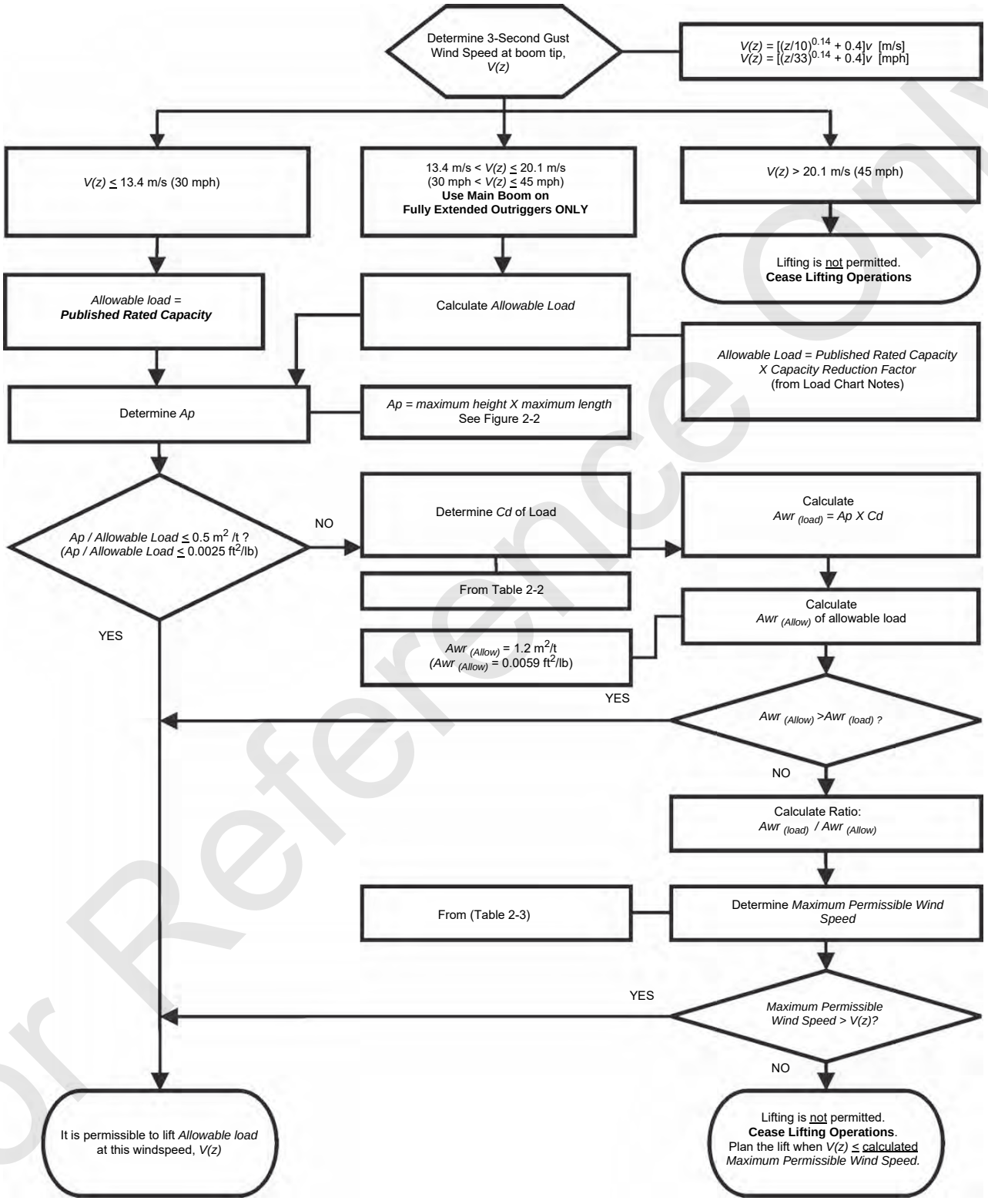
$$Awr_{(allow)} = 0.0012 \times m_{(load)} \quad (2.4)$$

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.

Simplified Method to Determine Maximum Permissible Wind Speed



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

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

FIGURE 2-1

Calculation of Projected Wind Area (Ap):

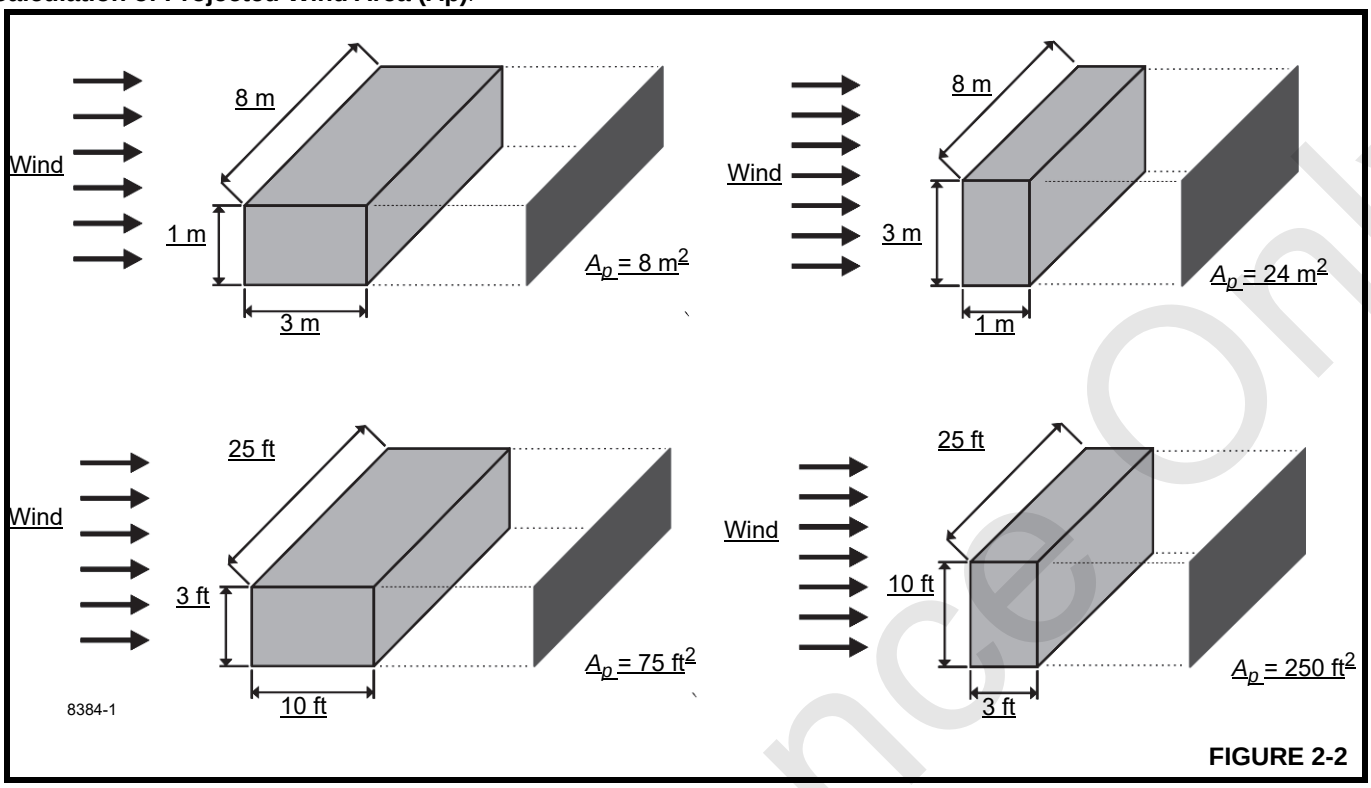


FIGURE 2-2

Determining Wind Drag Coefficient (Cd)

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

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

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

Table 2-2 Wind Drag Coefficient

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
NOTE: Not all crane models allow lifting operations in all configurations or speeds of 20.1 m/s (45 mph). Refer to load chart notes for allowable configurations and maximum permissible wind speed.					

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

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

For wind speed ***V(z)*** (3-second gust speed at boom tip height) ***V(z)*** > 13.4 m/s ≤ 20.1 m/s, the Reduced Capacity shall be calculated by multiplying the Published Rated Capacity by the following factors:

	Main Boom Length in Meters								
Wind Speed *V(z)* > 13.4 m/s ≤ 20.1 m/s	10.9	12.2	15.2	18.4	21	24.4	27.4	30.5	33.5
Factor	0.9	0.9	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] ***Awr***$_{(allow)}$ = 0.0012 x calculated reduced capacity in kg.
Wind resistance area of load, ***Awr***$_{(load)}$ = projected wind area ***Ap*** x wind drag coefficient ***Cd*** for the load.

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

NOTE: Not all crane models allow lifting operations in all configurations or speeds of 20.1 m/s (45 mph). Refer to load chart notes for allowable configurations and maximum permissible wind speed.

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 (8)			
6	32,950 (50.5)	32,925 (55.5)	32,825 (63.5)	28,350 (68.5)	18,225 (72)	18,2 (7)	*18,225 (78)		
7	28,325 (42.5)	28,300 (49)	28,225 (59)	26,250 (65)	18,225 (69)	,225 ( )	18,225 (74.5)	*16,725 (78)	*11,400 (78)
8	24,150 (32.5)	24,150 (42)	23,975 (54.5)	23,275 ( )	,225 ( )	1 ,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)	0,25 ( )	18,2 (63)	16,575 (67)	15,050 (70)	13,875 (72.5)	11,400 (74.5)
10		17,200 (20.5)	17 (4	17, 5 (54)	17,325 (60)	15,125 (6)	13,725 (67.5)	12,700 (70.5)	11,400 (72.5)
12			2,07 ( )	1 ,225 (45.5)	12,575 (53.5)	12, 5	11,600 (63)	10,725 (66.5)	10,050 (69)
14				9,000 (35)	9,360 (6)	9,730 (53.5)	9,955 (58.5)	9,205 (62)	8,620 (65)
16				6,75 (19)	7,1 (37.5)	7 5 (47)	7,920 (53)	7,980 (57.5)	7,470 (61.5)
18					5 (2)	5,960 (39.5)	6,340 (47.5)	6,525 (53)	6,530 (57.5)
20						4,755 (30.5)	5,145 (41)	5,320 (48)	5,495 (53)
22						3,790 (16.5)	4,210 (33.5)	4,380 (42.5)	4,545 (48.5)
24							3,435 (23.5)	3,620 (36)	3,780 (43.5)
26								2,975 (28)	3,150 (37.5)
28								2,400 (16)	2,620 (31)
30									2,135 (22)
Minimum boom angle (°) for indicated length (no load)									0
Maximum boom length (m) at 0° boom angle (no load)									33.5

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

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

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

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FIGURE 2-3

Table 2-5 *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
NOTE: Not all crane models allow lifting operations in all configurations or speeds of 20.1 m/s (45 mph). Refer to load chart notes for allowable configurations and maximum permissible wind speed.					

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)***.

NOTE: Not all crane models allow lifting operations in all configurations or speeds of 20.1 m/s (45 mph). Refer to load chart notes for allowable configurations and maximum permissible wind speed.

Example 1: Crane Configuration:

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

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

The maximum allowable wind resistance area of load is:

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

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

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

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

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

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

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

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

Lifting Limits at wind speed V(z) > 13.4 m/s **and ≤ 20.1 m/s,** at this configuration:

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

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

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

Load example 1.1:

With <u>known</u> Wind Drag Coefficient of the load ***Cd***, and

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

wind resistance area of load can be estimated as

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

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

- Is the load to be lifted less than allowable load?
  11,200 kg ≤ 12,040 kg YES
- Is $Awr_{(load)}$ less than $Awr_{(allow)}$?
  13.8 m^2 ≤ 14.45 m^2 YES

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

Load example 1.2:

With <u>unknown</u> Wind Drag Coefficient of the load ***Cd***,

- Load to be lifted of 10,000 kg,

- Projected Wind Area ***Ap*** = 5.45 m^2,
- Wind Drag Coefficient ***Cd*** = unknown

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

- the wind resistance area of load can be estimated as ***Awr***$_{(load)}$ = ***Ap*** x ***Cd*** = 5.45 x 2.4 = 13.08 m^2

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

- Is the load to be lifted less than allowable load?
  10,000 kg ≤ 12,040 kg YES
- Is ***Awr***$_{(load)}$ less than ***Awr***$_{(allow)}$?
  13.08 m^2 ≤ 14.45 m^2 YES

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

Load example 1.3a:

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

- Load to be lifted of 14,000 kg,
- Projected Wind Area ***Ap*** = 21.85 m^2,
- Wind Drag Coefficient ***Cd*** = 1.2

the wind resistance area of load can be estimated as:

Awr$_{(load)}$ = ***Ap*** X ***Cd*** = 21.85 x 1.2 = 26.22 m^2

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

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

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

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

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

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

- Is ***Awr***$_{(load)}$ less than ***Awr***$_{(allow)}$?
  26.22 m^2 ≤ 18.06 m^2 NO

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

Ratio $\frac{Awr_{(load)}}{Awr_{(allow)}} = \frac{26.2}{18.0} = 1.45$

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

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

Load example 1.3b:

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

- Load to be lifted of 8,000 kg,
- Projected Wind Area ***Ap*** = 15.25 m^2,
- Wind Drag Coefficient ***Cd*** = 1.3

the wind resistance area of load can be estimated as

Awr$_{(load)}$ = ***Ap*** x ***Cd*** = 15.25 x 1.3 = 19.83 m^2

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

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

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

Ratio $\frac{Awr_{(load)}}{Awr_{(allow)}} = \frac{19.8}{14.4} = 1.37$

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

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

Rated Load Chart Example - Non-metric

RATED LIFTING CAPACITIES IN POUNDS
36 FT. - 110 FT. BOOM

ON OUTRIGGERS FULLY EXTENDED - 360°

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

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

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

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

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FIGURE 2-4

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

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

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

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

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

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

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

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

NOTE: Not all crane models allow lifting operations in all configurations or speeds of 20.1 m/s (45 mph). Refer to load chart notes for allowable configurations and maximum permissible wind speed.

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

NOTE: Not all crane models allow lifting operations in all configurations or speeds of 20.1 m/s (45 mph). Refer to load chart notes for allowable configurations and maximum permissible wind speed.

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)***.

NOTE: Not all crane models allow lifting operations in all configurations or speeds of 20.1 m/s (45 mph). Refer to load chart notes for allowable configurations and maximum permissible wind speed.

Example 2:

A crane is configured with:

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

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

The maximum allowable wind resistance area of load is:

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

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

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

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

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

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

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

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

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

- Maximum load 20,160 lb
- Maximum wind resistance area of load 119 ft^2

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

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

Load example 2.1:

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

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

then the wind resistance area of load can be estimated as

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

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

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

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

Load example 2.2:

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

- Load to be lifted of 18,000 lb,
- Projected Wind Area ***Ap*** = 45 ft^2,
- Wind Drag Coefficient ***Cd*** = unknown

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

the wind resistance area of load can be estimated as

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

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

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

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

Load example 2.3a:

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

- Load to be lifted of 22,000 lb,
- Projected Wind Area ***Ap*** = 180 ft^2,
- Wind Drag Coefficient ***Cd*** = 1.2

the wind resistance area of load can be estimated as:

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

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

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

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

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

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

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

- Is $Awr_{(load)}$ less than $Awr_{(allow)}$,?
  216 ft^2 ≤ 149 ft^2 . . . . . NO

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

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

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

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

Load example 2.3b:

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

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

the wind resistance area of load can be estimated as:

Awr$_{(load)}$ = ***Ap*** x ***Cd*** = 125 x 1.3 = 162 ft^2

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

- Is the load to be lifted less than allowable load?
  12,000 lb ≤ 20,160 lb YES
- Is ***Awr***$_{(load)}$ less than ***Awr***$_{(allow)}$,?
  162 ft^2 ≤ 119 ft^2 NO

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

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.

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

Lifting Operations

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

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

If the boom extension, or auxiliary boom nose is to be used, 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 crane configuration. Refer to the RCL operator manual supplied with the crane.

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

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, boom extension, etc.) must be considered part of the load.

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

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

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

The crane can tip over or fail structurally if:

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

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

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

Load Chart capacities are based on freely suspended loads. **Do not pull posts, pilings, or submerged articles. 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 crane will lean toward the boom and the load will swing out, increasing the load radius. Make sure that the crane's capacity is not exceeded when this occurs.

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

Never push or pull with the crane boom.

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

Using only one hoist at a time when lifting loads is recommended. See “Tilt-Up Panel Lifting” on page 2-19 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.

Multiple Crane Lifts

Multiple crane lifts are not recommended.

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

- Secure the services of a qualified person to direct the operation.
- Make sure 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 cranes so equipped.
- Calculate the amount of weight to be lifted by each crane and attach slings at the correct points for proper weight distribution.
- Make sure that the load lines are directly over the attach points to avoid side loading and transfer of loading from one crane to the other.
- Do not travel. Lift only from a stationary position.

Lifting Multiple Loads

Grove recommends lifting only one load at a time.

Lifting two or more separately rigged loads at one time is only permitted during steel erection in accordance with 29CFR1926.753 when the following criteria are met:

1926.753(e)(1) A multiple lift shall only be performed if the following criteria are met:

- 1926.753(e)(1)(i) A multiple lift rigging assembly is used;
- 1926.753(e)(1)(ii) A maximum of five members are hoisted per lift;
- 1926.753(e)(1)(iii) Only beams and similar structural members are lifted; and
- 1926.753(e)(1)(iv) All employees engaged in the multiple lift have been trained in these procedures in accordance with § 1926.761(c)(1).
- 1926.753(e)(1)(v) No crane is permitted to be used for a multiple lift where such use is contrary to the manufacturer's specifications and limitations.

1926.753(e)(2) Components of the multiple lift rigging assembly shall be specifically designed and assembled with a maximum capacity for total assembly and for each individual attachment point. This capacity, certified by the manufacturer or a qualified rigger, shall be based on the manufacturer's specifications with a 5 to 1 safety factor for all components.

1926.753(e)(3) The total load shall not exceed:

- 1926.753(e)(3)(i) The rated capacity of the hoisting equipment specified in the hoisting equipment load charts;
- 1926.753(e)(3)(ii) The rigging capacity specified in the rigging rating chart.

1926.753(e)(4) The multiple lift rigging assembly shall be rigged with members:

- 1926.753(e)(4)(i) Attached at their center of gravity and maintained reasonably level;
- 1926.753(e)(4)(ii) Rigged from top down; and
- 1926.753(e)(4)(iii) Rigged at least 7 feet (2.1 m) apart.

1926.753(e)(5) The members on the multiple lift rigging assembly shall be set from the bottom up.

1926.753(e)(6) Controlled load lowering shall be used whenever the load is over the connectors.

Tilt-Up Panel Lifting

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

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

- The crane must be set up and operated in accordance with Grove's instructions in the Operator Manual, Load Capacity Chart, and decals affixed to the crane.
- The hoist rope from the main hoist shall be reeved over the main boom nose reeved for two parts of line.
- The hoist rope from the auxiliary hoist shall be reeved over the auxiliary boom nose reeved for one part of line 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 crane and the auxiliary hoist line connected to the end farthest from the crane.
- The anti-two-block system shall be installed and inspected to confirm that it is active to monitor both hoist lines.
- The RCL hoist selection shall be set to main hoist and two parts of line.
- The wire rope and sheaves shall be inspected prior to and following the lifting operations for chaffing or scrubbing.
- The total gross load shall not exceed 80% of the standard load chart. The operator shall be responsible to control this as the RCL does not have a feature to set reduced lifting limits.
- The auxiliary hoist line shall be considered part of the deducts to determine net allowable load.
- The panel shall be lifted so that the hoist lines are in line with the crane.
- The load shall be controlled to prevent rotation of the load and to 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 crane and panel shall be taken into consideration. Operations shall be halted if the wind can cause a loss of control in handling the load.
- The main hoist line shall be used to raise the panel into the vertical position.

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

Counterweight

On cranes equipped with 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. [29CFR 1926.1434]

Outrigger Lift Off

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

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

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

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, subpart 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.

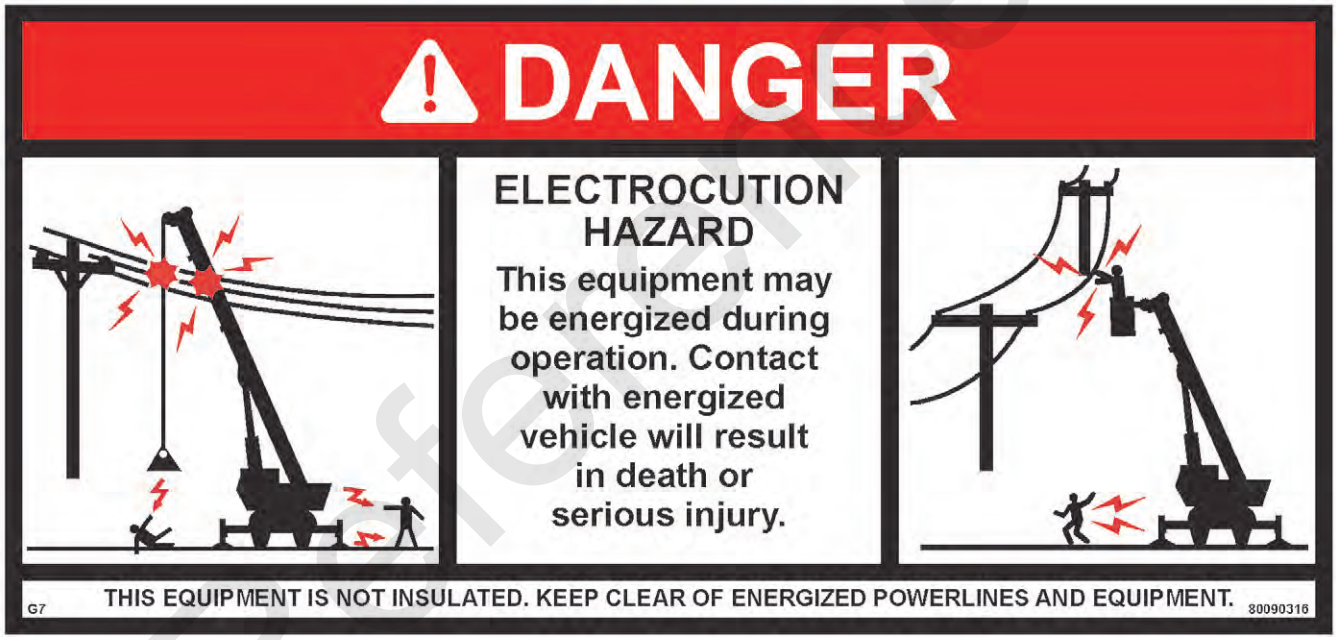
DANGER

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.



8822 **Example decal. For reference only.**

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

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

This equipment is **not insulated**. Always consider all parts of the load and the equipment, including the 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.

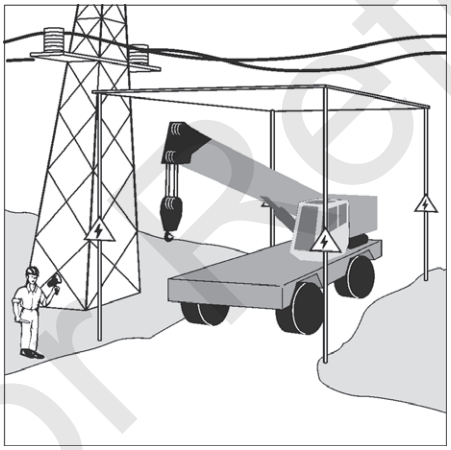
Set-Up and Operation

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 death or serious injury. 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 National Product Support. 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 National Product Support.

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.

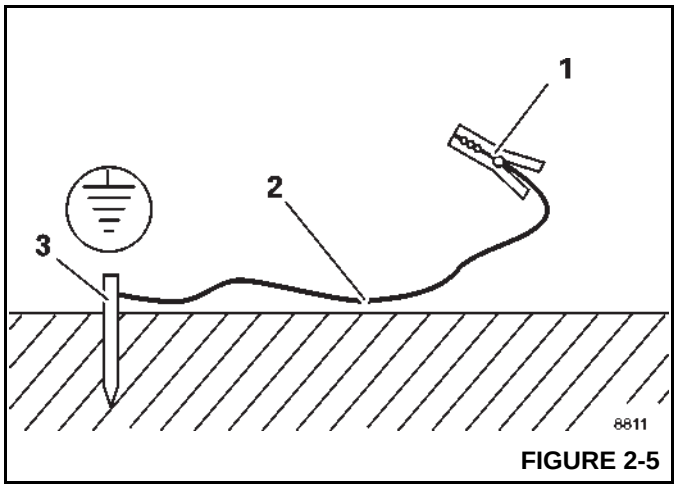


FIGURE 2-5

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, 07004-2900

  - 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 death or serious injury.

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.

A 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 death or serious injury. 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 death or serious injury. 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 National Product Support 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 (If Supported)

NOTE: Synthetic hoist rope is not supported on all National models. For more information, contact National Product Support.

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

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 National Product Support.

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.***

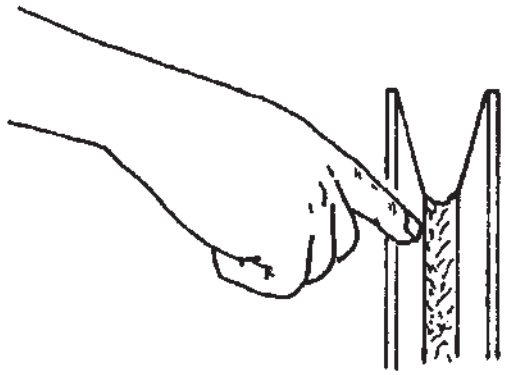
Installing a new rope:

- 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 death or serious injury.

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 death or serious injury.

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 intermediate position(s), the outriggers must also be pinned when operating from the intermediate 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.

8820 **Example decal. For reference only.**

Keep unauthorized personnel clear of the working area during operation.

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

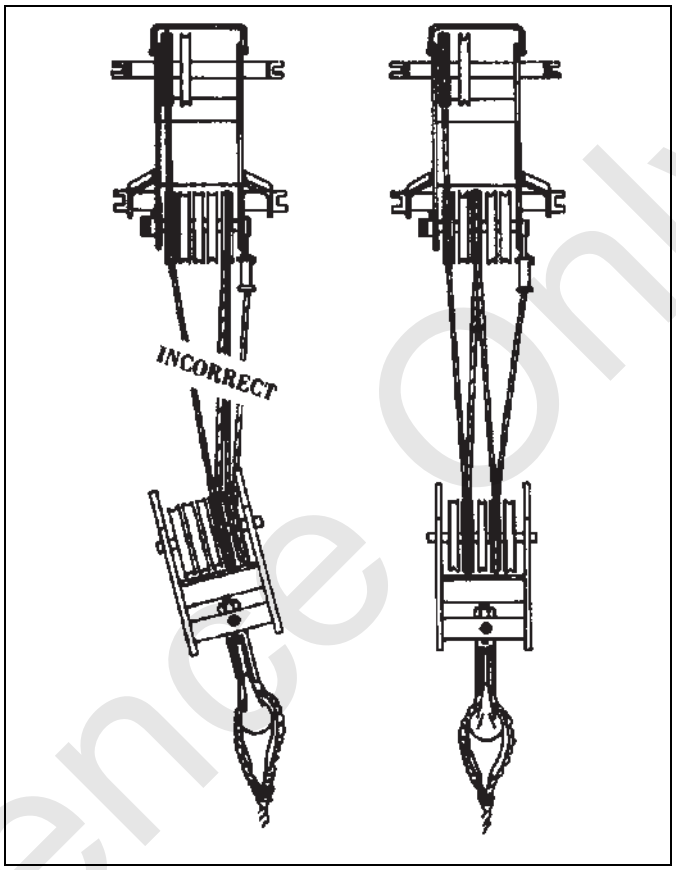
You must always be aware of everything around the equipment while lifting or traveling. If you are unable to clearly see in the direction of motion, you must post a look out or signal person before moving the equipment or making a lift. Sound the horn to warn personnel.

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.

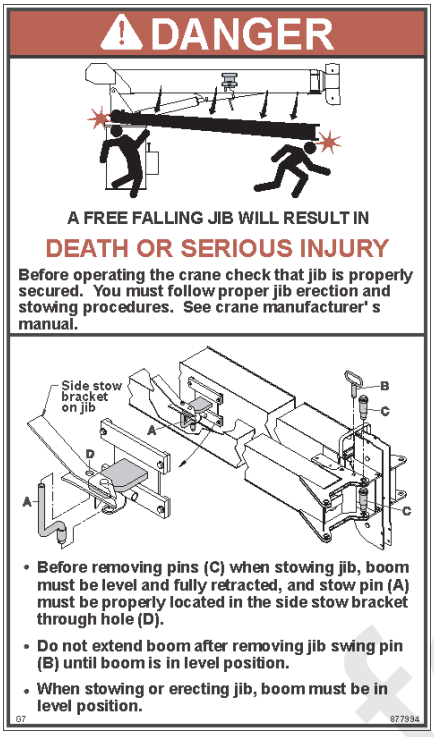
JIB

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.

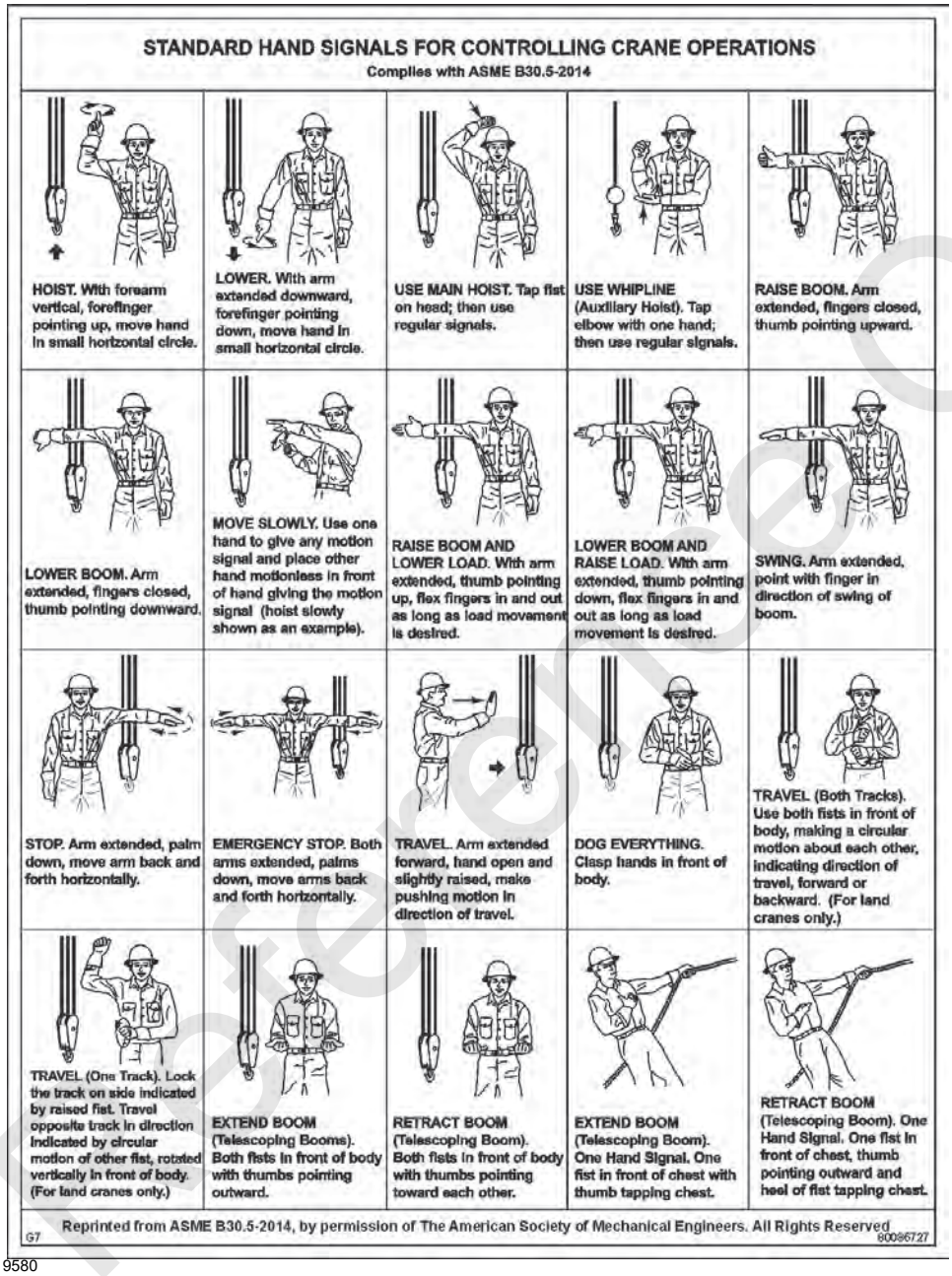

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FIGURE 2-6

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 cm^3 per cm^3 of volume for 1°C of temperature change (0.00043 in^3 per in^3 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)			*Metric*						
STROKE					Temperature Change (°C)						
(m)	5	10	15	20	25	30	35	40	45	50	55
1.5	6	12	17	23	29	35	41	46	52	58	64
3	12	23	35	46	58	70	81	93	104	116	128
4.5	17	35	52	70	87	104	122	139	157	174	192
6	23	46	70	93	116	139	163	186	209	232	255
7.5	29	58	87	116	145	174	203	232	261	290	319
9	35	70	104	139	174	209	244	279	313	348	383
10.5	41	81	122	163	203	244	284	325	366	406	447
12	46	93	139	186	232	279	325	372	418	464	511
13.5	52	104	157	209	261	313	366	418	470	522	575
15	58	116	174	232	290	348	406	464	522	581	639
16.5	64	128	192	255	319	383	447	511	575	639	702
18	70	139	209	279	348	418	488	557	627	697	766

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

MODEL SPECIFIC INFORMATION

On cranes equipped with a boom mounted personnel platform, use only a platform approved by National Crane.

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 equipment, you must carry out specified inspections on the equipment.

These inspections apply only to overloads up to 50%. For overloads of 50% or higher, equipment operation must be stopped immediately and National Product Support must be contacted for corrective action.

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

WARNING

Overload Hazard!

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

- Perform the inspections outlined in this publication for overloads up to 50%.
- Stop operating the equipment and contact National Product Support 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 equipment owner.

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

Boom Inspection

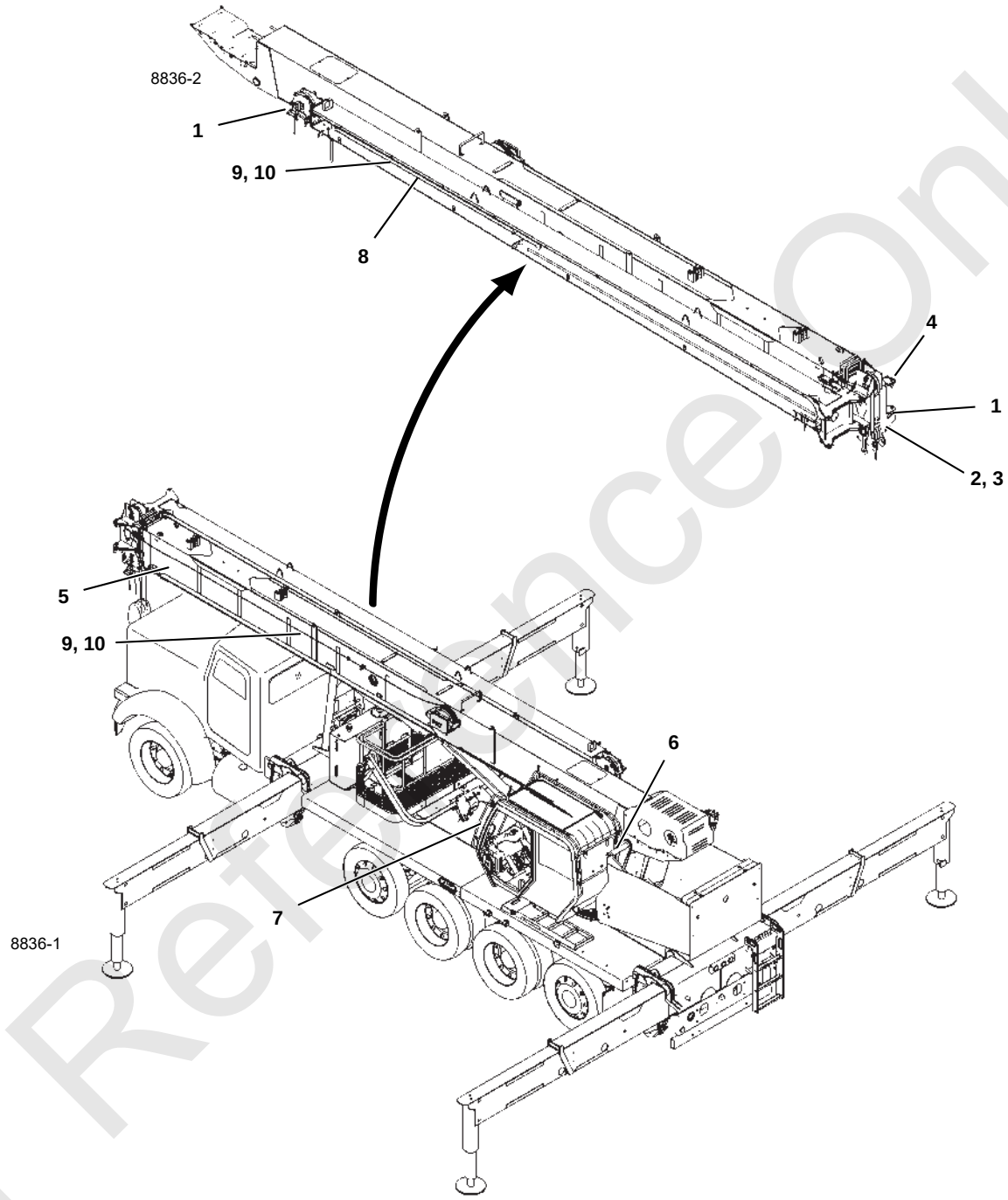


Illustration for reference only.
Your crane may be different.

NOTE: The following checklist includes all features that can be found on National Crane. 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	Superstructure-Base Section	Inspect for cracked welds.	
8	Jib Section	Inspect for bent or twisted section. Check for straightness.	
9	Welds	Inspect for cracks.	
10	Paint	Inspect for cracked paint which could indicate twisted, stretched, or compressed members.	

Superstructure Inspection

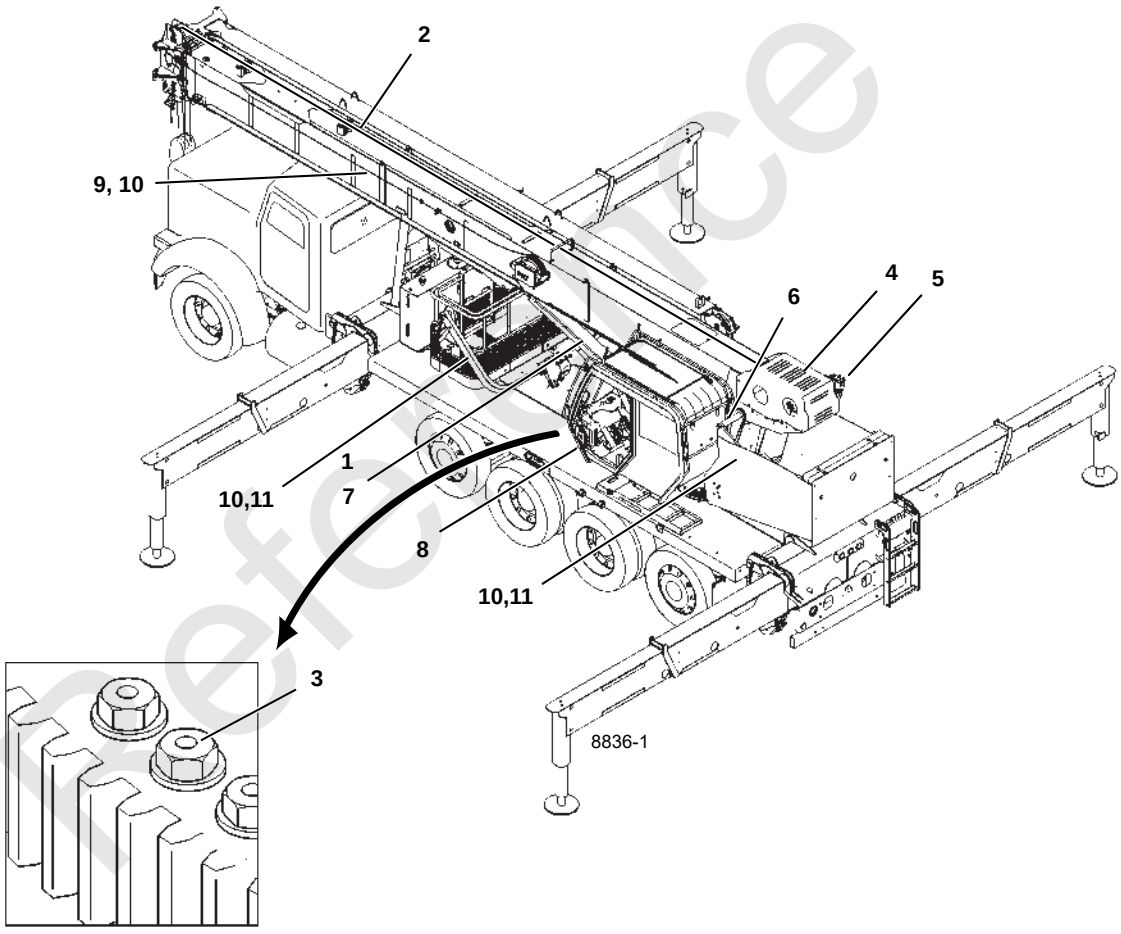


Illustration for reference only.
Your crane may be different.

NOTE: The following checklist includes all features that can be found on National Crane. 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	Superstructure Area	Inspect for deformation, cracked welds.	
9	Mounting Studs	Check bolts for proper torque.	
10	Welds	Inspect for cracks.	
11	Paint	Inspect for cracked paint which could indicate twisted, stretched, or compressed members.	

Carrier Inspection

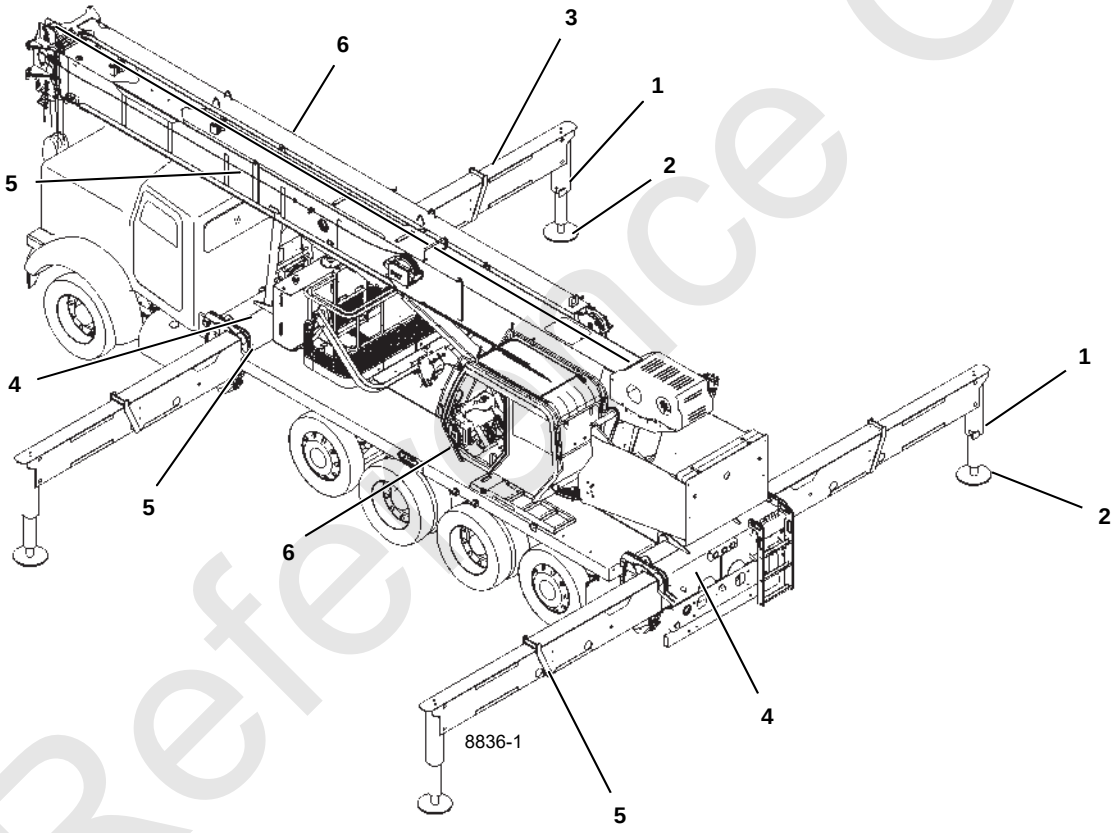


Illustration for reference only.
Your crane may be different.

NOTE: The following checklist includes all features that can be found on National Crane. 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

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

- Truck Cab Controls related to crane operation
- 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.

This crane has multiple computer systems (crane control, RCL, engine and transmission control) that are highly susceptible to voltage/amperage surges in the electrical system.

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

Charging the Batteries

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.

CRANE THEORY OF OPERATION

Crane Software Overview

The NBT40-2 Series is equipped with a Controller Area Network (CAN) bus electronic system that controls the majority of the devices on the crane. This is a distributed system consisting of several electronic modules that all perform different functions based on the crane's software. These modules are all connected together with a twisted pair of wires that allows all the modules to talk on the same databus - the CAN bus - to provide the information about the state of all the devices on the machine. There is a main module, or “server” module that controls all the other secondary modules called “client” modules in the system. The software that describes how the crane should react to the various switches, sensors, controllers, and pedals is installed on the server module which then controls the client modules functions.

When a switch or a pedal is used, an input is sent to an electronic module which monitors any change in value. When the input has been received and the crane software logic allows for this to be communicated to the output device, the machine then responds to the operator's input. For example, if the crane operator moves the swing left controller to rotate the machine, the “input” from the controller is read by the control modules but the crane server module knows that movement is not allowed unless the swing brake release switch is activated. In this example, the swing left proportional output is not energized and there is no crane movement.

For more information about the Rated Capacity Limiter, see “Rated Capacity Limiter” on page 7-1.

GETTING STARTED

The NBT40-2 Series cranes feature several interlocks that must be satisfied before operating the crane. To operate the crane from the crane cab, the machine must be started from the crane cab key switch (9, Figure 3-4). Starting the truck from the truck cab will not allow the crane to operate. There are several interlocking conditions that must be met before turning on and operating the crane from the crane cab:

- The lower ground level outrigger panel Emergency Stop (ESTOP) switches (9, Figure 3-1) must be released.
- The Crane Cab ESTOP switch (9, Figure 3-2) must be released.
- The truck ignition key switch must be OFF.

There are also interlocks that prevents the crane key switch from starting the truck engine:

- PTO must be engaged. For more information, see “Power Take Off (PTO)” on page 3-4.
- The truck park brake must be engaged.

If unable to activate the crane cab key switch, first check the status of these items and then cycle the crane cab key switch and try again. On some of the newer trucks, the electronic PTO will automatically drop out after the truck engine has been shut down. The PTO may need to be reengaged, or the engine may need to be cranked for the PTO signal to be reengaged.These interlocks are designed to ensure that the crane performs as desired and allow for all the ESTOP switches to be available for use if needed.

Crane Ignition and Control States

The crane control system consists of many “states” which describe groups of functions that can or cannot be performed while in that state. This allows for the machine to operate several ways when running the truck chassis, the crane, or radio remote control of the crane. These “states” can be seen through the crane’s diagnostic software program only and are available as part of the I/O screens.

Machine States

Since the crane and the truck chassis both have key switches, there is interlock logic to allow only one switch to be active at a time even if both switches are turned ON., The truck switch, when ON, will override the crane cab switch. The following list summarizes the machine states:

- Machine State 0: truck key off, crane key off
- Machine State 1: Crane jnterlocks (PTO, Park Brake). This state is truck key ON.
- Machine State 2: Truck Ignition rigging. This state enables the operator to set-up outriggers from the lower controls or rigging remote control before getting into the crane cab. The parking brake must be applied, the truck running, and the PTO turned ON.
- Machine State 3: Crane control rigging. This state is used to run the lower outrigger controls and bumper remote. It is often used when the operator is in the cab to deactivate crane controls and to remain in an idle state to disable the crane functions.
- Machine State 4: Crane Control active. This state enables the operator to use the boom controls. The seat switch and armrest conditions must be met to activate the crane power switch. The red LED in the crane power switch will turn ON when those conditions are met. Crane boom controls and cab outrigger controls can then be activated by turning ON the switch.
- Machine State 5: Emergency Stop (E-stop) active. This state is active when any of the E-stop buttons are pressed. This state turns off the truck ignition and stops boom commands. The RCL display remains ON and enables the user to enter the diagnostic screens to view any errors or active indicators. It also enables the operator to see the I/O screen and to view which E-stop is activated. This state does not include the radio remote E-stop.
- Machine State 6: Remote pre-operation active. This state is the idle state that enables the full function remote controls to come online, then stands by for the remote control start-up sequence. This state does not allow crane functions from the cab controls or the full function remote controls. This state is entered by turning the 3-position crane power rocker switch to the remote position. The machine state 4 interlocks must be met to enter this state.
- Machine State 7: Remote Control active. In this state, the remote control is activated by pressing the horn/ON button and allowing the horn to sound when in the remote pre-operational state. This allows the remote control to enable crane functions. To enable crane

functions using the full function remote, the remote control's Enable button must be pressed prior to actuating any boom control functions.

- Machine State 8: Remote Emergency Stop Active. This state is similar to Machine State 5, E-stop active state. This state is activated when the operator in an operational remote state presses the E-Stop from the remote. The operator will have a short period of time to review the issues on the diagnostic screen, or turn OFF the remote power switch before the system completely turns OFF.

Refer to *Crane Remote Control (Optional)*, page 3-35 and "Rated Capacity Limiter" on page 7-1 for more information on the crane remote controller operation.

TRUCK CAB CONTROLS

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

Truck Cab Ignition Switch

Truck cab ignition switch must be OFF in order for crane cab ignition switch to be operable. However, the crane's lower controls can be operated when the truck keyswitch is ON, provided the truck's park brake is ON and the PTO is engaged.

Power Take Off (PTO)

Manual Shift Control

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

Air Shift Control

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

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

Engine Speed Governor

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

Neutral Start/Safety Switch

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

CRANE CAB CONTROLS

The following sections describe controls located in the crane cab.

Crane Cab Operator Seat

The crane cab operator seat (Figure 3-4) is equipped with a occupancy sensor. The operator must be sitting in the operator seat to use crane functions. Crane functions are disabled if the operator seat is unoccupied. The outriggers can be operated from the lower control panels if the operator seat is unoccupied.

Crane Cab Left Armrest

The crane cab armrest (Figure 3-4) is equipped with a proximity switch that detects the armrest's position. The armrest must be in the DOWN position to operate crane functions. When the armrest is UP, crane operations are disabled, even if an operator is in the crane cab operate seat and the crane power switch is ON. The outriggers can be operated from the lower controls when an armrest is in the UP position. However, the crane cab outrigger controls are active only when the seat is occupied, armrest down, and crane power is ON.

Outrigger Controls

The outriggers can be operated from several locations, including the keypad controller (Figure 3-2) located on the (6 and 9, Figure 3-1) crane cab console and two ground station control keypads located on the left and right sides of the carrier frame. The cab outrigger controller contains the controls for extending and retracting the outrigger beams, for raising and lowering the outrigger stabilizer (jack) cylinders

and for raising and lowering the single front outrigger (SFO), if equipped. The right (passenger) side ground station controls all vertical outrigger cylinders and the SFO (if equipped), but only the horizontal beams on the right (passenger) side of the crane. The left (driver) side ground station controls all vertical outrigger cylinders and the SFO (if equipped), but only the horizontal beams on the left (driver) side of the crane.

An optional handheld remote control can also be used to operate the outriggers. For more information, see “Rigging Remote Control (Optional)” on page 3-32.

The outrigger midspan selector pin (1, Figure 3-1) can be used to extend the outrigger to 50% of its length. The outrigger 75% selector pin (10) is standard on NTC machines and can be used to extend the outrigger to 75% of its length. For more information about deploying the outriggers, see “Outrigger Setup” on page 4-1.

For more information about the cab outrigger controls, see “Cab Outrigger Control Panel” on page 3-5. For more information about the ground station outrigger controls, see “Ground Station Outrigger Control Panels” on page 3-5.

For more information about configuring the outriggers in the Rated Capacity Limiter (RCL), see “Step 3: Configuring the Outriggers” on page 7-7.

Cab Outrigger Control Panel

The cab outrigger control panel (Figure 3-2) is located on the superstructure cab front console panel and is used to control the outriggers from inside the cab. The control panel contains a touch pad with control buttons and indicators for extending and retracting the outrigger beams, raising and lowering the outrigger jack cylinders and raising and lowering the single front outrigger (SFO), if equipped. If not equipped with an SFO, the SFO LED indicators above the SFO button illuminate red. The crane cab control station contains a level indicator and an emergency stop switch. All outrigger functions can be controlled from the cab control panel.

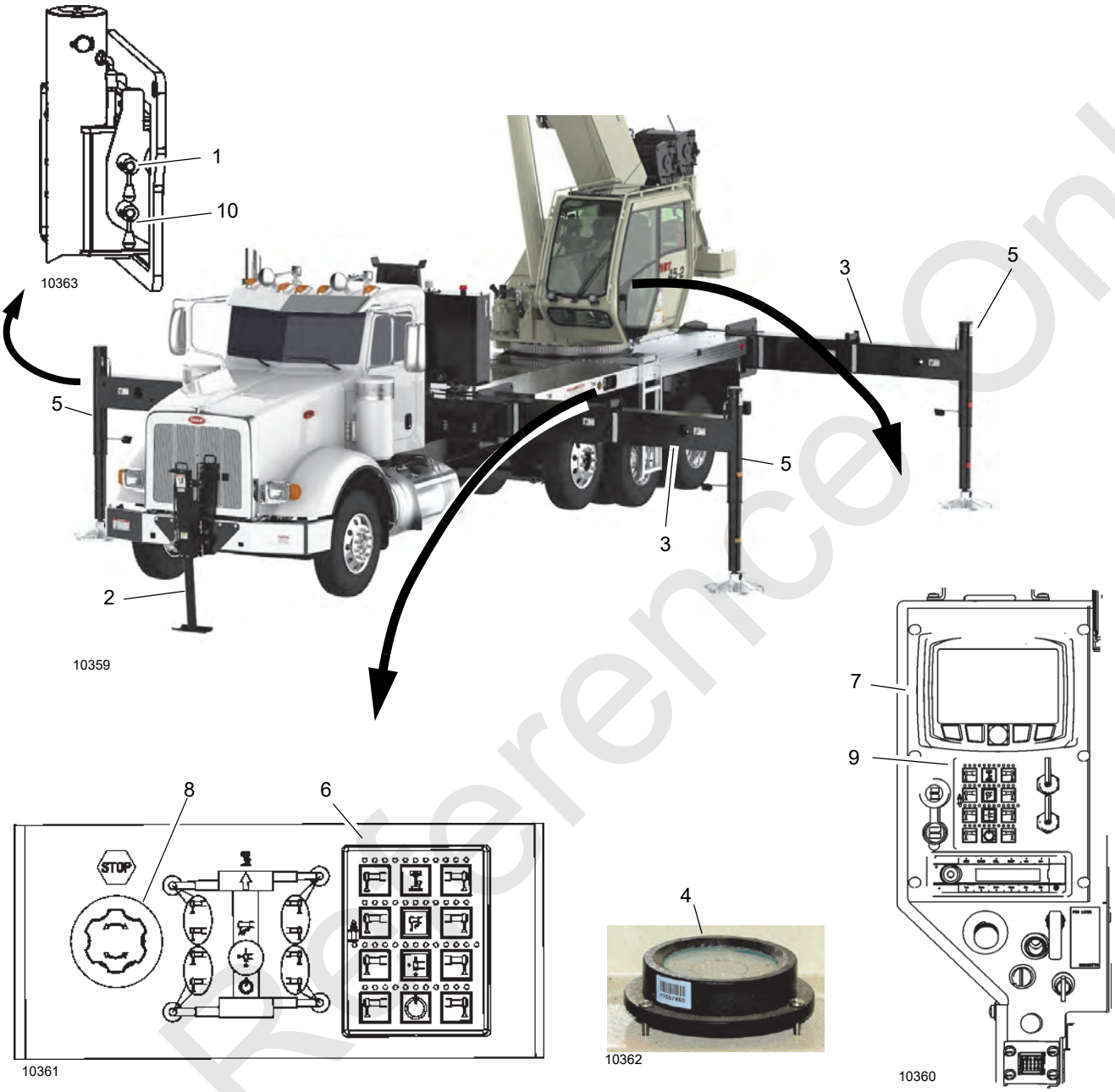
NOTE: The operator must be in the crane cab seat with left armrest lowered and crane power switch (Figure 3-4) ON for the crane cab outrigger controls to operate.

NOTE: To ensure a true reading always make sure the cab tilt is completely lowered.

Ground Station Outrigger Control Panels

The ground station control panels are located on the left (driver side) and right (passenger side) sides of the carrier decking (Figure 3-1). Each control station has control switches for extending and retracting the outrigger beams, for raising and lowering the outrigger jack cylinders and for raising and lowering the single front outrigger (SFO), if equipped. Each station contains a level indicator and an emergency stop switch.

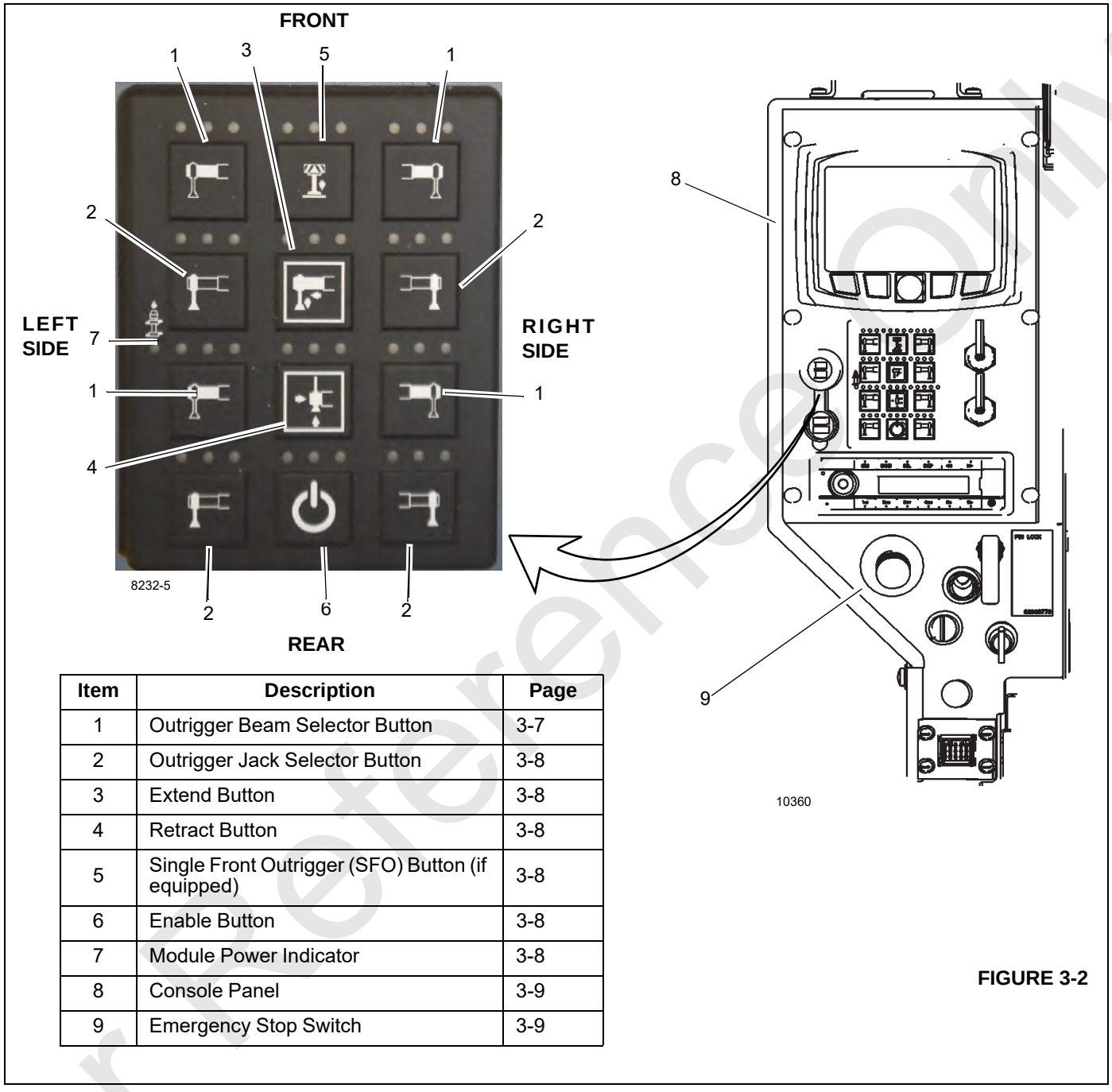
Outrigger beam functions can be controlled only from the side the ground station control panel is located.



Item	Description	Item	Description
1	Outrigger 50% (Midspan) Selector Pin	6	Ground Station Outrigger Controls
2	Single Front Outrigger	7	Console Panel
3	Outrigger Beam Assembly	8	Emergency Stop Switch
4	Level Indicator	9	Cab Outrigger Controls Panel
5	Outrigger Jack Cylinder	10	Outrigger 75% Selector Pin

FIGURE 3-1

CAB OUTRIGGER CONTROL



Item	Description	Page
1	Outrigger Beam Selector Button	3-7
2	Outrigger Jack Selector Button	3-8
3	Extend Button	3-8
4	Retract Button	3-8
5	Single Front Outrigger (SFO) Button (if equipped)	3-8
6	Enable Button	3-8
7	Module Power Indicator	3-8
8	Console Panel	3-9
9	Emergency Stop Switch	3-9

FIGURE 3-2

Outrigger Selector Buttons

There are four outrigger beam and four outrigger jack selector buttons located on each outrigger control panel (Figure 3-1 and Figure 3-2).

Pre-selection of a button or a combination of buttons (one or more beams or one or more jacks) may be selected within 5 seconds before pressing next function on cab outrigger control panel (Figure 3-3). The enable button activates the selected functions.

NOTE: A blue LED illuminates for 5 seconds indicating a button has been selected. A red LED illuminates if a button selection is unavailable.

NOTE: Extension beam and jack cannot be combined to operate simultaneously.

Enable Button

The enable button is located on the cab outrigger control panels (Figure 3-2) and is used in conjunction with pre-selection of outrigger selector switches to control the outrigger functions.

Pre-selection of a button or a combination of buttons (one or more beams or one or more jacks) may be selected within 5 seconds before pressing the enable button to activate all selected functions. A blue LED illuminates for 5 seconds, indicating the button has been selected. A red LED illuminates if a selection is unavailable.

Press the extend or retract button while holding the enable button to complete the operation.

NOTE: Extension beam and jack cannot be operated simultaneously.

Extend Button

The extend button is located on the outrigger control panel (3, Figure 3-2 and Figure 3-3) and is used in conjunction with the enable buttons to control both the outrigger beams or the jacks functions.

Retract Button

The retract button is located on the outrigger control panel (4, Figure 3-2 and Figure 3-3) and is used in conjunction with the enable buttons to control both the outrigger beams or the jacks functions.

LED Indicators

LED indicators display the status of the control button being selected (Figure 3-2) on the cab outrigger control panel. A blue LED will illuminate for 5 seconds after a button has been selected.

- Blue indicates active selection
- Green indicates pre-selection is enabled
- Red indicates inactive selection (For example: the operator is in the crane cab and the crane is in crane mode, and a ground station keypad is activated, the indicator will be red because the ground station keypad is inactive.)

Module Status

The module status indicator is located on all outrigger control panels and indicates the outrigger control station (Figure 3-2) is activated when a green LED illuminates. The control station cannot be activated if the crane is performing another function. (For example: operating the boom.)

Outrigger Beam Selector Button

The outrigger beam selector buttons (1, Figure 3-2 and Figure 3-3) are used to operate the front or rear outrigger beams. Both sides can be operated from the cab outrigger control panel.

NOTE: The following details apply to both ground station control panels as indicated.

The ground control outrigger beam selector buttons (Figure 3-1 and Figure 3-3) are used to operate the front or rear outrigger beam only on the side of the crane the ground control is located.

- The panel on the right side operates the outrigger beams for right side only.
- The panel on the left side operates the outrigger beams for left side only.

Outrigger Jack Selector Button

Use the outrigger jack selector buttons (2, Figure 3-2 and Figure 3-3) to indicate which jack you desire to operate.

Single Front Outrigger Button (SFO) - if equipped

The Single Front Outrigger (SFO) button is located on the outrigger control panel for the cab outrigger controls (Figure 3-2) and ground outrigger controls (Figure 3-1 and Figure 3-3). The SFO button is used to lower and raise the optional single front outrigger (if equipped). To operate the SFO, press the SFO button to activate and then press extend/retract button and the enable button. The SFO automatically retracts if any of the other jacks are adjusted and must be reset if lifting is to be continued. If not equipped with an SFO, the red LED is lit.

Rigging Wireless Remote Control (Optional)

The wireless rigging remote control (Figure 3-22) can be used to extend and retract the outriggers from outside of the crane. The remote control is stored in the operator cab. For more information, see “Rigging Remote Control (Optional)” on page 3-32.

Outrigger Selection Enable

After pushing the desired selector buttons, the enable button and either the extend or retract button energizes the control solenoid to allow hydraulic fluid to flow through the control solenoid valve and the individual solenoid valves and moves the selected component in the desired direction.

Emergency Stop Switch

There is an emergency stop switch (9, Figure 3-2 and Figure 3-3) located at each outrigger control on each side of the carrier (Figure 3-3) and inside the cab on the front console (Figure 3-2). Pressing an emergency stop switch shuts down the engine. If the emergency switch is pressed and the crane interlocks are engaged and the crane is powered from

the crane cab, the RCL will display which emergency switch was pressed.

NOTE: Use the emergency stop switch only in the case of an emergency to shut down the engine. Do not use the emergency stop switch regularly as a means of turning off the crane.

Crane Level Indicator

A bubble level indicator is located inside the cab near the right side armrest. This indicator provides the operator with a visual indication for determining how level the crane is when operating the outriggers. There are two additional level indicators located at each ground level control station.

NOTE: To ensure a true reading always make sure the cab tilt is completely lowered.

Ground Station Outrigger Control Panel

The following paragraphs describe the outrigger controls and indicators (Figure 3-3) found on the ground station outrigger control panels.

Outrigger Control Panel

There is one outrigger control panel on each side of the machine fender decking, as shown in Figure 3-3. The following details apply to both control panels as indicated.

- The panel on the right side operates the horizontal outrigger beams for that side only.
- The panel on the left side operates the horizontal outrigger beams for that side only.
- The vertical stabilizers (jacks) may be operated from the left or right side of the unit.
- Each control panel features a control switch for raising and lowering the single front outrigger (SFO).
- Each control panel features an emergency stop switch.

Outrigger Beam Selector Switch

The outrigger beam selector button (1, Figure 3-3) is used to operate the front or rear outrigger beam on the same side of the crane the ground control is located.

Jack Selector Button

Use the jack selector button (2, Figure 3-3) to indicate which jack you desire to operate.

Extend and Retract Buttons

The extend and retract buttons (3, 4, Figure 3-3) operate both the outrigger beams or the jacks.

After pushing the desired selector button, pushing the extend or retract button or the enable button energizes the control solenoid to allow hydraulic fluid to flow through the control solenoid valve and the individual solenoid valve and move the selected component in the desired direction.

Single Front Outrigger Button (SFO)

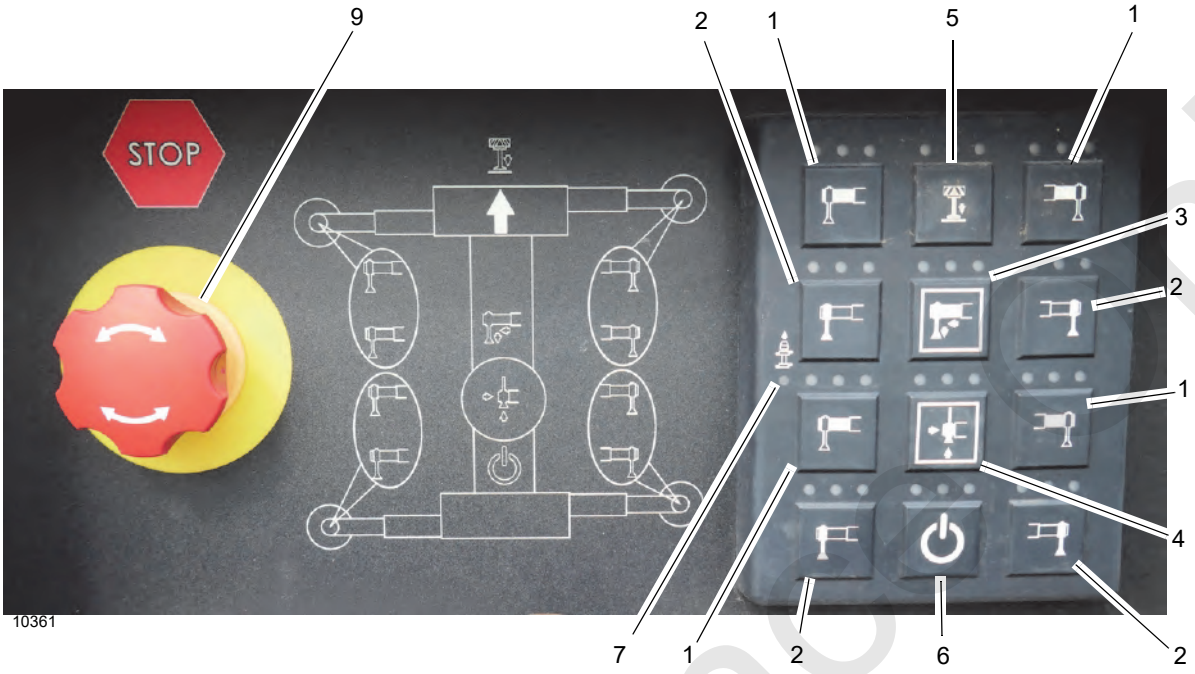
The single front outrigger (SFO) button (5, Figure 3-3) is located in the center of the of the top row of buttons of the ground station outrigger control panel. It must be used with the extend/retract button or enable button to control the operation of the SFO (if equipped). The SFO retracts automatically when any of the other four jacks are retracted; therefore, it must be reset if lifting is to be continued.

If not equipped with an SFO, the LED indicators above the SFO button illuminate red.

Emergency Stop Switch

There is an emergency stop switch (9, Figure 3-3) on the outrigger controls on each side of the carrier. Pressing either switch shuts down the engine. If the emergency switch is pressed and the crane interlocks are engaged and the crane is powered from the crane cab, the RCL will display which emergency switch was pressed.

NOTE: Use the emergency stop switch only in the case of an emergency to shut down the engine; do not use the emergency stop switch regularly as a means of turning off the machine.



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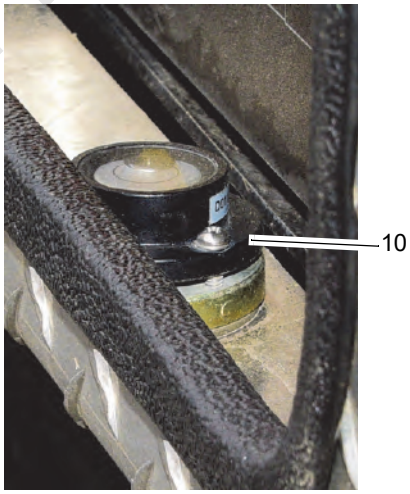
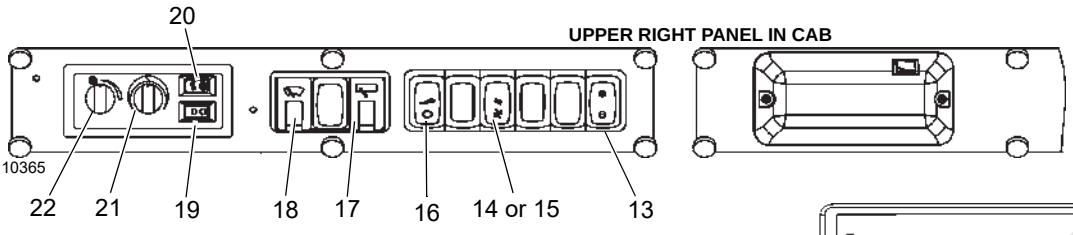
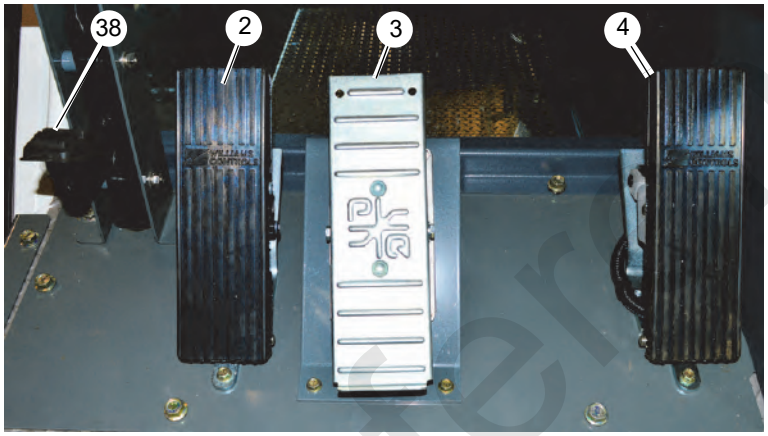


FIGURE 3-3

CRANE CONTROLS





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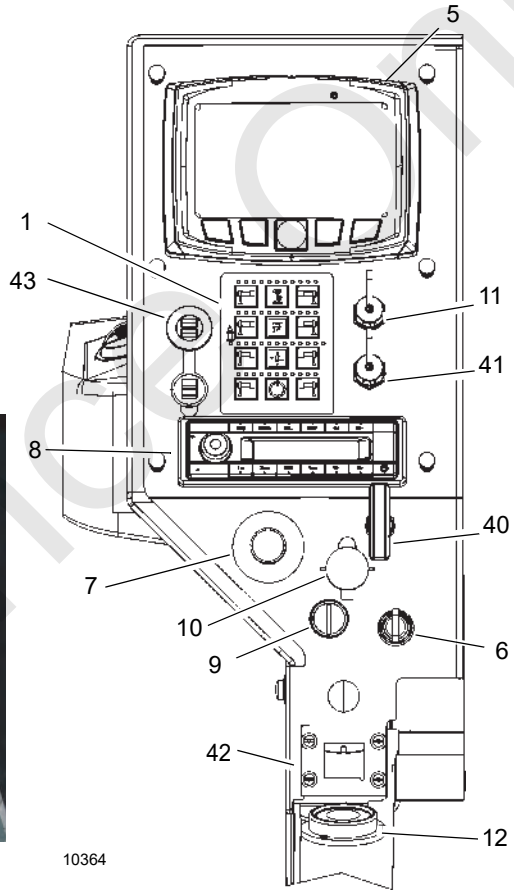

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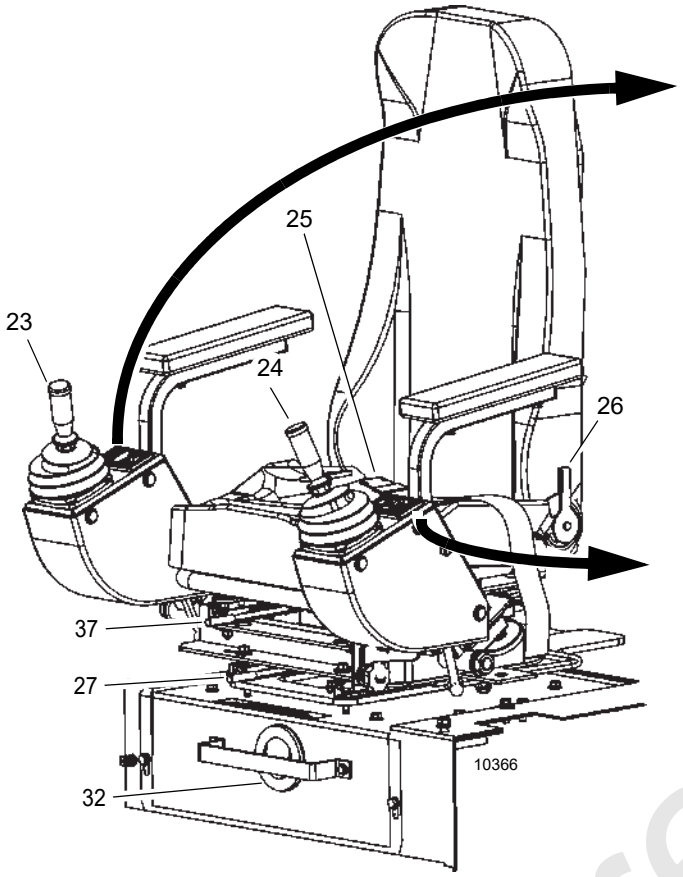
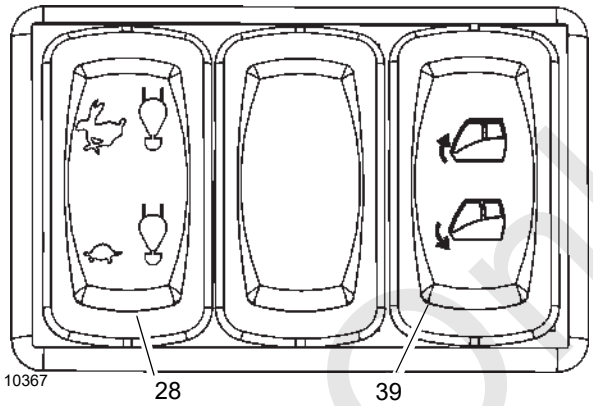
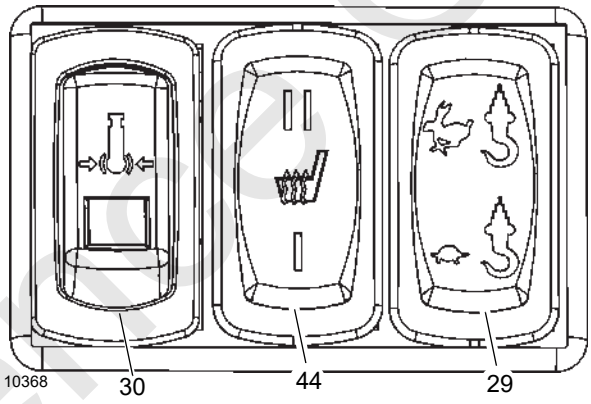
FIGURE 3-4







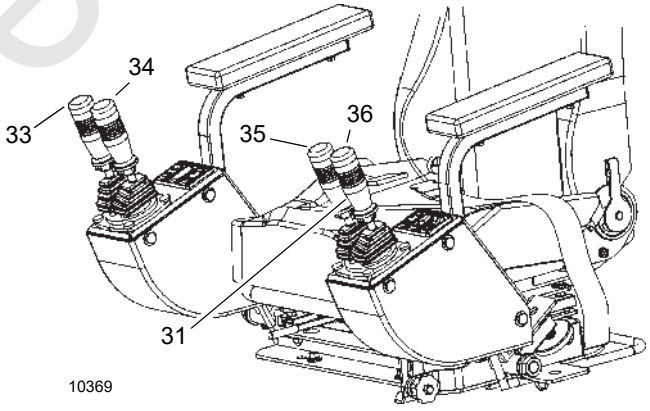


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FIGURE 3-4 continued

Swing Brake Pedal

CAUTION

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

The swing brake pedal (2, Figure 3-4) is located on the left side of the crane cab floor. Pressing the pedal down applies brake to the superstructure and prevents rotation. Releasing the pedal allows the superstructure to rotate freely.

Swing Brake Indicator

When the swing brake is locked, the swing brake indicator icon will be displayed on the crane cab RCL console display panel. For more information about the RCL icons, see Table 7-3 on page 7-4.

Swing Brake Control Switch

The swing brake control switch (30, Figure 3-4) is located on the left seat armrest and is a two position switch, press forward to lock the swing brake. When the swing brake is locked, the swing brake indicator icon will be displayed on the crane cab RCL console display panel. Press and slide the back half of the switch (1, Figure 3-5) to unlock the swing brake.

The back half of the switch (1, Figure 3-5) is designed with a locking mechanism to secure the swing brake in the locked position and prevent accidental movement of the cab and superstructure.

FIGURE 3-5

Horn Button

The horn button (31, Figure 3-4) is located on the cab seat left controller. The operator can use this horn to provide a warning that the superstructure is rotating.

House Lock

The house lock (40, Figure 3-4) is used to lock the superstructure from rotating when the boom is over the front or over the rear of the crane. It consists of a push-pull handle on the console and house lock control pin. The house lock should be engaged during transport.

360° Positive Swing Lock (Optional)

If installed, the 360° swing brake pedal (38, Figure 3-4) is located on the far left side of the crane cab floor. The pedal is used to activate the swing lock assembly to prevent the superstructure from turning at any position. Pressing the pedal down applies brake to the superstructure and prevents rotation. Releasing the pedal allows the superstructure to rotate freely.

House Lock Control (Pin Type)

The house lock control cable handle is located on the console of the cab (1, Figure 3-6). The purpose of the house lock is to lock the superstructure in position directly over the front or rear of the crane. With the superstructure positioned directly over the front and placed in the boom rest, push the control handle down and turn handle clockwise. The house lock pin (2, Figure 3-6), located near the cab, will drop into a socket on the carrier frame, locking the superstructure in place (3, Figure 3-6). When the control handle is turned counterclockwise and pulled up, the pin is pulled out of the socket, unlocking the superstructure. Turn the handle on the cable clockwise to secure the superstructure in the unlocked position.

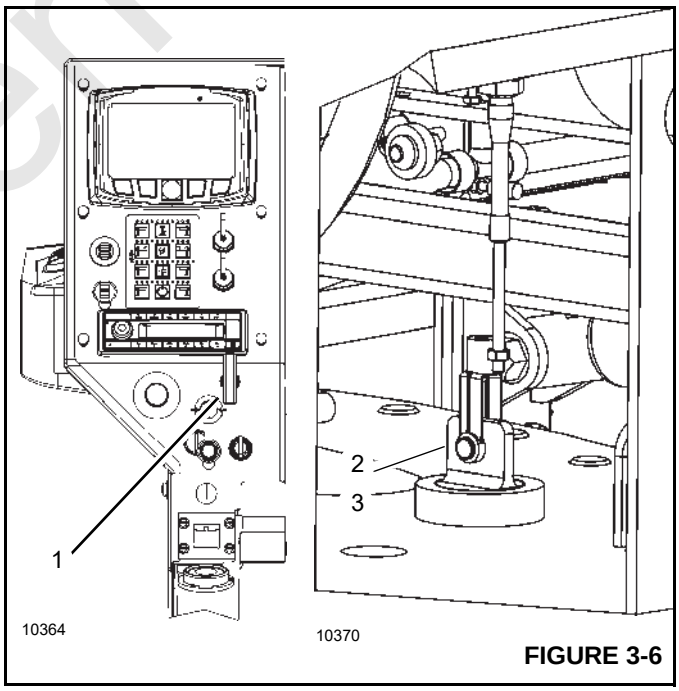

FIGURE 3-6

Boom Telescope Pedal (Standard with Aux Hoist)

The crane is equipped with the boom telescope pedal only when the auxiliary hoist option is included. The telescope foot pedal (3, Figure 3-4) is located on the crane cab floor and is used to extend and retract the boom. Pushing down at

the top of the pedal extends the boom out; pushing down at the bottom of the pedal telescopes the boom in.

Foot Throttle Pedal

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

AM/FM/Bluetooth Radio and Speakers

The AM/FM/Bluetooth radio (8, Figure 3-4) is located on the operator console. For more information about the radio features, see the radio operator manual.

The stereo speakers (1, Figure 3-7) are located behind the operator seat.

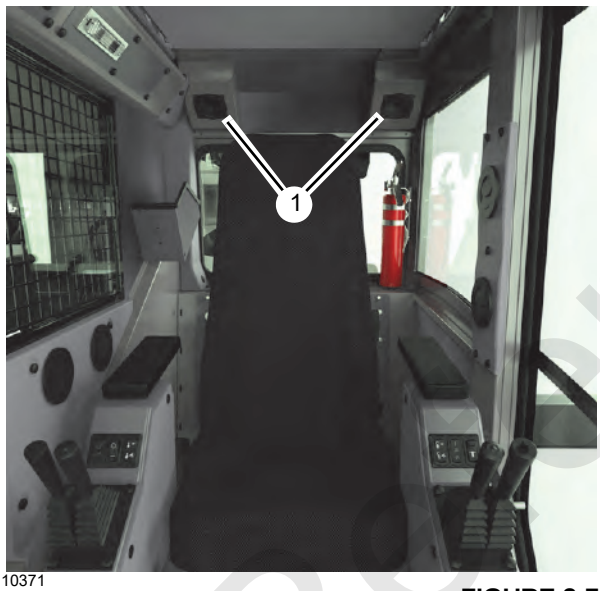

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FIGURE 3-7

RCL Display

The display (5, Figure 3-4) is for the Rated Capacity Limiter (RCL). For more information, see “Rated Capacity Limiter” on page 7-1.

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

The RCL continuously monitors these parameters and provides the operator with an updated readout of the crane status. If a rated capacity condition is violated, the RCL warns the operator with an alarm and locks out the crane functions.

DANGER

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

RCL Override Switches

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 serious injury to personnel and/or damage to equipment and property.

There are two RCL Override Switches located in the crane cab.

The switch located on the front control panel is a momentary type switch (6, Figure 3-4). Turn the key to the On position (right) to temporarily override RCL restrictions. Releasing the key allows the RCL restrictions to be engaged.

The RCL bypass switch (1, Figure 3-8) located behind the cab seat is an off/on switch and overrides the RCL and crane control lockouts until the switch is turned to the OFF position. The RCL bypass switch (1) is not a momentary switch and remains engaged until turned OFF.

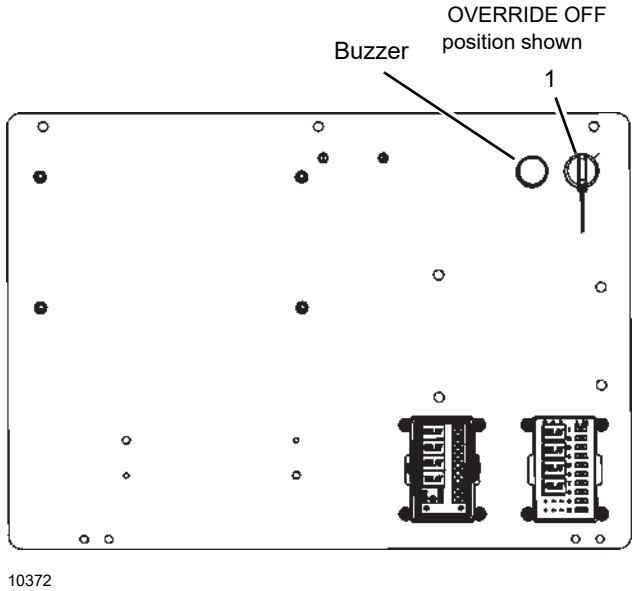


FIGURE 3-8

The RCL is bypassed only as long as the switches are in the ON position. When overridden, warning icons appear on the RCL display. For more information, see “About the RCL and ATB Override Warnings” on page 7-6.

When an overload condition is reached, certain controls are automatically disabled. Turning the key switch to the ON position re-engages the boom down, telescope out and hoist up controls. These functions were disabled when an overload condition was sensed by the RCL. It is important to read and understand the RCL Override information before using the RCL override on/off switch. For information concerning the operation and maintenance of the RCL system, see Section 7 - Rated Capacity Limiter in this manual.

Emergency Stop Switch

The crane emergency stop switch (7, Figure 3-4) is located on the cab console and is used to shut down the truck engine in an emergency. Push the red button in to shut down the engine, rotate the knob and pull out to resume normal operation.

NOTE: Use only the emergency stop switch in the case of an emergency to shut down the engine. Do not use the emergency stop switch regularly as a means of turning off the machine.

Emergency stop switches are available on the ground station outrigger control panels on the sides of the crane, For more information, see “Ground Station Outrigger Control Panels” on page 3-5. Emergency stop switches are also available on the optional remote controls. For more information, see “Rigging Remote Control (Optional)” on page 3-32 and “Crane Remote Control (Optional)” on page 3-35.

AC/Heater Vents

The cab features six air conditioner and heating vents located on the control panel, side panels, and under the seat.

Crane Ignition Switch

The crane ignition switch (9, Figure 3-4) is located on the crane cab console and controls the truck engine and crane cab power. The ignition switch has four positions:

- OFF shuts down engine and cab power
- ON activates truck engine ignition and all cab power
- Start is truck engine start
- Accessory position

NOTE: The crane cab keyswitch has power only when the truck keyswitch is OFF.

For more information about the ignition states, see *Crane Ignition and Control States*, page 3-3.

12V Receptacle

This 12 volt accessory outlet (10, Figure 3-4) is located on the lower part of the front control panel and is designed to mate with most 12 volt adapter plugs.

Diagnostic Connector (USB-B)

The Diagnostic USB Port (11, Figure 3-4) is located on the front control panel. Use this port to download software and diagnostic troubleshooting. It is used for servicing the RCL system.

A laptop computer with a USB connector and the appropriate electrical system software is required. Contact National Product Support to obtain the appropriate diagnostic cables.

Crane Diagnostic Connector

The crane diagnostic connector (42, Figure 3-4) is located on the lower part of the front control panel. It is used for servicing the Crane Control System (CCS) RCL control module.

A laptop computer with a USB connection, CAN bus grid connect tool, adapter diagnostic cable, and the appropriate software are required. Contact National Product Support to obtain the appropriate diagnostic cable.

Diagnostic Connector—Display USB-A Port

The display USB-A port (41, Figure 3-4) located on front control panel is used to install and update RCL display software and display diagnostics.

USB-A Power Port

The standard USB-A power port (43, Figure 3-4) is located on the front operator console. Use this port to charge a compatible USB cable and device.

Level Indicator

The bubble level indicator (12, Figure 3-4) is located near the right interior wall of the cab. The indicator provides the operator with a visual indication for determining the levelness of the machine.

NOTE: To ensure a true reading always make sure the cab tilt is completely lowered.

Engine Hi/Low Switch

The truck engine Hi/Low Switch (13, Figure 3-4) is located on the right overhead console.

It is a two position (+/-) momentary switch that is a secondary throttle control which provides idle-control inputs that increase and decrease the truck engine idle.

This is an increment/decrement style switch, press and release the (+) or (-) side of the switch to increase or decrease idle speed incrementally.

Press and hold the switch in either the Hi or Low direction and the engine will ramp to maximum RPM or minimum RPM.

Press and hold the minus (-) position at idle for five seconds to shut off the truck engine.

Crane Function Power Switch

The crane function power switch (14, Figure 3-4) is located on the right overhead console. The switch has two positions: OFF disables joystick controllers and the swing brake switch (assuring the brake stays locked). The OFF position prevents inadvertent operation of these functions and assures the swing brake is set when the crane is not powered. The ON position restores power to the joystick controllers and the swing brake.

Remote Power Switch (Optional)

The radio remote switch (15, Figure 3-4) is used to enable the radio remote controls. The truck ignition must be OFF before the crane can be operated with a radio remote control. The crane ignition switch must be in the ON position.

Work Light Switch

The work light switch (16, Figure 3-4) is a two position rocker switch, ON and OFF, located on the right overhead console. It turns the cab outside working lights on or off.

Skylight Wiper Switch

The skylight wiper switch (17, Figure 3-4) is located in the overhead console. This is a Hi/Low toggle type switch with 6 intermittent positions, intermittent timing is 2-15 seconds, wiper washer timing is 3 seconds.

Windshield Wiper/Washer Switch

The windshield wiper/washer switch (18, Figure 3-4) is located in the overhead console. This is a Hi/Low, rocker/toggle switch with 6 intermittent speed positions, ranging from 2 to 15 seconds and 2 constant low high speeds. The wiper/washer timing is 3 seconds.

The windshield wiper fluid must be replenished periodically. For more information about the windshield wiper fluid reservoir, see “Windshield Wiper Fluid Reservoir” on page 3-19.

Air Conditioning/Heater Controls

The air recirculation on/off switch (19, Figure 3-4) selects recirculated or fresh air.

Function switch (20, Figure 3-4) allows operator to select either the heater or air conditioner.

Temperature control (21, Figure 3-4) controls the temperature for both the heater and air conditioner.

Fan speed control (22, Figure 3-4) controls the fan for both heater and air conditioner.

Single Axis Controller (Boom Lift/Hoist Rope) (Optional)

The boom lift control level (33, Figure 3-4) and the main hoist control lever (34, Figure 3-4) are located on the right armrest.

Push the boom lift lever (33) forward to lower the boom, pull back to raise the boom.

Push the main hoist lever (34) forward to pay out loadline, pull the lever back to pay in loadline.

Single Axis Controller (Swing/Boom Tele)

CAUTION

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

The swing control lever (36, Figure 3-4) and the telescope or auxiliary hoist control lever (35, Figure 3-4) are located on the left armrest.

Push the swing lever (36) forward to rotate the superstructure clockwise, pull the swing lever back to rotate the superstructure counterclockwise. If the swing lever is actuated in a direction opposing the active direction of movement, the swing brake is applied proportionally to the position of the controller until the rotation comes to rest. At this point, hydraulic torque is applied in the direction of swing input.

Push the telescope lever (35) forward to extend the boom, pull the lever back to retract the boom. If equipped with an auxiliary hoist, this lever (35) operates the auxiliary hoist lever and the telescope pedal (3, Figure 3-4) controls the boom telescoping function.

Dual Axis Controller (Boom Lift/Main Hoist)

The boom lift and main hoist (lift/main) control lever (23, Figure 3-4) is located on the right armrest.

The lever when positioned to the left raises the boom. Positioning the lever to the right lowers the boom.

Pushing the lever forward will pay out the hoist rope and pulling the lever back pays in the rope.

Moving the lever in a diagonal direction actuates the two functions simultaneously.

Dual Axis Controller (Swing/Tele/Aux Hoist) (Optional)

CAUTION

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

The swing and telescope or auxiliary hoist (swing/tele or swing/aux) control lever (24, Figure 3-4) is located on the end of the left armrest.

The lever controls the swing and telescope functions when the crane is <u>not</u> equipped with an auxiliary hoist. When equipped with an auxiliary hoist, the lever controls swing and auxiliary hoist functions and telescope functions are controlled through a foot pedal (3, Figure 3-4).

Swing/Telescope — Move the lever left to swing left (counterclockwise). Move the lever right to swing right (clockwise). Positioning the lever forward telescopes the boom out and pulling the lever back telescopes the boom in. If the swing lever is actuated in a direction opposing the direction of movement, the swing brake is applied proportionally to the position of the controller until the rotation comes to rest. At this point, hydraulic torque is applied in the direction of swing input.

Swing/Auxiliary Hoist — If equipped with an auxiliary hoist, positioning the lever forward lets out hoist rope. Pulling the lever back reels the rope in. Moving the lever in a diagonal direction actuates the two functions simultaneously.

Seat Back Adjustment

To adjust the back of the seat pull the adjustment knob (26, Figure 3-4) and then adjust the seat as needed.

Seat/Controls Assembly Slide Adjustment Lever

Moving the seat/controls assembly slide adjustment lever (27, Figure 3-4) slides the seat/controls assembly either forward or backward.

Seat Slide Adjustment Lever

Moving the seat slide adjustment lever (37, Figure 3-4) slides the seat (only) either forward or backward.

Operator Seat Heater

The crane features a heated operator seat in the crane cab. The switch to activate the heated seat is located on the armrest controls (44, Figure 3-4). The switch features two heat settings. The light on the switch illuminates when the seat heater is active.

Main Hoist Speed

The main hoist speed selector switch (28, Figure 3-4) is located on the right seat armrest. It is a three position switch (HI-OFF-LOW), designated as rabbit (fast) hoist motor speed and turtle (slow) hoist motor speed. The center switch position turns off the hoist functions.The main hoist speed symbol appears on the RCL display. For more information about the Hoist Rotation Indicator (HRI) icons visible on the RCL display screen, see Table 7-3 on page 7-4.

Auxiliary Hoist Speed

If equipped, the auxiliary hoist speed selector switch (29, Figure 3-4) is located on the left seat armrest. It is a three position switch (HI-OFF-LOW), designated as rabbit (fast) hoist motor speed and turtle (slow) hoist motor speed. The center switch position turns off the hoist functions. The auxiliary hoist speed appears on the RCL display. For more information, see Table 7-3 on page 7-4.

Hoist Rotation Indicator (HRI) System

The following sections describe the HRI system. For information about the HRI icons visible on the RCL display screen, see Table 7-3 on page 7-4.

Hoist Rotation Indicator (HRI) Display

The HRI information appears on the operating screen of the RCL display. The icon indicates the current hoist in operation and which direction the hoist is rotating. For information about the HRI icons visible on the RCL display screen, see Table 7-3 on page 7-4.

Hoist Rotation Indicators (HRI)

The Hoist Rotation Indicators for the auxiliary and main hoist are located on top of each hoist control lever. Each indicator is electronically driven by an input signal from a sensor attached to its related hoist and an output signal from a control module. Each hoist control lever pulses when its hoist is running so the operator's thumb can sense it.

3rd Wrap Indicator

The 3rd wrap indicator (sometimes called the *minimum wrap indicator*) notifies the operator when there are three wraps of hoist wire rope left on the hoist drum. The 3rd wrap indicator sensor is located on the left (driver) side of the main and auxiliary hoists as installed. Each hoist is equipped with a tapered roller. When the 3rd (minimum) wrap of the last layer is reached, the 3rd wrap indicator sensor is activated and an icon on the RCL display will show solid. This feature can be turned off, only give the operator a visual icon and an auditory alarm, or lockout the hoist down function including the visual icon and auditory alarm.

The 3rd wrap indicator icon appears on the RCL display. For more information about the icon, see Table 7-3 on page 7-4.

Cab Tilt Switch

The cab tilt switch button (39, Figure 3-4) is located on the right seat armrest. It is a three position, momentary spring centered rocker switch. It has three positions, up, and down and at rest, allowing the cab to be tilted either up or down.

NOTE: The cab tilt feature and the cab must be completely down before travel.

Adjustable Swing Speed Valve

The crane is equipped with an adjustable swing speed valve (1, Figure 3-9) that sets the maximum swing speed of the machine. Turn the valve knob clockwise to increase and counterclockwise to decrease speed. Increasing the speed decreases the ability to free swing. If free swing functionality is necessary, a compromise between speed and free swing is required.

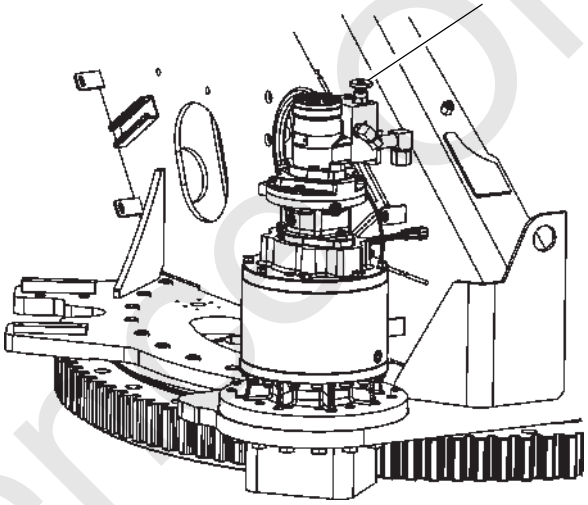


FIGURE 3-9

HEATER

The diesel powered supplemental heater (1, Figure 3-10) is located inside the superstructure frame. The heater controls the temperature of the crane cab by cycling coolant between the heater and the cab blower box located in the cab. Controls (20, 21, 22, Figure 3-4) for the heater are located on the overhead control panel in the crane cab.

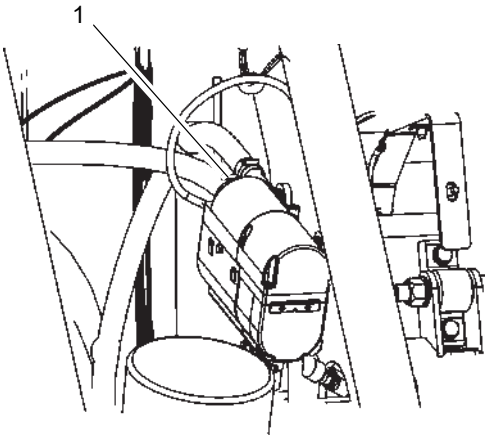


FIGURE 3-10

WARNING

Explosion Hazard!
Do not mix gasoline with diesel fuel. Death or serious injury can occur due to explosion.

Heater Cold Weather Fuel Mixture

At temperatures below 20°F (-7°C), add a cold weather additive or mix kerosene with the diesel fuel at a 50/50 ratio. Add the mixture to the heater diesel fuel tank (1, Figure 3-11).

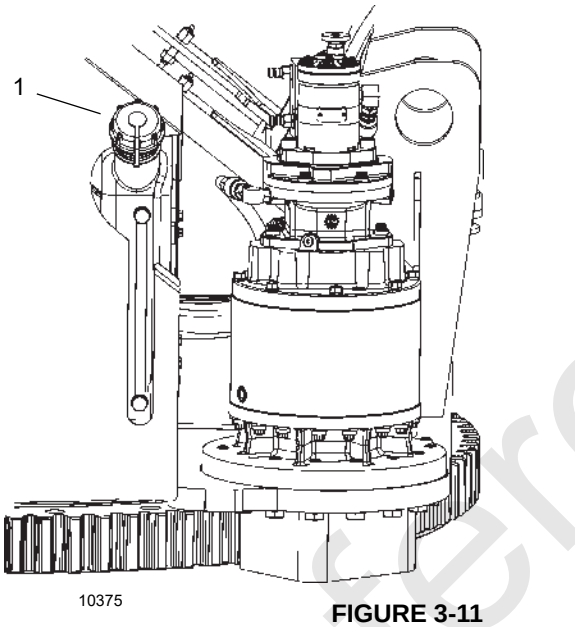


FIGURE 3-11

Heater Coolant

The heater coolant bottle (1, Figure 3-12) is mounted to the air conditioner. The coolant should contain a minimum 50/50 ratio mixture of water and antifreeze to prevent freezing or slushing.

FIGURE 3-12

Hydraulic Pump Suction Inlet Valve

The hydraulic pump inlet (1, Figure 3-13) is located on the front of the hydraulic tank.

To open the valve, turn the handle in the direction of flow. (2).

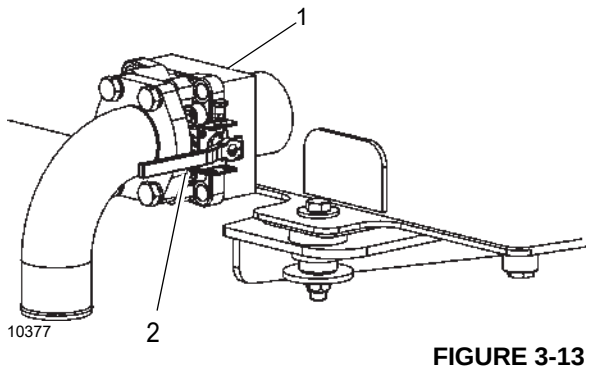


FIGURE 3-13

Windshield Wiper Fluid Reservoir

The windshield wiper fluid reservoir (1, Figure 3-14) is located behind the operator cab. Re-fill as needed.

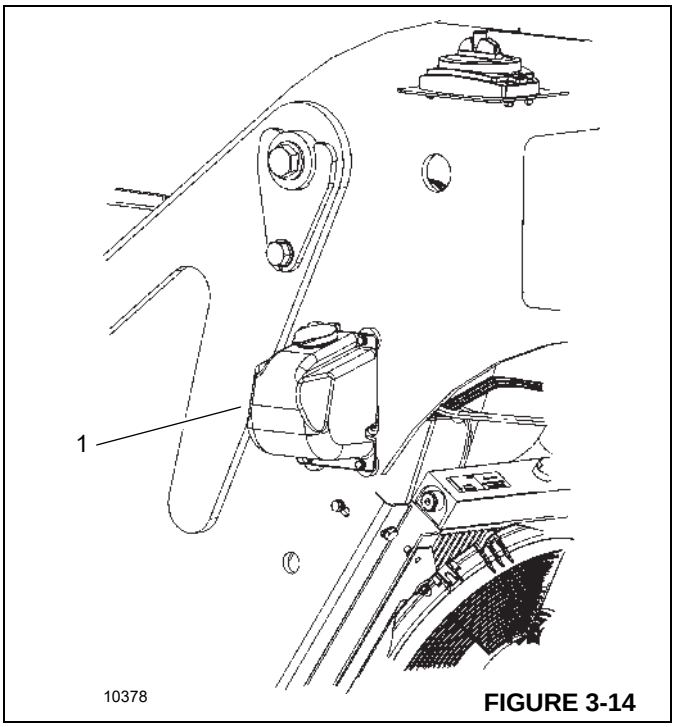


FIGURE 3-14

OPERATING PROCEDURES

You need to be familiar with the safety precautions outlined in the section titled *Safety Precautions*, page 2-1 before operating the crane.

Equipment Familiarization

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

Crane Cab Access

To enter the crane cab use the ladder (3, Figure 3-15) stowed next to the cab on the carrier decking and position it as shown in Figure 3-15. The ladder is secured in position with catches (4). After opening the cab door, climb the ladder and at the same time grasp the grab handles (2) in the cab doorway to enter the cab. Do not try to access the crane cab by other means. When done, release the ladder using release handle (5) and lift and rotate to the stowed position.

Deploying the Cab Ladder

1. Remove the ladder pin (1).
2. Lift and swing the ladder (3) to the vertical position over the edge of the deck.
3. Secure the ladder on the ladder catches (4) on the side of the decking.

CAUTION

To avoid damage to the ladder, ensure the ladder is in the deployed position before operating the crane.

Accessing the Cab

After opening the cab door, climb the ladder and at the same time grasp the grab handles (2) in the cab doorway to enter the cab. Do not try to access the crane cab by other means.

Stowing the Cab Ladder

1. Release the ladder (3) from the ladder catches (4) using the release handle (5).
2. Rotate the ladder (3) up to the decking.
3. Secure the ladder (3) with the ladder pin (1).

FIGURE 3-15

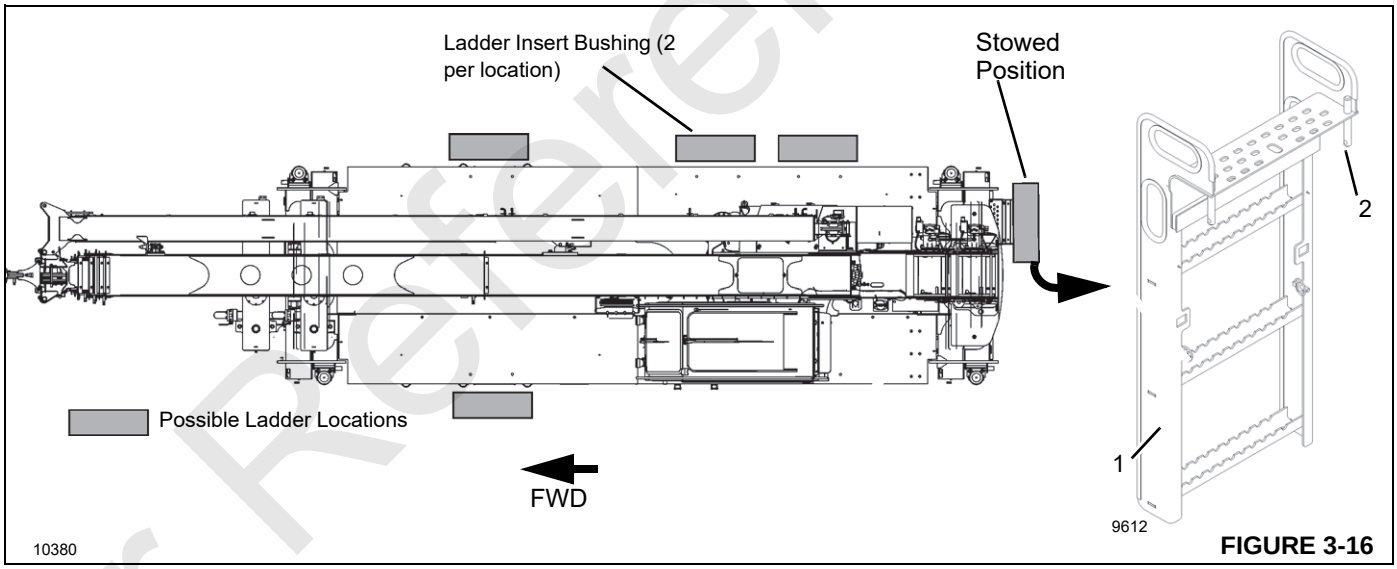


FIGURE 3-16

Using the Movable Ladder to Access Decking

Use the movable ladder (1, Figure 3-16) stowed on the right (passenger) rear bumper to access different areas of the decking. In the stowed position, use the ladder to access to the rear of the crane and the hydraulic tank and hoist area of the superstructure.

The movable ladder (1) can also be used to access different locations on the decking from the right and left sides of the crane. Figure 3-16 shows the possible locations. The ladder must be stowed in the rear bumper position and secured to the bumper with linch pins prior to transport.

CAUTION

Failure to stow and secure the movable ladder with linch pins prior to transport can result in damage to the ladder.

Removing the Ladder from Stowed Position

To remove the ladder (1) from the stowed position:

1. Remove the linch pins (1, Figure 3-17) from brackets (2).

NOTE: The ladder weighs approximately 11 kg (24.3 lbs).

2. Using the handles, lift the ladder so the ladder pins (2, Figure 3-16) are removed from the holes in the rear bumper.

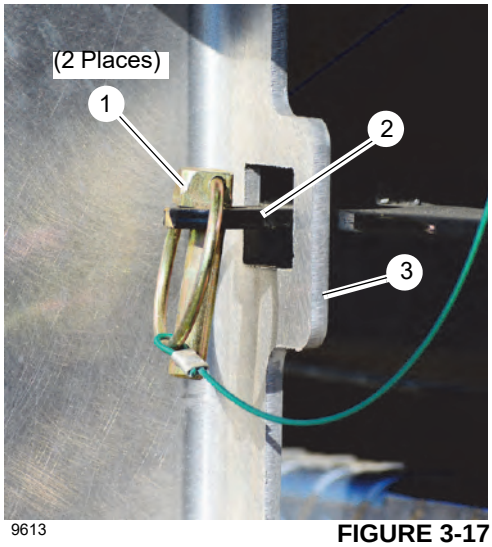


FIGURE 3-17

Installing the Ladder in Decking

To install the ladder in the decking:

1. Select the location to install the ladder. See Figure 3-16 for locations.

NOTE: The ladder weighs approximately 11 kg (24.3 lbs).

2. Using the handles, lift the ladder over the decking so the ladder pins (2) can be inserted in deck bushings.
3. Insert the ladder pins (2) in the bushings in the deck. Be sure the ladder pins are inserted securely in the bushings before using the ladder.

Stowing the Ladder on Rear Bumper for Transport

To stow the ladder (1, Figure 3-16) in rear bumper stowage location for transport:

NOTE: The ladder weighs approximately 11 kg (24.3 lbs).

1. Lift and remove the ladder pins (2, Figure 3-16) from the bushings in the deck.
2. Lift the ladder and install the ladder pins (2) in the bushings in the top of the rear bumper.
3. Install the linch pins (1, Figure 3-17) in the brackets (2) to secure the ladder (3) to the rear bumper.

Accessing the Boom and Hoists

DANGER

FALLING HAZARD

Death or serious injury may result from falling from an elevated height.

Use proper fall protection as required by local, state or federal regulations and maintain three points of contact when working at elevated locations.

DANGER

ENTANGLEMENT HAZARD

Death or serious injury may result if entanglement occurs during hoist operation.

Keep all body parts, safety harness, and loose clothing clear while hoist is running.

Use the ladder (1, Figure 3-18) to access the top of the superstructure, including the boom and main and auxiliary hoists. The ladder is located on the left side of the crane superstructure. Connect a safety harness to the connection point (2). Use the ladder grab handles when using the steps.

The linch pin (3) must be secured when using the ladder and during travel.

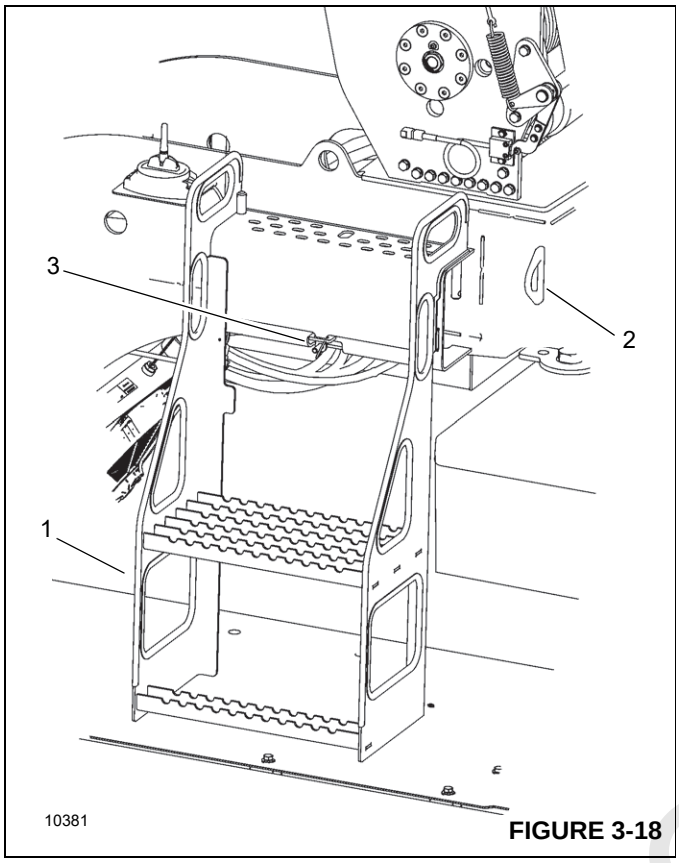


FIGURE 3-18

Equipment Checks

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

- For any unusual conditions such as pools of hydraulic fluid or lubricating oil under the chassis, any outrigger which may have crept down or up and any signs of damage or improper maintenance.
- The tires are inflated to the proper pressure.
- The level of the hydraulic reservoir oil.
- The operation of the “E-stop” and horn circuits.
- For missing and loose bolts.
- For damaged structural members and welds.
- All rope guides and rope keepers.
- All sheaves for free turning.
- The hoist rope for kinks, broken strands or other damage in accordance with instructions under the section *Hoist Rope Inspection And Maintenance*, page 6-3.
- To see that the hydraulic hoses and fittings are in good condition and show no signs of leaking. The hoses should be free from cuts and abrasions and there should be no evidence of binding. Any damage or leakage should be repaired immediately.
- The RCL and anti-two-block system for proper operation.
- The electrical wiring connecting the various parts of the system for physical damage.

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

For a complete list of inspections, see “Crane Inspection And Maintenance” on page 6-1.

Cold Weather Operation

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

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

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

Operation Below -40°C

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

CRANE WARM-UP PROCEDURES

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

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

Before starting the crane, ensure the appropriate lubricants are used to provide lubrication for the prevailing ambient temperatures in which the crane will operate in (a list of lubricants and their temperature ranges can be found in the

Lubrication section of your crane's *Operator Manual*, by contacting your local National Crane distributor, or by contacting National Product Support directly).

CAUTION

Crane Damage Hazard!

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

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

Engine

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

Warm-up Procedures for All Temperature Ranges:

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

Transmission

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

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

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

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 3-24).
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 (controller position) until the fluid reaches at least 10°C (50°F). It is then recommended that all crane functions be cycled to remove cold fluid from all components and cylinders of the hydraulic system. If there is any unusual sound coming from the crane's hydraulic pumps or motors, stop the operation and engine immediately and contact a National Crane 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 (controller position) until the fluid reaches at least 10°C (50°F).

- **From 95°C to 10°C (200°F to 50°F):** Crane operation with a load is allowed with no restrictions.
- **Above 95°C (200°F):** No crane operation is allowed. Let the crane's hydraulic oil cool by running the engine at idle with no functions actuated.

Anti-two Block Check

DANGER

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

Check the anti-two block (A2B) 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, do one of the following:

- manually lift the weight.
- slowly raise the hoist rope.
- slowly extend (telescope) the boom.
- with the load block close to the A2B switch weight and the boom at 70° boom angle, slowly lower the boom.

DANGER

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

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

RCL Check

Perform the following checks to verify proper RCL operation.

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

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

DANGER

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

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 wire 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 grade or locations with overhead obstructions.
- The outrigger jacks must be supported on a firm level surface at the fully retracted, mid-span, three-quarter, or fully extended positions.
- Avoid overhead power lines.

Before Leaving the Truck Cab

- Position the truck so that the outriggers can be extended with no obstructions.
- Position the truck transmission to one of the following:
  - Park if available (common on automatic transmissions). Otherwise,

- Neutral (common for manual and automated manual transmissions).

- Set the truck park brake. Wheel chocks may also be required.
- Engage the power takeoff.
- Turn the truck cab ignition switch to OFF.

DANGER

Truck must be in neutral with the park brake set before starting engine from crane cab to avoid sudden potential movement of truck.

Stowing and Parking

WARNING

Tipping Hazard!

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

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

When parking the crane, it should be placed in the smallest, most stable operational configuration that the job site practically allows by doing the following steps:

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

CAUTION

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

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

Unattended Crane

WARNING

Tipping Hazard!

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

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

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

Before Making the Lift

- Set the outriggers as described in the section titled *Outrigger Setup*, page 4-1.
- Program the RCL. For more information, see “RCL Setup” on page 7-7.
- Check all controls for proper operation. If any abnormal operations are detected, the condition must be corrected before continuing.
- Check the work area for electric power lines.

LOAD CHART

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

the crane cab. Make sure the load, the working area, and the crane configuration are within the load limit specified in the load chart.

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

Using the Load Chart

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

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

- **Load Radius** — The horizontal distance from the centerline of rotation to the center of the vertical load line or block.
- **Loaded Boom Angle** — The loaded boom angle is the angle between the boom's base section and the horizontal plane parallel to the ground. The loaded boom angle combined with the boom length calculates the operating radius.
- **Working Area** — The area measured in a circular arc above the center line of rotation to the suspended load.
- **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 3-20) 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 load line 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 several parts, which include various outrigger configurations for retracted span, partial span(s), and fully extended span, and over rear operation. 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.

NOTE: The range diagram and hoist data chart shown in this manual are examples only. See the load charts attached to the crane for actual values.

- The load chart 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 3-20) shows the operating radius and the height from horizontal of the unloaded boom.
- The hoist data chart (Figure 3-21) 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 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 the 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, find the load planned to be lifted and find the shortest boom length required to lift the load at the radius to which the vehicle can get. 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.
2. Program the RCL. For more information, see “RCL Setup” on page 7-7. 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. Use light variable movements of the controls when moving the load to avoid sudden stops.
5. Retract and lower the boom after the lift is complete.

SHUT DOWN AND PREPARATION FOR ROAD TRAVEL

CAUTION

Disengage PTO for travel, including within a job site.

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

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

CAUTION

Machine Damage Hazard!

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

Fully retract the outrigger jacks and properly store the pads.

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

WARNING

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

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

2. Ensure sheave mast assembly, if so equipped, is properly stowed.
3. If equipped, remove and stow the anemometer assembly. For more information, see “Wind Speed Indicator (Optional)” on page 3-37.

WARNING

Do not travel with mast assembly extended to prevent damage to equipment.

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

4. Retract and place the boom in boom rest.
5. Engage the swing brake.
6. Engage the house lock.
7. Lower the cab tilt completely down.
8. Ensure the hoist access ladder is properly stowed and secured or removed from equipment.
9. Secure the hook block/downhaul weight and A2B weight:

- 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 and stowed securely before traveling. If the hook block or downhaul weight remains reeved on the boom, it must be secured at the tie down on the carrier provided for that purpose.
  - Slowly hoist up until there is a slight tension on the hoist rope. It may be necessary to override the A2B function to tension the rope.
  - 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 positions during travel.

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

10. Ensure the Single Front Outrigger is fully retracted, if equipped.

11. Ensure the outrigger beams and jacks are fully retracted.

12. Engage the mechanical travel lock at each outrigger beam if equipped.

13. Remove the jack pads and place on the stowage brackets.

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

15. Close and/or secure all windows.

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

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

18. Ensure tires are properly inflated.

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

20. Release the park brake before moving truck.

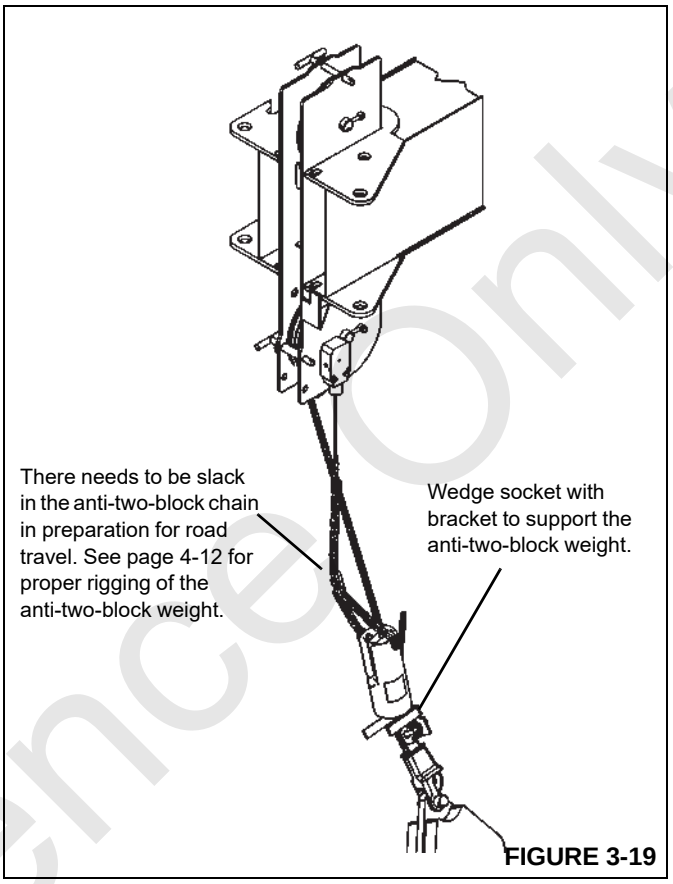
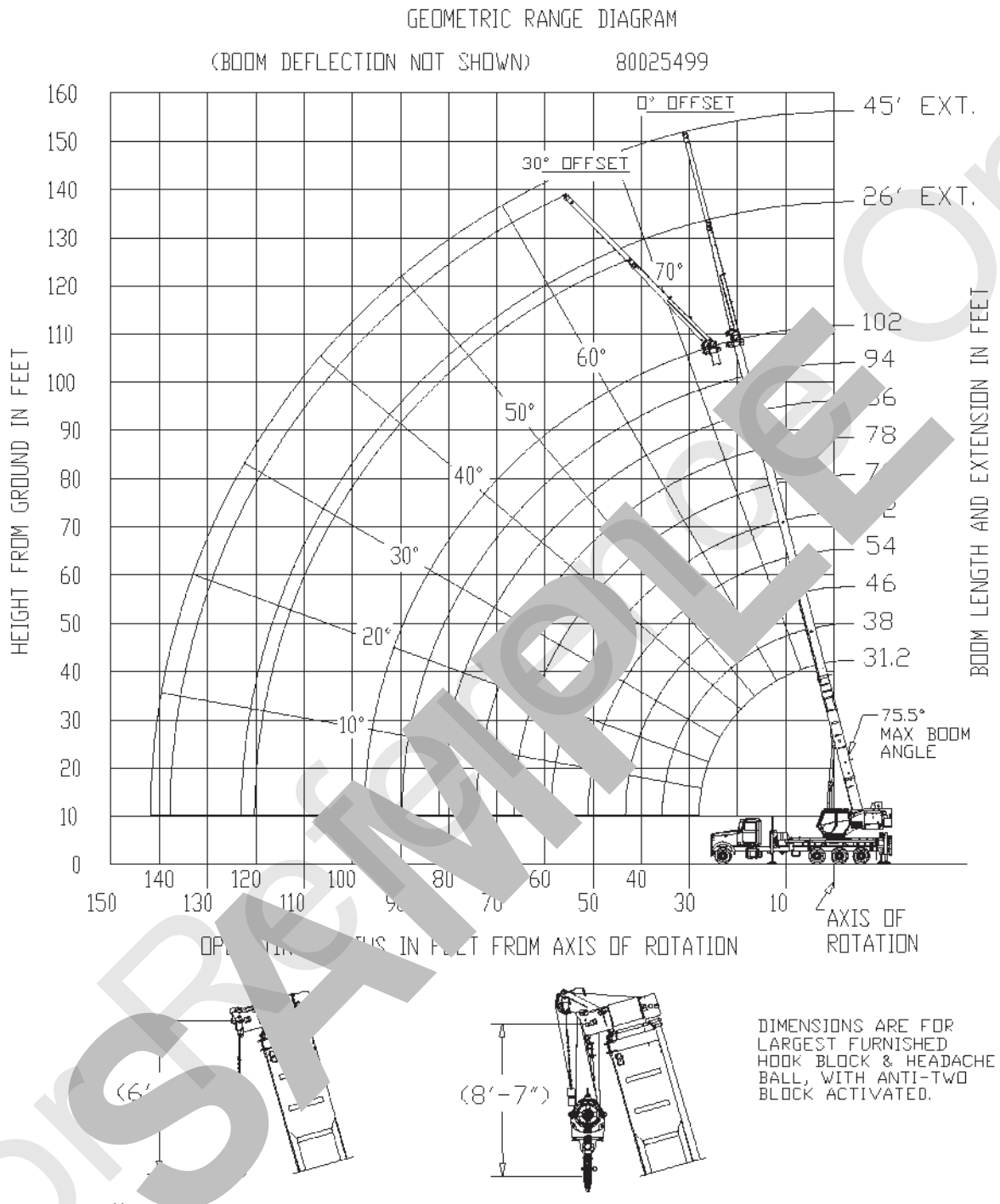


FIGURE 3-19



*THIS DRAWING SHOWS THE PHYSICAL REACH OF THE MACHINE. ALWAYS REFER TO LOAD CHART TO SEE WHICH PORTIONS OF THIS DIAGRAM ARE VALID FOR THE SPECIFIC MACHINE CONFIGURATION AND WHERE THE LOADS ARE STRUCTURALLY OR STABILITY LIMITED.

FIGURE 3-20

WEIGHT REDUCTIONS FOR LOAD HANDLING DEVICES

AUXILIARY BOOM NOSE	71 lb
HOOKBLOCKS and HEADACHE BALLS:	
55 ton, 5 sheave (14" sheave) (CE)	1098 lb+
40 ton, 3 sheave (12" sheave)	600 lb+
20 ton, 1 sheave	400 lb+
7 ton overhaul ball	171 lb+

+Refer to rating plate for actual weight.

When lifting over boom extension, deduct total weight of all load handling devices reeved over main boom nose directly from boom extension capacity.

NOTE: All load handling devices and boom attachments are considered part of the load and suitable allowances MUST BE MADE for their combined weights. Weights for Manitowoc furnished equipment.

LINE PULLS AND REEVING INFORMATION

HOISTS	CABLE SPECS.	POSSIBLE LINE PULLS	NOMINAL CABLE LENGTH
Main Standard	5/8" (16 mm) Dyform 34 LR Rotation Resistant (Non-rot... Min. Breaking Strength 5... lb	...,280 lb	...t.
Main & Aux Optional	5/8" (16 mm) 6x1... EEIPS, IWRC Min. Breaking St...ngth 45...	...,280 lb	450 ft.

The approxima... of 5/8... rope is 1.0 lb/ft.

Parts of line	1	2	3	4	5	6	7	8	9
Max. boom length (ft.) at max. elevation with stated rigging and load block at ground level	147 (includes 45' ext.)	...	...	81	66	55	47	40	35
Low speed lift (lb)	...	22560	...	45120	56400	67680	78960	90240	100000
High speed lift (lb)	...0	...	15000	20000	25000	30000	35000	40000	45000

HOIST PERFORMANCE

Wire Rope Layer	Hoist Line Pulls Two Speed Hoist Low Available lb*	Hoist Line Pulls Two Speed Hoist High Available lb*	Drum Rope Capacity (ft.) Layer	Drum Rope Capacity (ft.) Total
1	15,000	7,516	82	82
2	13,529	6,765	92	174
3	12,299	6,150	101	275
4	11,275	5,637	110	385
5	10,407	5,204	119	504

*Max. lifting capacity: Dyform 34 LR and 6x19 class = 11,280 lb

FIGURE 3-21

RIGGING REMOTE CONTROL (OPTIONAL)

The crane may be equipped with an optional hand held radio rigging remote control.

FIGURE 3-22

The rigging Remote Control (1, Figure 3-22) is a palm size remote control and is shipped with each crane as optional equipment. This rigging remote control has limited functions as described in the following sections; it does not allow full remote control of the crane.

The rigging remote control operates the front and rear outriggers, main hoist up/down, auxiliary hoist up/down, and the single front outrigger SFO (if equipped).

Turn the red power switch at the top to turn on the remote. To enable the remote press the ON/Horn button. When the remote is enabled, the horn will sound. To enable the hoists the boom must meet the following requirements:

- The boom must be within -5.0° and 10.0°, and
- The boom length must be less than 10' extended

Press the extend/ payout or retract/ pay in button at the bottom of the remote for the needed function. A LED will turn ON at the top of the remote signaling the selection made. Press and hold the function required. If pressing a hoist function, the hoist runs at slow speed, regardless of switch position on the cab armrest and will only run for a predetermined period of time. The outrigger functions run as long as the button is pressed. All functions are available. However, only certain functions can be selected simultaneously. Each of the hoists, the outrigger beams and the outrigger jacks are separated into button groups that will allow them to be run together. For example, only outrigger jack functions can be run together. If a beam is selected, it will be ignored while the outrigger jack is still being pressed. The same is true for the outrigger beams. The hoists run independent of each other.

When finished, press the top switch to turn off the remote.

If the remote is left turned on for more than 5 minutes, the remote will shut itself off.

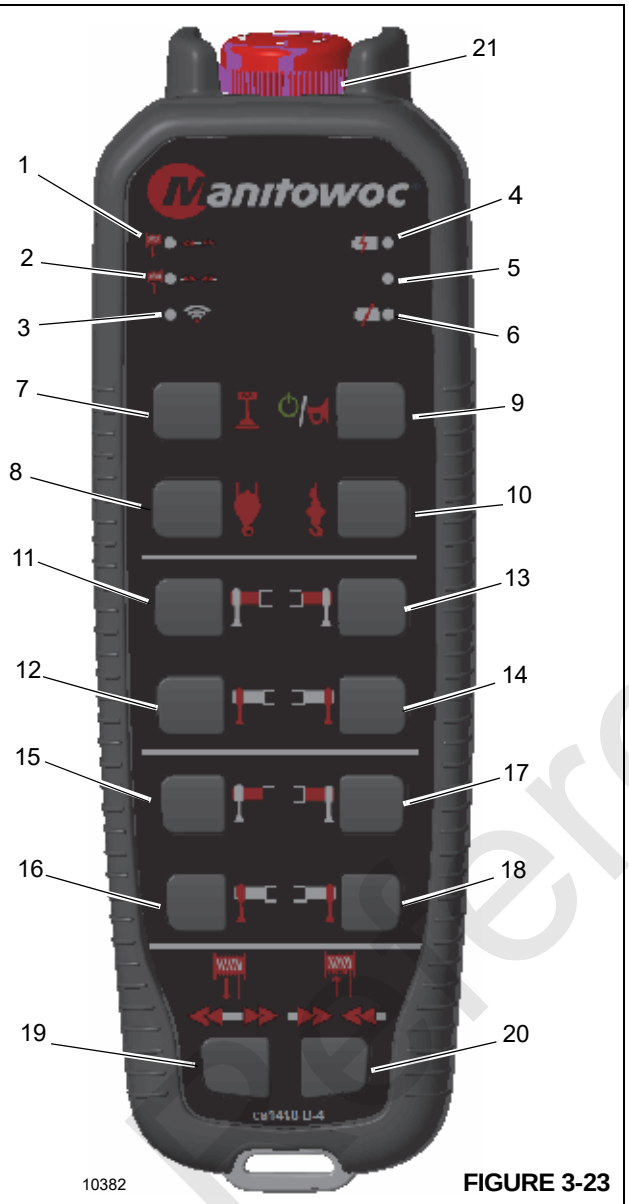
For more information about setting the outriggers with the rigging remote control. see “Setting the Outriggers with the Rigging Remote Control” on page 4-3.

Rigging Remote Control Battery Charging

The rigging remote control features rechargeable batteries. Use the charger and power adapter to charge the batteries. Install the remote control in the charger and plug the power adapter in any 12V receptacle

Operation

The following sections describe the features, major components of, and how to use the rigging remote control.



10382 **FIGURE 3-23**

Item	Description
1	LED — Extend/Hoist Down
2	LED — Retract/Hoist Up
3	LED — Radio Link Active
4	LED — Charging
5	LED — (Not Used)

Item	Description
6	LED — Low Battery Indication
7	Single Front Outrigger (SFO)
8	Main Hoist Group
9	Start/Horn
10	Auxiliary Hoist Group
11	Front Left Beam
12	Front Left Jack
13	Front Right Beam
14	Front Right Jack
15	Rear Left Beam
16	Rear Left Jack
17	Rear Right Beam
18	Rear Right Jack
19	Extend Direction Preselection Button
20	Retract Direction Preselection Button
21	STOP Button

Rigging Remote Control LEDs

Table 3-1 Rigging Remote Control LEDs

LED Icon	Description
 10382-4	Retract/Hoist Up — This LED illuminates when the retract preselection button (20, Figure 3-23) is selected. States: • Solid — The retract preselection button (20, Figure 3-23) selected and retract mode is active. • Flashing — Hoist, outrigger, or SFO button pressed before Pre-selection button is pressed. Pre-select the Extend/Hoist Down button to clear this warning. If the remote is not initialized, press the Power/Horn button.
 10382-5	Extend/Hoist Down — This LED illuminates when the extend preselection button (19, Figure 3-23) is selected. States: • Solid — The extend preselection button (19, Figure 3-23) selected and extend mode is active. • Flashing — Hoist, outrigger, or SFO button pressed before Pre-selection button is pressed. Press the Extend/Hoist Down button to clear this warning.

Table 3-1 Rigging Remote Control LEDs (Continued)

LED Icon	Description
 10382-3	Radio Link Active — This LED illuminates when there is an active link with the radio transmitter. States: • Solid — The remote is in Active mode with an active link with radio transmitter in active mode. • Flashing — The remote is in Wake Up mode. **NOTE:** When radio communication is lost between the remote and the receiver, all LEDs flash.
 10382-2	Charge Indication — This LED indicates if the remote control batteries are being charged. States: • Solid — The remote is charging. • Off — The remote is not charging.
 10382-1	Low Battery Indication — This LED illuminates when battery power is low. States: • Solid — Battery power is low. • Flashing — Remote Control Error occurred. • Off — Battery power is present.

About Pre-selectable Direction Buttons

The pre-selectable buttons (19 and 20, Figure 3-23) determine the direction of travel (retract or extend) of subsequent hoist, outrigger, or SFO operations. The pre-selection mode button must be selected before operating the outriggers, hoists, or SFO. To leave the selected direction of travel, press the button a second time. The pre-selection mode button times out after five seconds if no function is activated.

To select a direction of travel (extend or retract):

1. Press the pre-selectable direction button (19 or 20).
2. Operate the outriggers, hoists, or SFO.

To deselect the direction of travel:

1. Press the pre-selectable button a second time, or do not activate a function for five seconds.

Entering Active Mode

Enter Active Mode to extend or retract the hoist and outriggers and SFO. When in Active Mode, the Radio Link Active LED turns solid green.

1. Press the Start/Horn button (9, Figure 3-23).
2. Press Start/Horn button (9) again. The horn will sound.
3. Press the extend or retract preselection button (19 or 20).

Entering Wake-up Mode

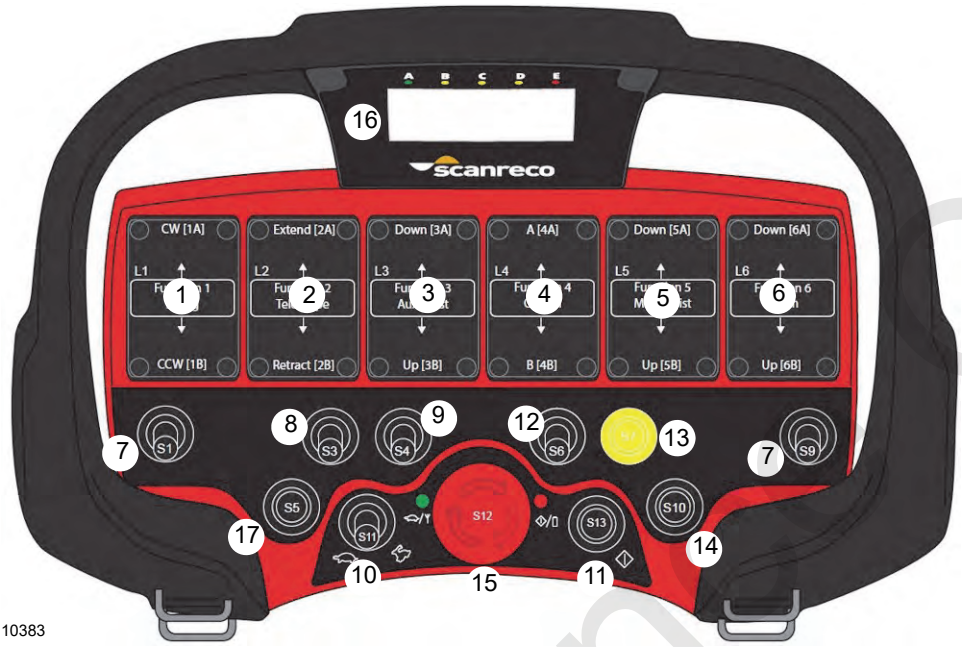
Wake-up Mode puts the remote control in a stand-by state. The Radio Active Link LED will flash. No buttons will be active until you enter Active Mode. Wake-up mode reduces the possibility of inadvertent operation and reduces battery consumption.

To enter Wake-up Mode

1. Press the Start/Horn button (9, Figure 3-23).
2. Press any button except the Start/Horn button (9).

   Wake-up Mode is entered.

CRANE REMOTE CONTROL (OPTIONAL)



Item	Description
1	Swing
2	Telescope
3	Auxiliary Hoist
4	Blank
5	Main Hoist
6	Boom
7	Enable
8	Auxiliary Hoist Speed
9	Main Hoist Speed

Item	Description
10	Hydraulic Speed Control
11	ON Button/Horn
12	Engine RPM
13	RCL Override (Momentary)
14	Engine Start
15	STOP
16	LCD Screen
17	Enter

FIGURE 3-24

The optional Crane Remote Control (Figure 3-24) will allow full remote control of the crane. The optional outrigger Remote Control is disabled when using the optional Crane Remote Control.

If any interference is present in the area and the remote does not function properly, the radio's channel is automatically changed.

Refer to the Crane Remote Control Operator's Manual for operating instructions for this optional remote control.

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

The LCD Screen (16, Figure 3-24) on the display is used to communicate signal strength and battery level. RCL information is displayed to the operator.The crane remote can be used only when the crane cab ignition key is in the ON position, the crane power switch is OFF, and the remote power switch is ON.

When the crane remote control is active, the rigging remote control will function. Likewise, when the outrigger remote is active, the crane remote control will function. However, when both remotes are active, there is a five second delay before the remote becomes active and usable when switching from one remote to the other.

Crane Remote Control Battery Charging

If the crane remote control is not used for a long period, it is recommended that the removable battery be charged before using the remote control.

The crane remote control features a removable battery. When the crane remote control is not used, remove the battery and install the battery in the charger to charge the battery. Access the battery by removing the battery compartment screw on the back of the crane remote control.

When the battery icon flashes on the remote control display (Figure 3-24) the batteries are low and should be recharged or replaced immediately.

⚠ CAUTION

Do not store the battery in your pocket. Metal objects can short the battery and cause burns.

⚠ CAUTION

Rechargeable batteries (NiMH or NiCd) must be fully charged before first use! Never attempt to charge standard non-rechargeable batteries!

Activating the Crane Remote Control

1. In the crane superstructure cab, turn the crane ignition (9, Figure 3-4) to ON.
2. In the cab, turn the Crane Remote Control switch (15, Figure 3-4) to ON.
3. To use the remote, the red STOP button (15, Figure 3-24) must be activated to turn on the transmitter.
4. Press the ON/Horn button (2) to activate the remote. The crane horn will sound as confirmation that the remote is now active.
5. Press and hold the Engine Start button (14) to start the crane. The remote can now be used to control the crane.
6. Move the controller that corresponds to the desired movement to activate desired function.
7. Press the red STOP button (11) when finished with the remote. This will shut off the crane.

NOTE: Anytime the remote loses connection (remote switch is turned off, E-stop activated, communication loss) the remote control will need to be re-initialized in order to continue using the remote. 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 4 to step 7.

8. Turn OFF the crane power switch (15, Figure 3-4) in the crane cab to de-activate the remote control. If the remote is left turned ON for more than 60 minutes, the remote will time out and shut itself off.
9. In the operator cab, turn the crane ignition key (9) to OFF.

The remote controller can be stored in the crane cab or the truck cab.

⚠ DANGER

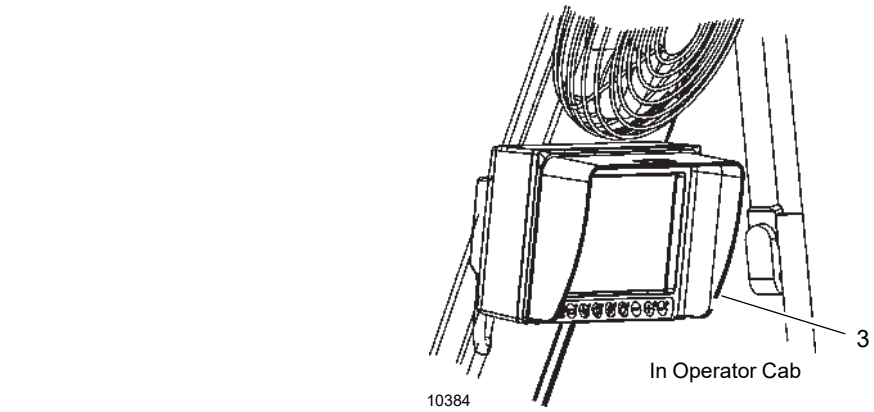
Be sure to turn off the remote by pressing the red stop button to de-activate the controls in order to prevent the crane from functioning if the controller switches are inadvertently depressed or bumped during storage. Failure to comply with these instructions may cause death or serious injury.

CAMERA SYSTEM (OPTIONAL)

If equipped, the crane features two cameras:

- Hoist Camera—This camera (1, Figure 3-25) enables the operator to view the hoists during operation.
- Rear View Camera—This camera (2) enables the operator to view in the rear of the crane, including the swing area and outriggers that aren't visible from the cab.

The cameras are viewed in the cab on the camera monitor (3). The operator can switch between cameras using the monitor controls. For more information about the monitor, see the manufacturer's user manual.



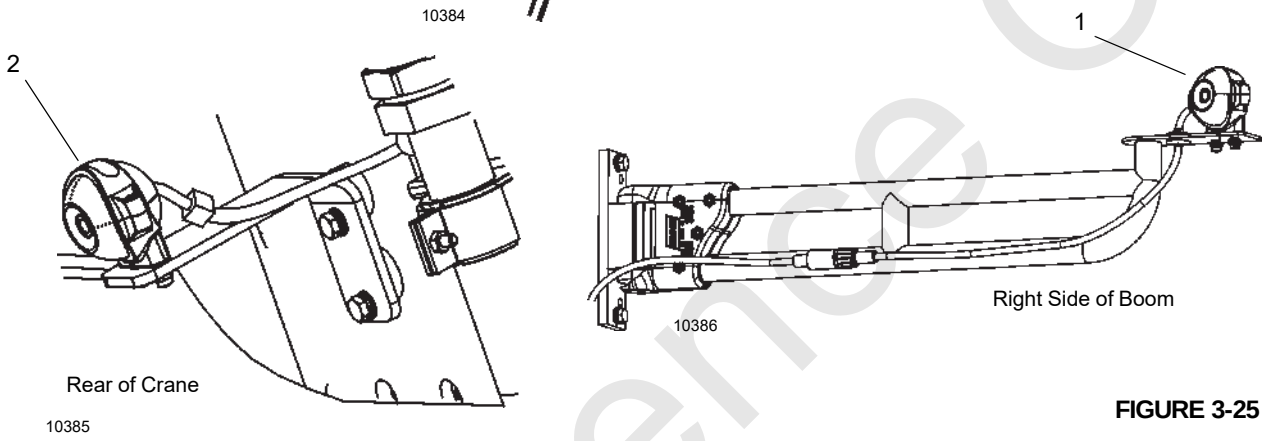


FIGURE 3-25

WIND SPEED INDICATOR (OPTIONAL)

The cranes feature an optional wind speed indicator to measure wind speed at the end of the boom. The wind speed indicator features a radio anemometer assembly and a wireless gateway router. The anemometer (1, Figure 3-26), which captures wind speed data at the end of the boom or jib, is battery powered and communicates wirelessly with the gateway router (2) located in the crane cab. The gateway router receives data from the anemometer and routes the data to the RCL display. For information about how the wind speed indicator appears in the RCL, see Table 7-3 on page 7-4.

If using a jib, the anemometer assembly should be relocated to the end of the jib to ensure accurate wind speed readings.

If not in use or when in transport, the anemometer should be stored on the storage rack in the operator cab.

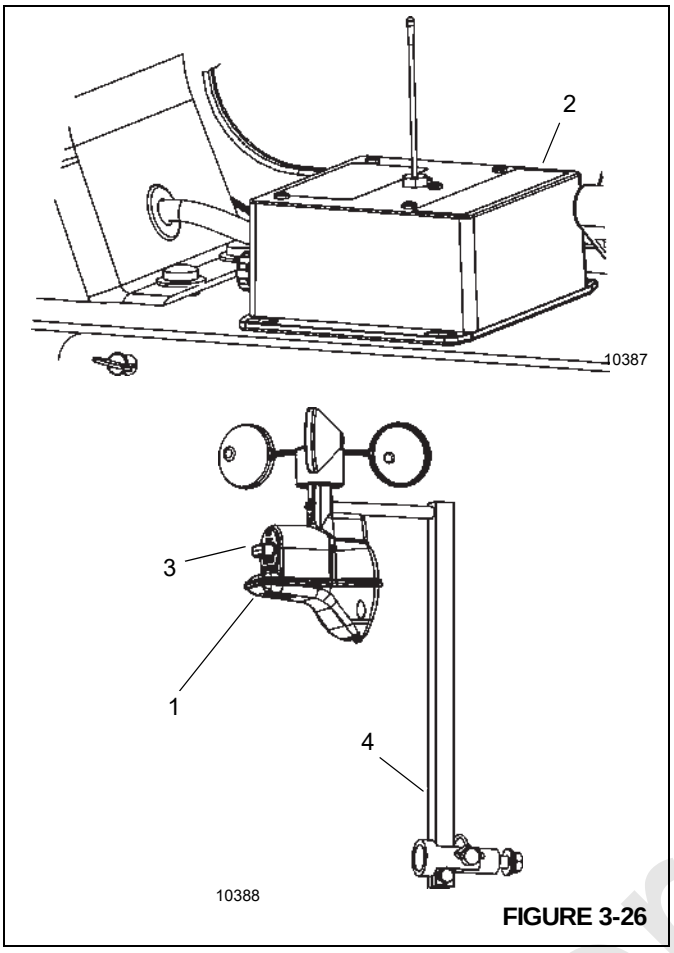


FIGURE 3-26

Removing the Anemometer Assembly

Use the following procedure to remove the anemometer assembly, including the mast, from the end of the boom or jib.

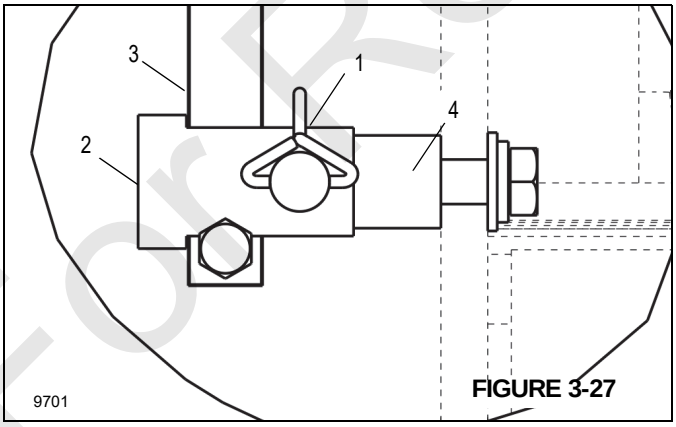


FIGURE 3-27

1. Lower the boom as necessary to access the anemometer.
2. Remove the safety pin clip (1, Figure 3-27). Remove the pin.
3. Remove the bushing (2) from the anemometer mast (3) and rod keeper (4).
4. Remove the anemometer mast (3) from the rod keeper (4).
5. Re-Install the bushing (2) and safety pin (1) on the rod keeper (4).

Installing the Anemometer Assembly

Use the following procedure to install the anemometer assembly, including the mast, on the boom or jib. Install the anemometer assembly on the right side of the boom or jib sheave case.

1. Lower the boom as necessary to access the anemometer.
2. Install the anemometer mast (3, Figure 3-27) on the rod keeper (4).
3. Install the bushing (2) over the mast (3) and rod keeper (4). Align the bushing and keeper holes so the safety pin can be installed.
4. Install the safety clip (1) in the bushing (2) and keeper holes (4). Secure the pin (1) with the safety clip.

Changing the Anemometer Battery

Use the following procedure to change the battery in the wireless anemometer. For more information about acceptable battery types, see “Specifications” on page 6-10.

1. Lower the boom as necessary to access the anemometer.
2. Remove the battery cover (Figure 3-26) and old battery from the anemometer.
3. Install the replacement battery. For more information about acceptable battery types, see “Specifications” on page 6-10.
4. Replace the battery cover.
5. Turn power on to the crane. Using the RCL screen, verify that the anemometer is transmitting data.

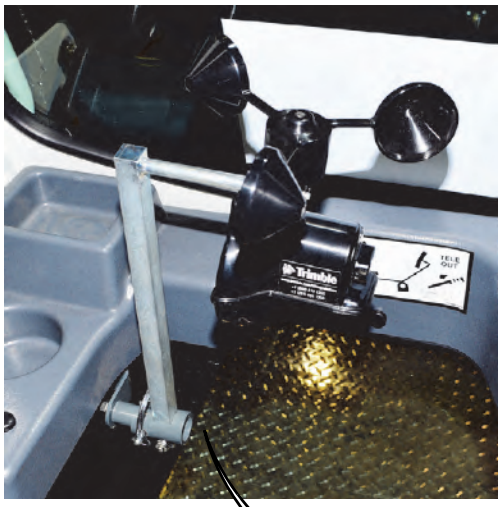
Stowing the Anemometer Assembly

Use the following procedure to stow the anemometer assembly on the storage bracket in the crane cab near the 360 swing lock pedal (if installed).

NOTE: The anemometer should be removed and stowed on the storage bracket in the cab before transporting the crane to avoid damage to the anemometer.

NOTE: The battery should be removed if the anemometer will be stored for a prolonged period of time.

1. Remove the anemometer assembly from the boom or jib. For more information, see “Removing the Anemometer Assembly” on page 3-38.



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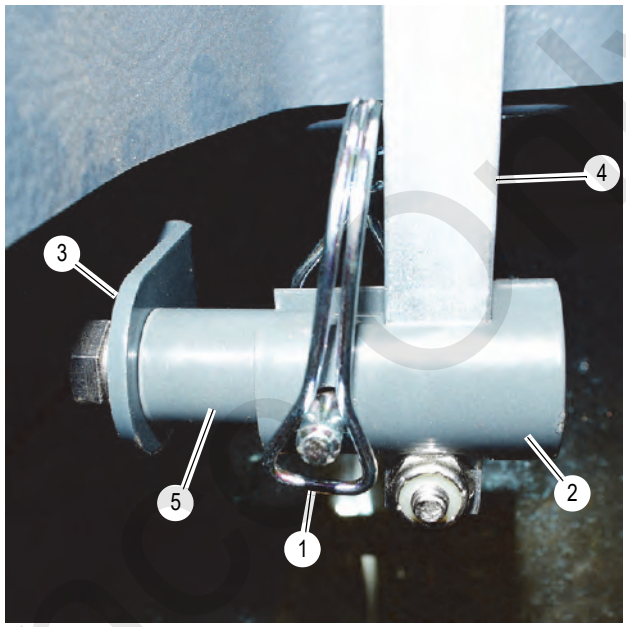

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FIGURE 3-28

2. In the cab, remove the safety pin (1, Figure 3-28) and bushing (2) from the anemometer stowage bracket (3).
3. Install the anemometer mast (4) on the stowage bracket rod keeper (5).
4. Install the bushing (2) over the mast (4) and rod keeper (5). Align the bushing and keeper holes so the safety pin can be installed.
5. Install the safety clip in the bushing (2) and keeper holes (5) to secure the anemometer mast (4). Secure the pin (1) with the safety clip.

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SECTION 4
SET-UP

SECTION CONTENTS

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

- Set the outriggers
- Erect the jib
- Stow the jib
- Remove the jib
- Use multi-part reeving
- Install the hoist rope
- Install the anti-two-block weight
- Install a wedge socket

⚠ DANGER

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

To properly level the crane, the boom must be positioned over the front of the crane, fully lowered to horizontal and fully retracted (for cranes fitted with a boom rest, the boom should be stowed onto the rest).

NOTE: To ensure a true reading always make sure the cab tilt is completely lowered.

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, relevel the crane using the procedures under *Setting the Outriggers*, page 4-2.

Bubble Level Adjustment

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

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

Site Selection

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

- uneven
- rocky
- muddy

Setting the Outriggers

The outrigger setup procedure is as follows:

NOTE: To ensure a true reading, always make sure the cab tilt is completely lowered.

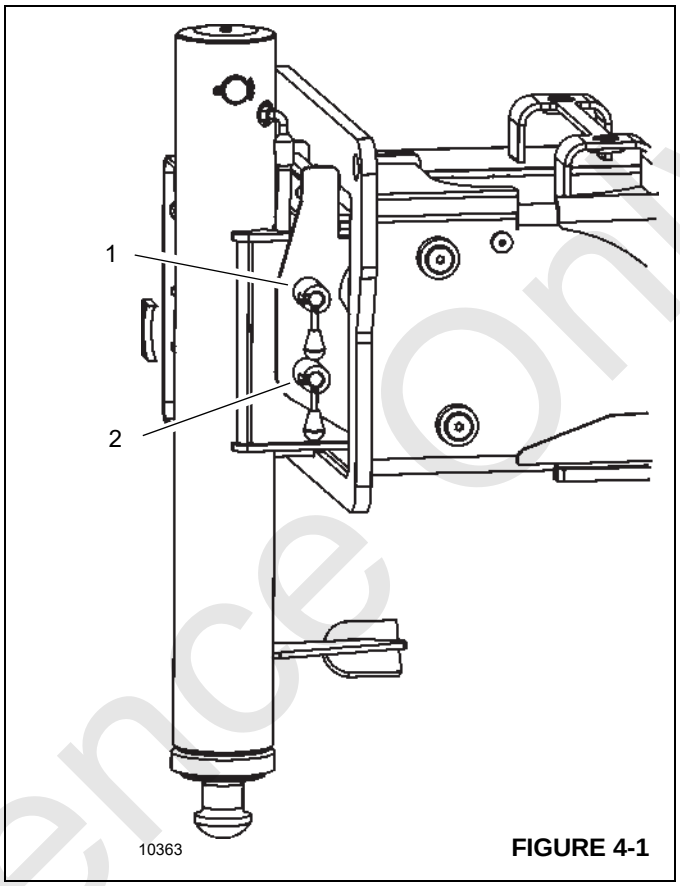


FIGURE 4-1

1. Operate the ground station or cab outrigger control panel (see Figure 3-1).
2. Select the desired outrigger beam with the extension button and press the extend button to extend the outrigger beams.
3. Set all four outrigger beams to desired position:
   - **a.** 0% extended position. Does not require the outrigger beams to be extended.
   - **b.** 50% extended position. Engage the 50% manual lock by rotating the handle clockwise (1, Figure 4-1) for the midpoint position.
   - **c.** (NTC40-2/NTC45-2 only) 75% extended position. Engage the manual lock (2, Figure 4-1) by rotating the handle clockwise.
   - **d.** Fully extended position. All locks should be disengaged for the fully extended position.

DANGER

All four outriggers must either be fully retracted (0%), at the midpoint (50%), three-quarters (75%) (NTC40-2/NTC45-2 only), or fully extended (100%), and the RCL set to the correct position. Failure to do so creates a tipping hazard.

Do NOT use position locks in combination. Using more than one position lock at a time may result in an undesired span.

NOTE: The RCL will automatically preselect the outrigger position based on inputs from the four outrigger beam extension monitoring sensors.

4. Remove the front outrigger floats from the carrying brackets and install the floats on the stabilizer.
5. Secure the front outrigger floats to the stabilizers with the pins and clips.
6. Select the desired stabilizer with the stabilizer selector switch and press the extend button to extend the stabilizer.
7. Extend all four stabilizers until the truck tires are about 100 mm (4 in) off the ground.
8. Using the level indicator, adjust the stabilizers until the bubble 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 4-2.

FIGURE 4-2

9. Extend the single front outrigger (SFO) only after all other outriggers are set. Press the SFO button to activate and the extend/retract button to extend. Hold the extend button for two seconds after the SFO contacts the ground.
10. Verify that the RCL has preselected the outrigger position mode correctly.

Using the Hoist Jog Switch

The hoist jog switch (1, Figure 4-3) is located on the front bumper. Use the hoist jog switch to raise or lower the main (2) or auxiliary (3) hoist when stowing the hook block or overhaul weight. The hoist jog switches are active when the boom is stowed in the boom rest.

DANGER

Use the hoist jog switch only when stowing the overhaul weight or hook black on the front bumper. Do not use the hoist jog switch when a load is attached. Using the hoist jog switch while a load is attached can result in death, injury, or damage to equipment.

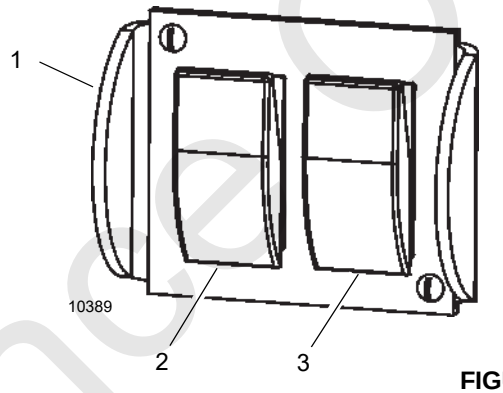


FIGURE 4-3

Setting the Outriggers with the Rigging Remote Control

Use the following procedure to set the outriggers and SFO with the rigging remote control. For more information about the rigging remote control, see *Rigging Remote Control (Optional)*, page 3-32.

DANGER

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

To setup the outriggers with the remote control:

1. Set up the crane on a stable surface. For more information, see *Outrigger Setup*, page 4-1.
2. Turn on crane power.
3. Make sure the Crane Power Switch is turned OFF.
4. Make sure the boom length is extended less than 10 ft and greater than -5°.
5. Make sure the boom angle is less than 10 degrees and greater than -5.
6. Select the pre-selectable direction button (extend or retract).

DANGER

All four outriggers must either be fully retracted (0%), at the midpoint (50%), three-quarters (75%) (NTC40-2/NTC45-2 only), or fully extended (100%), and the RCL set to the correct position. Failure to do so creates a tipping hazard.

Do NOT use position locks in combination. Using more than one position lock at a time may result in an undesired span.

7. Extend or retract the outriggers, SFO, and hoists as needed.

JIB SAFETY INFORMATION

1. Ensure the proper jib mode is selected in the RCL.
2. The anti-two block (ATB) switch weight and electrical connection must be attached to the jib when deployed.
3. Do not lift the load with the main boom when the jib is pinned on the tip of the main boom unless the RCL is configured for jib operation.
4. Operate with jib by radius when main boom is fully extended. If necessary, increase boom angle to maintain loaded radius.

   When radius is between points listed on capacity chart, the load shown at the next longer radius shall be used.
5. Operate with jib by boom angle when main boom is not fully extended. Do not exceed rated jib capacities at any reduced boom lengths.

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

DANGER

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

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

- Side stow bracket completely engaged into stow hook with stow pin properly in place.
- Both pins (6, Figure 4-4) in upper and lower jib holes properly in place through mating holes on boom tip.

6. Ensure the jib is stowed correctly (Figure 4-4):
   a. Removal of right side attachment pins (6), without proper installation of stow pin (1) and jib swing pin (5), may allow jib to fall off.
   b. Extending boom with jib stowed and failure to remove right side attachment pins (6), will damage unit upon extension.
7. Swing the jib into working or stowed position only when right side attachment pins (6) are installed, boom is horizontal, and the stow pin (1, Figure 4-4) and jib swing pin (5) are removed. Jib could swing uncontrollably if boom is not horizontal.
8. Crane shall be fully set up according to proper set-up procedures outlined previously when stowing or erecting jib.
9. Operate boom and turn functions very slowly and carefully when using the jib.
10. The area where jib swings around must be clear of obstructions, personnel and power lines when stowing and erecting jib.
11. Use safety glasses when installing pins with hammer.
12. Do not extend/retract boom unless boom is horizontal when stow pin (1, Figure 4-4) and jib swing pin (5) are removed during stowing or erecting procedures.
13. Always put spring clips in pins to ensure that they will stay in place.
14. When the jib is stowed, the boom cannot be fully retracted if a boom tip attachment option is installed.

Also, when manually extending the jib:

1. Jib retaining pin (9, Figure 4-4) must always be installed when operating.
2. All swing around (stow and erecting) operations shall be done with jib retracted and pinned.
3. Extendable section may slide out of 1st section jib when jib retaining pin (9, Figure 4-4) is removed. Keep personnel clear of area.

DEPLOYING AND STOWING THE JIB

General Warnings

DANGER

To prevent death or serious injury, always wear personal protective equipment; i.e., a hard hat, eye protection, gloves, and metatarsal boots.

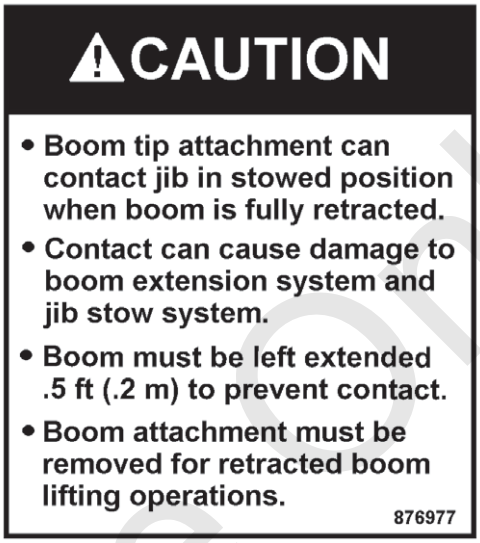
DANGER

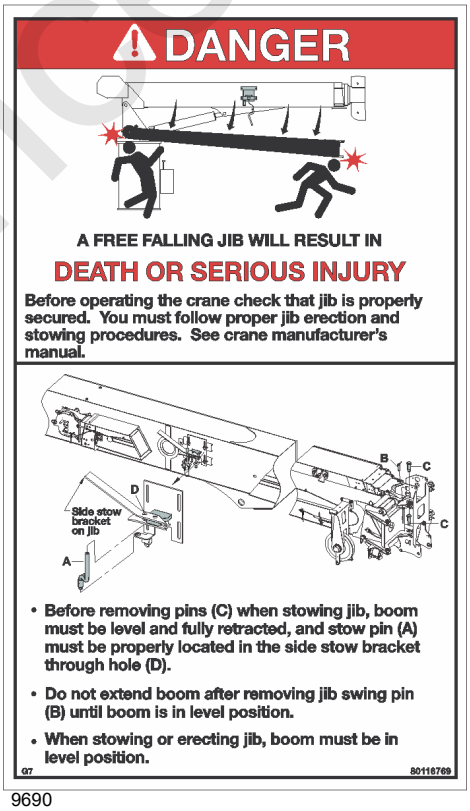
Boom angles are used to control speed at which jibs swing during erecting and stowage. Improper boom angles will cause uncontrollable swing speeds of jib.

NOTE: Tag line used in these procedures is to control the movement of the jib.

DANGER

Before attempting to erect or stow the jib, read and strictly adhere to all danger decals installed on the boom/boom nose, jib, and stowage brackets.





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JIB OPERATION

The NBT40-2 Series cranes can support the following jib:

- 31 to 55 ft (9.5 to 16.8 meters) Telescoping Jib

Use the following procedures to deploy and stow the jib.

Deployment Procedure

DANGER

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

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

- Side stow bracket completely engaged into stow hook with stow pin properly in place.
- Both pins (6, Figure 4-4) in upper and lower jib holes properly in place through mating holes on boom tip.

1. Remove rope keeper pins from boom or auxiliary boom nose and jib. Remove hook block and downhaul weight. Remove loadline from boom and place in an area to minimize possible damage.

NOTE: The auxiliary boom nose must be removed before deploying or installing the jib on the boom nose. For more information, see *Removing the Auxiliary Boom Nose*, page 4-23.

2. Remove the auxiliary boom nose if installed. For more information, see *Removing the Auxiliary Boom Nose*, page 4-23.
3. Using boom telescope function, fully retract the boom.
4. Using lift function, lower boom so that attachment pins (6 and 7, Figure 4-4) 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 slide out when below horizontal.

5. Install right side attachment pins (6) in upper and lower jib lugs, secure with retainer spring clips. These pins are used as a pivot point to swing jib into the deployed position.
6. Locate the stowed position of left side attachment pins (7). If in jib attachment holes or boom sheave case jib holes, remove pins from storage location.
7. Check that the jib is engaged on stowage brackets (front and rear) with the stow pin (1) installed and fully seated before removing the swing pin (5) from the boom nose.
8. Remove jib swing pin (5) from top lug of jib.
9. Using the lift function, raise the boom to the horizontal position.
10. Remove stow pin (1) and stow in hook bracket (3), secure with spring clip.
11. Attach tag line to sheave case end of jib.

CAUTION

Use caution during this step. The jib is free to swing away from the boom during boom extension.

12. Using telescope function, slowly extend boom approximately 30 cm (12 in). This procedure will pull the jib out of the hook bracket (3).
13. Using tag line, swing jib into deployed position.
14. Install upper left attachment pin (7) and spring clip. A slight hammer strike may be necessary to install pins. Always use proper eye protection during this step.
15. Use the alignment jack (10) to align lower left side attachment pin (7).
    a. Remove the jack handle (11) from the boom stowage bracket and check that the jack release valve is closed.
    b. Extend the alignment jack (10) so that the lower left pin holes (7) are aligned.
    c. Install the lower left side attachment pin (7) and spring clip.
    d. Open the jack release valve and retract the jack (10).
16. Deploy the mast sheave assembly (16, Figure 4-5). See *Setting the Mast Sheave*, page 4-11.
17. Using hoist function, un-spool enough loadline to the reeve loadline over the jib sheave case. Keep slight tension on loadline to avoid bird caging of loadline on hoist drum.
18. If not already done, remove the mast assembly rope retainer (17, Figure 4-5). Route the loadline over the mast sheave assembly (16). Secure the hoist rope with the mast assembly rope retainer (17). Keep slight tension on loadline to avoid bird caging of loadline on hoist drum.
19. Remove rope retaining pins and lock pins (11, Figure 4-5) from the jib nose. Route loadline over jib sheave (12) and install keeper (13). Install the jib

retaining pins using lock pins (11). Install line block to end of loadline.

20. Remove ATB switch and weight/chain assembly and install on jib tip, see Figure 4-7. Make sure to use keeper provided with switch.

21. Disconnect ATB/RCL cord (14, Figure 4-4) going to boom ATB switch and attach to quick coupler on jib ATB/RCL wire (12) on rear of jib between the upper and lower jib lugs.

22. If equipped, remove capscrew, flat washer, lock washer, and the anemometer from the boom. Install the wind speed indicator on the end of the jib using capscrew, flat washer, and lock washer. For more information, see *Wind Speed Indicator (Optional)*, page 3-37.

23. Install jib swing pin (5, Figure 4-4) and spring clip into jib lugs.

24. To manually extend the telescoping jib, pull the spring clip and jib retaining pin (9, Figure 4-4), and extend extendable jib section out by pulling on sheave case. The extendable jib section, as it extends, will hit a mechanical stop that allows for jib retaining pin installation. Install retaining pin and spring clip.

25. Make ATB cable (Figure 4-5) connections as required.

Stowing Procedure

⚠ DANGER

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

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

- Side stow bracket completely engaged into stow hook with stow pin properly in place.
- Both pins (6, Figure 4-4) in upper and lower jib holes properly in place through mating holes on boom tip.

1. Using lift function, lower boom so that side attachment pins (6 and 7, Figure 4-4) are easily accessible from the ground.

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

2. Pull the jib retaining pin (9, Figure 4-4) and fully retract extendable section into the base jib section. Retraction of extendable jib section may be facilitated by attaching loadline wedge socket to jib nose. Slowly activate the hoist up function until the extendable jib section is fully retracted.

3. Reinstall jib retaining pin (9, Figure 4-4) through the base and extendable jib sections and install spring clip.

4. Remove loadline from jib sheave case and the mast assembly. Place loadline in area to avoid possible damage from stow procedure.

5. Disconnect ATB/RCL wire connector (12, Figure 4-4) at rear of the jib. Re-connect ATB/RCL switch connector on boom tip. Move weight/chain assembly to boom tip, see Figure 4-7.

6. Lower the mast sheave assembly (16, Figure 4-5). Secure with retaining clip and pin. For more information, see *Setting the Mast Sheave*, page 4-11.

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

8. Remove spring clips from left side attachment pins (7, Figure 4-4 and Figure 4-5) on both upper and lower jib lugs.

9. Remove the jib swing pin (5, Figure 4-4) from the boom nose.

CAUTION

Always use proper eye protection during this step.

10. Remove left side attachment pins (7, Figure 4-4 and Figure 4-5) from upper and lower jib lugs. Do not remove right side attachment pins (6) at this time. The right side attachment pins (6) will be used as a pivot point to swing jib into stowed position. A slight hammer strike may be necessary to remove pins.

11. Raise the boom to the horizontal position.

12. Extend boom for the telescoping jib approximately 30 cm (12 in).

:

CAUTION

Use caution when swinging the jib to avoid unnecessary impact between the jib side plates and the hook bracket on the boom base section.

13. Using tag line attached to jib sheave case, slowly swing jib into stowed position (parallel with tele 1 boom), the right side attachment pins (6, Figure 4-4) are the jib pivot points during this operation.

14. Install jib swing pin (5, Figure 4-4) with spring clip through jib lug and boom sheave case holes. This pin

will keep the jib assembly in line (parallel) with the 1st section boom.

NOTE: Jib swing pin (5, Figure 4-4) does not retain the jib in its stowed position on the 1st section boom.

15. Using boom telescope function, slowly retract boom.

The jib stowage bracket (2, Figure 4-4) on the side of the jib will engage the hook bracket (3) on the side of the tele 1 boom, first lifting the jib and then engaging the jib stow bracket (2) and the hook bracket (3) completely upon full retraction of the boom.

Ensure the boom is fully retracted.

16. Install stow pin (1, Figure 4-4) with spring clip into the jib stowage bracket (2) on the jib. Complete engagement of stow brackets and proper installation of stow pin (1) is critical for secure jib stow attachment.

CAUTION

Always use proper eye protection during this step.

17. Remove right side attachment pins (6, Figure 4-4) from upper and lower jib lugs. A slight hammer strike may be necessary to remove pins.

18. Reinstall loadline over boom sheave case.

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

19. Make sure the jack ram and handle sleeve are securely installed.

JIB REMOVAL

Use the following procedure to remove the jib from the boom.

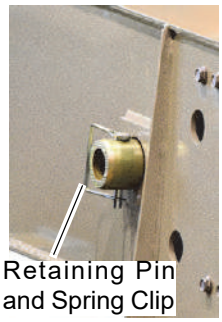
1. If necessary, disconnect ATB/RCL wire connector at rear of the jib. Re-connect ATB/RCL switch connector on boom tip. Move weight/chain assembly to boom tip (Figure 4-7).

2. If equipped, remove the anemometer assembly from the end of the jib. Install the anemometer assembly at the end of the boom. For more information, see *Wind Speed Indicator (Optional)*, page 3-37.

3. Perform steps 3 to 12 in the deployment procedure to position the jib at the boom tip. For more information, see *Deployment Procedure*, page 4-6.

NOTE: When rigging the jib for the assist crane, refer to the decal showing the jib balance point.

4. Attach rigging to the jib and lift the jib with an assist crane. With the assist crane supporting the jib, remove the right side attachment pins (6, Figure 4-5) in upper and lower jib lugs. Jib is now free of the boom.



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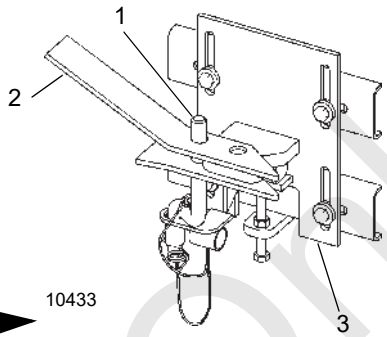

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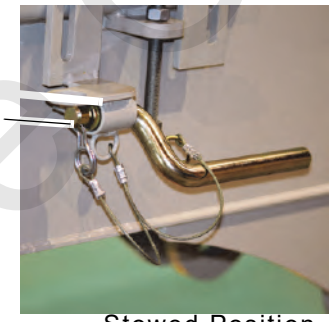

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Stowed Position for pin when jib is erected.

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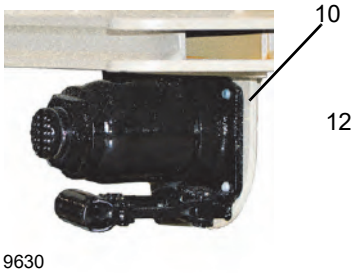
1	Stow Pin
2	Jib Stowage Bracket
3	Hook Bracket
4	Boom
5	Jib Swing Pin
6	Right Side Attachment Pins
7	Left Side Attachment Pins
8	Jib
9	Jib Retaining Pin
10	Alignment Jack
11	Jack Handle
12	ATB/RCL Connector



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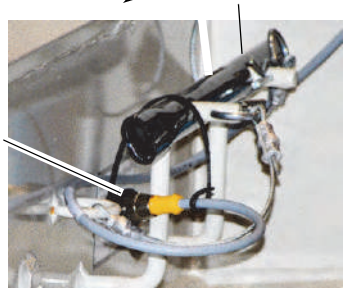

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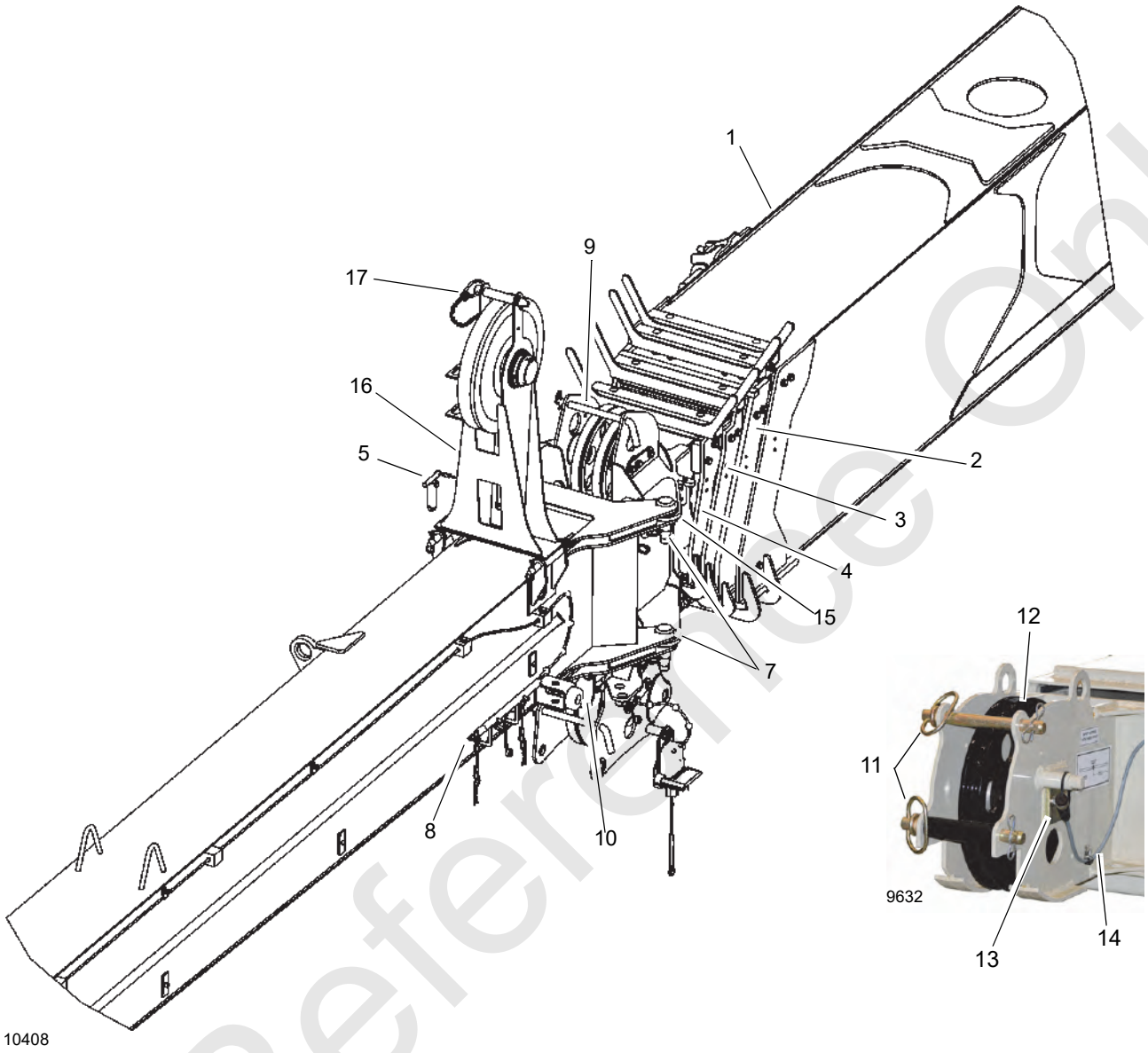
FIGURE 4-4



Item	Description
1	Boom Base Section
2	Tele Section 1
3	Tele Section 2
4	Tele Section 3
5	Jib Swing Pin
6	Right Side Attachment Pins (Not Shown)
7	Left Side Attachment Pins
8	Jack Handle
9	Upper Sheave Rope Retainer

Item	Description
10	Alignment Jack
11	Lock Pin
12	Jib Sheave
13	Keeper
14	ATB/RCL Cable
15	Tele Section 4
16	Mast Sheave Assembly
17	Mast Sheave Assembly Cable Retainer

FIGURE 4-5

JIB INSTALLATION

Use the following procedure to install the jib on the boom.

NOTE: The auxiliary boom nose must be removed before deploying or installing the jib on the boom nose. For more information, see *Removing the Auxiliary Boom Nose*, page 4-23.

1. Using lift function, lower boom so that right side attachment pins (6, Figure 4-5) 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 slide out when below horizontal.

NOTE: When rigging the jib for the assist crane, refer to the decal showing the jib balance point.

2. Attach rigging to the jib and lift the jib with an assist crane. Position the jib at the boom nose so the right side attachment pins (6, Figure 4-5) can be installed to secure the jib to the boom nose.
3. Install right side attachment pins (6) in the upper and lower jib lugs. Secure the pins with retainer spring clips. The right side attachment pins are used as pivot points to swing the jib into stowed position. The jib is now attached to the boom and ready to stow.
4. Attach a tag line to the end of the jib.
5. Remove the assist crane rigging as necessary to stow the jib.
6. Stow the jib on the side of the boom using steps 11 to 18 of the stowage procedure. For more information, see *Stowing Procedure*, page 4-7.

JIB MAINTENANCE

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

Setting the Mast Sheave

You the following procedure to raise and lower the jib mast sheave. The mast sheave must be set for jib operation.

CAUTION

The mast sheave assembly (1, Figure 4-6) must be positioned on top of the base section before attempting to use the jib. Failure to do so can cause damage to the mast and/or jib adapter.

1. Extend and set the outriggers.
2. Swing the boom over rear of truck chassis.

CAUTION

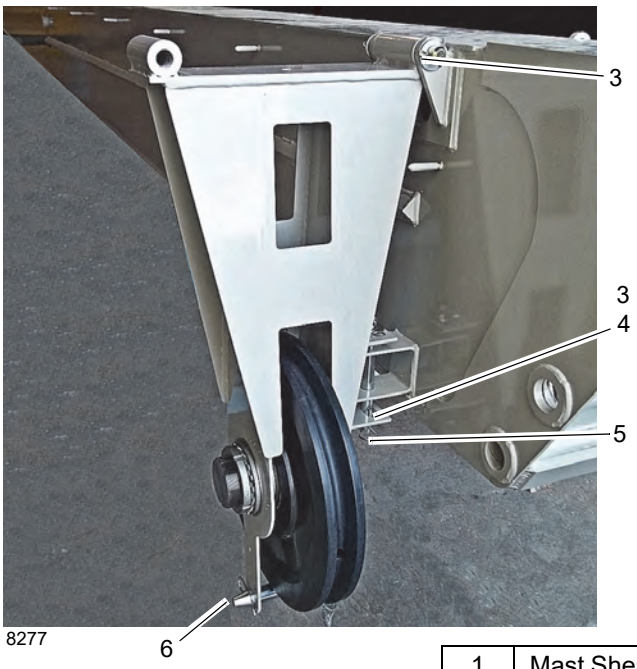
Do not overload the jib or the attachment points when lowering the boom.

3. Deploy the jib as outlined in (*Jib Operation*, page 4-6).
4. Remove the pin (3) from the mast stowage bracket.
5. Swing the mast (1) from the stowed position to the top of the jib (2).

CAUTION

Use caution to avoid pinch points while positioning mast.

6. Install pin (3) that was removed from the stowage bracket to secure the mast to the jib boom.
7. Install the retaining clip (5) to secure pin to mast.
8. Route hoist rope in groove in sheave wheel (7) and secure with retaining pin (6).



1	Mast Sheave Assembly
2	Jib Boom
3	Lock Pin
4	Mast Stowage Bracket
5	Retaining Clip
6	Retaining Pin
7	Sheave Wheel

FIGURE 4-6

Anti-Two Block (ATB) Weight Installation

To prevent the hoist rope from slipping out of the ATB weight, rig the weight as shown in Figure 4-7.

NOTE: The nuts, clamp and ATB bracket must be removed from the hoist rope in order to reeve the hoist rope through the hook block and boom nose sheaves when reeving for multi-part lines as shown in Figure 4-7. Install the clamp and nuts to the rope before performing a lift.

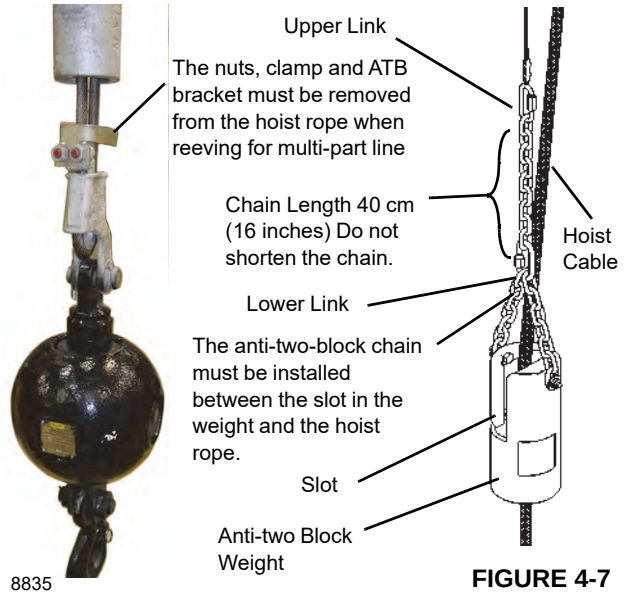


FIGURE 4-7

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.

NOTE: The ATB bracket is for single part line use only. Remove the ATB bracket shown in Figure 4-7 from the hoist rope when changing from a single part line to a multiple part line to allow the hoist rope and wedge socket to reeve through the sheaves on the boom nose and the hook block. Install the clamp and nuts to the rope before performing a lift.

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 for the rope supplied with the machine. Therefore, any replacement rope must meet the rope specification in this manual.

Possible Multi-Part Line Reeving Combinations

The NBT40-2 Series cranes support reevings of up to 8 line parts, depending on the hook block and auxiliary boom nose used. Possible components used for reeving include:

- Anti-Two Block. For more information, see *Anti-Two Block (ATB) Weight Installation*, page 4-12.
- Wedge Socket. For more information, see *Wedge Sockets*, page 4-18.
- Downhaul Weight—Used for 1-part reeving
- 1-Sheave Hook Block—Used for 2- and 3-part reevings
- 3-Sheave Hook Block—Used for 4- to 7-part reevings
- 4-Sheave Hook Block—Used for 8-part reevings

The cranes also feature optional 1-sheave auxiliary boom nose. The 1-sheave auxiliary boom nose can be used for 7- and 8-part reevings.

Table 4-1 shows the different possible reeving combinations with no auxiliary boom nose and 1-sheave auxiliary boom nose.

The reeving configuration is entered during RCL setup. For more information, see *RCL Setup*, page 7-7.

Table 4-1 Possible Multi-Part Line Reeving Combinations

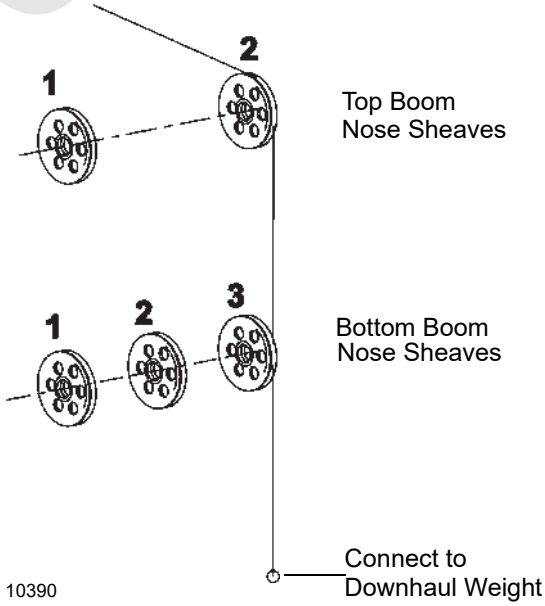
Line Parts	Reference Drawing
1-Part Line Reeving	

Table 4-1 Possible Multi-Part Line Reeving Combinations (Continued)

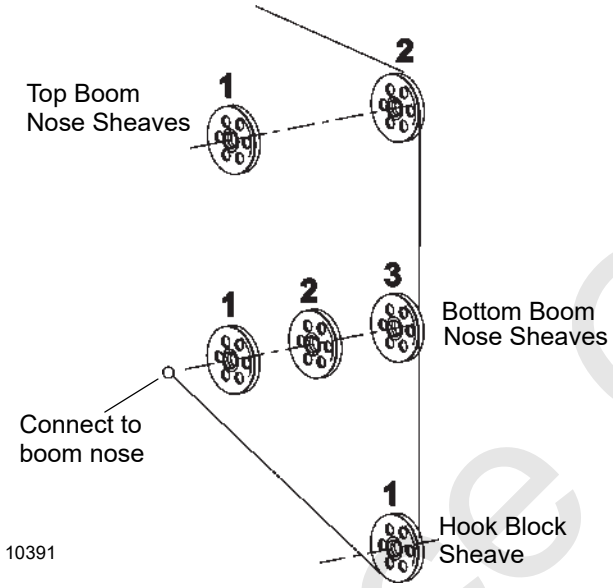
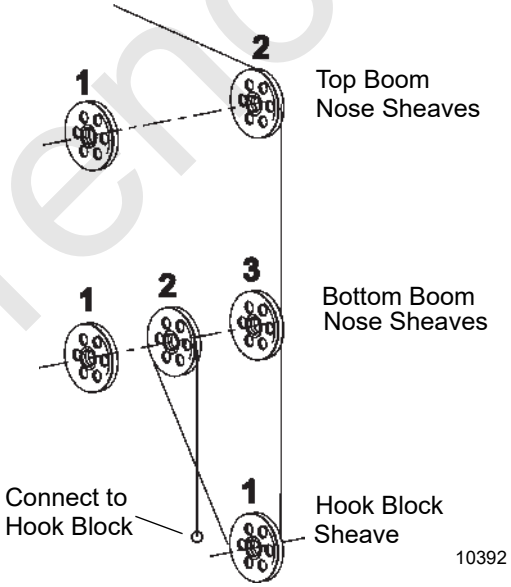
Line Parts	Reference Drawing
2-Part Line Reeving	
3-Part Line Reeving	

Table 4-1 Possible Multi-Part Line Reeving Combinations (Continued)

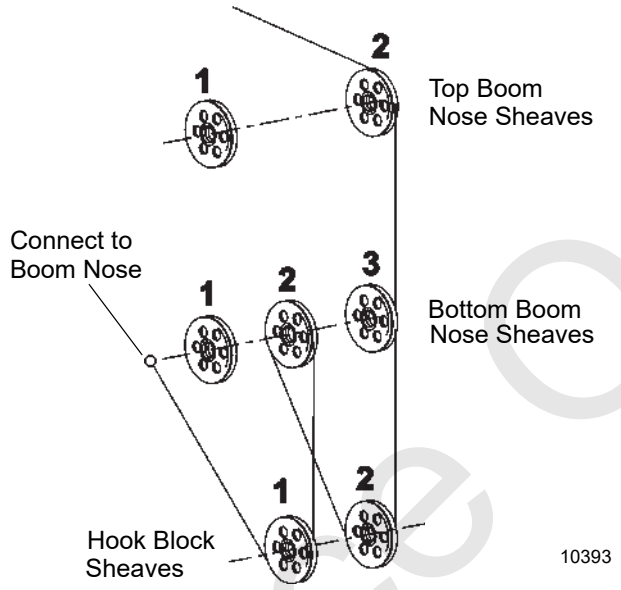
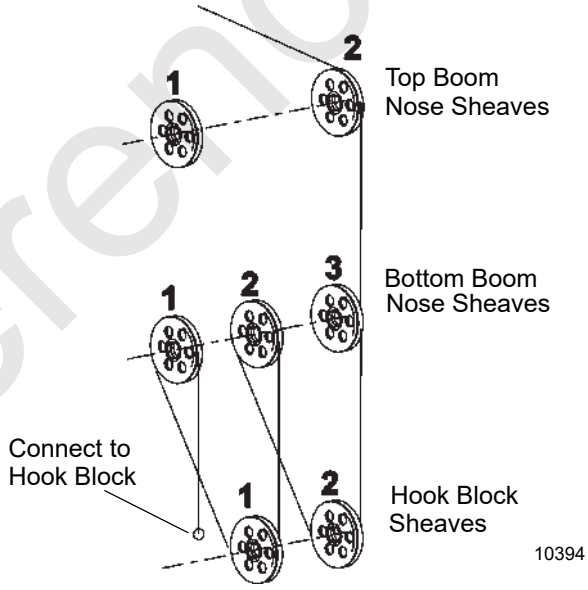
Line Parts	Reference Drawing
4-Part Line Reeving	
5-Part Line Reeving	

Table 4-1 Possible Multi-Part Line Reeving Combinations (Continued)

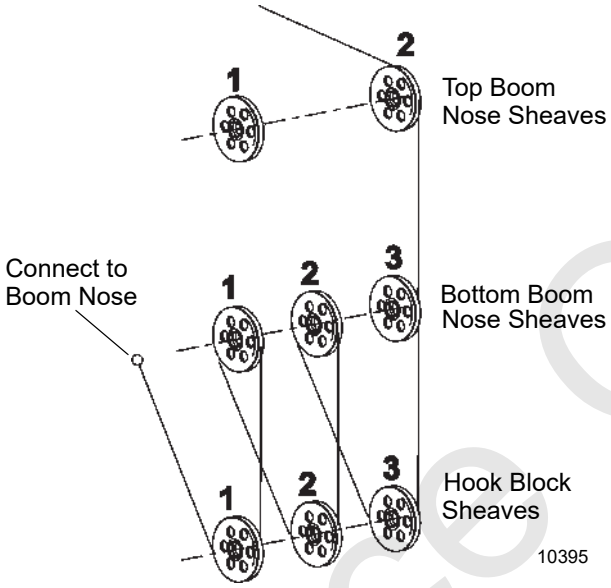
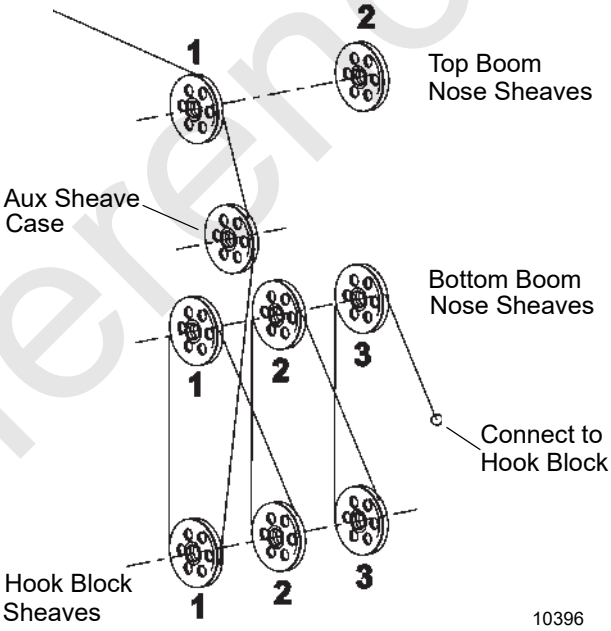
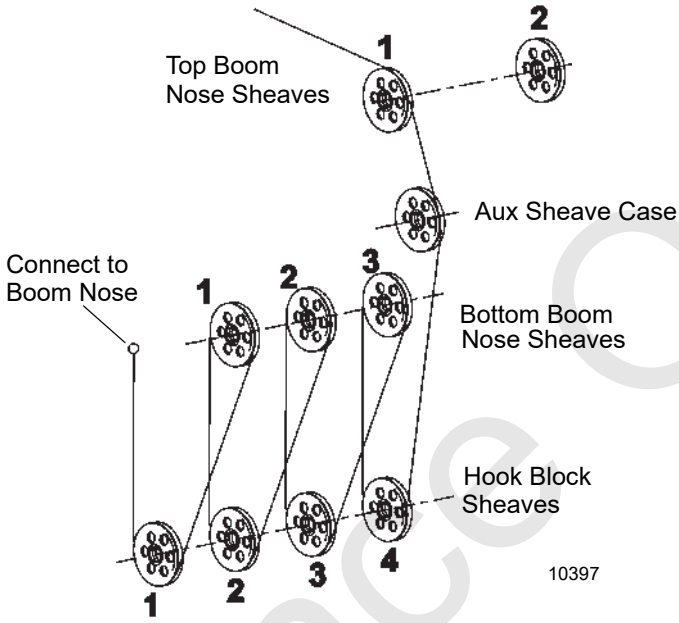
Line Parts	Reference Drawing
6-Part Line Reeving	
7-Part Line Reeving	

Table 4-1 Possible Multi-Part Line Reeving Combinations (Continued)

Line Parts	Reference Drawing
8-Part Line Reeving	

Lifting the Rated Load

The NBT40-2 Series can be rated to lift up to 90,000 lb (45 tons) [40823kg (40.8 metric ton)] at an 6 ft radius with the boom retracted with 8-parts of line. To make this lift the crane must be equipped with 0.63 in (16 mm) diameter wire rope with a rated breaking strength of 56,400 lb (25089 nm). This rope is required to have the appropriate 5:1 safety factor.

INSTALLING ROPE ON A HOIST

CAUTION

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

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

Install rope on the hoist drum in accordance with the following procedure:

1. Position the rope over the boom nose sheave and route to the hoist drum.
2. Position the hoist drum with the rope anchor slot on top.
3. Insert the rope through the slot and position around the anchor wedge (1, Figure 4-8).

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

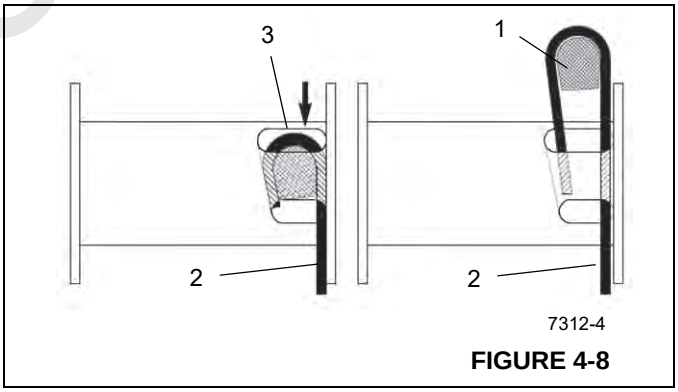


FIGURE 4-8

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

DANGER

ENTANGLEMENT HAZARD

Death or serious injury may result if entanglement occurs during hoist operation.

Keep all body parts and loose clothing clear while hoist is running.

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

WEDGE SOCKETS

To install a wedge socket:

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

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

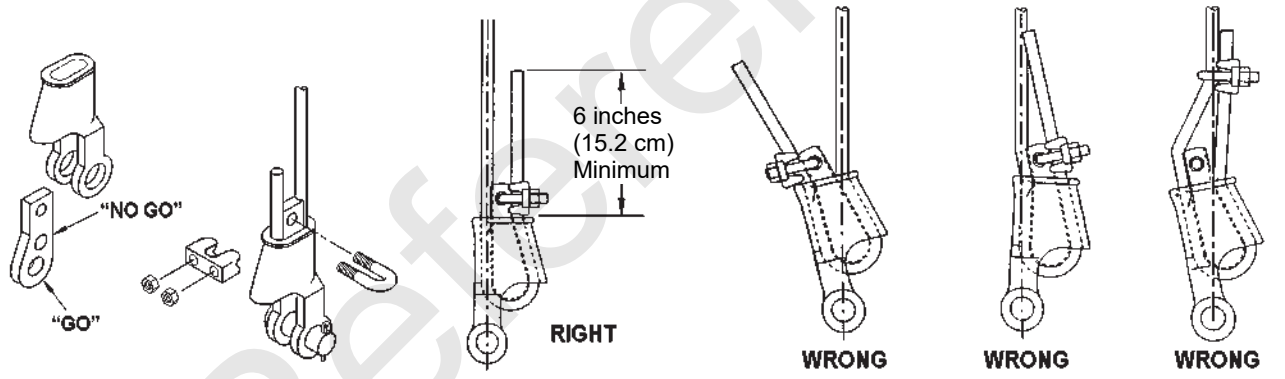
Terminator Wedge Installation

The NBT40-2 Series is shipped with a terminator wedge socket which is National Crane's preferred type of socket (Figure 4-9). Other wedge socket types are discussed under *Wedge Socket Installation*, page 4-19.

To attach a terminator wedge (Figure 4-9), 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 (Figure 4-9).
5. Do not attach dead end to live end or install wedge backwards.
6. Use a mallet to seat Wedge and Rope as deep into socket as possible before applying first load.

Terminator Wedge Socket



Torque Value Table

Cable Size (inches)	3/8	7/16	1/2	9/16	5/8	3/4	7/8	1	1-1/8	1-1/4
Torque ft/lbs	45	65	65	95	95	130	225	225	225	360
Torque values shown are based upon clean dry threads free of lubrication.										

FIGURE 4-9

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 4-10) of the rope is directly in line with the lugs 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.

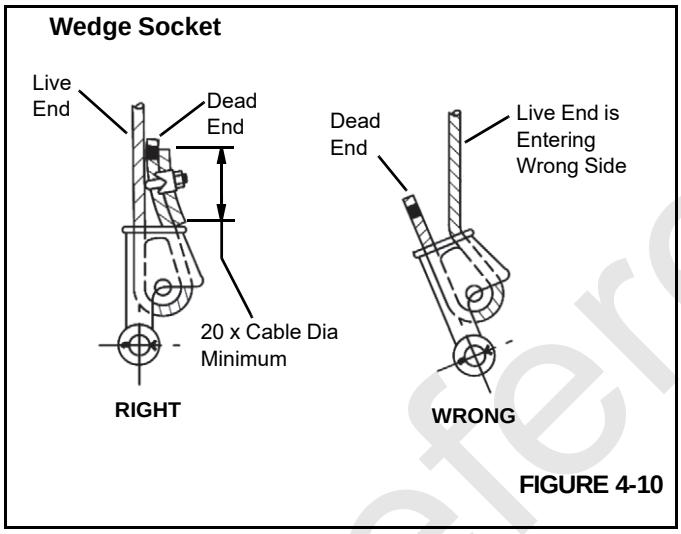


FIGURE 4-10

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 4-10) to protrude from the socket. Ensure the dead-end of the rope is of sufficient length to apply end treatment to the dead-end after the wedge has been seated.
5. Insert the wedge into the loop and pull the live-end of the rope until the wedge and rope are snug inside the socket. It is recommended that the wedge be seated inside the socket to properly secure the wire rope by using the crane's hoist to first apply a light load to the live-end.
6. After final pin connections are made, increase the loads gradually until the wedge is properly seated.
7. The wire rope and wedge must be properly secured inside the socket before placing the crane into lifting service. It is the wedge that secures the wire rope inside the socket. The dead-end treatment is used to restrain the wedge from becoming dislodged from the socket should the rope suddenly become unloaded due to the downhaul weight or hook block striking the ground, etc.

Sketches A through F (Figure 4-11) 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 ATB system and other components during use of the crane.

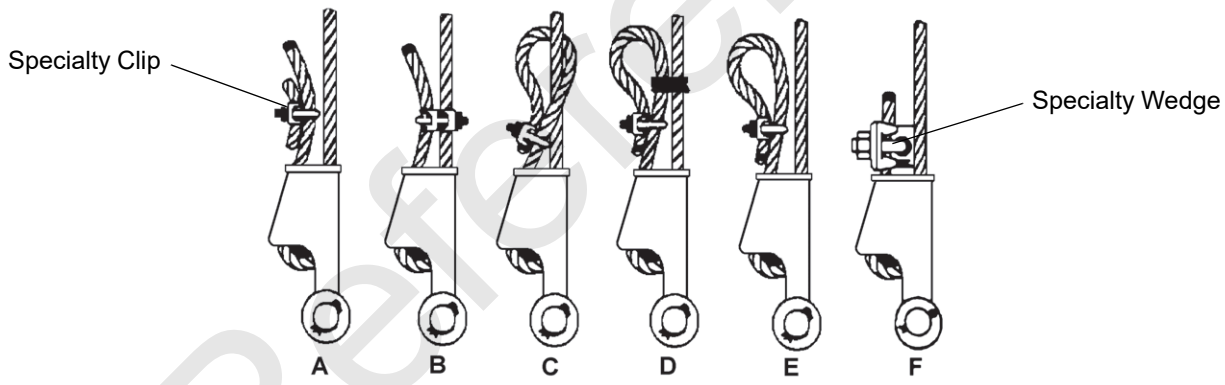
Of the methods shown below, National Crane prefers that method A or F be used, i.e., clipping a short piece of wire rope to the dead-end or using a commercially available specialty wedge. Typically, it is recommended that the tail length of the dead-end should be a minimum of 6 rope diameters but not less than 6 inches (15.2 cm) for standard 6 to 8 strand ropes and 20 rope diameters but not less than 6 inches (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 4-2).

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 manufacturer." Wire ropes are addressed in ASME B30.5, section 5-1.7.2 (2018 edition), ROPES, states: "Ropes shall be in accordance with the requirements of the crane manufacturer, rope manufacturer, or a qualified person, and should be in accordance with ASTM A1023/A1023M." Additional information is published by the Wire Rope Technical Board in the Wire Rope Users Manual, latest revised edition.

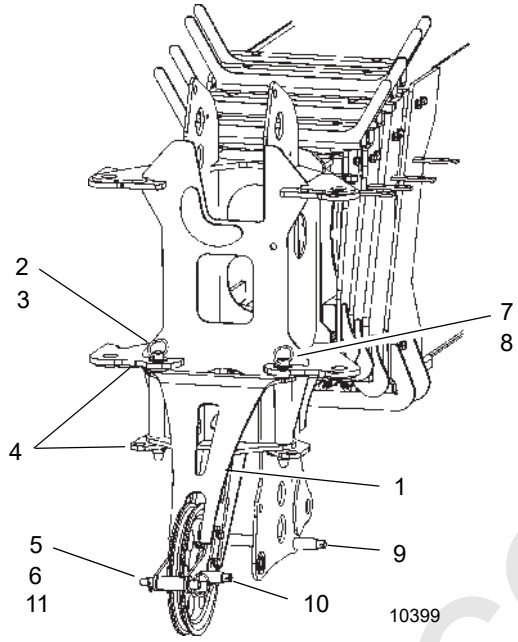
Table 4-2

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



Wedge Socket

FIGURE 4-11



Item	Description	Item	Description
1	Auxiliary Boom Nose	7	Left Side Pin
2	Right Side Pin	8	Left Side Cotter Pin
3	Right Side Cotter Pin	9	Main Sheave Case ATB Mounting Pin
4	Boom Nose Flange	10	Auxiliary Boom Nose ATB Mounting Pin
5	Hoist Rope Retention Pin	11	Bushing
6	Hoist Rope Retention Cotter Pin		

FIGURE 4-12

AUXILIARY BOOM NOSE (OPTIONAL)

The NBT40-2 features an optional single sheave auxiliary boom nose. The auxiliary boom nose can be used with the auxiliary hoist for single part line operation or with the main hoist and main boom nose for 7- and 8-part reevings. Use the following sections to install and remove the auxiliary boom nose.

NOTE: The auxiliary boom nose weighs 26.7 kg (58.9 lb). Two persons may be required to lift the auxiliary boom nose.

Installing the Auxiliary Boom Nose

Use the following procedure to install the single sheave auxiliary boom nose (1, Figure 4-12).

1. Fully extend the outriggers and SFO.
2. Remove the hook block or overhaul weight.
3. Remove the ATB switch and weight from the hoist rope and boom nose.
4. Remove hoist rope retaining pins as needed. Unreeve the hoist rope from the boom nose sheaves.
5. Position the auxiliary boom nose (1) between the left boom nose flanges. Install the left side pin (7). Secure the pin with cotter pin (8).
6. Install the right side pin (2). Secure the pin with cotter pin (3).
7. Remove cotter pin (6), hoist rope retention pin (5), and bushing (11) from the auxiliary boom nose.
8. Reeve the hoist rope over the auxiliary boom nose sheave. For more information, see *Possible Multi-Part Line Reeving Combinations*, page 4-13.
9. Install the hoist rope retention pin (5) and cotter pin (6) to secure the hoist rope.
10. Install ATB switch and weight on the auxiliary boom nose (10). If using the auxiliary boom nose for 7- or 8-part reevings, leave the ATB switch on the main sheave case (9). For more information, see *Anti-Two Block (ATB) Weight Installation*, page 4-12.
11. Install the overhaul ball or hook block.

Installing the Anti-Two Block (ATB) on the Auxiliary Boom Nose

Use the following procedures to install the ATB switch on the auxiliary boom nose. For more information about possible reeving combinations, see *Possible Multi-Part Line Reeving Combinations*, page 4-13.

Installing the ATB Switch

Use the following procedure to install ATB switch on the auxiliary boom nose (1, Figure 4-13). The main boom nose ATB switch (2) connector is connected to splitter (4) port A. When the ATB is not installed, a resistor is installed in splitter port B. Remove the resistor and connect the auxiliary boom nose ATB switch (1) to splitter (4) port B. The resistor is stored in the cap.

CAUTION

The main boom nose and auxiliary boom nose ATB switches are not interchangeable. Read the ATB switch label to verify the correct ATB switch is connected to the correct splitter port. The main boom nose ATB switch features a 24-inch (61 cm) cable and connects to splitter port A. The auxiliary boom nose switch features a 36-inch (91 cm) cable and connects to splitter port B. Connecting an ATB switch to the incorrect splitter port will cause the ATB alarm to sound.

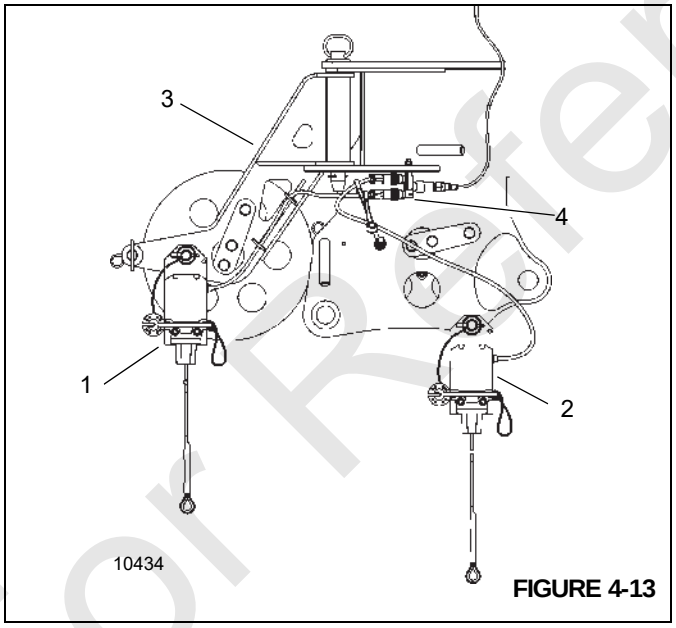


FIGURE 4-13

1. Install the auxiliary boom nose (3). For more information, see *Installing the Auxiliary Boom Nose*, page 4-21.
2. Install the ATB switch (1) to the post on the auxiliary boom nose (3). Secure the switch to post with pin.

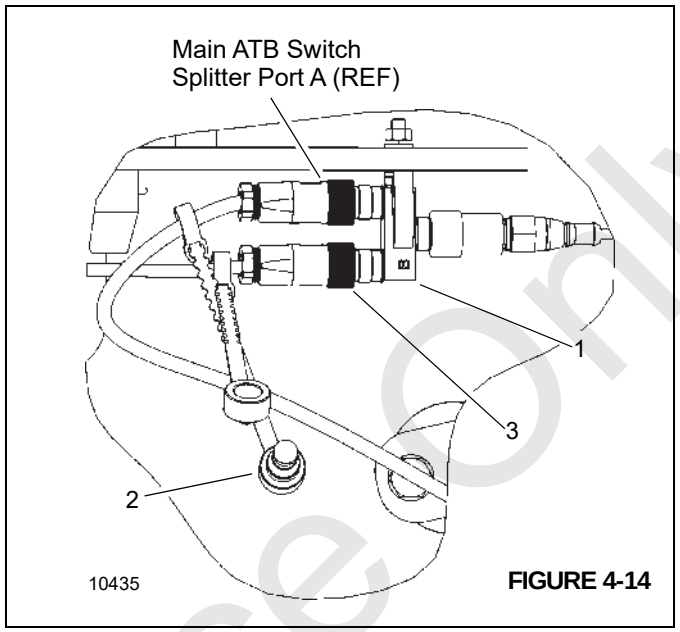


FIGURE 4-14

3. Remove the resistor from splitter port B (1, Figure 4-14). Store the resistor in the cap (2).
4. Connect the auxiliary boom nose ATB data connector (3) to splitter port B (1).
5. Reeve the hoist rope on the auxiliary boom nose as necessary.
6. Install the ATB weight block. For more information, see *Anti-Two Block (ATB) Weight Installation*, page 4-12.

Removing the ATB Switch

Use the following procedure the remove the ATB switch from the auxiliary boom nose.

1. Remove the ATB weight block. For more information, see *Anti-Two Block (ATB) Weight Installation*, page 4-12.
2. Unreeve the hoist rope from the auxiliary boom nose as necessary.
3. Disconnect the auxiliary boom nose ATB data connector (3, Figure 4-14) from splitter port B (1).

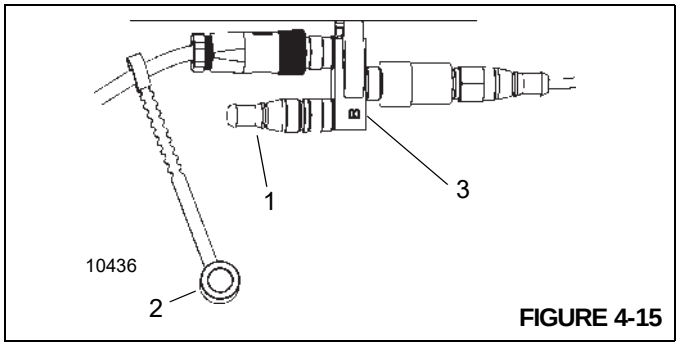


FIGURE 4-15

4. Remove the resistor (1, Figure 4-15) from the cap (2). Install the resistor in splitter port B (3).

5. Remove the ATB switch from the auxiliary boom nose.
6. Remove the auxiliary boom nose as necessary.

Removing the Auxiliary Boom Nose

Use the following procedure to remove the auxiliary boom nose (1, Figure 4-12) from the boom.

NOTE: The auxiliary boom nose must be removed before deploying or installing the jib or personnel platform on the boom nose. For more information, see *Deploying And Stowing The Jib*, page 4-5.

1. Fully extend the outriggers and SFO.
2. Remove the hook block or overhaul weight.
3. Lower the boom if necessary and remove the ATB switch and weight from the hoist rope and boom nose.
4. Remove the cotter pin (6), hoist rope retaining pin (5), and bushing (11) from the auxiliary boom nose (1). Unreeve the hoist rope from the auxiliary boom nose sheave.
5. Remove the right side cotter pin (3) from the right side pin (2). Remove the pin (2).
6. Remove the left side cotter pin (8) from the left side pin (7). Remove the pin (7). Remove the auxiliary boom nose.

NOTE: The left and right side pins (2) and (7) and cotter pins (3) and (8) can be stored by inserting and securing them in the auxiliary boom nose mounting holes.

7. Reeve the hoist rope on the boom nose sheaves.
8. Install the ATB switch and weight on the hoist rope. For more information, see *Anti-Two Block (ATB) Weight Installation*, page 4-12.
9. Install the overhaul ball or hook block.

Temporarily Moving the Auxiliary Boom Nose

DANGER

ENTANGLEMENT HAZARD

Death or serious injury may result if entanglement occurs during hoist operation.

Keep all body parts, safety harness, and loose clothing clear while hoist is running.

NOTE: The auxiliary boom nose must be removed before deploying or installing the jib.

NOTE: The auxiliary boom nose must be removed or fully installed before travel.

Use the following procedure to temporarily swing the auxiliary boom nose to one side. If re-reeving the main boom nose, the auxiliary boom nose can be temporarily moved to one side to access the boom nose sheaves. The auxiliary boom nose can be moved to the right side or the left side.

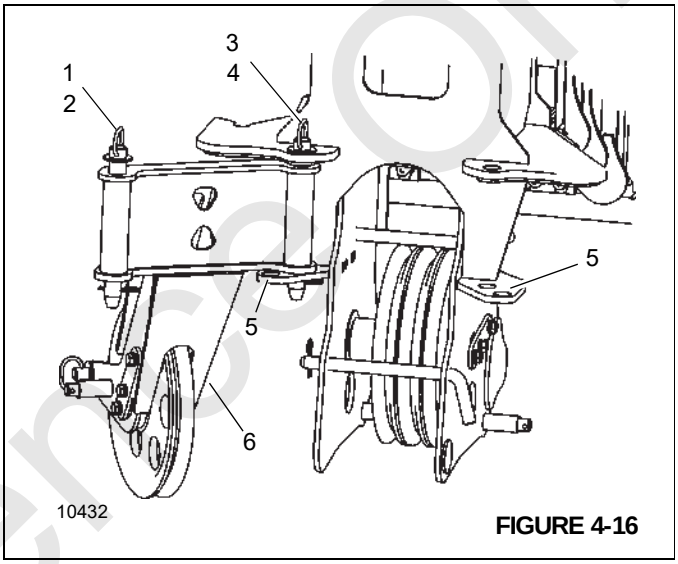


FIGURE 4-16

1. Remove the cotter pin (2 or 4, Figure 4-16) and pin (1 or 3) from one side of the auxiliary boom nose (6).
2. Swing the auxiliary boom nose to the side. Figure 4-16 shows the auxiliary boom nose (6) moved to the right side.
3. To temporarily hold the auxiliary boom nose in position, insert the pin (1 or 3) in the retention hole (5) in the boom nose mounting flange hole.
4. Adjust the boom nose reeving as necessary.
5. Remove the pin (1 or 3) from the retention hole (5).
6. Swing the auxiliary boom nose (6) into installed position.
7. Secure the auxiliary boom nose (6) to the boom nose with pin (1 or 3) and cotter pin (2 or 4).

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SECTION 5
LUBRICATION GREASE PROCEDURE AND CHARTS

SECTION CONTENTS

GENERAL

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

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

Environmental Protection

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

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

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

When filling and draining crane components, observe the following:

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

Lubricants

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

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 National Product Support.

NOTE: All fluids and lubricants may be purchased by contacting the National Product Support 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.

Open Gear Lubricant (LP-OGL)

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) (AFC)

The standard antifreeze/coolant is intended to provide protection against freeze-up down to -40° C (-40° F) and overheat temperature shutdown of 105° C (221° F).

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 (HYDO)

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 range specified in table can cause component damage.

NOTE: When operating the crane in temperatures -9°C (15°F) and below, follow the procedures in the section titled *Arctic Conditions Below -9°C (15°F)*, page 5-1.

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 range specified in table can cause component damage.

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 halogenated hydrocarbons, nitro hydrocabons and phosphate ester hydraulic fluids might not be compatible with hydraulic system seals and wear bands. Arctic hydraulic oil is not recommended for service in ambient temperatures above 0°C (32°F).

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

NOTE: All fluids and lubricants may be purchased by contacting the National Product Support 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 National Product Support if you have any questions.

LUBRICATION POINTS

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

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

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

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

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

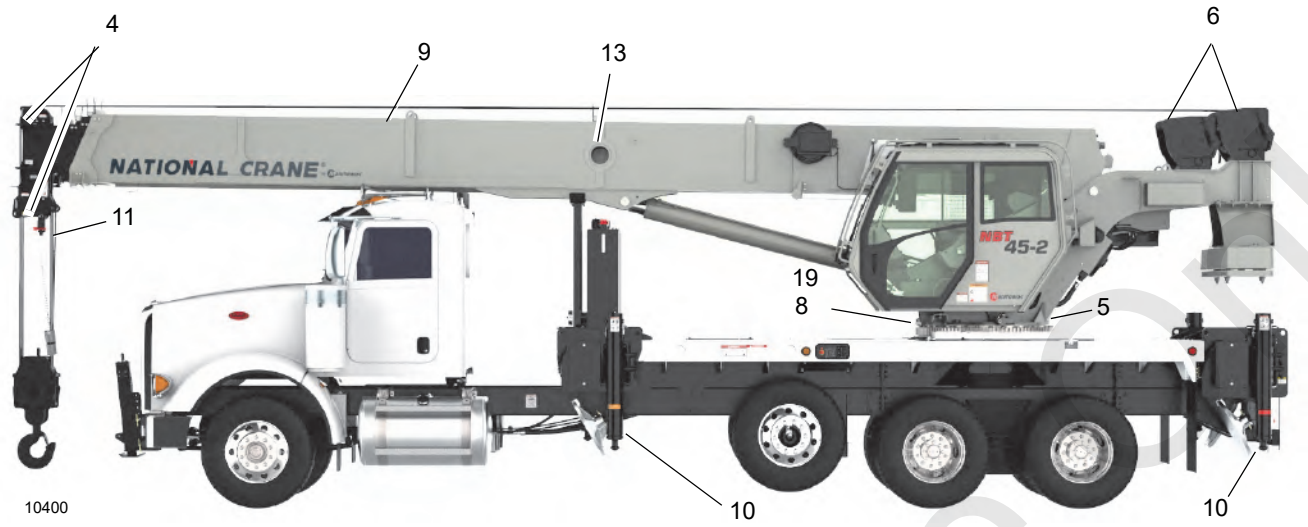
CAUTION

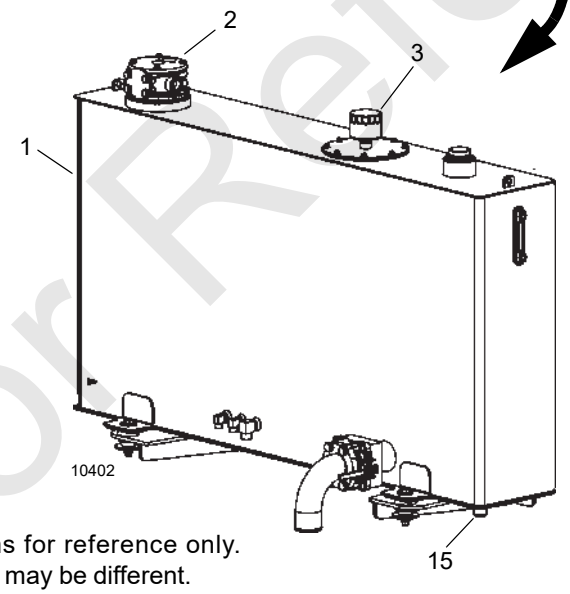
Lubrication intervals (page 5-4) are to be used only as a guide. Actual intervals should be formulated by the operator to correspond accordingly to conditions such as continuous duty cycles and/or hazardous environments.

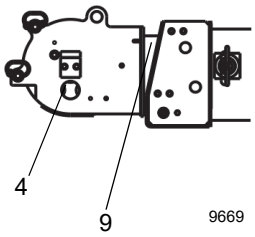
The following sections describe the lubrication points and gives the lube type, lube interval, lube amount, and application of each. Each lubrication point is numbered, and this number corresponds to the index number shown on the Lubrication Chart (Figure 5-1). Lube description and symbols are found in table below.

Symbol	Description	National Crane Lubrication Specification		
		Standard	Cold Weather -29C (-20F)	Cold Weather -40C(-40F) and Below
EP-MPG	Extreme Pressure Multipurpose Grease	6829003477	6829104275	6829104275
GL-5	Gear Lube (GL-5)	6829012964	6829012964	6829014058
AFC	Fully Formulated Anti-Freeze Coolant	6829101130	6829101130	6829104212
HYDO	Hydraulic Oil	6829006444	6829006993	6829006993
EP-3MG	Extreme Pressure 3% Moly Multipurpose Grease	6829015304	6829104275	6829104275
WRL	Wire Rope Lubricant	6829015236	6829015236	6829010993
EP-OGL	Open Gear Lubricant	6829102971	6829102971	6829102971
AGMA EP-4	Extreme Pressure Gear Lubricant	6829100213	6829103636	6829103636

Lubrication Points







Telescoping Jib

Illustrations for reference only.
Your crane may be different.

FIGURE 5-1

Item	Application	Recommended Lubricant	Procedure	Frequency
1	Hydraulic Oil Tank Reservoir	HYDO	Check and Fill Change	Weekly, Fill as required Semi-Annually
2	Hydraulic Tank Oil filter		Change or clean	After first 40 Hrs, Quarterly thereafter.
3	Breather, Hydraulic oil reservoir		Clean	Monthly
4	Sheave pins: boom (5 plcs), jib (1 pl), block (1 pl), Aux nose sheave (1 pl)	EP-MPG	Grease gun	Weekly
5	Swing bearing	EP-MPG	Grease gun	Weekly Apply grease until grease extrudes from the bearing circumference. Note: Rotate superstructure 90 degrees and apply grease to fittings. Continue rotating in 90 degree increments and grease fittings until the entire bearing is greased.
6	Hoist gearbox and brake	AGMA EP-4	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. For more information, see *Hoist Gearbox and Brake Oil*, page 5-6.
7	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 thereafter. For more information, see *Swing Gearbox Oil*, page 5-8.
8	Swing gear teeth	EP-OGL	Spray Can	Monthly
9	Boom Inner, Side and Bottom Wear Pads	EP-3MG	See page 5-6	Monthly or as required
10	Outrigger beams, bottom, sides	EP-3MG	Brush or roller spray can	Monthly or as required
11	Wire rope (loadline)	EP-OGL	Brush or spray	Semi-Annually
12	Swing Motor Pinion Bearing	EP-MPG	Grease Gun	Sparingly every 50 hours
13	Retract Sheaves, Rear of sections 2, 3, and 4: Fully retract the booms until the retract sheave grease fittings can be accessed from the rear of the Booms or extend the booms until the fittings are visible through the access holes at the center of boom.	EP-MPG	Grease Gun	Weekly
14	Extension Cables (Not Shown)	WRL	Spray or Brush	Any Time Boom is Disassembled or 7 Years

Item	Application	Recommended Lubricant	Procedure	Frequency
15	Hydraulic tank magnetic plug (tank bottom)		Clean	When servicing hydraulic tank, item 1
16	Cab Heater Reservoir	AFC	Check and Fill Change	Check and Fill: Weekly, Fill As Required Change: Semi-Annually
17	Hook Block Swivel Bearing	EP-MPG	Grease gun	Monthly
18	Hook Block Sheaves	EP-MPG	Grease gun	Monthly
19	Turntable Swing Lockpin	EP-OGL	Spray	Monthly

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

Side and Bottom Boom Wear Pad Lubrication

WARNING

Follow all load charts when greasing the boom.

Recommended lubricant is EP-3MG grease.

1. Fully extend and set the outriggers.
2. Lower the boom to horizontal.

   Extend the boom and apply grease to the side and bottom of the section 2, section 3, section 4, and section 5 with a brush.
3. Raise the boom to 75° and retract the boom.
4. Extend and retract the boom several times until the grease is evenly spread.
5. Repeat as necessary.

Outrigger Beam Lubrication

DANGER

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

Recommended lubricant is EP-3MG grease.

1. Fully extend and set the outriggers. Refer to *Outrigger Setup*, page 4-1.
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.

Hoist Gearbox and 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.

NOTE: The NBT40-2 cranes feature two hoists: Main and if equipped, Auxiliary. Use the inspection and oil change procedures below for each hoist.

The hoist(s) share(s) oil between the gearbox and brake. The hoist gearbox and brake oil should be checked through the sight glass every 500 hours of operation, or every three months. The oil should be changed after the first 100 hours of operation, and every 1,000 hours or 3 months thereafter. The hoist oil capacity is 5.44 liters (11.5 pints). See *Lubrication Points*, page 5-3 for oil type and maintenance intervals.

NOTE: Hoist lubricants are satisfactory for operation in temperatures from -23° C to 66° C (-10° F to +150° F). For operation outside this range, contact National Product Support for recommendations.

Inspect the Oil Level

Check the oil level in the sight glass (1, Figure 5-2) on the hoist. The oil should be approximately half-way up in the sight glass. The hoist gearbox and brake holds a maximum of 5.44 liters (11.5 pints) of oil.

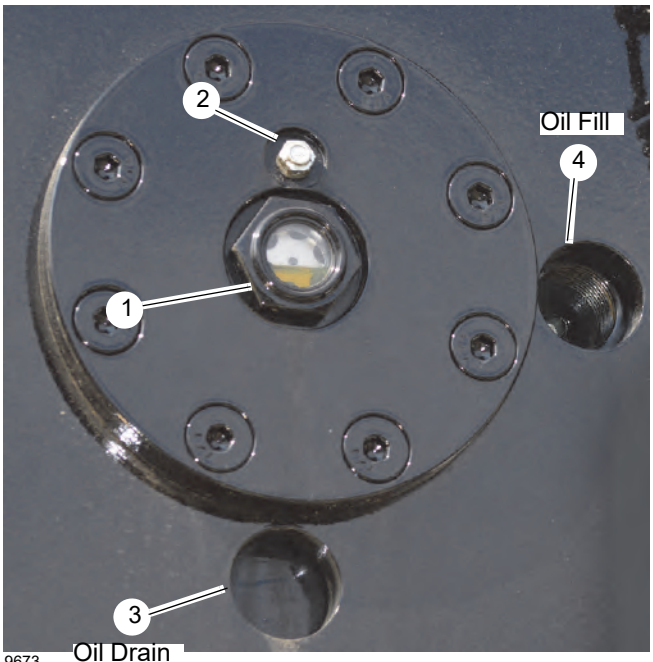


FIGURE 5-2

Replace the Hoist Oil

The hoist oil drain and fill plug is located on the drum. The plug can be accessed through one of two access holes. The bottom (6 o'clock position) access hole (3, Figure 5-2) is used when draining the oil. The access hole on the side (3 o'clock position) is the used when filling the hoist with oil (4).

When draining the hoist oil, use a short, 1 inch pipe with standard 1-11.5 NPSM thread. The pipe is installed in the larger, outer threads around the drain and fill plug and will serve as a drain for the oil. The pipe can also be used as needed when filling the hoist with oil.

The vent plug (2) is a one-way vent. It must be clean and unobstructed. Do not paint over the vent plug or replace it with a solid plug.

Drain the Gearbox and Brake Oil

1. Remove the vent plug (2, Figure 5-2). Clean with solvent as needed. Set aside for later use.
2. Rotate the hoist drum so the drain and fill plug (Figure 5-3) is aligned with the oil drain access hole at the 6 o'clock position (3, Figure 5-2).

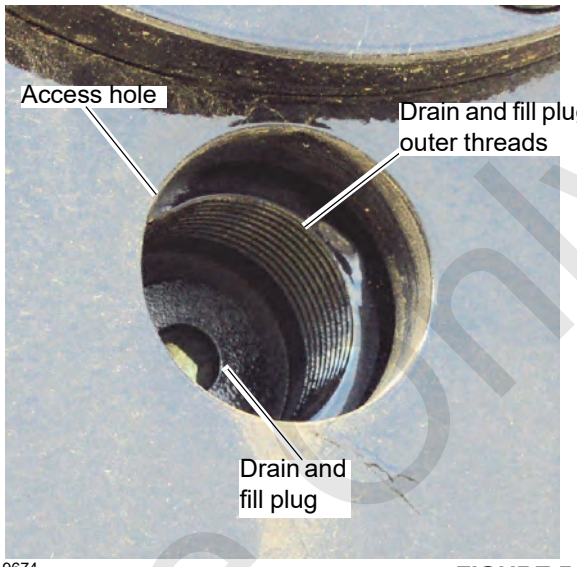


FIGURE 5-3

3. Install a short 1 inch (25 mm) pipe in the inner threads around the drain and fill plug (Figure 5-3).

NOTE: Place an oil pan or other receptacle under the drain pipe as needed.

4. Using a 5/16 inch (8 mm) Allen wrench, remove the drain and fill plug through the drain pipe. Allow the oil to drain from the hoist completely.
5. Inspect the O-ring on the drain and fill plug. Replace as needed.
6. Install the drain and fill plug through the 1 inch (25 mm) drain pipe using a 5/16 inch (8 mm) Allen wrench. Torque the fill and drain plug to 67.8 Nm (50 ft-lb).
7. Remove the 1 inch (25 mm) drain pipe from access hole.
8. Coat the vent plug (2, Figure 5-2) threads with oil and install the vent plug.

Fill the Gearbox and Brake Oil

1. Rotate the hoist drum so the plug aligns with the oil fill access hole at the 3 o'clock position (4, Figure 5-2).
2. Using a 5/16 inch (8 mm) Allen wrench, remove the drain and fill plug (Figure 5-3).

CAUTION

The hoist gearbox and brake holds a maximum of 5.44 liters (11.5 pints) of oil. Under- or over-filling the hoist can lead to damage of equipment.

5

3. Fill the hoist gearbox and brake with oil. See *Lubrication Points*, page 5-3 for specific lubricants.
4. Visually inspect the oil level through the sight glass (1, Figure 5-2). When done filling, the oil level should be approximately half-way up in the sight glass.
5. Using a 5/16 inch (8 mm) Allen wrench, install and tighten the drain and fill plug (4, Figure 5-3). Torque the drain and fill plug to 67.8 Nm (50 ft-lb).

Swing Gearbox Oil

The oil in the gearbox is recommended to be changed after first 50 hours of operation and every 500 hours thereafter.

1. Remove the vent/fill plug (1, Figure 5-4*)* and drain plug (2) to drain the gearbox oil*.*
2. Examine the used oil for signs of significant metal deposits and then dispose of it in a proper manner.
3. Replace the drain plug (2). Inspect and replace the o-ring as needed.
4. At the vent/fill level/fill plug (1). Fill the swing gearbox with 2.4 liters (2.5 quarts) of the appropriate type of oil, and then replace the vent/fill plug (1). Inspect and replace the o-rings as needed. *See Lubrication Points*, page 5-3 of this manual*.*
5. Inspect the outside of the swing gearbox daily for any visible leaks. The maximum oil capacity for this gearbox is 2.4 liters (2.5 quarts) of gear lube oil. Gearbox lubricants are satisfactory for standard operation in temperatures from -23° C to 82° C (-10° F to +180° F). For operation outside this range, contact National Product Support for recommendations.

Check the Oil Level

Open the fill port (1, Figure 5-4). The oil level should be 3.81 cm (1.5 in) below the top surface of the fill port.

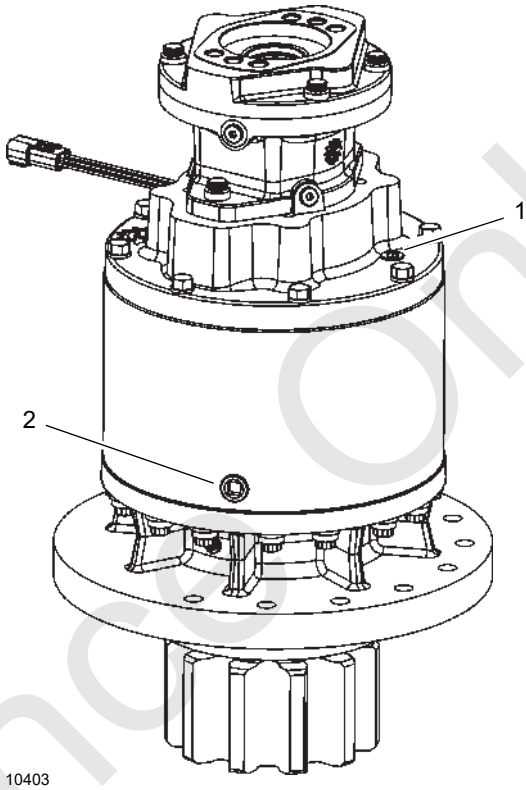


FIGURE 5-4

Hydraulic Oil Reservoir Level

The hydraulic oil reservoir has a sight gauge (1, Figure 5-5) located on the side of the reservoir. The oil in the hydraulic reservoir is sufficient when the level is between the High and Low marks on the sight gauge with the crane parked on a level surface in the transport position and the oil is 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.

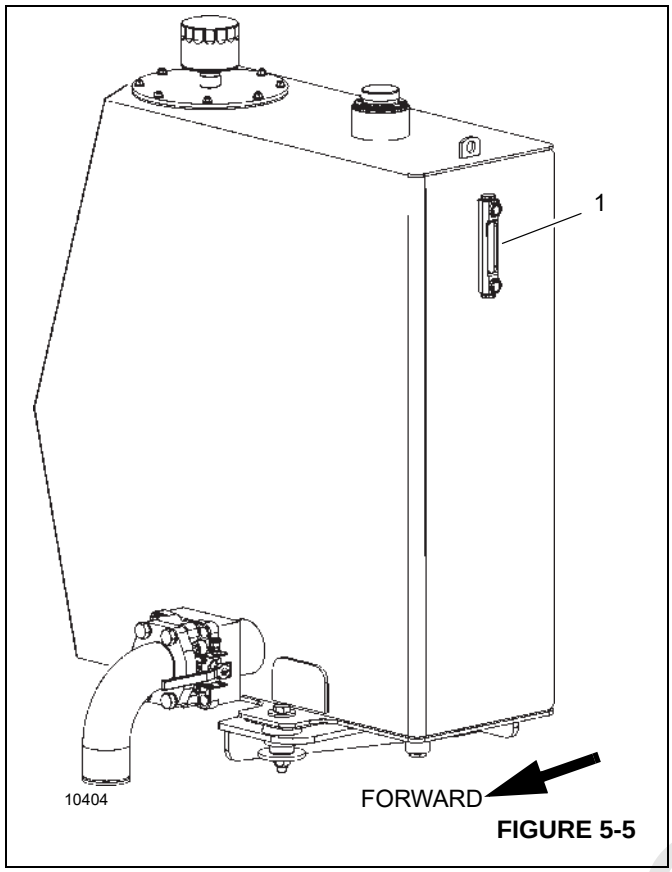


FIGURE 5-5

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. National Product Support 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.

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 (example: 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.

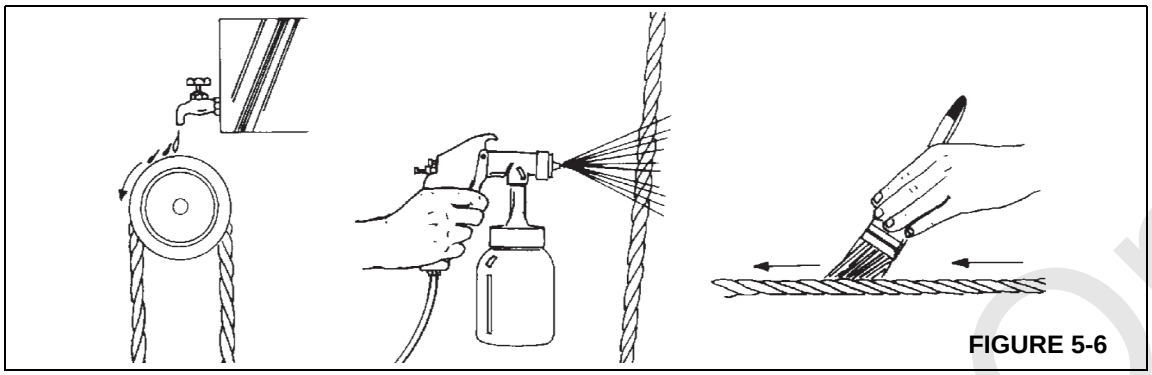


FIGURE 5-6

CARWELL® RUST INHIBITOR

Protecting Cranes From Rusting

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

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

Carwell is a treatment, not a coating. It contains no silicones, solvents, CFCs or anything that would be classified as hazardous under OSHA Regulation 29CFR-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 cleaning if the crane is operated:

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

- in high humidity, or when temperatures are just above the freezing point.

Cleaning Procedures

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

- High pressure water or steam is effective for cleaning the crane's undercarriage and wheel housings. Keeping these areas clean will not only help slow 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, National Product Support 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: National Product Support 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, National Product Support must be contacted and consulted as to what repairs may be required.

For scratches and marks in highly visible areas:

- Sand to remove the scratch and feather outward from the mark to blend the repair into the original surface. Body putty may be applied as necessary to hide the defect; then sand smooth.
- Cover all bare metal with a primer that is compatible with the original paint finish and allow to dry thoroughly.
- Prepare the surface prior to applying the finish coat of paint.
- Apply a finish coat paint using accepted blending techniques. Use of original paint colors is recommended to ensure 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 slow the effects of corrosion and enable you to do the repair at a later time during a normal maintenance interval.

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

Application

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

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

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

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

NOTE: Unit must be completely dry before applying treatment.

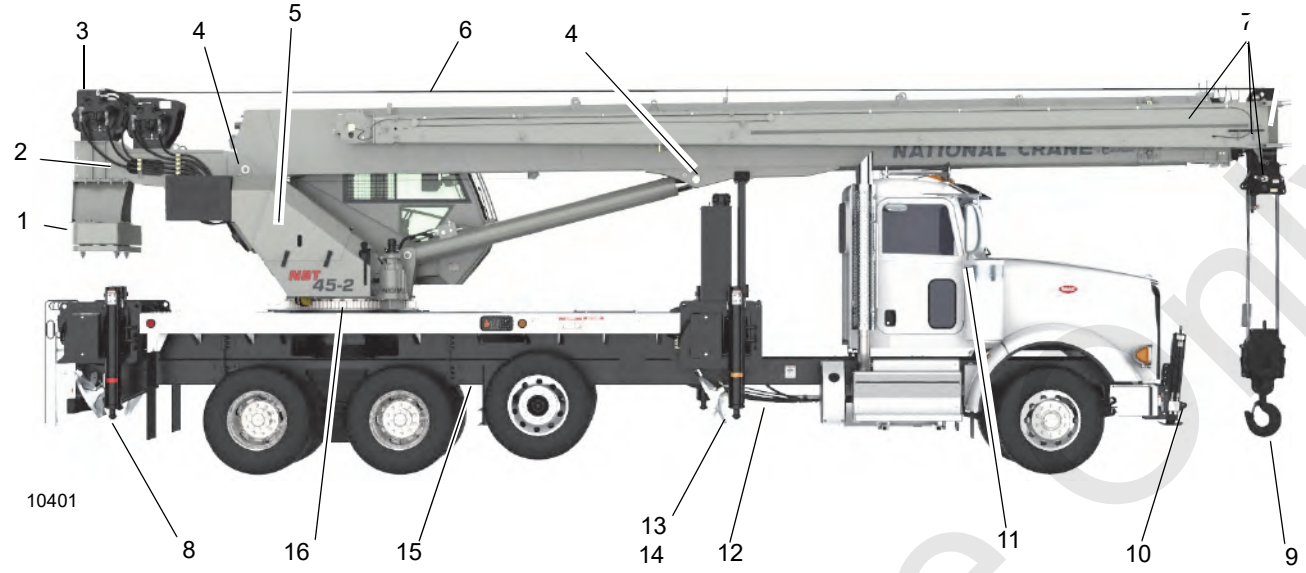
- Do not allow product to puddle or build-up on weather stripping, rubber gaskets, etc. Unit should not have puddles or runs evident anywhere.
- To ensure proper coverage of treatment, the product needs to be fogged on the unit.
- Use of pressure pots to apply the treatment to the unit being processed is recommended.
- Carwell treatment is available in 16 ounce spray bottles from National Product Support (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 National Product Support should you have any questions.

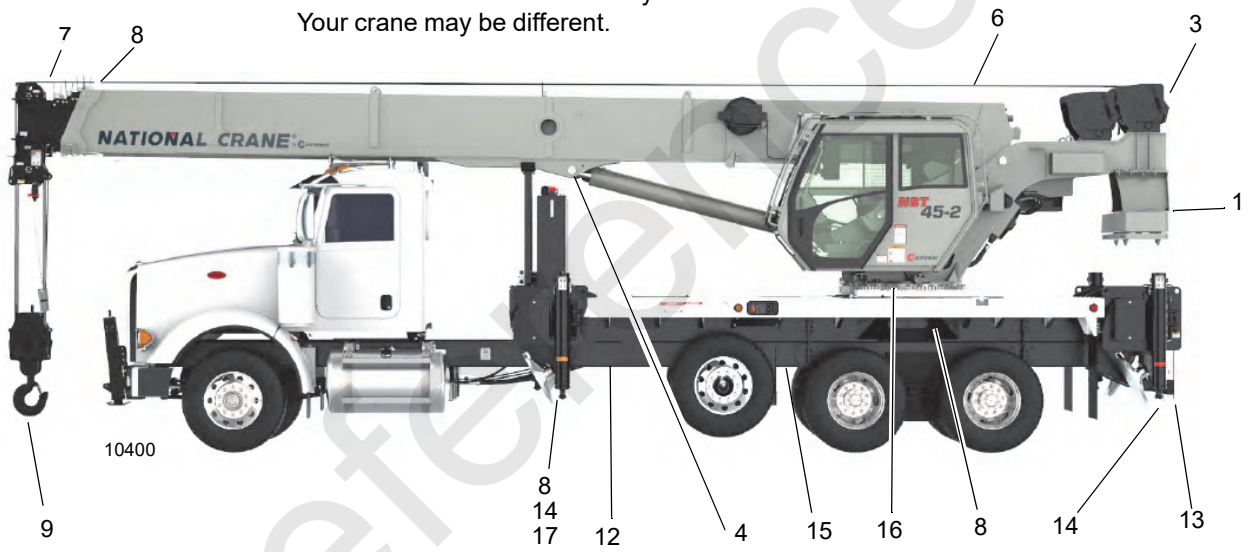
Areas of Application

Refer to Figure 5-7

- 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, downhaul weight pins/ hook block pins and fasteners.
- All hardware, clips, pins, hose connections not painted will have treatment applied.



Illustrations for reference only.
Your crane may be different.



Item	Description
1	Counterweight Pins
2	Hoist Plumbing Connections
3	Tension Spring
4	Pivot Shaft
5	Valve bank, Hose Connections inside turntable
6	Wire Rope
7	Boom Nose Pins, Clips
8	All Hardware, Clips, Pins, Hose Connections not painted Outrigger Pins, Clips
9	Downhaul Weight/Hook Block

Item	Description
10	Downhaul Weight/Hook Block Tiedown
11	Mirror Mounting Hardware
12	Powertrain Hardware
13	Outrigger Hose Connections
14	Outrigger Pins, Clips
15	Entire underside of unit
16	Turntable Bearing Fasteners
17	Outrigger Beam Hardware
18	Boom Extension Hardware (Optional)

FIGURE 5-7

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SECTION 6
MAINTENANCE CHECKLIST

SECTION CONTENTS

CRANE INSPECTION AND MAINTENANCE

Regularly scheduled inspection and maintenance intervals are required to keep the unit 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.

DANGER

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. If replacing a missing fastener or tightening a loose fastener, refer to the applicable torque chart in Section 1 of the Service Manual. Should a deficiency 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 ASME B30.5 require that dated and signed records of these periodic inspections be kept. An inspection log book is available from National Crane.

WARNING

If any deficiency determined during the inspection is a safety hazard the machine must be removed from service and the deficiency 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 rope and end attachment for corrosion, severe kinking, crushing, cutting, or slippage of rope clamps or wedge socket.
8. Loose parts or damage to rope hook blocks.
9. Position of rope with guides and on sheaves.
10. Free turning of sheaves.
11. Lubrication as specified by the Lubrication Chart. For more information, see “Lubrication Grease Procedure and Charts” on page 5-1.
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 ensure 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 jib 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 rope retainers are in place and tight.
22. All safety covers for proper installation.
23. Boom lift and outrigger holding valves for proper operation.
24. Outrigger pads and cribbing.
25. Hoist brake for proper operation at hoist capacity load.
26. Control and drive mechanisms for excessive wear and/or contamination from lubricants, water or other foreign matter.
27. All air, hydraulic, and working mechanisms before operating the PTO. Perform maintenance per PTO manufacturer’s specifications.

Weekly Inspections

Check the following items:

1. Battery water level.
2. Tire pressure.
3. Lubrication as specified by the Lubrication Chart. For more information, see “Lubrication Grease Procedure and Charts” on page 5-1.
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 crane Operation Manual is with the unit. If the manual is missing, obtain the serial number of the unit and order an operation 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 Chart. For more information, see “Lubrication Grease Procedure and Charts” on page 5-1.
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, superstructure, 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. Rope clip bolts above wedge socket at the end of the loadline should be properly torqued. See the *NBT40-2 Series Service Manual* for more information.
9. All boom wear pad retaining bolts.
10. Boom extension cables for proper tension or evidence of abnormal wear.

11. Sheaves and rope drums for wear and cracks.
12. Unwind the loadline and check according to rope maintenance procedure.
13. PTO for possible leaks. Tighten all air, hydraulic, and mounting hardware per manufacturer's specifications. Re-torque as necessary.

Periodic/Annual Inspection

Check the following items:

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

Special Boom Inspection

If the boom has not been disassembled and inspected in the last seven years of use, the boom is to be completely torn down to allow a thorough inspection of the extend and retract ropes, sheaves, and pins.

Stability

Stability of unit throughout working area. Check the stability procedure in Installation Section of the *NBT40-2 Series Service Manual* annually or when any changes are made to crane or truck.

HOIST ROPE INSPECTION AND MAINTENANCE

⚠ WARNING

Worn or Damaged Equipment Hazard!

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

Hoist 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: Hoist rope may be purchased through National Product Support.

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 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 rope should be replaced.

It is recommended that the rope inspection program include reports on the examination of 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 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 rope to abrasive material may shorten normal rope life. Frequent/periodic inspections and maintenance of rope is recommended for preventing premature wear and to insure long-term satisfactory performance.

NOTE: Refer to *Wire Rope Lubrication*, page 5-9 for wire rope lubrication requirements.

Dynamic Shock Loads

Subjecting rope to abnormal loads beyond the endurance limit will shorten the 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.

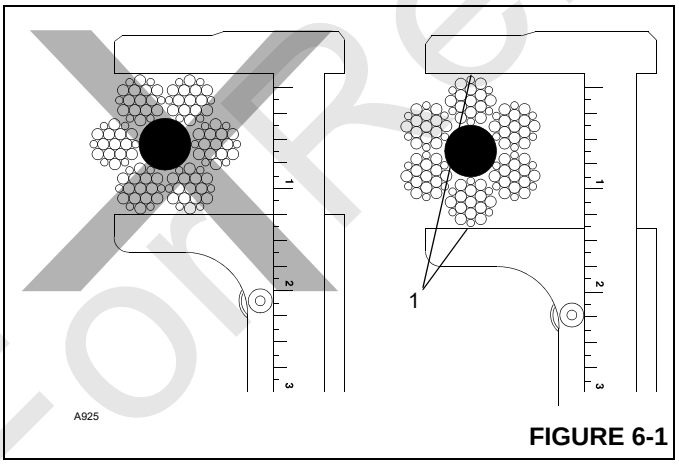


FIGURE 6-1

Inspection

All hoist rope in service needs to be inspected on a daily, monthly, and quarterly basis. Rope 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 rope diameter in a short rope length or unevenness of outer strands indicates the rope 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 rope. Never attempt to open the rope.

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 rope in continuous service must be inspected at the beginning of each work day. Inspect the wedge socket and length of rope 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 rope length used for daily operations for points showing kinks, sharp bends, or any other evidences of damage or excessive wear.

Monthly Inspections

Inspect the wedge socket and length of rope normally used in daily operations. Examine the rest of the rope for kinked, crushed or otherwise damaged points.

Periodic Inspections

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:

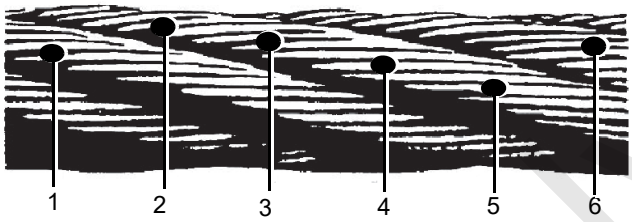
- Inspect for severely corroded or broken wires at end connections.
  - Reduction of rope diameter below nominal diameter.
- Inspect rope in areas subjected to rapid deterioration such as:
  - Sections in contact with saddles, equalizer sheaves, or other sheaves where rope travel is limited.
  - Sections of wire rope at or near terminal ends where corroded or broken wires may protrude.
  - Sections in contact with stationary surfaces where abrasion or chafing may take place as a result of equipment vibration.
- Inspect boom nose sheaves, hook block sheaves, jib/ extension sheaves, auxiliary boom nose sheave, and hoist drums for wear. Damaged sheaves or hoist drums can accelerate wear and cause rapid deterioration of the rope.

Inspect the wedge socket of the rope for greater wear than the rest of the rope. If the rope is in good condition, reverse the rope on the drum so that the wear is equalized along the total length of the rope.

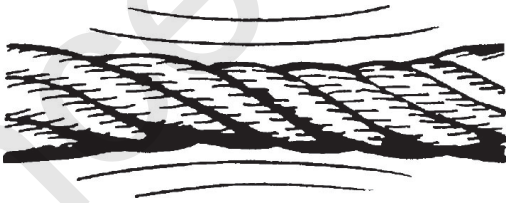
Wire Rope Replacement

No precise rules can be given for determination of the exact time for replacement of wire rope since many variable factors are involved. Determination regarding continued use or replacement of wire rope depends largely upon the good judgement of an appointed and qualified person who evaluates the remaining strength in a used rope after allowance for any deterioration disclosed by inspection.

- Wire rope replacement should be determined by the following information excerpted from a National Consensus Standard as referenced by Federal Government Agencies and as recommended by National Crane. All wire rope will eventually deteriorate to a point where it is no longer usable. Wire rope shall be taken out of service when any of the following conditions exist:
- 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 5%:
  - 0.4 mm (0.0156 in) for rope diameters to 8 mm (0.313 in)
  - 0.8 mm (0.031) for rope diameters 9.5 mm (0.375 in) to 0.50 in (12.7 mm)
  - 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) 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.
- National Crane recommends that for cable extended booms, a single damaged wire rope assembly shall require replacement of the complete set of extension cables.
- National Crane recommends that boom extension cables be replaced every seven (7) years.

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 ROPE

If the hoist rope needs to be replaced, care should be taken in selecting a suitable replacement rope. The rope strength requirements are shown on the crane load chart. The types of rope are optional with 6 × 25 and Dyform being the most common. A high strength, rotation resistant rope is preferred and is furnished as standard by National Cranes. This rope eliminates single part line load spin and prolongs rope life. It also eliminates load block spin up when multi-part reeving is used. For more information, see “Specifications” on page 6-10.

CRANE ADJUSTMENTS AND REPAIRS

Before adjustments and repairs are started on a crane, read and be familiar with the safety information outlined under “Maintenance” on page 2-25.

Boom Extension Cable

If a cable replacement is required for the boom extension system, the replacement cable must be obtained through National Product Support. Extension cables are pre-stretched and have special connections for proper operation.

NOTE: National Crane recommends that boom extension cables be replaced every seven (7) years.

Jib Jack Service and Maintenance

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

Adding Oil to the Jib Jack

To add oil to the jib jack, do the following:

1. Set the jack in an upright level position.
2. Lower the saddle and make sure the piston is fully depressed.
3. Remove the oil filler plug.
4. Fill until the oil is level with the filler plug hole.

Changing the Jib Jack Oil

For best performance and longest life, replace the oil at least once a year. To change oil, do the following:

1. Remove the filler plug.
2. Lay the jack on its side and drain the oil into a suitable drain pan. The oil will run slowly because air must enter as oil drains out.
3. Be careful to prevent dirt or foreign matter from entering the system.
4. Replace with proper oil as described above.

Lubrication

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

Rust Prevention

Check the ram every three months for any sign of rust or corrosion. Clean as needed and wipe with an oil saturated cloth.

NOTE: When not in use, always leave the saddle and ram all the way down.

HYDRAULIC SYSTEM

Oil Cooler

The heat exchanger must be kept clean for efficient operation of the hydraulic cooler system. Wash the heat exchanger core frequently to eliminate oil film, road dirt, and other foreign object buildup on the heat exchanger fins.

Frequent inspection and tightening of hose clamp eliminates the possibility of end connection failure due to back pressure from a cold startup.

If the cooler system fails to provide adequate performance, reduced air or oil flow through the heat exchanger is the probable cause. Inspect the cooling fan for proper operation. Any obstructions to air flow should be corrected (cooler too close to other truck components, foreign matter in heat exchanger fins, etc.) All hydraulic lines should be periodically

checked for obstructions, hose kinks, or other flow restrictions.

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 SIZE DESIGNATION	USAGE	TIRE LOAD LIMITS (kg/lbs.) AT VARIOUS COLD INFLATION PRESSURES (kPa/psi)											
		450 *65*	480 *70*	520 *75*	550 *80*	590 *85*	620 *90*	660 *95*	690 *100*	720 *105*	760 *110*	790 *115*	830 *120*
295/60R22.5	DUAL	1750 *3860*	1830 *4040*	1930 *4245*	2000 *4410*	2030 *4480*	2120 *4665*	2240 *4940*	2280 *5025*	2360 *5195*	2430 *5355*	2510 *5535*	**2575(H)** 141 ***5675*(H)**
	SINGLE	1850 *4080*	1950 *4300*	2050 *4515*	2120 *4675*	2230 *4925*	2330 *5125*	2430 *5355*	2500 *5520*	2590 *5710*	2650 *5840*	2760 *6085*	**2800(H)** 144 ***6175*(H)**
225/70R19.5	DUAL	**1180(D)** 114 ***2600*(D)**	1230 *2720*	1300 *2860*	**1360(E)** 119 ***3000*(E)**	1410 *3115*	1470 *3245*	**1550(F)** 123 ***3415*(F)**	1580 *3490*	1640 *3615*	**1700(G)** 126 ***3750*(G)**		
	SINGLE	**1250(D)** 116 ***2755*(D)**	1310 *2895*	1380 *3040*	**1450(E)** 121 ***3195*(E)**	1500 *3315*	1570 *3450*	**1650(F)** 125 ***3640*(F)**	1690 *3715*	1740 *3845*	**1800(G)** 128 ***3970*(G)**		
245/70R19.5	DUAL				1550 *3415*	1590 *3515*	1660 *3655*	**1750(F)** 127 ***3860*(F)**	1790 *3940*	1850 *4075*	**1950(G)** 131 ***4300*(G)**	1970 *4345*	**2060(H)** 133 ***4540*(H)**
	SINGLE				1650 *3640*	1700 *3740*	1770 *3890*	**1850(F)** 129 ***4080*(F)**	1900 *4190*	1970 *4335*	**2060(G)** 133 ***4540*(G)**	2095 *4620*	**2180(H)** 135 ***4805*(H)**
265/70R19.5	DUAL				1700 *3750*	1780 *3930*	1860 *4095*	1950 *4300*	2000 *4405*	2000 *4415*	**2120(G)** 134 ***4675*(G)**		
	SINGLE				1800 *3970*	1900 *4180*	1970 *4355*	2060 *4540*	2130 *4685*	2200 *4850*	**2300(G)** 137 ***5070*(G)**		
305/70R19.5	DUAL				2060 *4540*	2120 *4670*	2200 *4860*	2300 *5070*	2370 *5230*	2450 *5410*	**2575(H)** 141 ***5675*(H)**	2620 *5770*	**2725(J)** 143 ***6005*(J)**
	SINGLE				2240 *4940*	2330 *5130*	2420 *5340*	2500 *5510*	2610 *5745*	2700 *5945*	**2800(H)** 144 ***6175*(H)**	2870 *6340*	**3000(J)** 146 ***6610*(J)**

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

TABLE TBM-2R
Continued

TIRE SIZE DESIGNATION	USAGE	TIRE LOAD LIMITS (kg/lbs.) AT VARIOUS COLD INFLATION PRESSURES (kPa/psi)											
		450	480	520	550	590	620	660	690	720	760	790	830
		65	*70*	*75*	*80*	*85*	*90*	*95*	*100*	*105*	*110*	*115*	*120*
255/70R22.5	DUAL				1800	1860	1940	2000	2020	2090	**2120(G)** [134]	2230	**2300(H)** [137]
					3970	*4110*	*4275*	*4410*	*4455*	*4610*	***4675*(G)**	*4915*	***5070*(H)**
	SINGLE				1900	1980	2060	2120	2220	2300	**2360(G)** [138]	2450	**2500(H)** [140]
					4190	*4370*	*4550*	*4675*	*4895*	*5065*	***5205*(G)**	*5400*	***5510*(H)**
305/75R22.5	DUAL				2360	2440	2540	2560	2730	2830	**3000(H)** [146]	3010	**3150(J)** [148]
					5205	*5375*	*5595*	*5840*	*6025*	*6235*	***6610*(H)**	*6640*	***6940*(J)**
	SINGLE				2575	2680	2790	2900	3000	3110	**3250(H)** [149]	3310	**3450(J)** [151]
					5675	*5905*	*6150*	*6395*	*6620*	*6850*	***7160*(H)**	*7300*	***7610*(J)**
315/80R22.5	DUAL				2575	2650	2750	**2900(G)** [145]	2970	3070	**3150(H)** [148]	3270	**3450(J)** [151]
					5675	*5840*	*6070*	***6395*(G)**	*6545*	*6770*	***6940*(H)**	*7210*	***7610*(J)**
	SINGLE				2800	2910	3030	**3150(G)** [148]	3260	3370	**3450(H)** [151]	3590	**3750(J)** [154]
					6175	*6415*	*6670*	***6940*(G)**	*7190*	*7440*	***7610*(H)**	*7920*	***8270*(J)**
305/85R22.5	DUAL				2430	2520	2620	2725	2820	2920	**3075(H)** [147]	3110	**3250(J)** [149]
					5355	*5550*	*5780*	*6005*	*6215*	*6435*	***6780*(H)**	*6860*	***7160*(J)**
	SINGLE				2650	2770	2880	3000	3100	3210	**3350(H)** [150]	3420	**3550(J)** [152]
					5840	*6100*	*6350*	*6610*	*6830*	*7070*	***7390*(H)**	*7540*	***7830*(J)**

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

TABLE TBM-1R

TIRE SIZE DESIGNATION	USAGE	TIRE LOAD LIMIT AT VARIOUS COLD INFLATION PRESSURES											
		kPa	480	520	550	590	620	660	690	720	760	790	830
		psi	*70*	*75*	*80*	*85*	*90*	*95*	*100*	*105*	*110*	*115*	*120*
245/75R22.5 235/80R22.5	DUAL	kg	1430	1500	1600	1640	1710	1800	1840	1900	**1950(G)** [131]		
		lbs.	*3160*	*3315*	*3525*	*3615*	*3765*	*3970*	*4055*	*4195*	***4300(G)***		
	SINGLE	kg	1570	1650	1750	1800	1880	1950	2020	2090	**2120(G)** [134]		
		lbs.	*3470*	*3645*	*3860*	*3975*	*4140*	*4300*	*4455*	*4610*	***4675(G)***		
265/75R22.5 255/80R22.5	DUAL	kg	1600	1680	1750	1830	1910	2000	2050	2130	**2180(G)** [135]		
		lbs.	*3525*	*3705*	*3860*	*4040*	*4205*	*4410*	*4525*	*4685*	***4805(G)***		
	SINGLE	kg	1760	1850	1950	2010	2100	2180	2260	2340	**2360(G)** [138]		
		lbs.	*3875*	*4070*	*4300*	*4440*	*4620*	*4805*	*4975*	*5150*	***5205(G)***		
295/75R22.5 275/80R22.5	DUAL	kg	1860	1950	2060	2130	2220	**2300(F)** [137]	2390	2470	**2575(G)** [141]	2630	**2725(H)** [143]
		lbs.	*4095*	*4300*	*4540*	*4690*	*4885*	***5070(F)***	*5260*	*5440*	***5675(G)***	*5795*	***6005(H)***
	SINGLE	kg	2040	2140	2240	2340	2440	**2500(F)** [140]	2620	2710	**2800(G)** [144]	2890	**3000(H)** [146]
		lbs.	*4500*	*4725*	*4940*	*5155*	*5370*	***5510(F)***	*5780*	*5980*	***6175(G)***	*6370*	***6610(H)***
285/75R24.5 275/80R24.5	DUAL	kg	1870	1970	2060	2150	2240	**2360(F)** [138]	2410	2490	**2575(G)** [141]	2660	**2800(H)** [144]
		lbs.	*4135*	*4340*	*4540*	*4740*	*4930*	***5205(F)***	*5310*	*5495*	***5675(G)***	*5860*	***6175(H)***
	SINGLE	kg	2060	2160	2240	2360	2460	**2575(F)** [141]	2650	2740	**2800(G)** [144]	2920	**3075(H)** [147]
		lbs.	*4545*	*4770*	*4940*	*5210*	*5420*	***5675(F)***	*5835*	*6040*	***6175(G)***	*6440*	***6780(H)***

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

TABLE MWB-1	Tire Load Limits at Various Cold Inflation Pressures												
TIRE SIZE DESIGNATION	kPa *psi*	480 *70*	520 *75*	550 *80*	590 *85*	620 *90*	660 *95*	690 *100*	720 *105*	760 *110*		790 *115*	830 *120*	
445/65R19.5	kg *lbs.*	3410 *7540*	3610 *7930*	3750 *8270*	3960 *8680*	4100 *9040*	4250 *9370*	4410 *9730*	4540 *10100*	**4750(J)** ***10500*(J)**	162			
385/65R22.5	kg *lbs.*	2880 *6380*	3060 *6720*	3150 *6940*	3350 *7350*	3470 *7650*	3650 *8050*	3740 *8230*	3850 *8510*	4000 *8820*		4100 *9050*	**4250(J)** ***9370*(J)**	158
425/65R22.5	kg *lbs.*	3430 *7590*	3640 *7990*	3750 *8270*	3980 *8740*	4130 *9100*	4250 *9370*	4440 *9790*	4580 *10100*	**4750(J)** ***10500*(J)**	162	4880 *10700*	**5000(L)** ***11000*(L)**	164
445/65R22.5	kg *lbs.*	3720 *8230*	3950 *8660*	4125 *9090*	4320 *9480*	4470 *9870*	**4625(H)** ***10200*(H)**	161	4820 *10600*	4960 *11000*	5150 *11400*	5290 *11700*	**5600(L)** ***12300*(L)**	168

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

TABLE TTB-3R		TIRE LOAD LIMITS (kg/lbs.) AT VARIOUS COLD INFLATION PRESSURES (kPa/psi)										
TIRE SIZE DESIGNATION	USAGE	480 *70*	520 *75*	550 *80*	590 *85*	620 *90*	660 *95*	690 *100*	720 *105*	760 *110*	790 *115*	830 *120*
8R19.5	DUAL	1120 *2460*	1170 *2570*	**1215(D)** ***2680*(D)** 115	1260 *2785*	1310 *2890*	**1360(E)** ***3000*(E)** 119	1410 *3100*	1460 *3200*	**1500(F)** ***3305*(F)** 122		
	SINGLE	1150 *2540*	1220 *2680*	**1285(D)** ***2835*(D)** 117	1340 *2955*	1400 *3075*	**1450(E)** ***3195*(E)** 121	1500 *3305*	1550 *3415*	**1600(F)** ***3525*(F)** 124		
8R22.5	DUAL	1250 *2750*	1300 *2870*	**1360(D)** ***3000*(D)** 119	1410 *3100*	1460 *3200*	**1500(E)** ***3305*(E)** 122	1570 *3455*	1640 *3605*	**1700(F)** ***3750*(F)** 126		
	SINGLE	1290 *2840*	1360 *2990*	**1450(D)** ***3195*(D)** 121	1500 *3305*	1550 *3415*	**1600(E)** ***3525*(E)** 124	1670 *3675*	1740 *3825*	**1800(F)** ***3970*(F)** 128		
9R22.5	DUAL	1480 *3270*	1550 *3410*	1610 *3550*	1670 *3690*	**1750(E)** ***3860*(E)** 127	1820 *4005*	1890 *4150*	**1950(F)** ***4300*(F)** 131	2010 *4425*	2070 *4550*	**2120(G)** ***4675*(G)** 134
	SINGLE	1530 *3370*	1610 *3560*	1690 *3730*	1760 *3890*	**1850(E)** ***4080*(E)** 129	1920 *4235*	1990 *4390*	**2060(F)** ***4540*(F)** 133	2120 *4675*	2180 *4810*	**2240(G)** ***4940*(G)** 136
10R22.5	DUAL	1750 *3860*	1830 *4045*	1910 *4230*	**2000(E)** ***4410*(E)** 132	2080 *4585*	2160 *4760*	**2240(F)** ***4940*(F)** 136	2300 *5075*	2360 *5210*	**2430(G)** ***5355*(G)** 139	
	SINGLE	1850 *4080*	1940 *4280*	2030 *4480*	**2120(E)** ***4675*(E)** 134	2200 *4850*	2280 *5025*	**2360(F)** ***5205*(F)** 138	2430 *5360*	2500 *5515*	**2575(G)** ***5675*(G)** 141	
11R22.5	DUAL	1990 *4380*	2080 *4580*	2160 *4760*	2250 *4950*	**2360(F)** ***5205*(F)** 138	2460 *5415*	2560 *5625*	**2650(G)** ***5840*(G)** 142	2680 *5895*	2710 *5950*	**2725(H)** ***6005*(H)** 143
	SINGLE	2050 *4530*	2160 *4770*	2260 *4990*	2370 *5220*	**2500(F)** ***5510*(F)** 140	2600 *5730*	2700 *5950*	**2800(G)** ***6175*(G)** 144	2870 *6320*	2940 *6465*	**3000(H)** ***6610*(H)** 146
11R24.5	DUAL	2110 *4660*	2210 *4870*	2300 *5070*	2390 *5260*	**2500(F)** ***5510*(F)** 140	2580 *5675*	2660 *5840*	**2725(G)** ***6005*(G)** 143	2820 *6205*	2910 *6405*	**3000(H)** ***6610*(H)** 146
	SINGLE	2190 *4820*	2300 *5070*	2410 *5310*	2520 *5550*	**2650(F)** ***5840*(F)** 142	2770 *6095*	2890 *6350*	**3000(G)** ***6610*(G)** 146	3080 *6790*	3160 *6970*	**3250(H)** ***7160*(H)** 149
12R22.5	DUAL	2170 *4780*	2260 *4990*	2350 *5190*	2440 *5390*	**2575(F)** ***5675*(F)** 141	2630 *5785*	2680 *5895*	**2725(G)** ***6005*(G)** 143	2840 *6265*	2960 *6525*	**3075(H)** ***6780*(H)** 147
	SINGLE	2240 *4940*	2360 *5200*	2470 *5450*	2580 *5690*	**2725(F)** ***6005*(F)** 143	2820 *6205*	2910 *6405*	**3000(G)** ***6610*(G)** 146	3120 *6870*	3240 *7130*	**3350(H)** ***7390*(H)** 150
12R24.5	DUAL	2300 *5080*	2400 *5300*	2500 *5520*	2600 *5730*	**2650(F)** ***5840*(F)** 142	2770 *6095*	2890 *6350*	**3000(G)** ***6610*(G)** 146	3080 *6790*	3160 *6970*	**3250(H)** ***7160*(H)** 149
	SINGLE	2380 *5240*	2500 *5520*	2630 *5790*	2740 *6040*	**2900(F)** ***6395*(F)** 145	3020 *6650*	3140 *6910*	**3250(G)** ***7160*(G)** 149	3350 *7380*	3450 *7600*	**3550(H)** ***7830*(H)** 152

SPECIFICATIONS

Hydraulic

Hydraulic Pump	286 l/min (75.5 gpm) at 2200 rpm, Variable displacement, axial piston with load sense
Pump Displacement	130 cc/rev (7.93 in^3/rev)
Pump Max Pressure	338 bar (4900 psi)
Load Sense Relief Valve	294.8 ±3.45/-0 bar (4275 +50/-0 psi)
Pump Load Sense Margin	22.4 bar ±1.72 (325 psi ±25)
Required PTO Rating	156.5 kw (210 hp) at 2200 rpm
Boom Up	158.0 l/min at 317.2 6.9/-0 bar (42 gpm at 4600 +100/-0 psi)
Boom Down	56.8 l/min at 70.0 +31.0/-0 bar (15 gpm at 1015 psi +450/-0)
Outrigger Extend	206.84 bar (3000 psi)
Outrigger Retract	206.84 bar (3000 psi)
Telescope Extend	132.5 l/m at 220.0 bar +24.1/-0 bar (35 gpm at 3190 +350/-0 psi)
Telescope Retract	64.4 l/min at 190.0 +24.1/-0 bar (17 gpm at 2755 +350/-0 psi)
Swing	61.0 l/min at 160.0 +10.3/-0 bar (16 gpm at 2321 +150/-0 psi)
Swing Park Brake	Initial Release 15.2 bar (220 psi). Full release 20.3 bar (295 psi)
Full Dynamic Brake	Apply 41.0 bar (595 psi)
Cab Air Conditioner	49.2 l/min at 259.9 +10.3/-0 bar (13 gpm at 3770 +150/-0 psi)
Reservoir Capacity	404.7 l (109.6 gal)
Reservoir Return Filter	5 micron
Cab Tilt Cylinder	
Operating Pressure (Maximum)	206.84 +3.45/-0 bar (3000 +50/-0psi)
Single Front Outrigger (SFO) (if equipped)	
Extend	34.5 +13.8/-0 bar (500 +200/-0 psi)
Retract	127.6 +13.8/-0 bar (1850 +200/-0 psi)

Air Conditioner

Air Conditioner Hydraulic System	3770 psi
Minimum Evacuation Time	30 minutes
Refrigerant Charge Levels	2.5 pounds (+/- 0.5 ounce)
Additional Pag Oil Required Above 6 ounces in Compressor	4.0 ounces

Hoist System

Wire Rope:	
Length	137 m (449.5 ft)
Diameter (Rotation Resistant)	16 mm (5/8 in)
Nominal Breaking Strength	25,592 kg (56,420 lb)
Maximum Line Pull (First Layer)	5240 kg (17,250 lb)
Maximum Operating Pressure	300 +17.2/-0 bar (35 gpm at 4350 +250/-0 psi)
Maximum Flow	132.5 l/min (35 gpm)
Gearbox Oil Capacity	5.44 l (5.75 qt)

Brake Oil Capacity..... Shared with gearbox

Maximum Line Pull per Layer @ 310.2 bar (4500 psi)	
Layer	**Low Speed KG (lb)**
1	7824 (17250)
2	7008 (15450)
3	6350 (14000)
4	5801 (12790)
5	5343 (11780)

Swing Gearbox

Weight (no oil) ..... 104.8 kg (231.0 lbs)
Output Torque (Continuous) ..... 6383.6 N-m (56500 in-lbs)
Brake Release Pressure (Final)..... 20.3 bar (295 psi)
Brake Torque (Static and dynamic)..... 350.3 N-m (3100 in-lbs)
Gearbox oil capacity ..... 2.4 l (2.5 qt)

Crane Operating Speeds

(Performance based on full governed RPM and 100° F (37.8° C) hydraulic reservoir temperature.)
Rotation 360°..... 36 ±7 sec (1.8 ± 0.2 rpm) Adjustment Knob Closed
Boom up -10° to 80° ..... 28 ±5 sec
Boom Down 80° to -10° ..... 30 ±5 sec
Boom Extend/Retract Five Section
- Extend 34 ft to 142 ft (Angle 60°)..... 125 ±10 sec
- Retract 34 ft to 142 ft (Angle 60°) ..... 103 ±10 sec

Outrigger Beam Extend ..... 10 ±3 sec
Outrigger Beam Retract..... 10 ±3 sec
Outrigger Jack Extend ..... 10 ±3 sec
Outrigger Jack Retract..... 10 ±3 sec

Counterweights

NBT40-2 Standard Counterweight ..... 372 kg (820 lb)
NBT45-2 Standard Counterweight ..... 1794 kg (3955 lb)
NTC40-2 Standard Counterweight ..... 372 kg (820 lb)
NTC45-2 Standard Counterweight ..... 1794 kg (3955 lb)
NBT45-2 Counterweight (Optional) ..... 2716 kg (5986 lb)
NTC45-2 Counterweight (Optional) ..... 2716 kg (5988 lb)

Anemometer (Optional)

Measurement Range ..... 0 to 241.4 kph (0 to 150 mph)
Radio Range (clear line of sight)..... 1402.1 m (4600 ft)
Radio Frequency (FCC) ..... 902 to 928 MHz
Battery
- Type ..... D Cell Lithium 3.6V or Alkaline 1.5V
- Lithium Battery Life (Installed)..... 4 years for 40 hr/week or 20 months for continuous use
- Alkaline Battery Life..... 1 year for 40 hr/week or 6 months for continuous use

Gateway Router (Crane Cab)
- Frequency (FCC)..... 915 MHz

Camera (Optional)

Monitor (Crane Cab)

Input Voltage ..... 12 volts to 60 volts (±10%)
Size ..... 17.78 cm (7 inches)
Resolution ..... WVGA 800 x RGB x 480 Pixels

Cameras (Hoist and Rear View)

Power Input ..... 12 to 24 V/DC
Video Signal ..... NTSC 720 (Hor) x 480 (Vert), 60 fields per second
View Angle (Hoist Camera) ..... 80° (Horizontal)
View Angle (Rear View Camera) ..... 170° (Horizontal)

General

NBT40-2..... 36.3 metric tons (40 tons) at 1.83 m (6 ft) radius
NBT45-2..... 40.8 metric tons (45 tons) at 1.83 m (6 ft) radius
NTC40-2..... 36.3 metric tons (40 tons) at 1.83 m (6 ft) radius
NTC45-2..... 40.8 metric tons (45 tons) at 1.83 m (6 ft) radius
Overall Length (127 ft Boom) ..... 11729 mm (461.8 in)
Overall Length (142 ft Boom) ..... 12455 mm (490.4 in)
Overall Width..... 2566 mm (101.0 in)
Overall Height..... 3906 mm (153.8 in)

Boom Length, 127 ft ..... Extended 38.7 m (127 ft)
Boom Length, 142 ft ..... Extended 43.3 m (142 ft)
Jib Length (Telescoping 4-plate Construction..... Retracted 9.5 m (31 ft), Extended 16.8 m (55 ft)

Machine Weight (Standard torsion box, no jib, no SFO, no auxiliary hoist)
NBT40-2 (127 ft Boom) ..... 16501 kg (36378 lbs)
NBT40-2 (142 ft Boom) ..... 17064 kg (37620 lbs)
NBT45-2 (127 ft Boom) ..... 17932 kg (39533 lbs)
NBT45-2 (142 ft Boom) ..... 18495 kg (40775 lbs)
NBT45-2 (127 ft Boom w/ optional max counterweight) ..... 18858 kg (41575 lbs)
NBT45-2 (142 ft Boom w/ optional max counterweight) ..... 19420 kg (42814 lbs)

Machine Weight (Extended torsion box, no jib, no SFO, no auxiliary hoist)
NBT40-2 (127 ft Boom) ..... 16802 kg (37042 lbs)
NBT40-2 (142 ft Boom) ..... 17365 kg (38288 lbs)
NBT45-2 (127 ft Boom) ..... 18233 kg (40197 lbs)
NBT45-2 (142 ft Boom) ..... 18796 kg (41438 lbs)
NBT45-2 (127 ft Boom w/ optional max counterweight) ..... 19159 kg (42238 lbs)
NBT45-2 (142 ft Boom w/ optional max counterweight) ..... 19721 kg (43477 lbs)

SECTION 7
RATED CAPACITY LIMITER

SECTION CONTENTS

FIGURE 7-1

RCL SYSTEM OVERVIEW

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

WARNING

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 RCL is not a scale and should not be relied upon solely to accurately weigh loads.

The National Crane RCL system consists of an operator's console, anti-two-block switch, length sensor, angle sensor, slew potentiometer, outrigger length sensors, rod and base side lift cylinder pressure transducers, telescope extend transducers, the main directional control valve transducers for pressure, and if equipped, a wind speed indicator. The load charts are loaded into the crane display. The RCL calculates the load and radius information during operation. When a load is lifted, the RCL compares the calculated actual load from the load chart for the given conditions. If an overload condition is sensed, audible and visual warnings are generated and the moment increasing functions are locked out from increasing the overload condition. The RCL override switches can be used to override the lockout. For more information about the RCL override switches, see "RCL Override Switches" on page 3-14.

Components:

- RCL display on the operator console.
- RCL control module (front console).
- Length/angle sensor with cable reel mounted on side of boom.
- Lift cylinder pressure transducers integral to lift cylinder hold valve.
- Telescope extend pressure transducer at the base of the boom.
- Anti-two-block switch (ATB) on the boom nose.
- Outrigger length sensors (on each outrigger beam).
- Slew sensor internal to the electric swivel.
- Main directional control valve
- If equipped, wind speed indicator: an anemometer on the boom or jib and a wireless gateway router in the crane cab.

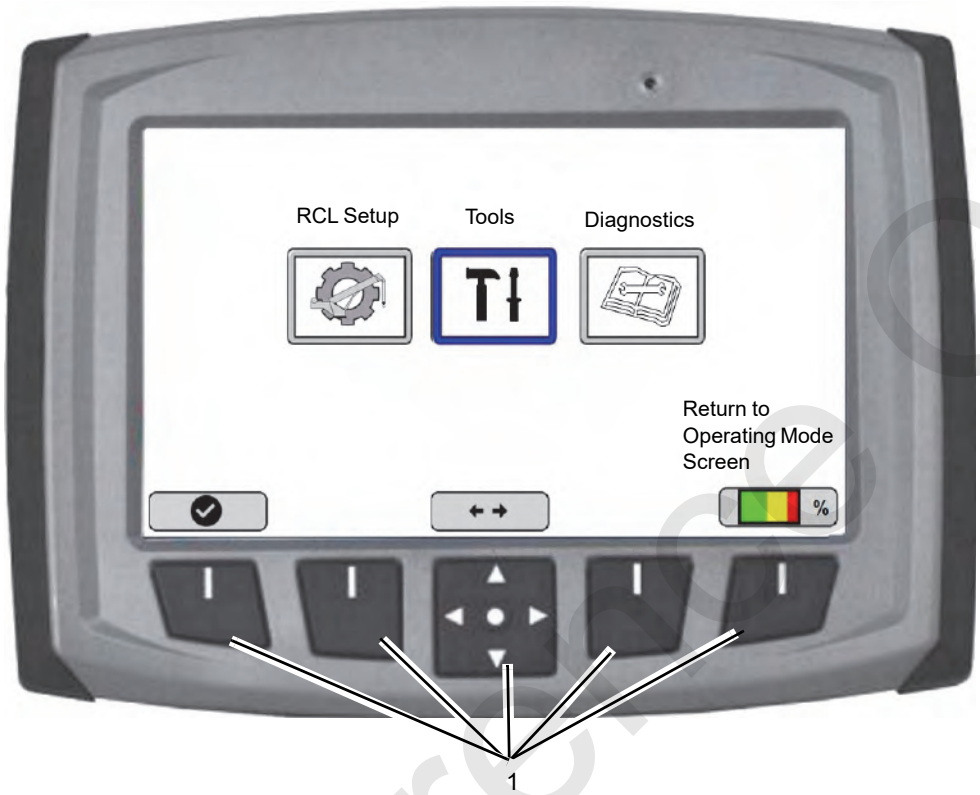


FIGURE 7-2

About the RCL Display

The **Main Menu** screen displays when:

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

This screen should not display when:

- If the 2-hour configuration timer has not expired. The operating mode screen will appear at the last operating mode.
- Any time a personnel platform is configured before shutdown. This is regardless of time between shutdown and start-up. This personnel platform operating mode screen will appear.
- If any sensors are not configured or calibrated.

Main Menu Screen

The **Main Menu** screen (Figure 7-2) is divided into the following three major sections which are used to set-up, operate, calibrate, and troubleshoot the Rated Capacity Limiter (RCL) system. Table 7-1 shows the icons on the Main Menu screen.

Table 7-1 Main Menu Options

Icon	Description
	**RCL Set-Up** — Highlight and press the Select function key (Figure 7-2) to configure the RCL system. This screen includes configuration and establishing operational limits based on the boom, outrigger, hoist, and reeving. The RCL Set-up screen is where the operator configures the RCL operating mode screen, confirm the correct operating mode, and takes the operator tot he RCL working screen. For more information about RCL set-up, see “RCL Setup” on page 7-7.
	**Tools** — Highlight and Select function key (Figure 7-2) to access the tools screen, see page 7-14. This screen includes setting units of measure, configuring controller output, calibrating RCL sensors, configuring hydraulic filter reminder, and screen brightness. For more information, see “Tools” on page 7-14.

Table 7-1 Main Menu Options (Continued)

Icon	Description
	**Diagnostic** — Highlight and press the Select function key (Figure 7-2) to access the RCL diagnostic menu, see page 7-18. This menu includes Chassis and Crane Information and Warnings, Crane Electrical Fault Monitoring, Hour Meter, Load Chart Part Number, and Module Input/Output screens with Software Versions and Real-Time Sensor information. For more information, see “Diagnostics” on page 7-18.

The RCL display (Figure 7-2) shows available button functions based on the current screen and the current system status. An icon showing the available functions for each button appears above each button.

The buttons (1) 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 button to highlight the desired function, then confirm selection by pressing button #1.

Main Menu Function Keys

The **Main Menu** screen has *function keys* (1, Figure 7-2) that are used to highlight and select the functions shown on the display screen. Table 7-2 describes the RCL function keys.

Table 7-2 RCL Function Keys

Icon	Description
	Return to Operating Mode Screen button, For more information, see “Accessing Operating Mode Screen” on page 7-11. This key is displayed only if the RCL has been through configuration and set-up.
	The Directional button is used to highlight 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.
 and 	The up and down arrow functions are used to increment or decrement configurable values or screen selections.
	The Select function key confirms the choice that is highlighted.
	The Back button goes back one selection during the RCL setup.
	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 appears for a few seconds each before the Main Menu Screen appears (Figure 7-2).

NOTE: If the crane is powered up after sitting idle within a 2 hour time period, the Configuration Confirmation Screen 9 (page 7-10) appears first.

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

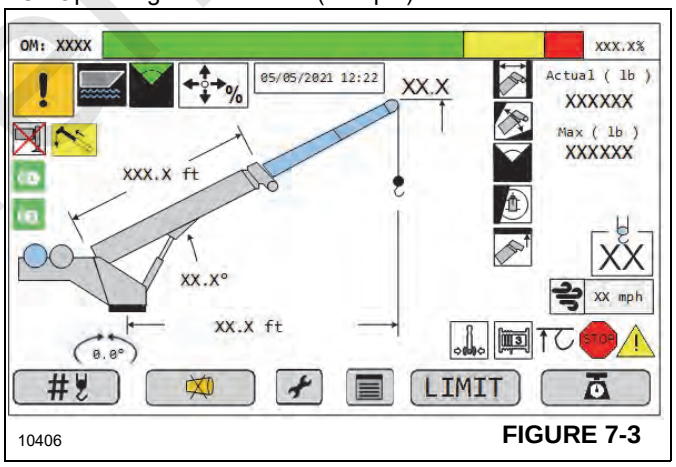
About RCL Symbols

Table 7-3 shows the RCL alert and limit symbols. The right side of the operating screen displays 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.

The Load Warning Icons appear when greater than or equal to 90% of allowable setting is reached. The Load Lockout Icons appear when 100% of the allowable setting is reached.

RCL Operating Mode Screen (Sample)



10406 **FIGURE 7-3**

Table 7-3 RCL Screen Symbols

Icon	Description
	**RCL Capacity Warning** — Continuous visual 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

Table 7-3 RCL Screen Symbols (Continued)

Icon	Description
	ATB 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
	General Warning — Refer to MAIN Menu option 3 “Diagnostics” screen to see the warning that is active.
	Slew Angle Limit — The slew angle is measured as the angle 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. For more information about setting slew angle limits, see “Setting the Slew Angle Limit” on page 7-12. A positive slew angle is to the right side of the boom rest +0.1° to +360° OR +0.1° > angle > 180° Negative slew angle is to the driver side of the boom rest from -0.0° to -180°.
	Tip Height Limit — The tip height is calculated as the distance 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 (assumes maximum outrigger deployment). For more information about setting tip height limits, see “Setting the Tip Height Limit” on page 7-13.
	RCL Boom Angle Limit — The angle limit is measured as the angle from horizontal of the boom by the boom angle sensor. This is to alert the operator of user defined limits above or below these settings. For more information about setting boom angle limits, see “Setting the Boom Angle Limit” on page 7-13.
	Radius Limit — The radius limit is calculated from the center of rotation to the hook block location on the horizontal plane. This is to alert the operator of a user set limit. For more information about setting radius limits, see “Setting Radius Limit” on page 7-13.
	RCL WADS Limit — The work area definition (WADS) limit is calculated 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. For more information, see “Setting the Virtual Wall” on page 7-12.

Table 7-3 RCL Screen Symbols (Continued)

Icon	Description
	Controller — This icon is activated when one or more controller (joystick) output percentages is less than 100%. Controller output can be configured in the Tools menu. For more information, see “About Adjusting Controller Output” on page 7-15.
	O/R Configuration Change — Shown to indicate that the O/R position has changed vs. the previously configured setup. This is NOT an RCL lockout condition. Buzzer sounds to indicate this setup change (can be silenced).
	O/R Setup Overridden — Shown to indicate that the operator has manually overridden the sensor data of the current outrigger configuration. This is NOT an RCL lockout condition no buzzer sounds or functions are disabled.
	Hoist Selection — Shows the selected hoist (main or auxiliary if equipped) highlighted in blue. An inactive hoist is displayed as gray. If the crane is not equipped with an auxiliary hoist, only one hoist is displayed.
	Hoist 1 (Main) Enabled
	(If Equipped) **Hoist 2 (Auxiliary) Enabled**
	Hoist 1 (Main) Raise
	(If Equipped) **Hoist 2 (Auxiliary) Raise**
	Hoist 1 (Main) **Raise High Speed**
	(If Equipped) **Hoist 2 (Auxiliary) Raise High Speed**
	Hoist 1 (Main) Lower
	(If Equipped) **Hoist 2 (Auxiliary) Lower**
	Hoist 1 (Main) Lower High Speed
	(If Equipped) **Hoist 2 (Auxiliary) Lower High Speed**
	Hoist 1 (Main) Inactive
	(If Equipped) **Hoist 2 (Auxiliary) Inactive**

Table 7-3 RCL Screen Symbols (Continued)

Icon	Description
	**Windspeed Indicator Reading (If Equipped)** — This box shaded depending on wind speed: • XX mph Green. Less than or equal to 18 mph • XX mph Yellow. Greater than 19 mph and less than or equal to 28 mph • XX mph Red. Greater than 29 mph
	**Swing Brake** — Indicates that swing brake is ON. This icon is not shown when the swing brake is OFF.
	**3rd Wrap Indicator** — Indicates when 3rd (minimum) wrap is detected. The icon flashes when the last layer is detected. For more information about the 3rd Wrap Indicator, see “3rd Wrap Indicator” on page 3-18.
	**Reeving Selection** — Reeving selecting screen. Pressing this button returns to the reeving configuration screen for number of parts of line selection.
LIMIT	**LIMIT** — Pressing enables the RCL Limits Menu screen.
	**TARE** — Pressing will enable or disable the TARE function. This zeros out the current calculated indicated load and shows the differential weight as the load is increased as long as the boom geometry does not change. TARE button icon flashes BLUE when active.
	**Reeved Parts** — Displays the number of rope parts reeved.
	**Horn Silence** — When activated, indicates the RCL warning horn is temporarily disabled for 15 seconds. The horn silence button icon is shaded when active.
	**Diagnostics** — Pressing this button returns to the diagnostics menu screen.
	**MAIN** — Pressing this key returns to the MAIN Menu screen.
	**Delete** — Pressing this key deletes the current setting or value.
	**Real Time I/O** — Pressing this button navigates to the Real Time Input/Output (I/O) screen.
	**Barge Mode** — Icon shown when barge mode was selected.

Table 7-3 RCL Screen Symbols (Continued)

Icon	Description
	**Electronic Telescope Extension Relief Pressure** (E-TERP)—Maximum allowable telescope pressure is approaching.
	**Electronic Telescope Extension Relief Pressure** (E-TERP)—Maximum allowable telescope pressure is reached. This warning cannot be overridden. To exit this condition, reduce the pressure below the maximum AND one of the following: • Retract the boom two feet, OR • Change the boom angle by 10 degrees, OR • Change the calculated load by 10% After the criteria is met, the operator can resume the telescope extend function.

About the RCL and ATB Override Warnings

Table 7-4 shows the RCL and ATB warning overrides that appear on the RCL screen. The RCL override bypasses the RCL for both overload and ATB alerts. For more information about the temporary and permanent RCL and ATB bypass switches, see “RCL Override Switches” on page 3-14.

⚠ 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.

Table 7-4 RCL and ATB Override Warnings

Icon	Description
	**RCL Override Warning (Red)** — Indicates that the operator bypassed the RCL. Use extreme caution when the RCL is bypassed.
	**ATB Override Warning (Red)** — Indicates that the operator bypassed the ATB. Use extreme caution when the ATB is bypassed.
	**Horn Silence** — Indicates the RCL warning horn is temporarily disabled for a period of 15 seconds per push. The horn silence button icon is shaded when active.

RCL SETUP

The RCL setup is where the lifting configuration of the crane is entered into the system. The RCL setup is required before the crane can be operated.

Perform the following steps to setup the RCL:

Step 1: Configuring a Personnel Platform

Step 2: Configuring the Jib Options

Step 3: Configuring the Outriggers

Step 4: Configuring Hoist and Reeving

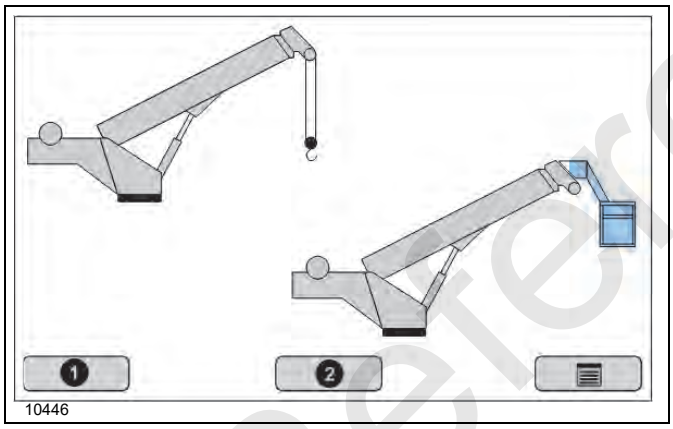
Step 5: Confirming the Configuration

When the crane ignition switch is turned on, the RCL powers up and displays the National Crane logo screen for a few seconds followed by the main menu screen.

Select the RCL setup icon on the main menu to begin RCL setup (Figure 7-2). When RCL setup is complete, the Operating Mode screen appears. For more information, see “Operating Mode” on page 7-10.

Step 1: Configuring a Personnel Platform

Screen 1



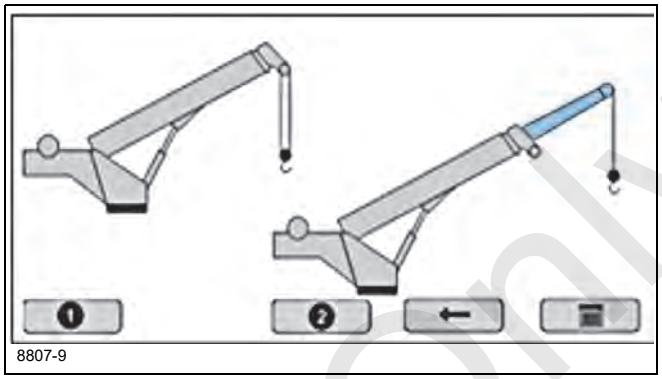
Is a personnel platform attached to the boom or the tip of the jib nose? Select 1 (no) or 2 (yes).

- The Main Menu button here returns to the Main Menu.
- If a personnel platform operating mode is confirmed and the machine is shut down, the RCL restarts without having to complete the setup sequence. This is to enable the personnel platform operating modes with radio remote operation.

Step 2: Configuring the Jib Options

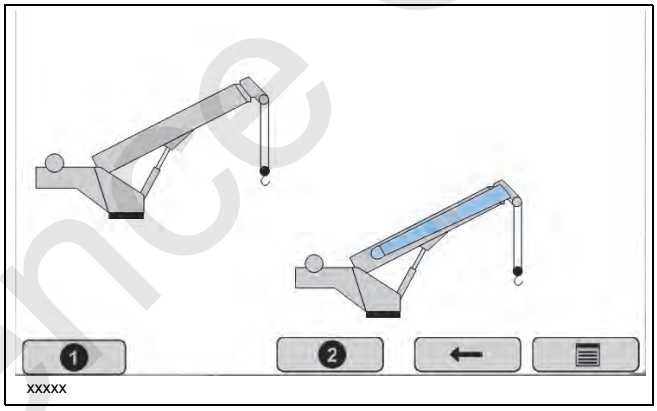
If the crane is <u>not</u> configured with a jib, the following set up screens will not appear. The system knows that no jib has been configured for use on the crane and bypasses these screens.

Screen 2



Is a jib attached to the boom nose? Select 1 or 2.

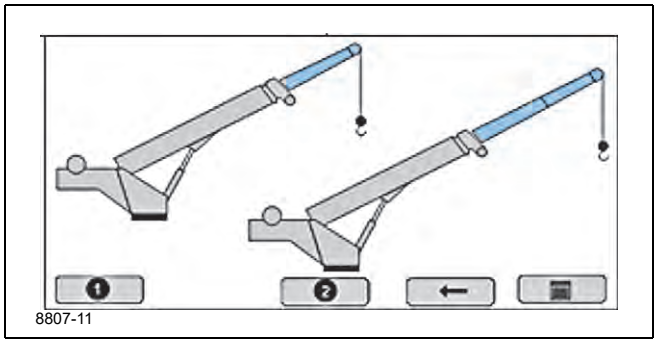
Screen 3-1A



Selected 1 on Screen 2. Now select 1 or 2 on Screen 3-1A:

- 1 — No jib
- 2 — Jib stowed on the side of the boom

Screen 3-2



Selected 2 on Screen 2. Now select 1 or 2: is the jib retracted or extended?

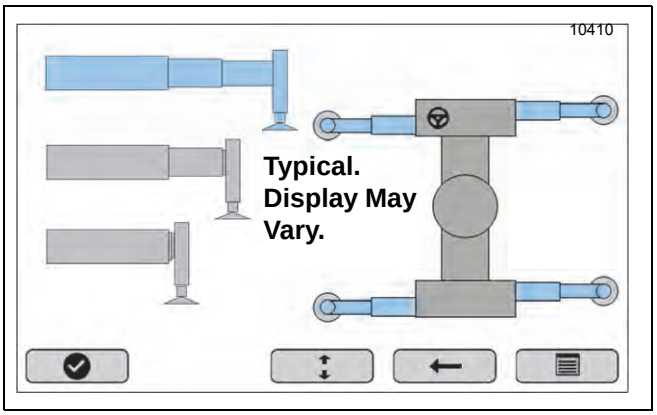
Step 3: Configuring the Outriggers

Use one of the following procedures to configure the outriggers:

- Outrigger Configuration Without Jib or Personnel Platform
- Outrigger Configuration with a Personnel Platform
- Outrigger Configuration with a Jib

Outrigger Configuration Without Jib or Personnel Platform

Screen 6



The current outrigger status is displayed by highlighting the current outrigger setting in blue, as shown in the left view of Screen 6. The non-current span setting is shown in gray.

The position of each outrigger is shown graphically on the right of the screen and will be either Fully Extended, 75% Extended, 50% Extended, 0% Extended, or in between (Figure 7-4).

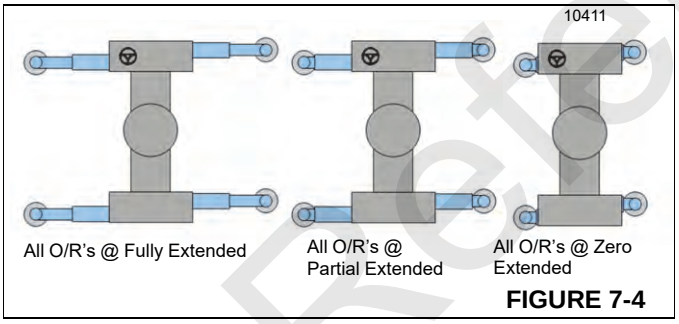


FIGURE 7-4

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

In Figure 7-5 one side of the outriggers is fully extended and the other side is at 50% extended. In the Figure 7-5 example, the configuration selected by the RCL and shaded in blue on the left of the display screen would be 50% extended. The user can override this pre-selection by using the up/down arrow keys and selecting the check mark when complete.

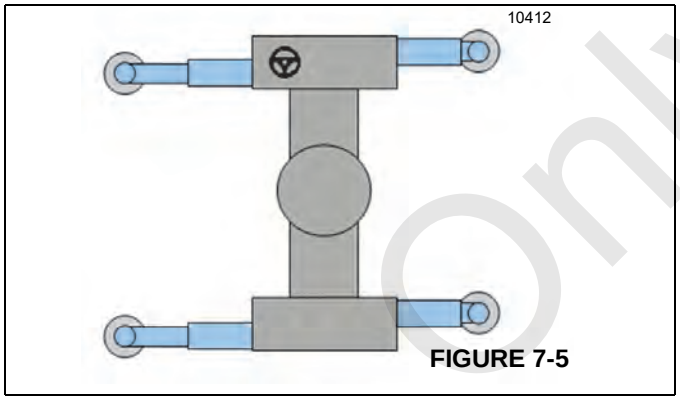


FIGURE 7-5

If any of the Outrigger Length Monitoring Sensors are out of range or not functioning properly, that beam will be missing and an icon with an exclamation point will be shown.

To correct the sensor error, recalibrate the outrigger sensor(s), and if needed, replace the sensor(s). For more information about calibrating and replacing the outrigger sensor(s), see the *Service Manual*.

⚠ DANGER

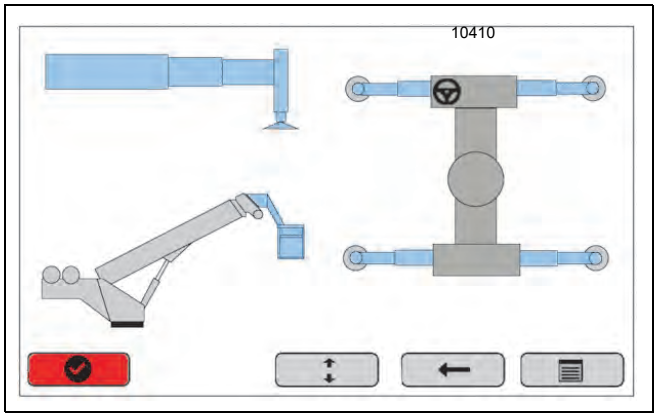
Use extreme caution when operating the crane with the RCL system overridden. Use of the RCL system override to operate the crane in a non-permissible range can result in death or injury to personnel and/or damage to equipment and property.

The user can override the outrigger sensor error and visually inspect the deployed outrigger(s). Use the markings on the sides of the outrigger(s) and the outrigger pin location(s) as guides to validate the outrigger position.

Outrigger Configuration with a Personnel Platform

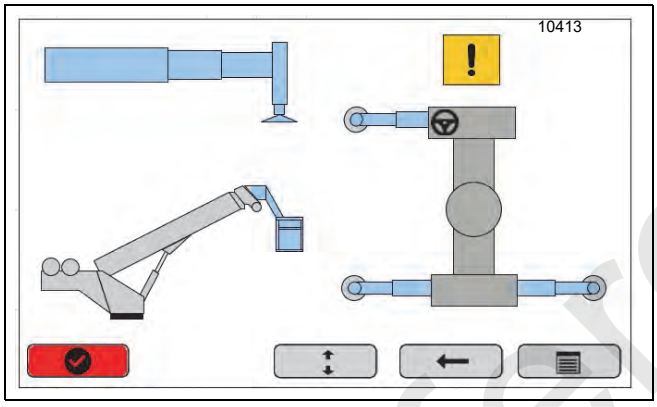
When using the personnel platform, Fully Extended outriggers are required. Select the check mark after machine is Fully Extended as displayed on Screen 6-1. When within Fully Extended range, the left-hand O/R graphic changes from GRAY to BLUE.

Screen 6-1



If the user attempts to select the check mark before the Fully Extended condition is met, the check mark button is missing. The user can override the setup using the arrow keys and the check mark.

Screen 6-2

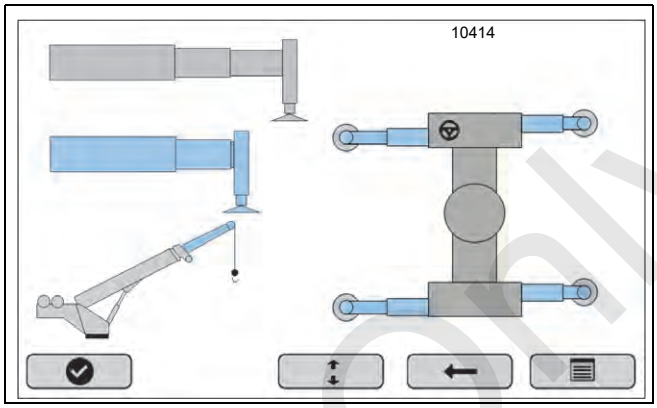


If the user selects a setup configuration different than the predefined selection given by the RCL, the O/R override icon is displayed on the confirmation screen and on the RCL Operating Mode Screen shown on page 7-10.

Outrigger Configuration with a Jib

When using the jib, Fully Extended, 75% Extended, or 50% Extended outriggers are required. Select the check mark after the outriggers are in one of the acceptable predefined positions. When within Fully Extended, 75% Extended, or 50% Extended range, the appropriate left-hand O/R graphic changes from GRAY to BLUE.

Screen 6-3

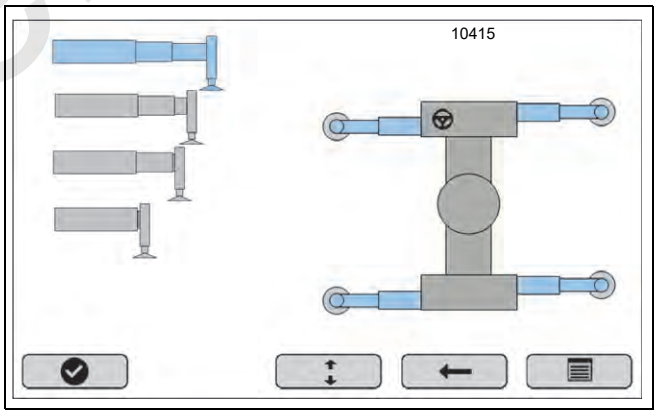


If the user attempts to select the check mark before Fully Extended, 75%, or 50% Extended condition is met, the check mark button is colored RED when depressed and the user can override the setup using the arrow keys.

If the user selects a setup configuration different than the one selected by the RCL, the O/R override icon is displayed on Confirmation Screen (screen 9 on page 7-10) and on the RCL Operating Screen shown on page 7-10.

If the 75% Extended outrigger position option is enabled and neither the jib nor personnel platform are selected, then the screen appears as shown on Screen 6-4.

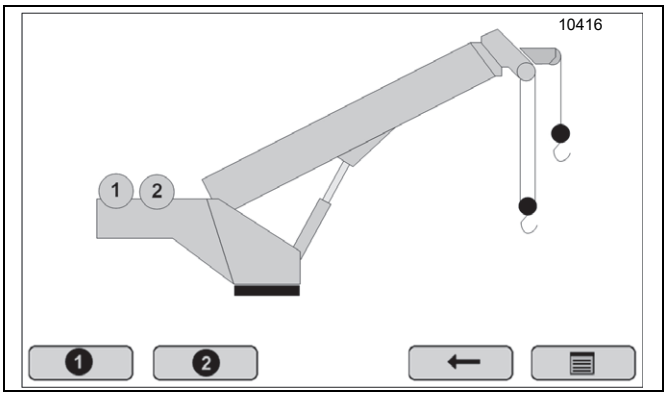
Screen 6-4



Select the check mark after machine is in outrigger setup configuration without jib or personnel platform with 75% extended.

Step 4: Configuring Hoist and Reeving

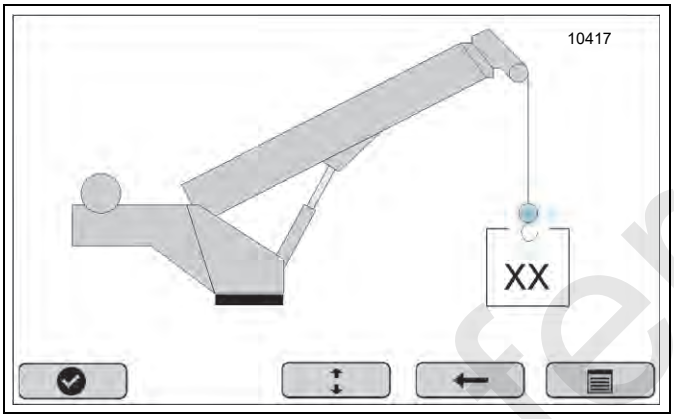
Screen 7



Select 1 to show the Main Hoist enabled. Select 2 to show the auxiliary hoist enabled.

The hoist that is being used is displayed as in Screen 7 and on the RCL Operating Mode Screen in blue (page 7-10).

Screen 8



After hoist selection, use the up and down arrows to change reeving from 1 part line up to 7 parts line on Screen 8.

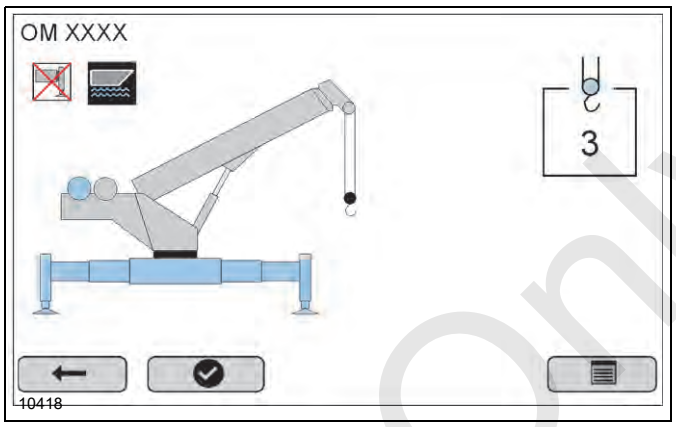
Step 5: Confirming the Configuration

After the RCL crane configuration setup is complete, confirmation Screen 9 is displayed. Check the configuration and select check mark if the configuration is correct. This verifies the lift configuration of the crane.

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

If the machine is shut down and restarted again within 2 hours, the operator can select check mark at Screen 9. Selecting OK automatically returns the RCL to the configuration used at shutdown. Re-configuration of the RCL is not required.

Screen 9

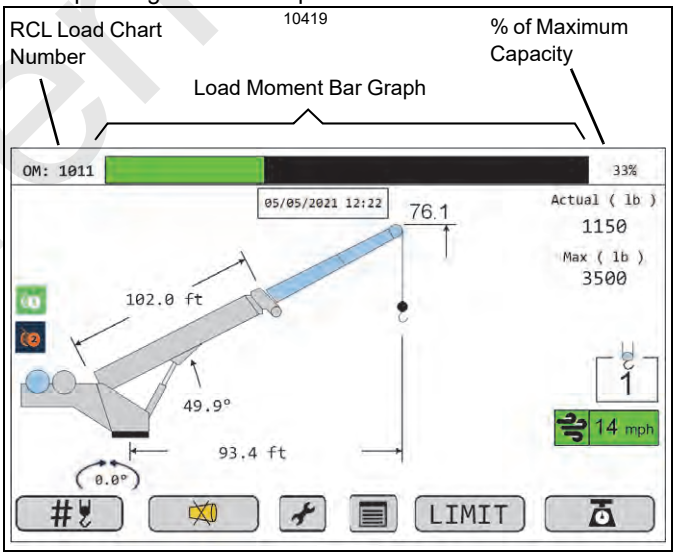


OPERATING MODE

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

The following *RCL Operating Mode - Sample* has been set up with an extended jib and displays the following. Table 7-3 describes the keys, symbols, and alerts shown on the RCL Operating Mode screen.

RCL Operating Mode - Sample



- Boom Length (BL) = 102.0 ft
- Boom Angle (BA) = 49.9°
- Load Radius (LR) = 93.4 ft
- Boom Tip Height (TH) = 76.1 ft
- # Parts of Line (#) = 1
- Maximum Allowable Load (ML) = 3,500 lb
- Actual Load (AL) = 1,150 lb
- Wind Speed = 14 mph
- Main Hoist = Active
- Auxiliary Hoist = Inactive
- Slew Angle: 0.0°% of Maximum Capacity = 33%

Accessing Operating Mode Screen

Use this procedure to access the Operating Mode screen.

The Operating Status key appears only after the RCL configuration and set-up is complete. The Operating Status icon configuration shows current approximate percentage of load capacity. Table 7-5 shows the different meanings of the Operating Status icon.

Table 7-5 Operating Status Icon Meanings

Status	Description
	Approximately less than or equal to 84.9% of capacity.
	Approximately greater than 85% and less than or equal to 94.9% of capacity.
	Approximately great than or equal to 95% of capacity.
	Indicates that the user is in an Override condition. For more information about override conditions.

The Operating Status icon appears only if a valid RCL configuration has been entered. For more information setting RCL configuration, see “RCL Setup” on page 7-7. The image on the button displays the real-time Rated Capacity Bar Graphics status.

To access the operating mode screen:

- Press the function key.

Activating the 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:

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

The TARE button icon flashes blue in color when active.

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

Overriding the RCL System

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.

Two mechanical key switches in the crane cab can be used to override the RCL system. The key switch on the console temporarily overrides the RCL system so long as the key is turned. The key switch behind the operator’s seat overrides the RCL system for as long as the key is in the ON (Override) position. For more information, see “RCL Override Switches” on page 3-14.

WORK AREA DEFINITION SYSTEM (WADS)

The Work Area Definition System (WADS) enables the operator to set operational limits to restrict crane operation to defined areas. The operational limit icons are displayed in the warning cluster on the RCL Operating Mode screen. These icons flash and a buzzer sounds when the operator violates the limits.

NOTE: Crane functions are not disabled when the operational limit extents are reached.

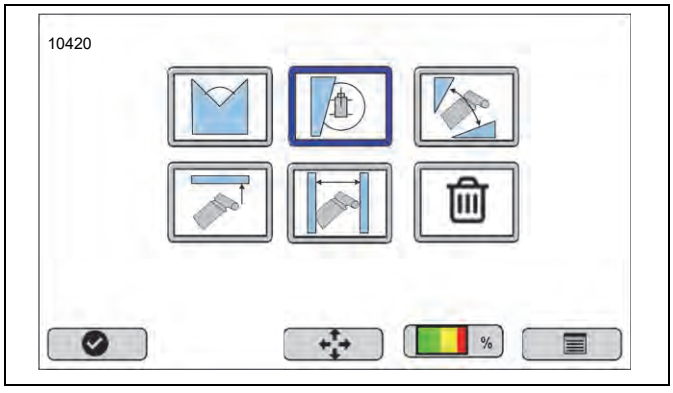
Accessing the WADS Screen

To access the WADS:

- Select the LIMIT function key on the RCL Operating Mode screen.

  The RCL Limits Menu screen appears.

RCL Limits Menu



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

Table 7-6 shows the selections on the WADS screen.

Table 7-6 WADS Icons

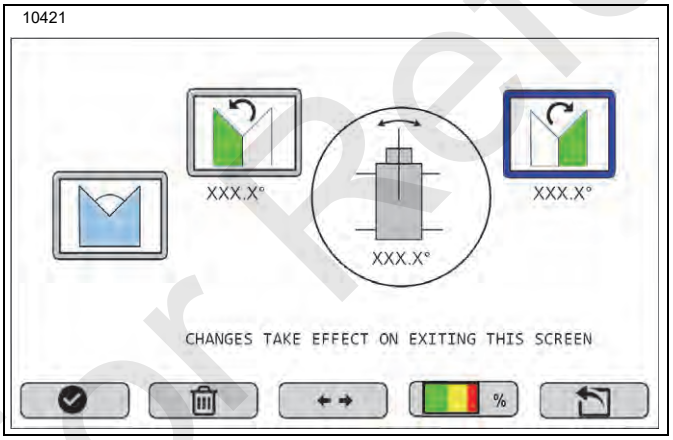
Icon	Description
	Set a slew angle limit. For more information, see “Setting the Slew Angle Limit” on page 7-12.
	Set a WADS limit. For more information, see “Setting the Virtual Wall” on page 7-12.
	Set a boom angle limit. For more information, see “Setting the Boom Angle Limit” on page 7-13.
	Set a tip height limit. For more information, see “Setting the Tip Height Limit” on page 7-13.
	Set a radius limit. For more information, see “Setting Radius Limit” on page 7-13.
	Delete all limits. For more information, see “Deleting All Limits” on page 7-14.

Setting the Slew Angle Limit

Use the following procedure to set the slew angle limit. The RCL #1 screen is updated in real time. The current slew angle is shown in the top right corner (xxx.x°) of the Limit #1 screen. The left and right slew angle limits appear below the current slew angle.

Use the function key with a  for counterclockwise settings and the function key with a  for clockwise slew settings.

RCL Limit #1



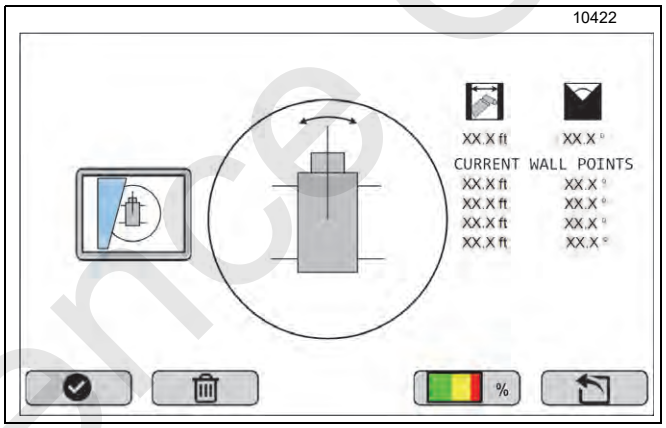
1. Rotate the crane superstructure to the desired position (the number appears on the display screen).
2. Select the SET function key  to store the current slew angle.
- Select DEL function key  to remove the current setting.
- ESC  to return to previous screen when finished.
- Return to the main working screen.

Setting the Virtual Wall

Use the following procedure to set the virtual wall. The virtual wall allows the operator to create virtual “walls” of operation.

NOTE: The crane functions are not disabled when operational extent (virtual wall) is reached.

RCL Limit #2



There can be up to four set points which form 3 virtual walls. The points are taken from the slew angle and calculated radius.

A minimum of two points are required to create a virtual wall. Points are stored as distance in feet (RADIUS) from the center of rotation and angle (SLEW ANGLE) from the center line of truck with the boom in the boom rest, see Figure 7-6.

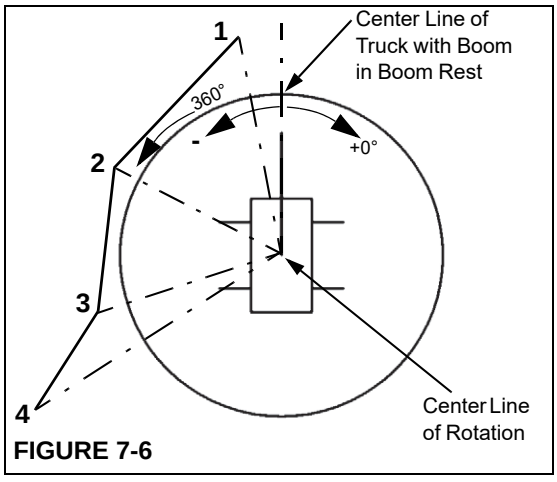


FIGURE 7-6

1. Rotate the crane superstructure to the desired position (the radius and slew angle appears on the display screen).
2. Select the SET function key to set the current boom nose position.
3. Complete the following as needed to set other virtual walls:

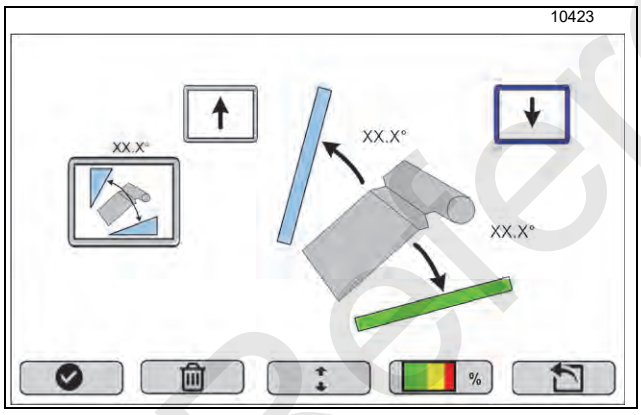
- Select DEL function key to remove the current settings.
- Select OK to store each position after input.
- ESC to return to previous screen with no inputs.
- Return to the main working screen.

Setting the Boom Angle Limit

Use the following procedure to set the boom angle limit. The minimum (MIN), maximum (MAX), or MIN and MAX boom angle limits can be set. When a limit is set, the limit bar turns green on the screen.

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

RCL Limit #3



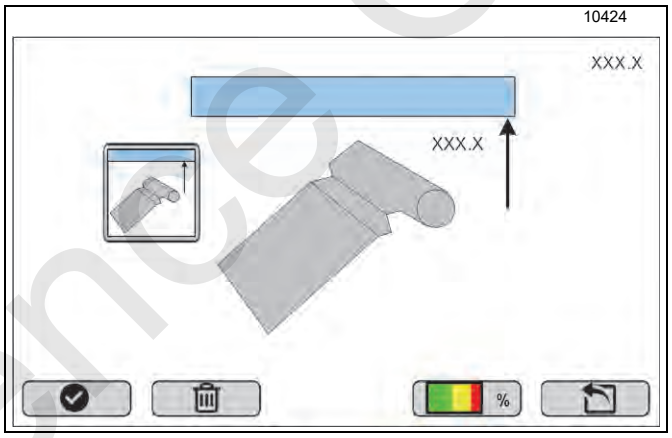
1. Move the crane boom to the desired boom angle (the angle number appears on the display screen).
2. Select SET to set the MAX boom angle.
3. Do one of the following:

- Boom down to select a lower limit. Select SET to set the MIN boom angle.
- Selecting DEL function key removes the current boom angle setting.
- ESC to return to previous screen with no inputs.
- Return to the main working screen.

Setting the Tip Height Limit

Use the following procedure to set the limit for the maximum boom tip height. The current boom tip height is always shown in the upper right hand corner.

RCL Limit #4



1. Move the crane boom to the desired boom tip height point (it appears on the display screen).
2. Select one of the following:

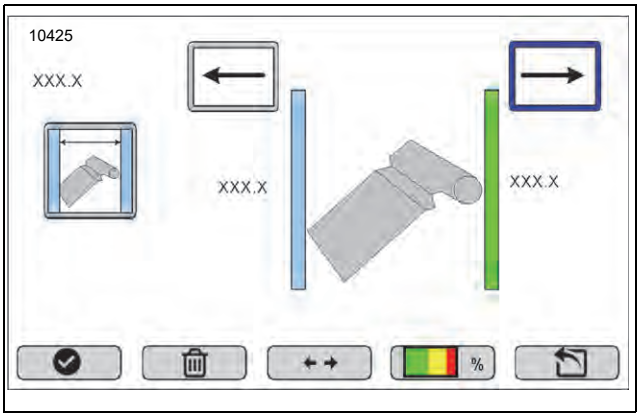
- Select SET to store the current boom tip position as the MAX.
- Select DEL to delete the established limit.
- ESC to return to previous screen with no inputs.
- Return to the main working screen.

Setting Radius Limit

Use the following procedure to set the limit for the boom radius. This screen can set either the maximum (MAX) radius, the Minimum (MIN) boom radius, or both the MIN and MAX radius.

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

RCL Limit #5

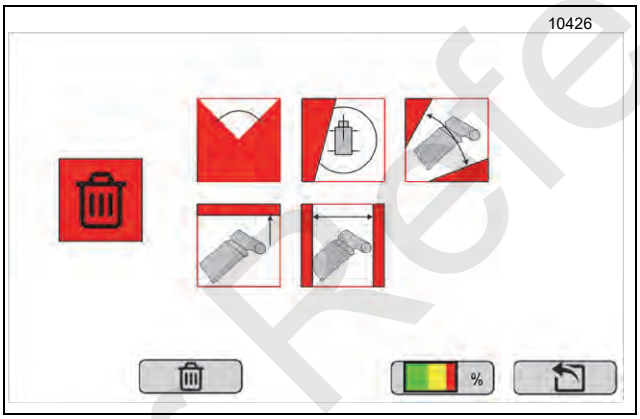


1. Move the crane boom to the desired boom radius (it appears on the display screen).
2. Do one of the following

- Select SET to set the MAX boom radius.
- Select SET, function key (3) to set the MIN boom radius.
- Selecting either DEL function key removes that radius limit setting.
- ESC to return to previous screen with no inputs.
- Return to the main working screen.

Deleting All Limits

RCL Limit #6



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

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

TOOLS

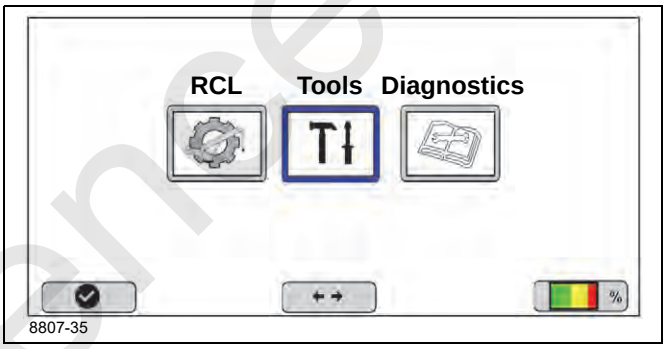
The Tools menu is where the following tasks can be performed:

- Setting units of measure
- Configuring Controller Output
- Calibrating and configuring the RCL
- Configuring the hydraulic filter reminder
- Setting Screen Brightness

Accessing the Tools Menu

Use this procedure to access the Tools menu from the main RCL menu. Use the arrow keys to scroll and select items in the Tools menu. Select OK after making the selection.

MAIN Menu

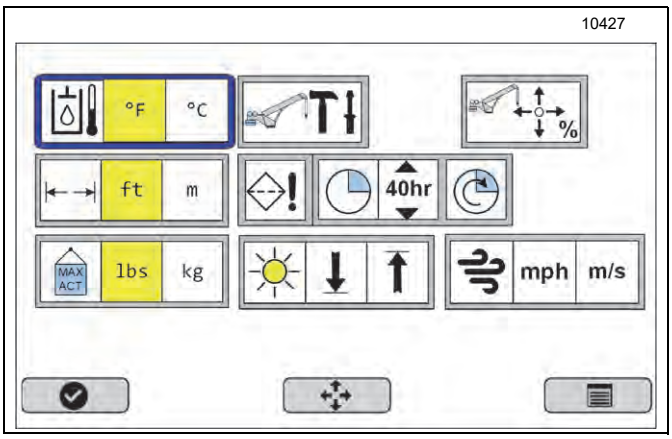


To access the Tools Menu:

- Use the directional arrows to highlight the Tools icon. Press the OK key.

  The Tools Menu appears.

Tools Screen



Setting Units of Measure

The unit of measure can be changed for the measurements shown in Table 7-7. Yellow indicates the currently set value.

Table 7-7 Units of Measure

°F °C	**Temperature** — Select either °F (Fahrenheit) or °C (Celsius).
ft m	**Length** — Select either ft (feet) or m (meter).
lbs kg	**Weight** — Select either lbs (pounds) or kg (kilograms).
mph m/s	**Wind Speed** (If equipped) — Select either miles per hour (mph) or meters per second (m/s).

To change the unit of measure:

1. Access the Tools menu.
2. Use the arrow key to highlight the measurement.
3. Press the Select function key.

Setting up the Hydraulic Filter 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 one of three different intervals. When the timer expires, an indicator is turned on for the operator to know it is time to change the filter. To reset the timer, select the far right icon. Table 7-8 shows available options.

Table 7-8 Hydraulic Filter Reminder Icons

Icon	Description
	Configure—Highlight and press OK to change the interval of the hydraulic filter reminder. The icon indicates the status of the timer. The icon is white when the filter is okay. The icon is red when the interval is elapsed and the filter needs to be changed.
40hr	**Set Interval**—Using the directional control keys, highlight the interval setting. The timer duration turns yellow when selected. To change the timer, select the check mark. The interval can be set for 40, 250, or 500 hours.
	Reset—Highlight and press OK to reset the reminder. Reset restarts the timer at the configured interval.

Setting RCL Screen Brightness

The brightness of the RCL screen can be changed. Adjust the screen to one of a range of 5 settings.

1. In the Tools menu, select the screen brightness icon.
2. Increase or decrease the brightness as necessary using the navigation buttons.
3. Press the Select function key.

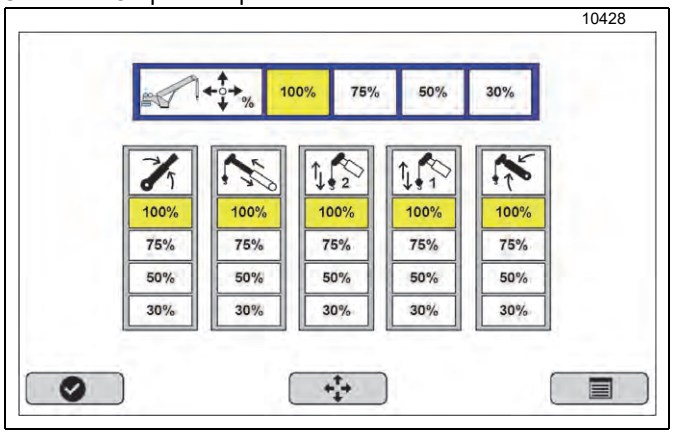
About Adjusting Controller Output

The crane is equipped with electronic Controllers the allow for more customization from the operator. The maximum speed of all crane functions can be decreased from 100% (default value) to either 75%, 50%, or 30% using this feature. If desired, each crane function can be set individually to a value less than the default value of 100%. For example, the operator can set swing to be 50% and all other outputs to 75% if desired. When these settings are modified from all functions at the default 100% setting, this controller output icon is shown on the top left corner of the operating mode screen while the crane is being operated as a visual feedback to the operator that a controller setting is set. These values change in real-time and are saved at machine shutdown. It is important to note that when a controller setting is set to less than 100%, full use of the crane controller is still allowed, but the maximum function speed is reduced according to the speed reduction.

Accessing the Controller Output Setup Screen

- Select the Tools on the MAIN Menu screen and the Tools menu appears.
- Select the Controller Output Setup icon to display the Controller Output Setup screen.

Controller Output Setup



About the Controller Output Setup Screen

The Controller Output Setup screen allows the operator to select what percentage of maximum hydraulic valve spool shift to use when operating the crane in “Crane Control.” This function does NOT work in “Radio Remote Control” mode.

- The top horizontal bar on the Controller Output Setup screen allows the operator to select all the crane functions be set to either 100%, 75%, 50%, or 30%.

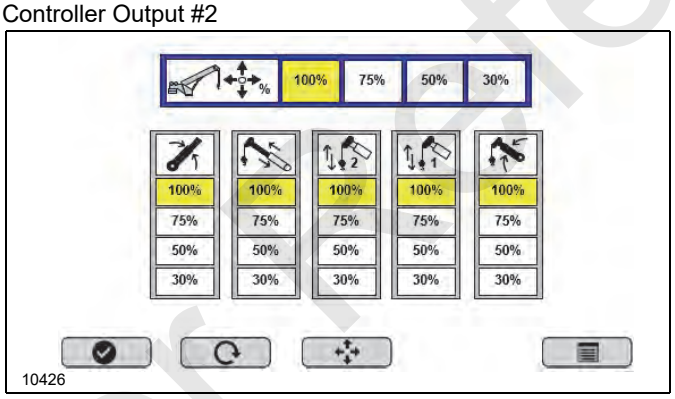
- The four/five vertical bars on the screen allow the operator to select a range of either 30%, 50%, 75%, or 100% for each function. Each function is identified by the icon at the top of the vertical bar as noted in the following table.

Table 7-9 Controller Output Icons

	Swing Control
	Boom Telescoping
	Auxiliary Hoist
	Main Hoist
	Boom Lift

- Yellow indicates the current setting.
- Default value for the Controller Output screen is all values @ 100%, as shown in Controller Output #2 screen.

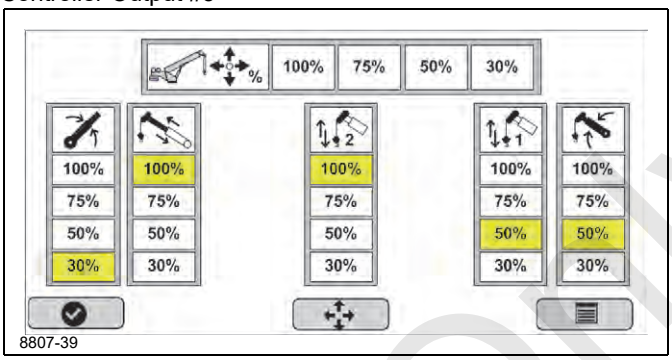
Controller Output #2



- The operator can also set the desired output for each function as shown in Controller Output #3 screen.

  Using the navigation buttons selects the function to be adjusted. Use the cycle button to select the speeds. After the speed is selected, click OK (check mark) button to save the value. If the screen is exited before selecting OK (check mark) button, the changes are not saved.

Controller Output #3



- When a Controller value is not set at 100% (default), the RCL Operating Mode screen (page 7-4) identifies the non-standard setting in the upper left hand corner. For more information about the different icons, see Table 7-3.
- Values are saved when the machine is shutdown.

SYSTEM CONFIGURATION

Use the following procedure to access the System Configuration Menu. The System Configuration menu is where the functions shown in Table 7-10 can be accessed.

Table 7-10 System Configuration Menu Icons

Icon	Description
	**Sensor Calibration Menu** — Select this icon to calibrate crane sensors. This icon appears red if sensors need to be calibrated. For more information, see the *Service Manual*.
	**Enable Chart Loading** — Select this icon to upload a new load chart. For more information, see the *Service Manual*.
	**Software Update** — Select this icon to load software updates. For more information, see the *Service Manual*.
	**Crane Function Configuration** — For more information, see the *Service Manual*.
	**Truck/Engine Configuration** — For more information, see the *Service Manual*.
	**Component Addressing** —Select this icon to update or add a CAN bus address to a component. This icon appears red when components need to be addressed. For more information, see the *Service Manual*.
	**Real-Time Clock Configuration** — Select this icon to update the RCL system time and date information. For more information, see “Setting System Date and Time” on page 7-17.

Accessing the System Configuration Menu

Use the following procedure to access the System Configuration menu. The password 12331 is required to continue to the System Configuration Menu.

1. In the main menu, select the Tools icon.

   The Tools menu appears.

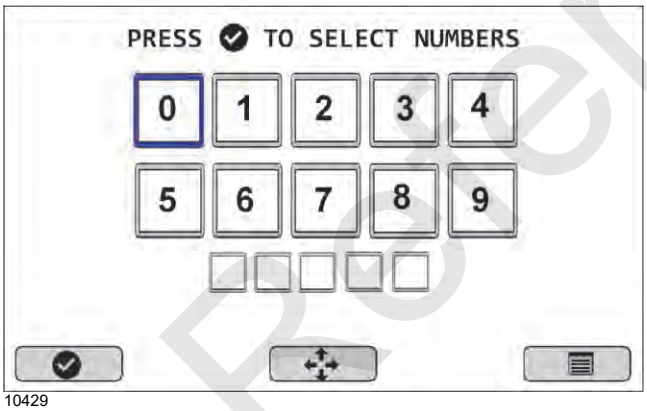
2. In the Tools menu, select the System Configuration icon  .

3. Enter the password 12331 to continue to the System Configuration menu. For more information, see “Entering the System Configuration Password” on page 7-17.

Entering the System Configuration Password

A 5-digit password is required to access the system configuration screen. After three failed attempts, there is a three second timeout before the user can re-enter the password. After all numbers are entered, the green OK (check mark) button appears.

Use the navigation pad to select one of the choices on the screen.



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Setting System Date and Time

Use the following procedure to set the RCL system Date and Time. Table 7-11 shows the functional keys available in the Time Set screen.

Table 7-11 Time Set Functional Keys

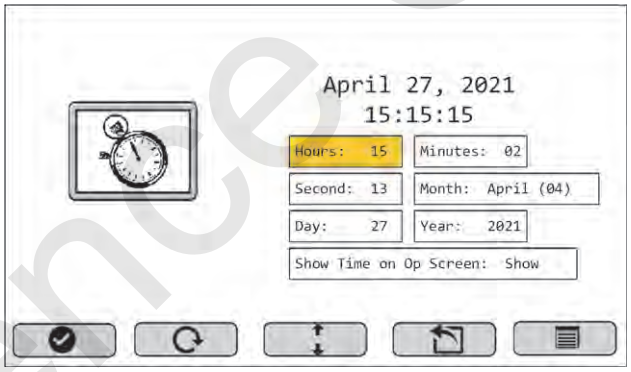
Icon	Description
	Use this button to set changes to a field.

Table 7-11 Time Set Functional Keys (Continued)

Icon	Description
	Use this button to cycle (tab) through the fields that can be changed.
	Use this button to increase and decrease the value in the selected field.
	Use this button to return to the System Configuration screen without saving changes.
	Use this button to return to the main menu.

1. In the System Configuration menu, select the Time Set icon  .

   The Time Set screen appears.



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2. Do the following to update the field(s):

- Use the cycle button as needed to tab through the fields available to update.
- Use the Increment/decrement button as needed to increase or decrease the value in the highlighted field.

3. Press the Select button to save changes.

CALIBRATING RCL SENSORS

The RCL sensors are located ton the crane and are used to monitor the lifting geometry and system pressures of the crane is where physically located.

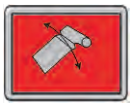
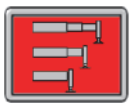
When a sensor requires calibration, its icon appears with a RED background in the RCL. Table 7-12 shows the Sensor Calibration warning icons. The sensors are calibrated at the factory before the crane is delivered, but need to be calibrated in the following circumstances:

- The sensor readings are inaccurate (individual sensor only must be calibrated)
- The sensor or component being measured is replaced, adjusted, removed, or reinstalled (individual sensor only must be calibrated)

- The software has a major revision update (all sensors must be calibrated)
- The RCL display is replaced (all sensors must be calibrated)

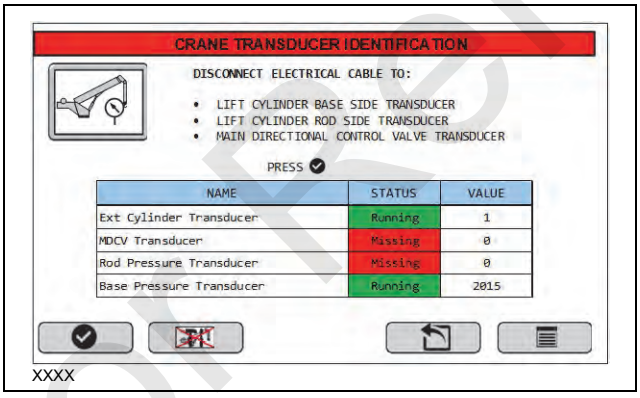
For more information about RCL calibration and related maintenance procedures, see the *Service Manual*.

Table 7-12 Sensor Calibration Warnings

Icon	Description
	**Slew Angle** — Indicates that the slew sensor needs to be calibrated.
	**Boom Angle** — Indicates that the boom angle sensor needs to be calibrated.
	**Boom Length** — Indicates that the boom length sensor needs to be calibrated.
	**Transducer** — Indicates that a transducer(s) needs to be calibrated.
	**Outrigger Sensor** — Indicates that the sensors on the outriggers needs to be calibrated.

The calibration reset button  resets all calibrations while in the Calibration screen.

Main Sensor Calibration Menu



XXXX

Use the navigation buttons to move to the function keys.

Select ESC button  to return to the System Configuration menu screen without deleting any limit values.

A password is required to calibrate a sensor. For more information, see “Entering the System Configuration Password” on page 7-17.

DIAGNOSTICS

The Diagnostics Menu screen contains crane and truck operating information and warnings, an hour meter, and fault code displays.

About the Diagnostics Screen

Table 7-13 shows the softkey buttons on the bottom of the Diagnostics screen. Use the appropriate function button to navigate to the next screen.

Table 7-13 Diagnostics Navigation Buttons

Icon	Button	Description
	Button #1	Navigates to Diagnostic Screen 2 (Fault Codes) when pressed.
	Button #2	Navigates to real-time Input/ Output (I/O) screen when pressed.
	Button #4	Appears only when a valid crane configuration has been entered and navigates to RCL Operating Mode Screen.
	Button #5	Navigates to Main Screen when pressed.

Table 7-14 describes the icons and data that populate the Diagnostics screen.

Table 7-14 Diagnostics Screen Icons

	**Truck Engine RPM** — Shows the current engine RPM. If data from the truck is missing, this icon is gray and a double dash displayed. If the truck does not support sending data, no error code is populated.
	**Truck Diesel Fuel Level** — 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. GRAY if missing or not supported.

Table 7-14 Diagnostics Screen Icons (Continued)

	Diesel Exhaust Fluid (DEF) Level — Displays the DEF level. YELLOW indicates ON. Fast Flash indicates an error. If a warning appears, consult the truck manufacturer's manual or your National Crane dealer. Gray with double dashes when no data is broadcast or not supported.
	Hydraulic Oil Temp — 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 default value.
	**Crane Hour Meter** — The crane hour clock monitors the hours the crane system is turned ON within one-tenth of an hour. The time is saved when crane is shutdown.
	Battery Voltage — If the truck battery voltage drops below 10.5 Volts or if the voltage is greater than 16 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.
	Engine Water Temperature — If the engine water temperature rises above the maximum threshold, the general warning light is shown on the operating mode screen and this icon is highlighted RED. Fahrenheit is default value.
	**Engine Stop Lamp** — If an engine error is detected the icon is highlighted RED.
	Engine Warning Lamp — If an engine warning is detected the icon is highlighted YELLOW.
	Truck Regeneration Needed — 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. Gray if not supported.
	Module Fault — Turns RED when any CANbus device is missing, including sensors and modules.

Table 7-14 Diagnostics Screen Icons (Continued)

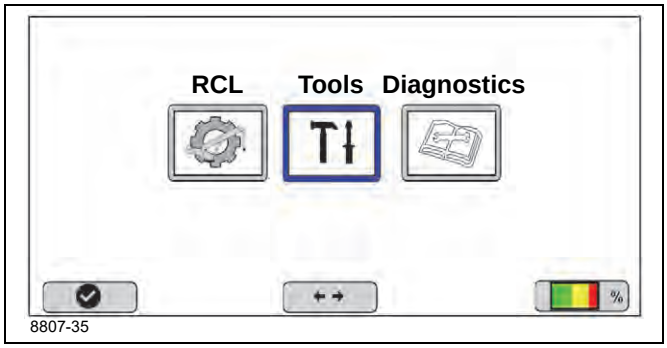
	Engine Oil Pressure Warning — If the truck engine oil pressure drops below 5 psi, the general warning light is shown on the operating mode screen and the truck engine oil pressure icon is highlighted RED on the diagnostics screen.
	Engine Oil Temperature — If the truck engine oil temperature rises above 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).
	Hydraulic Filter Reminder Warning — If the hydraulic filter reminder limit 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. The hydraulic filter time reminder can be configured. For more information, see "Setting up the Hydraulic Filter Reminder" on page 7-15.

Accessing the Diagnostics Menu

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

1. Select function button 5: the Main Menu function key  takes you to the Main Menu.

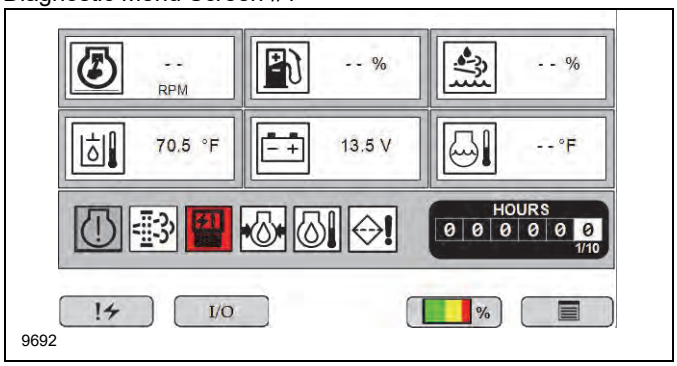
MAIN Menu



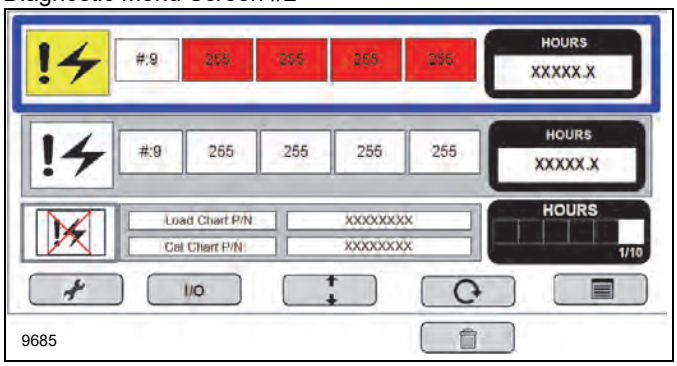
2. Select function key, Diagnostics.

   The Diagnostics menu appears.

Diagnostic Menu Screen #1



Diagnostic Menu Screen #2



About Faults and Real-Time I/O Diagnostics

Figure 7-7 shows active and logged faults. The crane control system saves the 50 most recent logged faults or errors and displays up to 20 of the most recent logged faults or errors in the crane and RCL control system(s). The circular arrow can be used to scroll through the active or logged faults. This series of numbers corresponds to a specific fault for a specific module, connector, and pin. To clear the logged fault codes, the button with the fault code icon and red “X” can be pressed.

Definitions of fault codes are available on the Manitowoc Diagnostics Code Mobile Application. Enter the fault code in the application to retrieve the definition. For more information, see “About the Manitowoc Diagnostic Code Mobile Application” on page 7-21.

The real-time I/O Diagnostics screens feature detailed information about the status of crane components. For more information, see “Viewing Real-Time I/O Diagnostics Screens” on page 7-21.

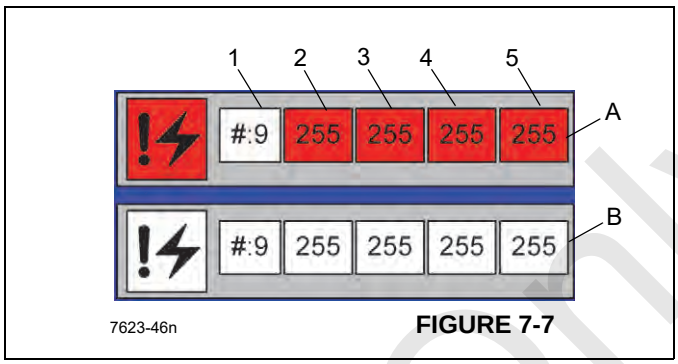


FIGURE 7-7

The following describes the fault code screen (Figure 7-7):

- Active Fault Box (Red, A, Figure 7-7) — The crane control system displays up to 20 active faults or system errors. Fault numbers are displayed when the fault occurs and clears when fault is corrected. The numbers correspond to a specific fault for a specific module, connector, and pin. The following data make up the fault code:
  - 1 — # Block — Indicates the number of the active fault already in the control system, use the circular arrow to scroll. Numbers are 1 through 20 with maximum of 20 faults.
  - 2 — Device Number
  - 3 — Group Number
  - 4 — Index
  - 5 — Error Number
- Logged Fault Box (B, Figure 7-7) — Logged faults are not currently active. Use the circular arrow to scroll through the codes.

Table 7-15 shows the navigation icons on the active alerts screen.

Table 7-15 Fault Screen Navigation Buttons

Icon	Description
	Press the UP/Down button to highlight the Logged Fault Code Box.
	Press the circular arrow button to scroll through the faults for either the “Active” or “Logged” faults.
	Button #4 changes to “delete” when the clear log icon is selected.
I/O	Button #2 navigates to real-time IO screen when pressed.
	Press button (#5) to navigate to the Main Menu.
	Press button (#1) to navigate to the Diagnostic Screen #1.

Viewing the Fault Codes List

Access the list of fault codes (diagnostics screen #2) from the Diagnostics menu. Use the directional button to scroll through the list of faults.

To access the fault codes menu:

1. Press the !⚡ function key.
2. Use the navigation buttons as needed to scroll through the fault codes.

Viewing Real-Time I/O Diagnostics Screens

Use the following procedure to view the real-time Input/Output (I/O) diagnostics screens. Use the directional button to scroll through the following I/O status screens:

- Module Status
- RCL System Information
- Interlock Information
- Outputs: Server Module
- Outputs: Lower Module
- Outputs: Throttle Module
- Inputs: Server Module
- Inputs: Lower Module
- Input Joysticks

To view real-time I/O diagnostics:

1. Navigate to the Diagnostics Menu. See “Accessing the Diagnostics Menu” on page 7-19.
2. Press the I/O I/O function key.

   The Real-time Diagnostics screen appears.
3. Use the navigation buttons to scroll through the real-time I/O screens.

About the Manitowoc Diagnostic Code Mobile Application

The Manitowoc Diagnostic Code Mobile Application is a free mobile application that enables the user to enter and retrieve information about specific crane fault codes on a mobile device. The application is available from the Google and Apple stores and compatible with most Android and Apple mobile smart devices.

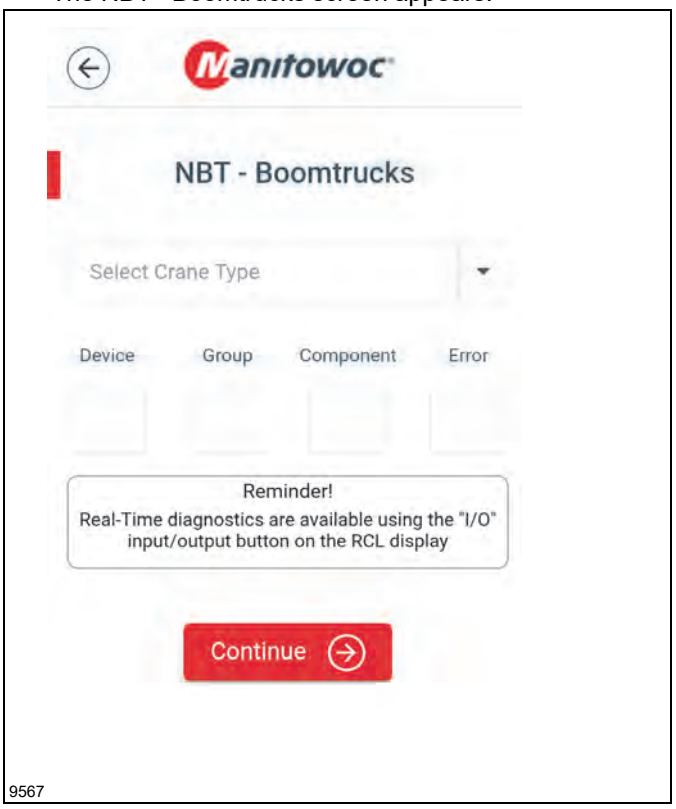
To look up a fault code with the Manitowoc Diagnostic Code mobile application:

1. Find the fault code you want to research in the RCL diagnostics screen. For more information, see “About Faults and Real-Time I/O Diagnostics” on page 7-20.
2. Open the Manitowoc Diagnostics Code Application on your smart device.

   The Diagnostic Code Application splash screen appears.

3. Click NBT.

   The NBT - Boomtrucks screen appears.



4. Complete the following using information from the error code displayed on the RCL:
   - Select Crane Type—Select the NBT crane type from the dropdown list.
   - Device—Enter the device number from the fault code.
   - Group—Enter the group information from the fault code.
   - Component—Enter the component information from the fault code.
   - Error—Enter the error number information from the fault code.
5. Click Continue.

   The Fault code information is displayed.

6. Click OK to return to the main screen.

APPENDIX 1
DECALS

Figure A-1 shows the locations of the decals on the NBT40-2.

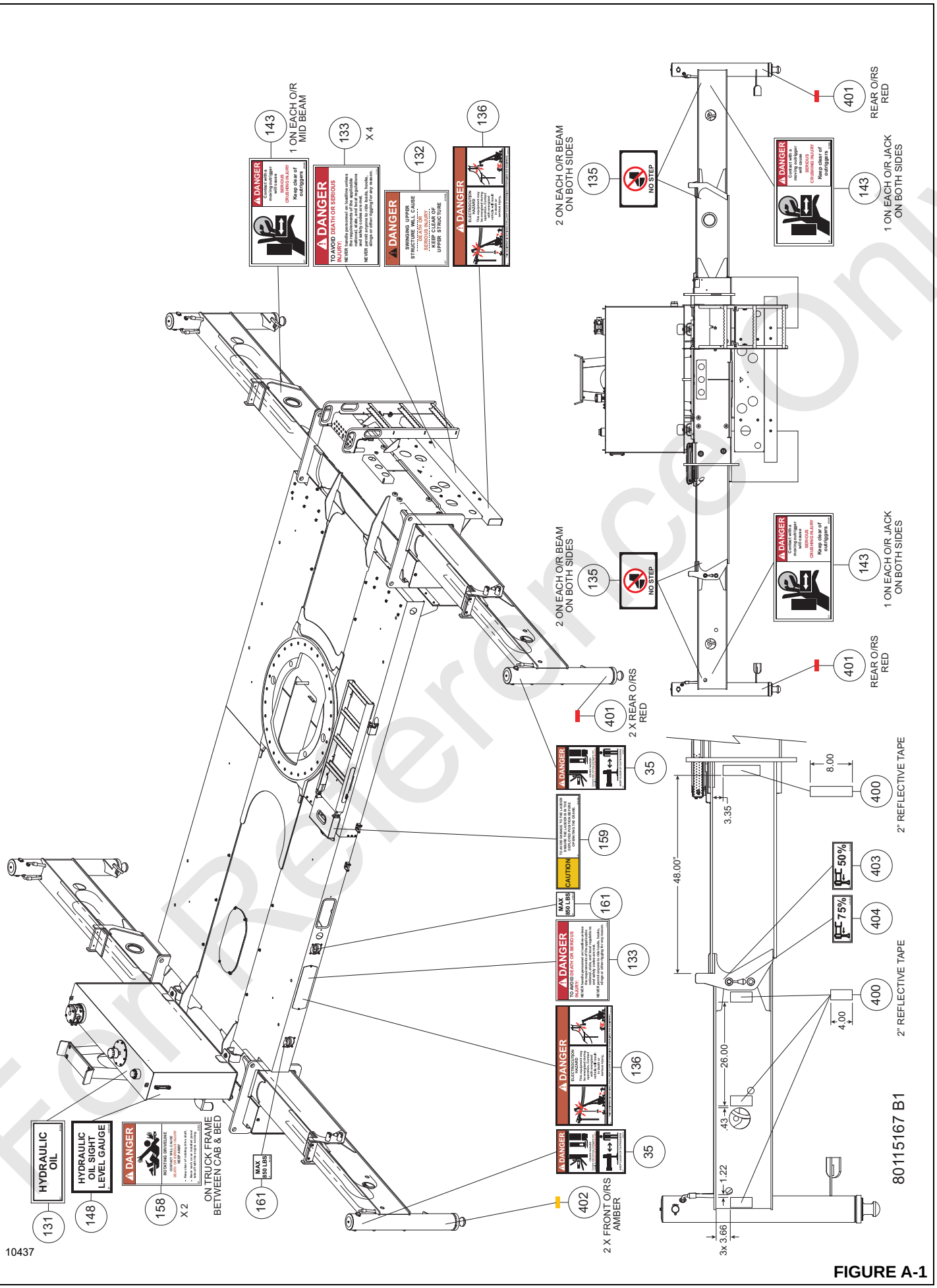


FIGURE A-1

NATIONAL CRANE

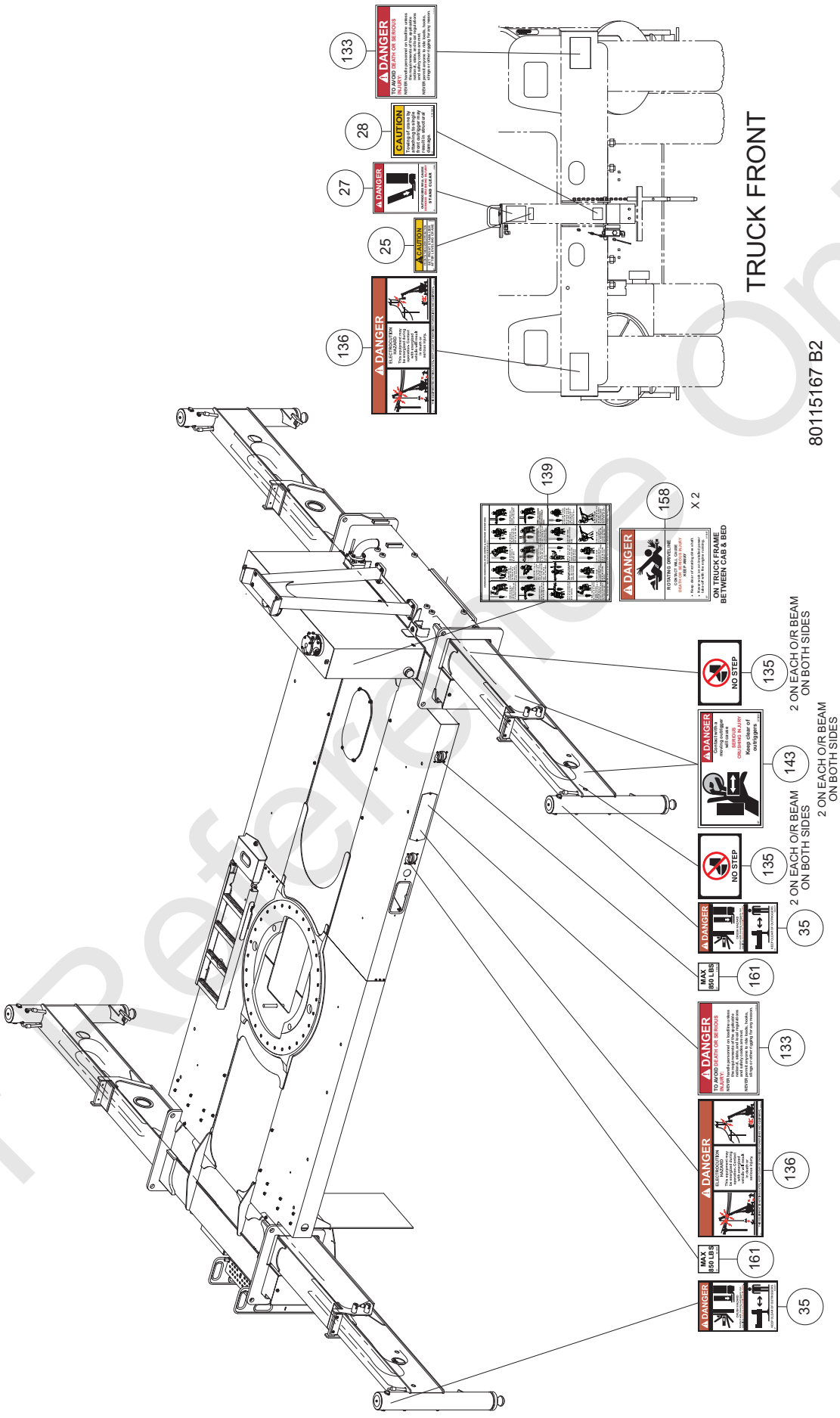


FIGURE A-1 continued

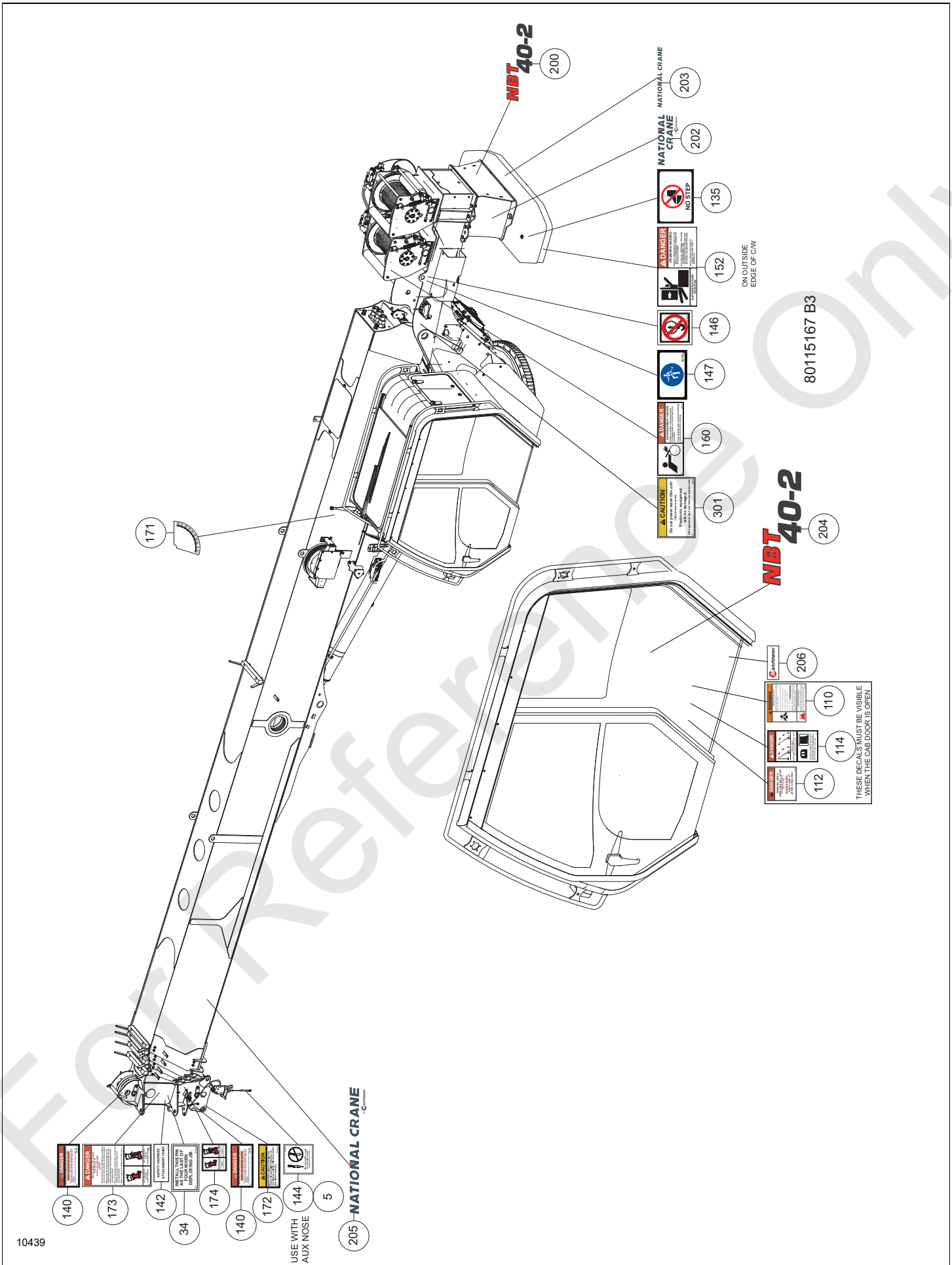


FIGURE A-1 continued

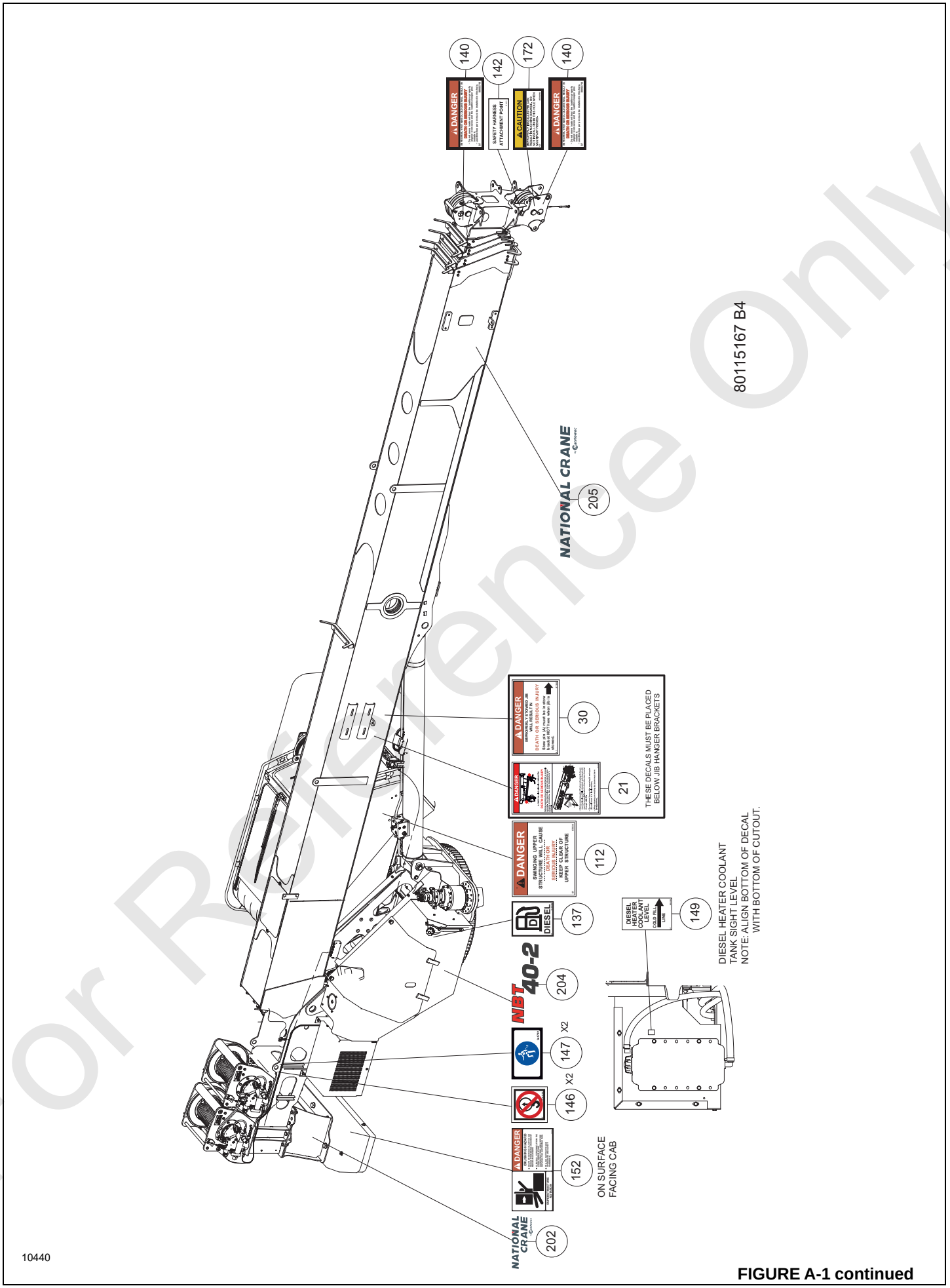


FIGURE A-1 continued

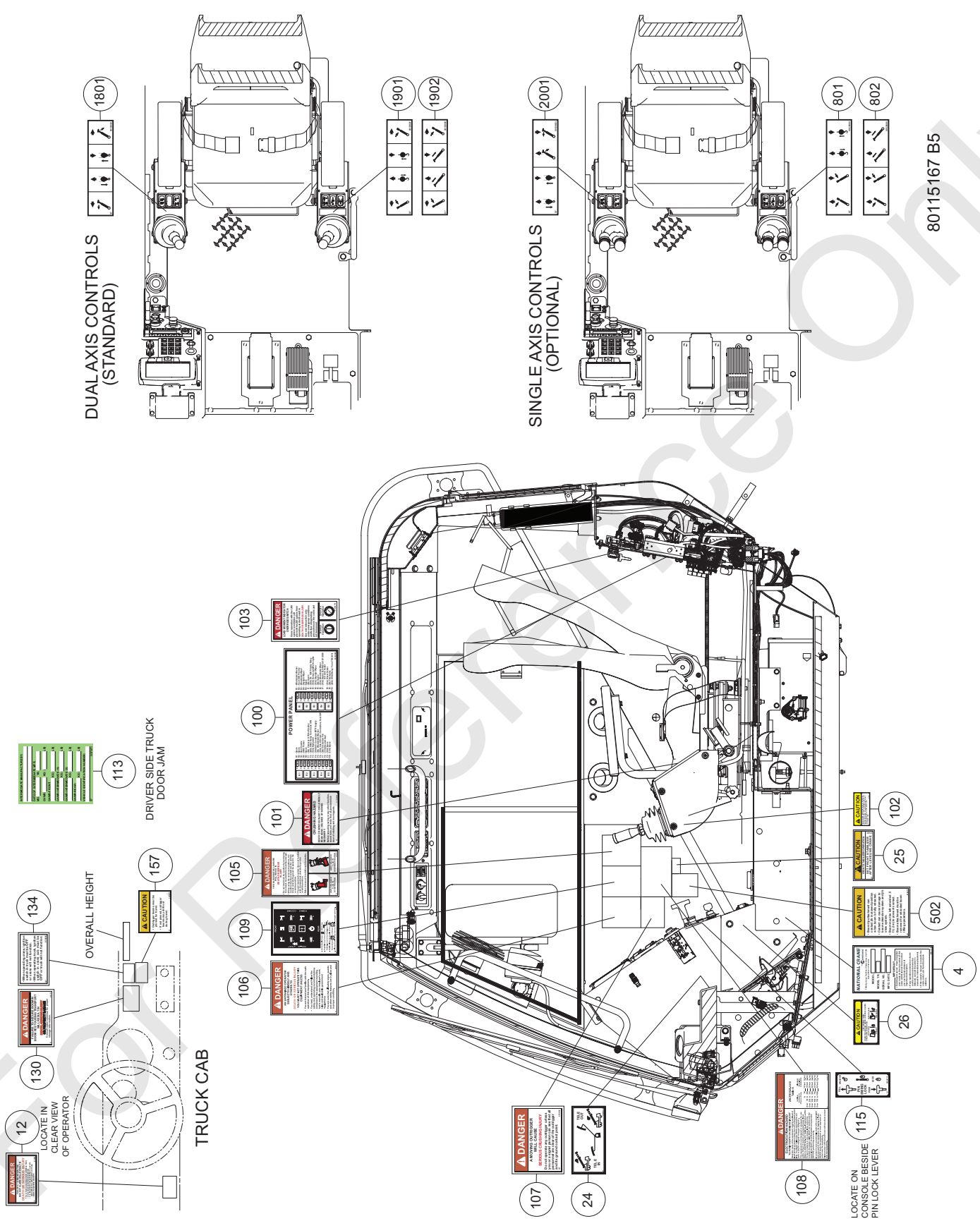


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FIGURE A-1 continued

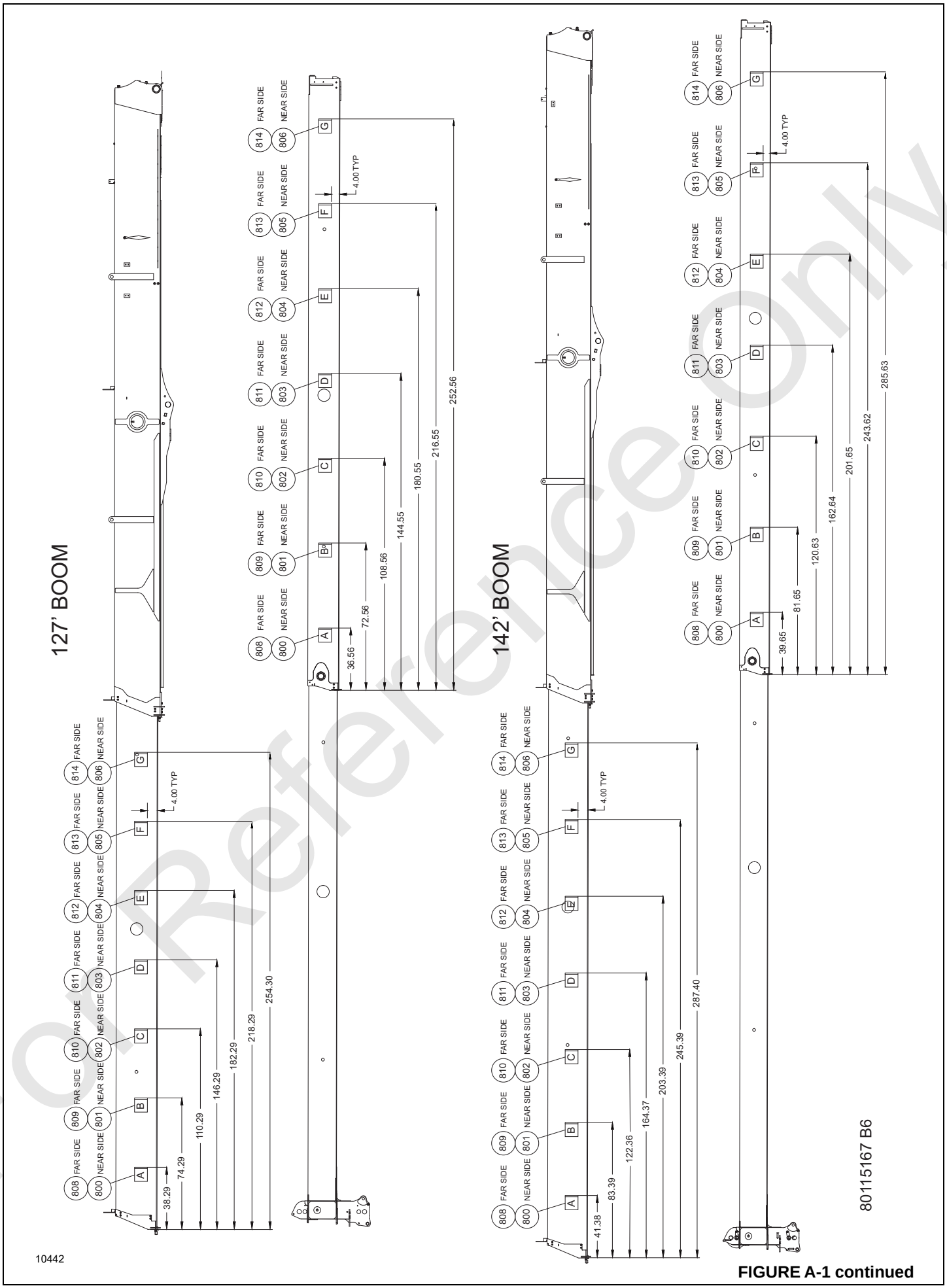

FIGURE A-1 continued

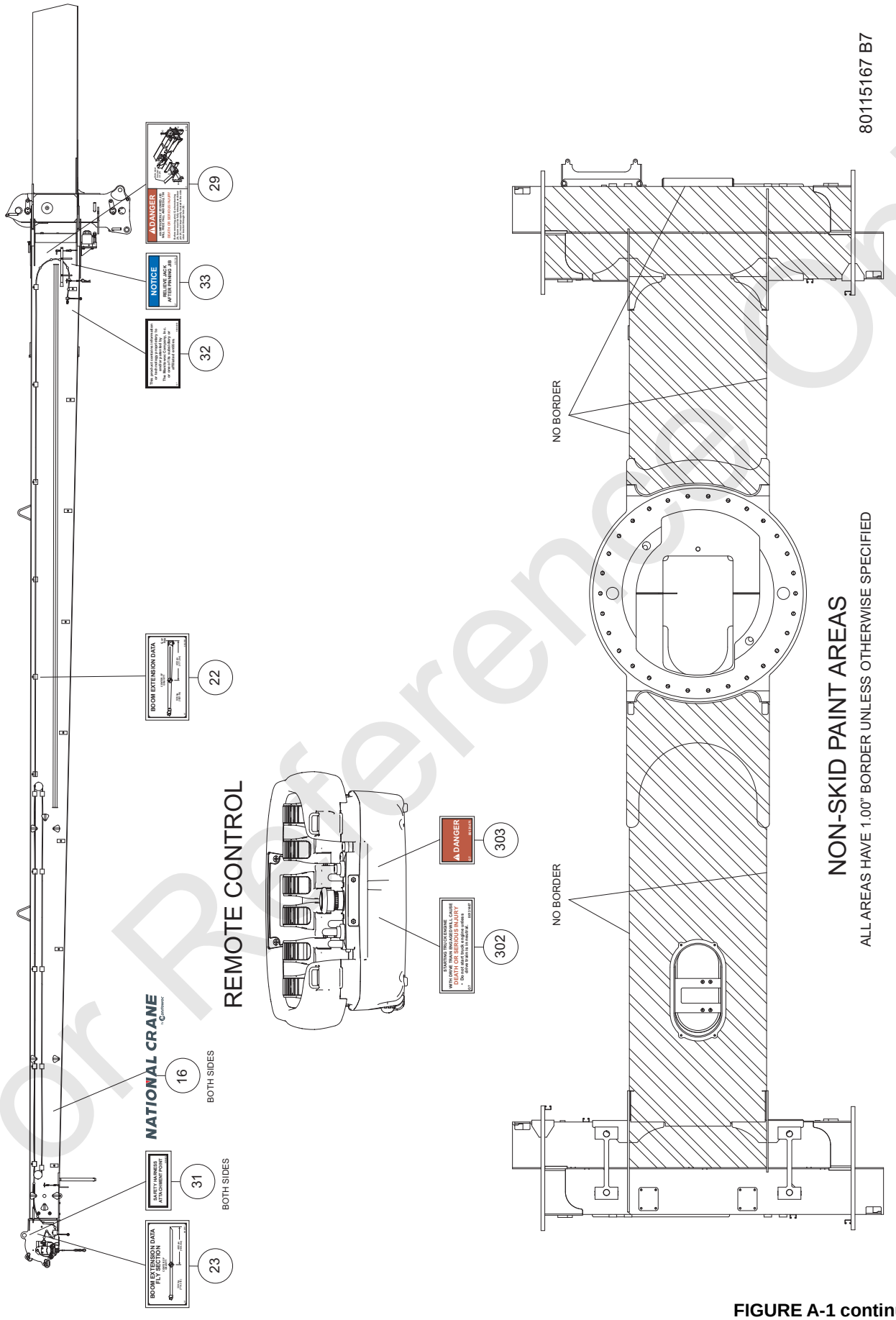

FIGURE A-1 continued

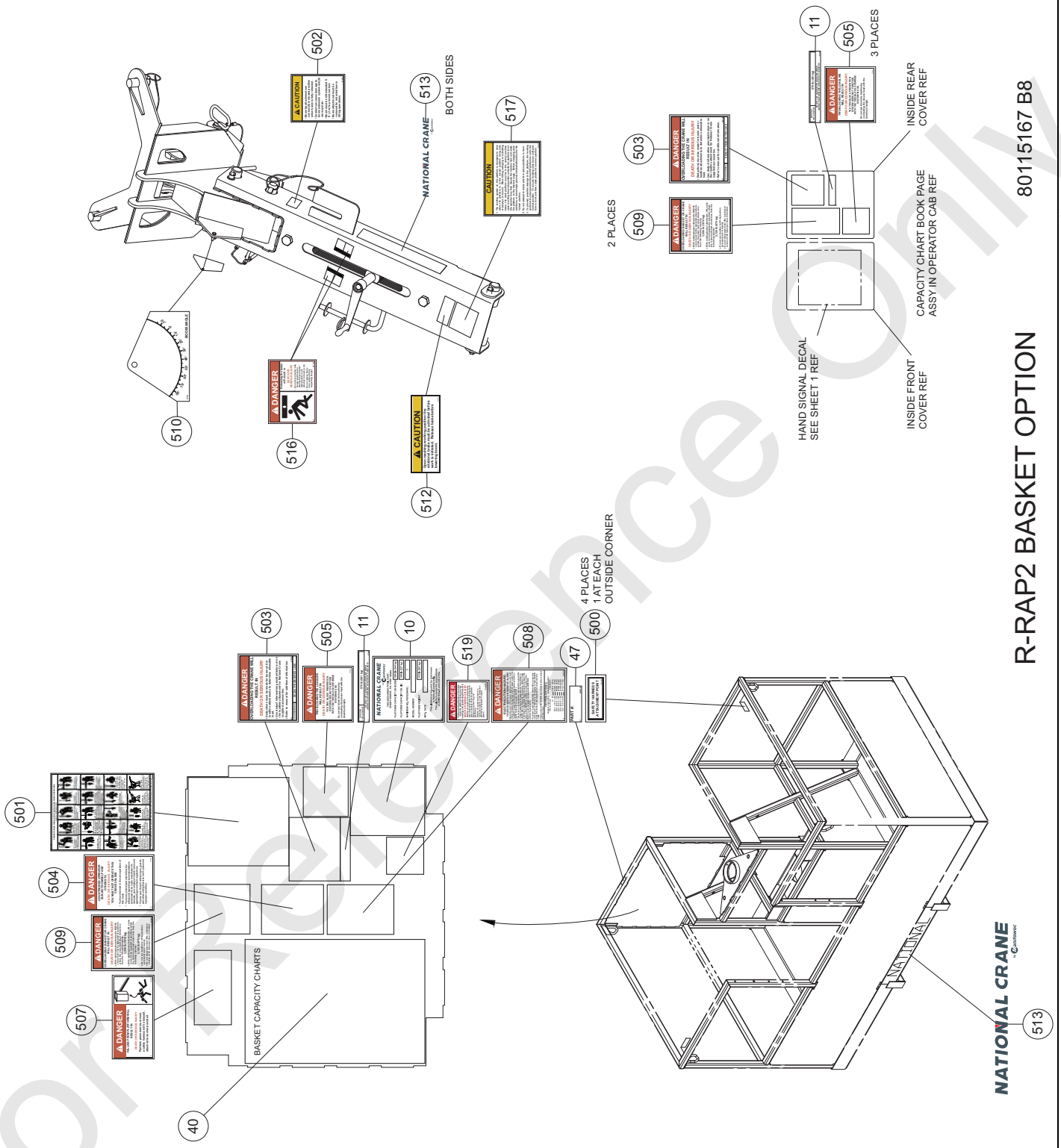

FIGURE A-1 continued

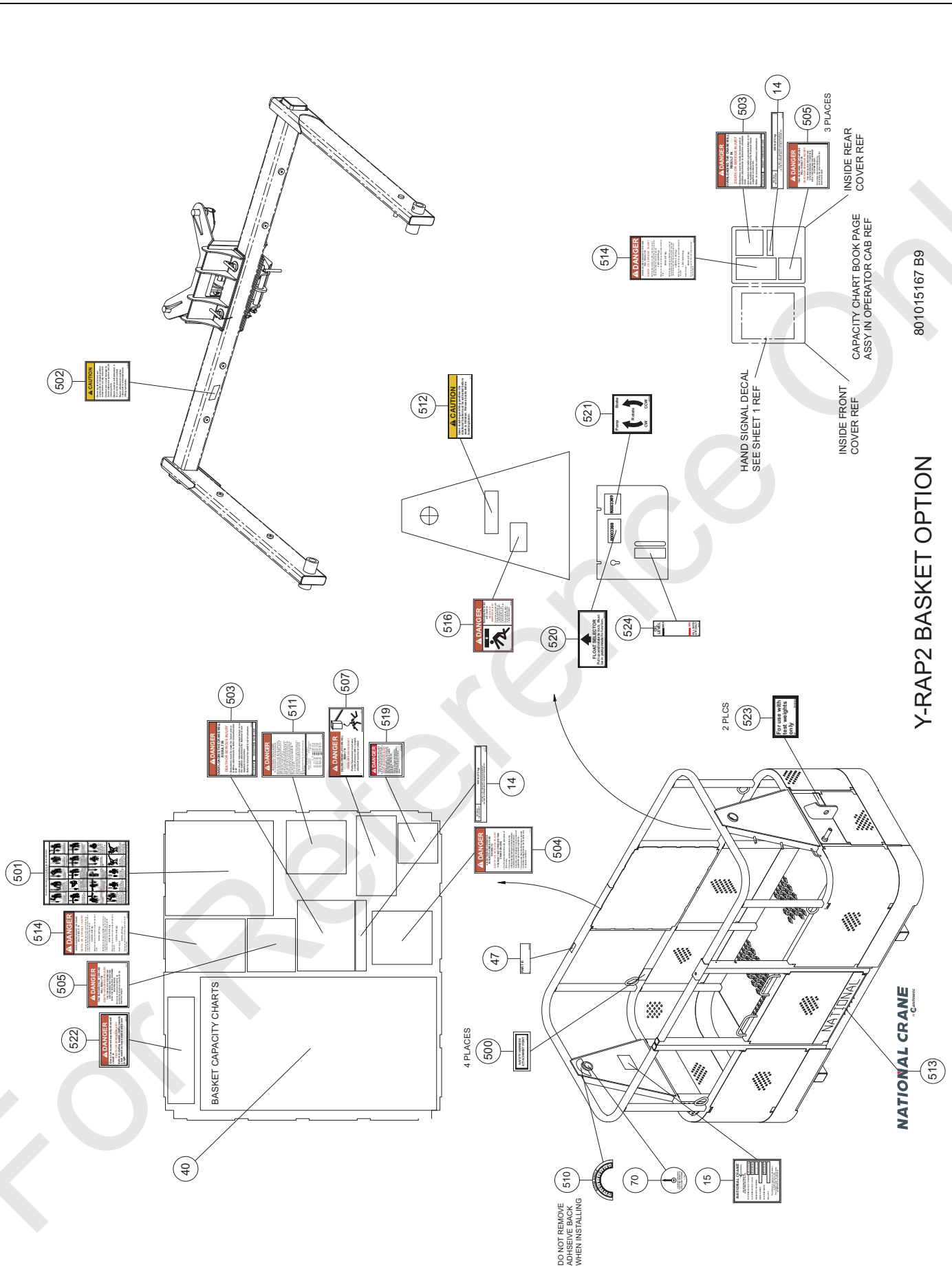

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FIGURE A-1 continued

Table A-1 Legend for Figure A-1

Item	Description
4	Serial No.
5	Support Chain
10	Platform Data 575-lb
11	Basket 575-lb Panel
12	DANGER—Backup Alarm Maintenance
14	Basket 600-lb Panel
15	Platform Data 600-lb
16	National—3.4-inch Gray
21	DANGER—Boom Extension Fall Hazard
22	Boom Extension T&L
23	Fly Boom Extension T&L
24	Telescope Boom (Pedal)
25	CAUTION—Single Front Outrigger Operation
26	CAUTION—360 Swing Lock
27	DANGER—Outrigger Crush Hazard
28	CAUTION—Towing Crane
29	DANGER—Boom Extension Crush Hazard
30	DANGER—Boom Extension Pin Stow Hazard
31	Safety Harness
32	Patent
33	NOTICE—Relieve Jack
34	Pin Installation
35	DANGER—O/R Crush Hazard
40	BCC Panel
47	Part #
70	Calibrate Pointer
100	Power Panel
101	DANGER—Superstructure Swing Hazard
102	CAUTION—Armrest Position
103	DANGER—RCL Override Switch
105	DANGER—A2B Override Hazard
106	DANGER—Untrained Operator
107	DANGER—O/R Crush Hazard
108	DANGER—Electrocution Hazard
109	Outrigger Functions
110	WARNING—California Prop 65
112	DANGER—Superstructure Crush Hazard

Table A-1 Legend for Figure A-1 (Continued)

Item	Description
113	Intermediate Conformity
114	DANGER—Tip Over Hazard
115	Pin Swing Lock
130	DANGER—Boom Transport
131	Hydraulic Oil
132	DANGER—Superstructure Crush Hazard
133	DANGER—Riding Hazard
134	Ignition Off
135	No Step
136	DANGER—Electrocution Hazard
137	Diesel
139	Hand Signal
140	DANGER—Loadline
142	Safety Harness
143	DANGER—O/R Crush Hazard
144	Support Chain
146	Tie Down or Lift Point Prohibited
147	Wear Body Harness
148	Hydraulic Oil Sight Level Gauge
149	Diesel Heater Cool Level
152	DANGER—CWT Crushing Hazard
157	CAUTION—Outriggers Pinned for Travel
158	DANGER—Driveline Hazard
159	CAUTION—Avoid Ladder Dam
160	DANGER—Entanglement Warning
161	Maximum Weight
171	Boom Angle Indicator—Left-hand
172	CAUTION—No Pin
173	DANGER—A2B Override Hazard
174	A2B Flag Position
200	NBT40-2 Nomenclature
202	NTC40-2 Nomenclature
203	NBT45-2 Nomenclature
204	NTC45-2 Nomenclature
205	National Crane Nomenclature
206	Manitowoc Decal
301	CAUTION—Electronic Equip

Table A-1 Legend for Figure A-1 (Continued)

Item	Description
302	Drive Train Engage
303	DANGER
400	Reflective Tape
401	Reflective Tape
402	Reflective Tape
403	50% Outrigger Position
404	75% Outrigger Position
500	Safety Harness
501	Hand Signal
502	CAUTION—Boom Attachment
503	DANGER—Overload Hazard
504	DANGER—Untrained Operator
505	DANGER—A2B Override Hazard
507	DANGER—Fall Hazard
508	DANGER—Elect Hazard-chart
509	DANGER—Basket Overload Hazard
510	Boom Angle Indicator—Basket
511	DANGER—Electrical Hazard-chart
512	CAUTION—Rotational Brake
513	National 1.3-Inch Gray
514	DANGER—Yoke Basket Overload Hazard
516	DANGER—Basket Brake Hazard
517	CAUTION—Leveling System
519	DANGER—Basket Movement Hazard
520	Float Selector
521	Pump Brake
522	DANGER—Wrong Cc
523	Test Weights
524	Oil Level
800	A-6.50
801	Swing/Auxiliary Hoist Single
	B-6.50
802	Swing/Telescope Single Axis
	C-6.50
803	D-6.50
804	E-6.50
805	F-6.50

Table A-1 Legend for Figure A-1 (Continued)

Item	Description
806	G-6.50
808	A-6.50
809	B-6.50
810	C-6.50
811	D-6.50
812	E-6.50
813	F-6.50
814	G-6.50
1801	Main Hoist & Lift—Dual
1901	Swing & Aux Hoist—Dual
1902	Swing & Tele—Dual
2001	Boom Lift/Main Hoist

INDEX

Numerics

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