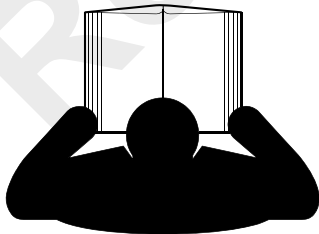



# OPERATOR MANUAL

## Supplement

### Crane Warm-up Procedures

	<h2> DANGER</h2> <p><b>An untrained operator subjects himself and others to death or serious injury. Do not operate this crane unless:</b></p> <ul style="list-style-type: none"><li>• You are trained in the safe operation of this crane. Manitowoc is not responsible for qualifying personnel.</li><li>• 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.</li><li>• You are sure that all safety signs, guards, and other safety features are in place and in proper condition.</li><li>• The Operator Manual and Load Chart are in the holder provided on crane.</li></ul>
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- Transmission ..... 1
- Hoist ..... 1
- Swing Drive and Turntable Bearing ..... 1
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Reference Only

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

## COLD CLIMATE ENGINE OPERATION

Engine specific cold climate operation information is available through your Cummins dealer/service center under Service Bulletin 3379009.

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

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### CAUTION

#### Crane Damage Hazard!

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

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

---

## Engine

### 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

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.

### Warm-up Procedures for Rough Terrain (RT) and Industrial Cranes:

1. Engage the parking brake and apply the service brake.
2. Shift the transmission into the highest gear and increase the engine RPM to 1500 for 15 seconds, then allow the engine RPM to return to idle.
3. Repeat Step 2 until the temperature of the transmission sump reaches normal operating temperature.

### Alternate Warm-up Procedures for Rough Terrain (RT) and Industrial Cranes:

1. Setup the crane on outriggers.
2. Engage the transmission with 4-wheel drive selected (if equipped) and allow crane to run at idle until the temperature of the transmission sump reaches normal operating temperature.

**NOTE:** Warm-up operation of 4-wheel drive transmission engaged in 2-wheel drive only could cause transmission damage.

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

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

## Hoist

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

### Warm-up Procedures:

1. Without operating the hoist function, warm the hydraulic oil (see *Hydraulic Oil System*, page 2-2).
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

### Warm-up Procedures for Temperatures Below -35°C (-30°F):

1. Setup the crane on outriggers.
2. Engage the transmission (see *Transmission*, page 2-1) with 4-wheel drive selected (if equipped) and allow

crane to run at idle until the temperature of the transmission sump reaches normal operating temperature.

**NOTE:** Warm-up operation of 4-wheel drive transmission engaged in 2-wheel drive only could cause transmission damage.

## Hydraulic Oil System

### Operating Limits and Warm-up Procedures:

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

# Shuttlelift CD3330F/FL Grove YB4409/XL

## Operator Manual





# OPERATOR MANUAL

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

## CD3330F/3330FL & YB4409/YB4409XL

Crane Model Number

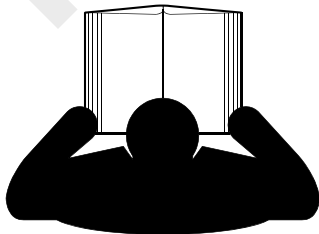
This Manual is divided into the following sections:

SECTION 1	INTRODUCTION
SECTION 2	SAFETY INFORMATION
SECTION 3	OPERATING CONTROLS AND PROCEDURES
SECTION 4	CAPACITY CHART
SECTION 5	ATTACHMENTS
SECTION 6	MAINTENANCE
SECTION 7	ADJUSTMENTS
SECTION 8	SPECIFICATIONS

### NOTICE

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

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



## **DANGER**

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

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

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 **CALIFORNIA  
PROPOSITION 65 WARNING**

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

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 **CALIFORNIA  
PROPOSITION 65 WARNING**

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

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The original language of this publication is English.



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# SECTION 1 INTRODUCTION

## SECTION CONTENTS

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## GENERAL

This operator manual provides the information you need to correctly operate and maintain the Shuttlelift 3330F/FL and Yardboss 4409 and 4409XL cranes.

**NOTE:** Before you operate the crane, carefully read this manual completely, so you will understand the safety instructions and the operation of the controls and safety equipment. You must comply with all DANGER, WARNING, and CAUTION notices. They are for your benefit.

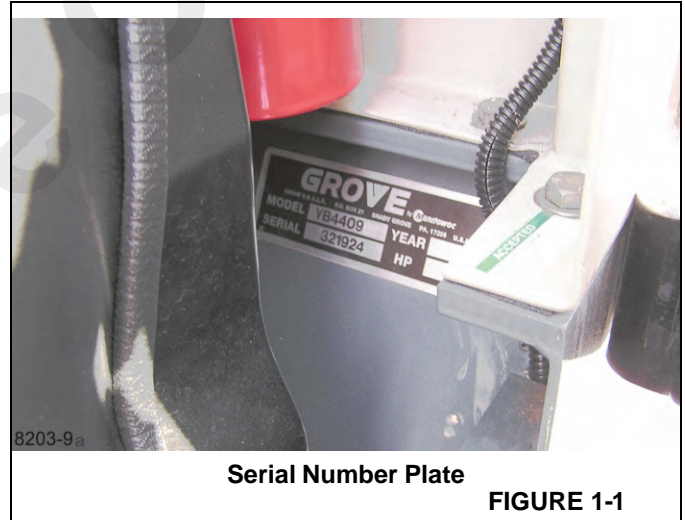
## DIRECTIONAL REFERENCE

All references to the right side, left side, front, and rear are given from the operator’s seat looking in a forward direction.

## SERIAL NUMBER PLATE

For easy reference, when contacting the distributor/manufacturer about this machine, record the machine’s serial number in the space provided below Figure 1-1. The numbers are stamped on the serial number plate which is located behind the operator’s seat. See Figure 1-1. Components, such as the pump, transmission, engine, axles, etc., have their own serial number plates that will be found on the housing of the component.

**NOTE:** The replacement of any part on this product with anything other than a manufacturer’s authorized replacement part may adversely affect the performance, durability, or safety of this product and will void the warranty. The manufacturer assumes no liability for unauthorized replacement parts which adversely affect the performance, durability, or safety of this product.



**Serial Number Plate** **FIGURE 1-1**

**CRANE SERIAL NUMBER:** \_\_\_\_\_

## REPORTS

**NOTE:** A Delivery Report form must be filled out by the manufacturer’s distributor, signed by the purchaser, and returned to the manufacturer once the product is sold and/or put into service. This report activates the warranty period, assuring that your claims during the warranty period will be honored and processed expediently. To guarantee full warranty service, make sure your distributor has returned the report to the manufacturer. An engine warranty form must also be filled out, signed and returned to the engine manufacturer for full warranty coverage.

**DISCLAIMER**

The manufacturer reserves the right to make improvements in design or changes in specifications at any time without incurring any obligation to install them on units previously sold.

**CUSTOMER SUPPORT**

Manitowoc 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.

**New Owners**

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

Go to: [http://www.manitowoccranes.com/MCG\\_CARE/Includes/EN/changeOfOwnership.cfm](http://www.manitowoccranes.com/MCG_CARE/Includes/EN/changeOfOwnership.cfm) and complete the form.

**SPECIFICATIONS****ENGINE**

Make and Model .....	Cummins QSB3.3 Tier 4i diesel
Type of Aspiration .....	Turbocharged
Horsepower .....	74.6 kW (100 hp) @ 2600 rpm
Low Idle Speed .....	800 rpm
Intermediate Speed Control (ISC) Idle Speed .....	1200 rpm - Coolant Temperature is less than 71° C (160° F)
Maximum Engine Speed .....	2600 rpm

**BOOM**

Construction .....	Telescopic, welded box sections
Number of Sections .....	Three section, full proportional (Standard) Four section (Optional)
Boom Length (From Boom Pivot Point)	
Short Boom .....	2.95 m (9 ft 8 in) to 6.45 m (21 ft 3 in)
Long Boom .....	3.89 m (12 ft 8 in) to 9.20 m (30 ft 2 in)

**MAST ROTATION - 360°**

Mast Bearing (Diameter) .....	860.6 mm (33.884 in)
Swing Drive Mechanism .....	Hydraulic motor driven gearbox
Swing Speed .....	2 rpm

**ELECTRICAL**

Type .....	12 volts, direct current
Alternator .....	120 amps
Battery .....	90 amp/hr

**FUEL TANK**

Capacity .....	64 l (17 gal)
----------------	---------------

**HYDRAULIC SYSTEM**

Primary Pump .....	Variable displacement piston pump
Secondary Pump .....	Gear, two-section
Main Control Valves	
Standard Outriggers .....	Six-section, closed center, load sense, with individual section compensation

Independent Outriggers.....	Eight-section, closed center, load sense, with individual section compensation
Swing Motor .....	Single section, gerotor-type
Hoist Motor .....	Fixed displacement, axial piston
Hydraulic Filters .....	One 10-micron filter in line from valves One 30-mesh suction filter inside hydraulic tank
Hydraulic Cylinders .....	Double-acting cylinders for lift, crowd, steering and outriggers
Hydraulic Tank.....	147.6 l (39 gal) capacity, steel construction with internal baffles

**WIRE ROPE**

Wire Rope (Main Hoist):

Diameter.....	13 mm
Type .....	8x25 Galv.
Length:	
Short Boom .....	24.4 m (80 ft)
Long Boom.....	39.6 m (130 ft)

Wire Rope (Optional Below Deck Winch):

Diameter.....	6 mm (1/4 in)
Length .....	30.5 m (100 ft)

**TORQUE CONVERTER**

Model .....	Borg and Beck
Type .....	Hydraulic

**TRANSMISSION**

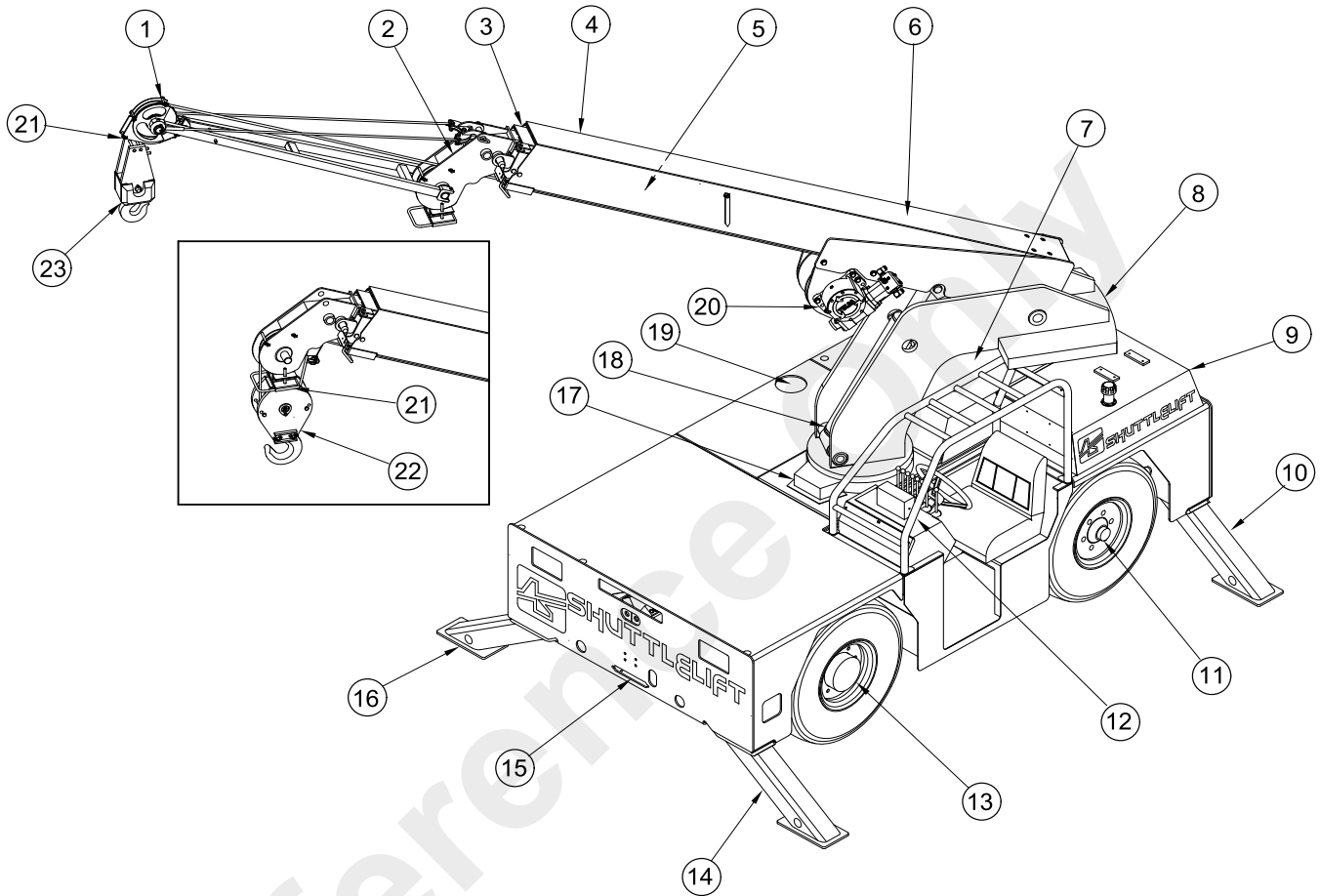
Type .....	International Transmissions Limited
Model .....	SS620
Type .....	Synchroshuttle
Travel Speed:	
First.....	7.44 km/h (4.62 mph)
Second.....	11.68 km/h (7.26 mph)
Third.....	21.48 km/h (13.35 mph)
Fourth .....	35.65 km/h (22.15 mph)

**FRONT AXLE, DRIVE/STEER**

Type .....	Carraro
Model .....	26.18M-164
Ratio.....	10.66:1

NOMENCLATURE

a1018



Item	Description	Item	Description
1	Optional Boom Extension	13	Steering Drive Axle
2	Inner Boom (3rd Section)	14	Left Front Outrigger
3	Intermediate Boom (2nd Section)	15	Optional Winch Location
4	Main Boom (1st Section)	16	Right Front Outrigger
5	Sequencing Boom Location	17	Swing Gearbox and Motor Location
6	Telescope Cylinder Location	18	Lift Cylinder
7	Engine Compartment Location	19	Fuel Tank Location
8	Mast	20	Hoist Gearbox, Motor and Brake
9	Hydraulic Oil Tank	21	Anti-Double Blocking Mechanism
10	Left Rear Outrigger	22	Hoist Block
11	Rear Non-Drive Steering Axle	23	Single Line Drop Block
12	Cab Guard (Shown) / Optional Enclosed Operator's Cab (Not Shown)		

FIGURE 1-2



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### SAFETY MESSAGES

#### General

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

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

To alert personnel to hazardous operating practices and maintenance procedures, safety messages are used throughout the manual. Each safety message contains a

safety alert symbol and a signal word to identify the hazard's degree of seriousness.

## Safety Alert Symbol



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

## Signal Words



### DANGER

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



### WARNING

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



### CAUTION

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

### CAUTION

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

**NOTE:** Emphasizes operation or maintenance procedures.

## GENERAL

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

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

This information has been provided to assist in promoting a safe working atmosphere for yourself and those around you. It is not meant to cover every conceivable circumstance

which could arise. It is intended to present basic safety precautions that should be followed in daily operation.

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

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

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

## Warning Signs

Refer to the *Parts Manual* for a drawing indicating the location of warning signs on the crane.

## ACCIDENTS

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

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

### The Manitowoc Company, Inc.

1565 East Buchanan Trail  
Shady Grove, PA 17256-0021

Phone: 888-777-3378 (888-PSR.DEPT)  
717-597-8121

Fax: 717-593-5152

E-mail: [product.safety@manitowoc.com](mailto:product.safety@manitowoc.com)

## OPERATOR INFORMATION

You must **read** and **understand** this *Operator Manual* and the *Load Chart* before operating your new crane. You must also **view** and **understand** the supplied safety video. This manual and *Load Chart* must be readily available to the

operator at all times and must remain in the cab (if equipped) or operator's station while the crane is in use.

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

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

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



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

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

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

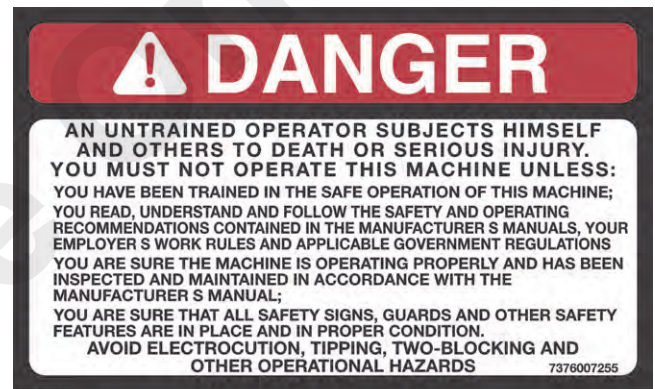
## OPERATOR QUALIFICATIONS

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

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

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

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



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

**You must not operate this crane unless:**

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

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

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

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

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

## OPERATIONAL AIDS

Operational aids are accessories that provide information to facilitate operation of a crane or that take control of particular functions without action of the operator when a limiting condition is sensed, 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, crane level indicator, hoist drum rotation indicator, load indicator, and wind speed indicator.

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

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

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

## Rated Capacity Limiter (RCL) Systems (If Equipped)

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

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

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

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

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

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

## Anti-Two-Blocking Device

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

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

Two-blocking is more likely to occur when both the main and auxiliary hoist lines are reeved over the main boom nose and 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 crane may be equipped with a working area limiter as part of the RCL system, designated as either Work Area Definition System (WADS) or Working Range Limiter (WRL). You must read and understand the operator manual before operating the working area limiter system. Become familiar with all proper operating procedures and with the identification of symbol usage.

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



**⚠ DANGER**

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

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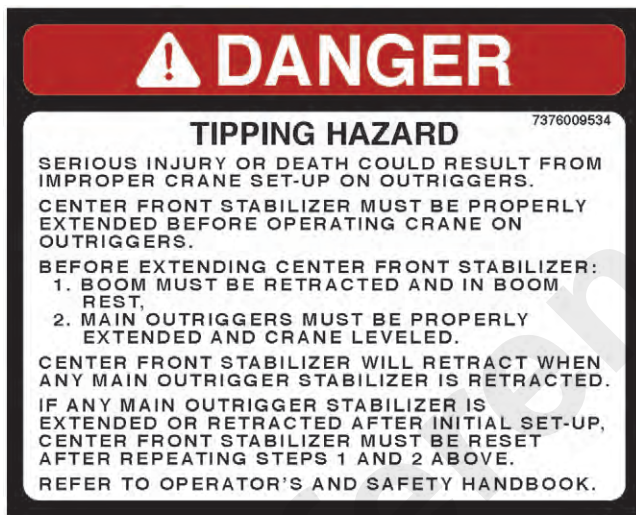
## CRANE STABILITY/STRUCTURAL STRENGTH

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

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

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

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



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

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

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

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

Check crane stability before lifting loads. Ensure the outriggers (or tires if lifting on rubber) are firmly positioned on solid surfaces. Ensure the crane is level, brakes are set, and the load is properly rigged and attached to the hook. Check the *Load Chart* against the weight of the load. Lift the load

slightly off the ground and recheck the stability before proceeding with the lift. Determine the weight of the load before you attempt the lift.

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



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

## Load Charts

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

*Load Chart* capacities are based on freely suspended loads.

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

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

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

## Work Site

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

operate. Be sure that the surfaces will support a load greater than the crane's weight and maximum capacity.

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

Be aware of the danger for people entering the working area. Do not allow unnecessary personnel in the vicinity of the crane while operating.

## WIND FORCES

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

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

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

Table 2-1 Beaufort Wind Scale

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

## Wind Speeds

The maximum permissible wind speed referred to in the load charts is the 3-second wind gust speed measured at the boom tip height and is designated as **V(z)**. This value is either recorded at boom tip or calculated based on mean

Wind 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. Manitowoc 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.

wind speed recorded at crane operation site. For lift planning purposes only, the 3-second wind gust speed, **V(z)**, may be calculated based on mean wind speed reported at <http://www.windfinder.com> "Super Forecast".

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

- a) If  $V(z)$  is  $\leq 13.4$  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  $\leq 20.1$  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  **$A_p$**  and by the wind drag coefficient  **$C_d$** . This limit can be determined by comparing the **Actual** wind resistance area with the **Allowable** wind resistance area.

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

Reference Only



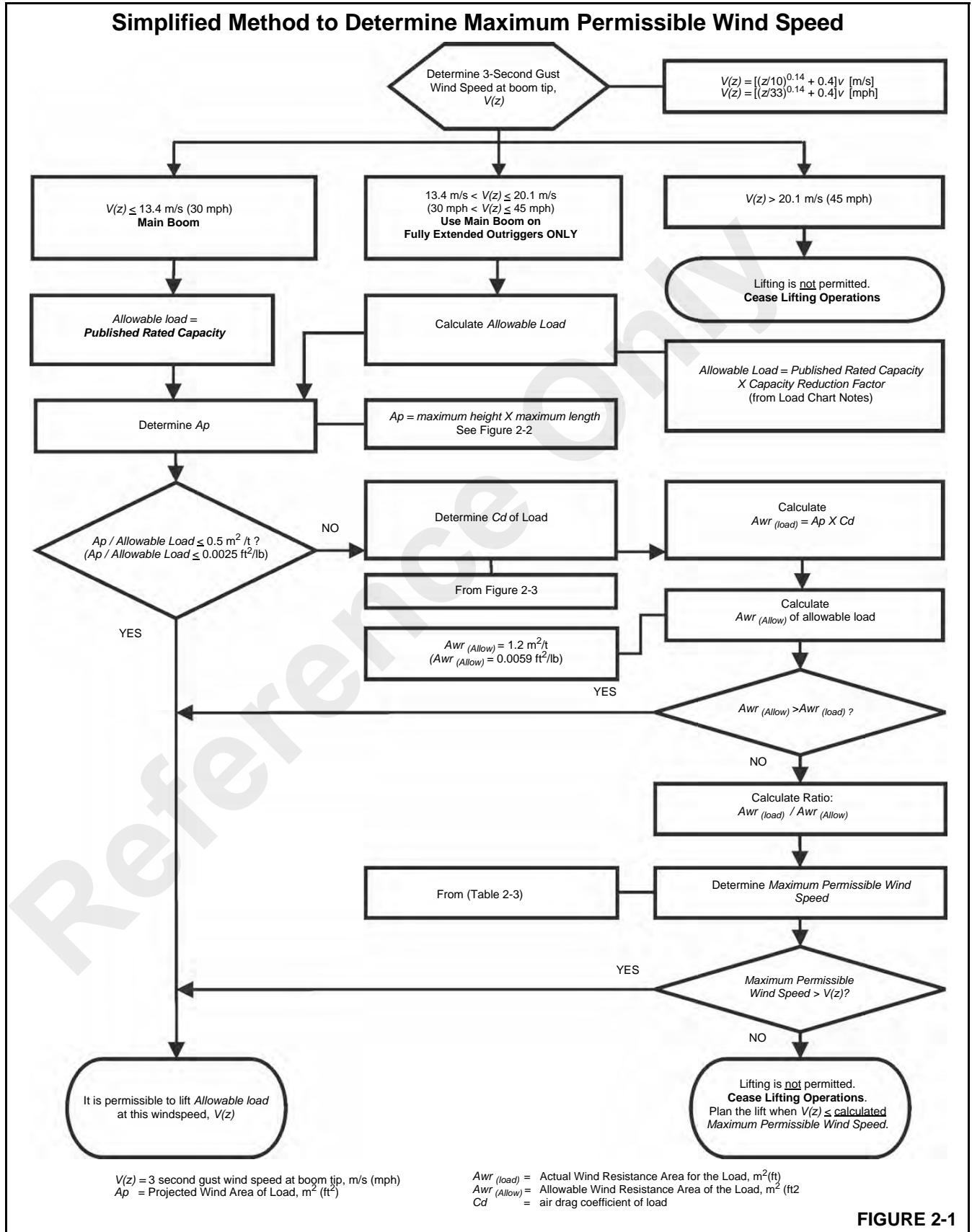


FIGURE 2-1

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

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

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

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

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

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

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

where:

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

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

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

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

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

then:

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

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

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

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

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

**Size and Shape of the load:**

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

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

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

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

where:

$Awr_{(load)}$  [m<sup>2</sup>] [ft<sup>2</sup>] - Wind resistant area of the load

$Ap$  [m<sup>2</sup>] [ft<sup>2</sup>] - projected wind area,

$Cd$  - wind drag coefficient.

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

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

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

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

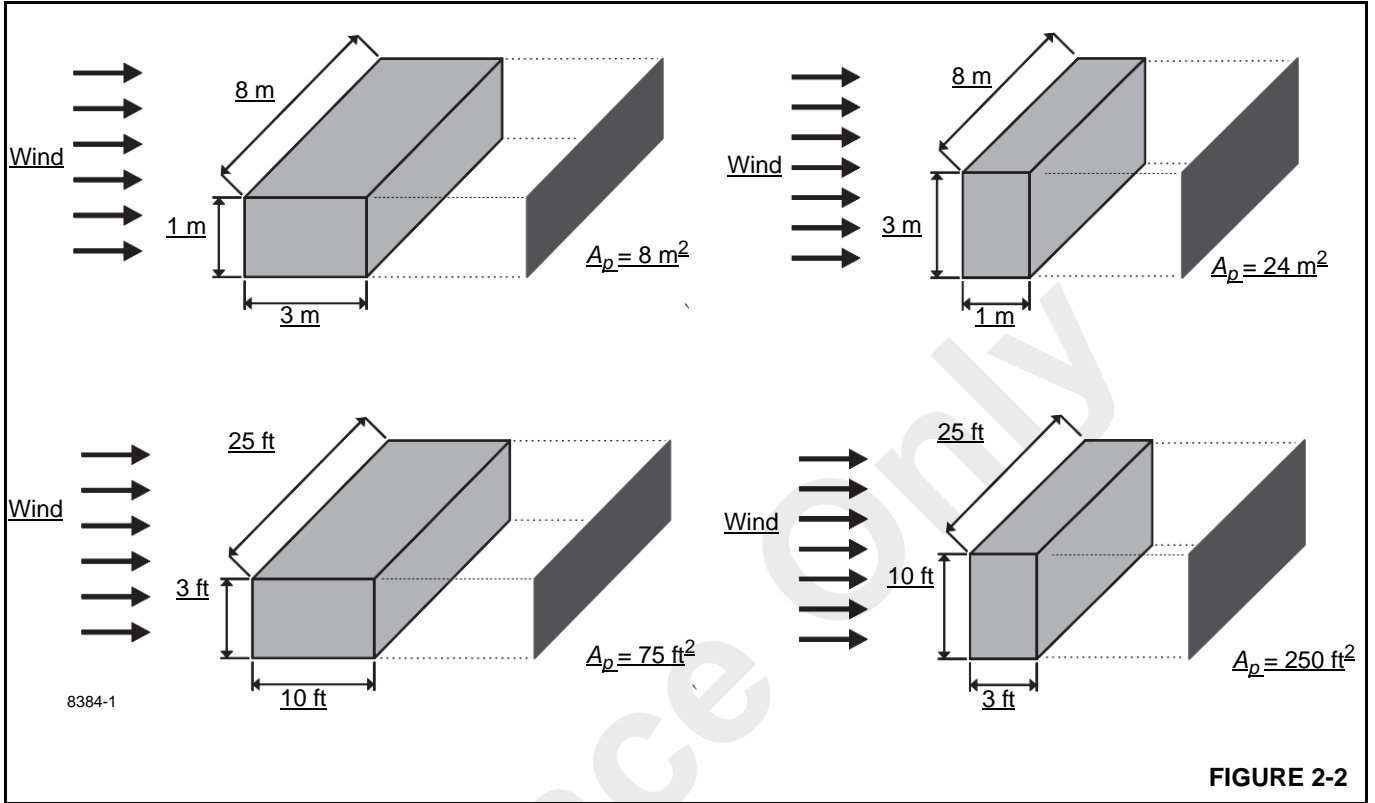
$$Awr_{(allow)} = 0.0012 \times m_{(load)} \quad (2.4)$$

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

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

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

Calculation of Projected Wind Area ( $A_p$ ):



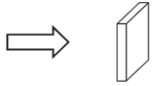



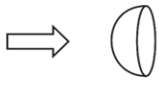
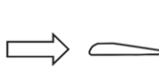

**Determining Wind Drag Coefficient ( $C_d$ )**

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

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

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

Table 2-2 Wind Drag Coefficient

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

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**Maximum Permissible Wind Speed**

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

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

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

Rated Load Chart Example - Metric

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

Radius in Meters	#001								
	Main Boom Length in Meters								
	10.9	12.2	15.2	**18.4	21.3	24.4	27.4	30.5	33.5
3	+60,000 (69.5)	40,950 (72)	40,950 (76)						
3.5	53,000 (66.5)	40,950 (69.5)	40,950 (74)	28,350 (78)					
4	47,450 (63.5)	40,950 (66.5)	40,950 (72)	28,350 (75.5)	*18,225 (78)				
4.5	42,875 (60.5)	40,950 (64)	40,950 (70)	28,350 (73.5)	18,225 (76)				
5	39,050 (57.5)	39,025 (61.5)	38,300 (67.5)	28,350 (72)	18,225 (75)	*18,225 (78)			
6	32,950 (50.5)	32,925 (55.5)	32,825 (63.5)	28,350 (68.5)	18,225 (72)	18,225 (75)	*18,225 (78)		
7	28,325 (42.5)	28,300 (49)	28,225 (59)	26,250 (65)	18,225 (69)	18,225 (72)	18,225 (74.5)	*16,725 (78)	*11,400 (78)
8	24,150 (32.5)	24,150 (42)	23,975 (54.5)	23,275 (61)	18,225 (69.5)	18,225 (72)	16,575 (74.5)	15,250 (74.5)	11,400 (76)
9	20,600 (16.5)	20,550 (33.5)	20,375 (49.5)	20,250 (55)	18,225 (63)	16,575 (67)	15,050 (70)	13,875 (72.5)	11,400 (74.5)
10		17,200 (20.5)	17,175 (42)	17,125 (54)	17,325 (60)	15,175 (64)	13,725 (67.5)	12,700 (70.5)	11,400 (72.5)
12			14,025 (35)	12,575 (45.5)	12,575 (53.5)	11,600 (59)	11,600 (63)	10,725 (66.5)	10,050 (69)
14				9,000 (35)	9,360 (36)	9,730 (53.5)	9,955 (58.5)	9,205 (62)	8,620 (65)
16				6,750 (19)	7,110 (37.5)	7,475 (47)	7,920 (53)	7,980 (57.5)	7,470 (61.5)
18					5,960 (27)	5,960 (39.5)	6,340 (47.5)	6,525 (53)	6,530 (57.5)
20						4,755 (30.5)	5,145 (41)	5,320 (48)	5,495 (53)
22							3,790 (16.5)	4,210 (33.5)	4,545 (48.5)
24								3,435 (23.5)	3,780 (43.5)
26									2,975 (28)
28									2,400 (16)
30									2,135 (22)
Minimum boom angle (°) for indicated length (no load)									0
Maximum boom length (m) at 0° boom angle (no load)									33.5

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

Lifting Capacities at Zero Degree Boom Angle									
Boom Angle	Main Boom Length in Meters								
	10.9	12.2	15.2	**18.4	21.3	24.4	27.4	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.

FIGURE 2-3

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

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

	Main Boom Length in Meters								
Wind Speed $V(z) > 13.4 \text{ m/s} \leq 20.1 \text{ m/s}$	10.9	12.2	15.2	18.4	21.0	24.4	27.4	30.5	33.5
Factor	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.7	0.6

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

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

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

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

**Example and Sample Calculations (metric)**

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

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

**Example 1: Crane Configuration:**

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

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

The maximum allowable wind resistance area of load is

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

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

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

- Maximum load 15,050 kg
- Maximum wind resistance area of load 18.06 m<sup>2</sup>

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

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

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

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

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

- Maximum load 12,040 kg
- Maximum wind resistance area of load 14.45 m<sup>2</sup>

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

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

**Load example 1.1:**

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

- load to be lifted of 11,200 kg,
- Projected Wind Area **Ap** = 9.20 m<sup>2</sup>,
- 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<sub>(load)</sub>** less than **Awr<sub>(allow)</sub>**?  
13.8 m<sup>2</sup> ≤ 14.45 m<sup>2</sup> YES

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

**Load example 1.2:**

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

- Load to be lifted of 10,000 kg,
- Projected Wind Area **Ap** = 5.45 m<sup>2</sup>,
- Wind Drag Coefficient **Cd** = unknown

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

the wind resistance area of load can be estimated as

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

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

- Is the load to be lifted less than allowable load?  
10,000 kg ≤ 12,040 kg YES
- Is **Awr<sub>(load)</sub>** less than **Awr<sub>(allow)</sub>**?  
13.08 m<sup>2</sup> ≤ 14.45 m<sup>2</sup> 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<sub>(load)</sub>**,

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

the wind resistance area of load can be estimated as:

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

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

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

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

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

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

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

- Is **Awr<sub>(load)</sub>** less than **Awr<sub>(allow)</sub>**?  
26.22 m<sup>2</sup> ≤ 18.06 m<sup>2</sup> NO

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

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

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

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

**Load example 1.3b:**

With large wind resistance area of the load **Awr<sub>(load)</sub>**,

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

the wind resistance area of load can be estimated as

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

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

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

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

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

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

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

Reference Only



Rated Load Chart Example - Non-metric

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

Radius in Feet	#0001								
	Main Boom Length in Feet								
	36	40	50	**60	70	80	90	100	110
10	130,000 (69.5)	90,300 (71.5)	90,300 (75.5)	*62,500 (78)					
12	112,500 (65.5)	90,300 (68.5)	90,300 (73)	62,500 (76.5)	*40,200 (78)				
15	93,250 (60)	90,300 (63.5)	90,250 (69.5)	62,500 (73.5)	40,200 (76)	*40,200 (78)			
20	71,550 (49.5)	71,500 (55)	71,300 (63)	62,500 (68)	40,200 (71.5)	40,200 (74.5)	40,200 (78)	*38,900 (78)	
25	56,650 (36.5)	56,600 (45)	56,350 (56)	53,650 (63)	40,200 (67)	40,200 (70.5)	37,950 (73)	34,900 (75)	*25,150 (78)
30	43,500 (11.5)	44,300 (32)	43,950 (48.5)	43,650 (57.5)	40,200 (62.5)	37,050 (66)	32,750 (69.5)	30,200 (72)	25,150 (74)
35			33,550 (40)	33,700 (51.5)	34,700 (58)	33,550 (62)	33,550 (66)	26,400 (69)	24,700 (71.5)
40			25,800 (28)	26,150 (44.5)	26,300 (52.5)	27,300 (58.5)	25,200 (62.5)	23,300 (66)	21,800 (68.5)
45				20,300 (36.5)	21,450 (47)	22,300 (54)	22,400 (59)	20,700 (62.5)	19,400 (65.5)
50				15,500 (25)	17,400 (41)	18,250 (49.5)	19,100 (55)	18,550 (59.5)	17,350 (62.5)
55					14,300 (33.5)	15,150 (44)	16,000 (51)	16,400 (56)	15,600 (60)
60					11,500 (23.5)	12,700 (38.5)	13,550 (46.5)	13,950 (52.5)	14,100 (56.5)
65						10,000 (31.5)	11,550 (41.5)	11,950 (48.5)	12,300 (53.5)
70						9,010 (22.5)	9,920 (36)	10,250 (44)	10,650 (50)
75							8,510 (29.5)	8,890 (39.5)	9,250 (46)
80							7,260 (21)	7,690 (34.5)	8,050 (42.5)
85								6,620 (28.5)	7,010 (38)
90								5,630 (20)	6,100 (33)
95									5,240 (27)
100									4,480 (19.5)
Minimum boom angle (°) for indicated length (no load)									0
Maximum boom length (ft.) at 0° boom angle (no load)									110

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

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

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

FIGURE 2-4

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

(Only for lifting with main boom on fully extended outriggers, with or without stowed extension)  
 For wind speed  $Vz$  (3-second gust speed at boom tip height) is greater than 30 mph  $\leq$  45 mph, the Reduced Capacity shall be calculated by multiplying the Published Rated Capacity by the following factors:

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

Wind resistance area of load,  $Awr_{(load)}$ , shall not exceed maximum allowable wind resistance area  $Awr_{(allow)}$ .  
 Maximum allowable wind resistance area in  $lb$ ,  $Awr_{(allow)} = 0.0059 \times$  calculated reduced capacity in  $lb$ .  
 Wind resistance area of load,  $Awr_{(load)} =$  projected wind area  $Ap \times$  wind drag coefficient  $Cd$  for the load.  
 For wind resistance area of load,  $Awr_{(load)} >$  maximum allowable wind resistance,  $Awr_{(allow)}$ , refer to crane Operator Manual.

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

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

Ratio:	1.2	1.4	1.6	1.8	2
	Maximum Permissible Wind Speed (mph)				
For Rated Capacity @ 30 mph	27.4 mph	25.4 mph	23.7 mph	22.4 mph	21.2 mph
For Allowable Capacity @ 45 mph	41.1 mph	38.0 mph	35.6 mph	33.5 mph	31.8 mph

**Example and Sample Calculations (Non-metric)**

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

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

**Example 2:**

A crane is configured with:

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

The ***Rated Load Chart Example - Non-metric*** (Figure 2-4), at maximum permissible wind speed,  $V(z) = 30$  mph, the

rated lifting capacity  $m_{(allow)}$  for this configuration is 25,200 lb.

The maximum allowable wind resistance area of load is:

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

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

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

- Maximum load 25,200 lb
- Maximum wind resistance area of load 149 ft<sup>2</sup>

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

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

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

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

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

- Maximum load 20,160 lb
- Maximum wind resistance area of load 119 ft<sup>2</sup>

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<sup>2</sup>.

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<sup>2</sup>,
- Wind Drag Coefficient **Cd** = 1.5

then the wind resistance area of load can be estimated as

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

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

- Is the load to be lifted less than allowable load?  
19,500 lb  $\leq$  20,160 lb YES
- Is **Awr<sub>(load)</sub>** less than **Awr<sub>(allow)</sub>**?  
105 ft<sup>2</sup>  $\leq$  119 ft<sup>2</sup> 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<sup>2</sup>,
- Wind Drag Coefficient **Cd** = unknown

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

the wind resistance area of load can be estimated as

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

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

- Is the load to be lifted less than allowable load?  
18,000 lb  $\leq$  20,160 lb YES

- Is **Awr<sub>(load)</sub>** less than **Awr<sub>(allow)</sub>**?  
108 ft<sup>2</sup>  $\leq$  119 ft<sup>2</sup> 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<sub>(load)</sub>**,

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

the wind resistance area of load can be estimated as:

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

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

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

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

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

- Is the load to be lifted less than allowable load?  
22,000 lb  $\leq$  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<sub>(load)</sub>** less than **Awr<sub>(allow)</sub>**?  
216 ft<sup>2</sup>  $\leq$  149 ft<sup>2</sup> 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<sub>(load)</sub>**,

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

the wind resistance area of load can be estimated as:

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

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

- Is the load to be lifted less than allowable load?  
12,000 lb  $\leq$  20,160 lb YES
- Is  $Awr_{(load)}$  less than  $Awr_{(allow)}$ ?  
162 ft<sup>2</sup>  $\leq$  119 ft<sup>2</sup> NO

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

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

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

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

## Lifting Operations

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

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

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

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

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

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

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

**Do not overload the crane** by exceeding the capacities shown on the appropriate *Load Chart*. Death or serious

injury could result from the crane tipping over or failing structurally from overload.

The crane can tip over or fail structurally if:

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

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

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

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

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

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

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

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

Never push or pull with the crane boom.

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

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

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

## Counterweight

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

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

## Outrigger Lift Off

Regarding "lifting" of an outrigger pad during craning activities, be advised that the rated loads for these cranes, as indicated on the crane's *Load Chart*, do not exceed 85% of the tipping load on outriggers as determined by SAE J765 OCT90 "Cranes Stability Test Code." An outrigger pad may lift off the ground during operation of the crane within the capacity limits of the *Load Chart*, yet the crane will not have reached instability. The "balance point" for stability testing according to SAE and Manitowoc criteria is a condition of loading wherein the load moment acting to overturn the crane is equal to the maximum moment of the crane available to resist overturning. This balance point or point of instability for a crane does not depend on "lifting" of an outrigger but rather on comparison of the "opposing" load moments.

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

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

## Multiple Crane Lifts

Multiple crane lifts are not recommended.

Any lift that requires more than one crane must be precisely planned and coordinated by a designated 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 designated person to direct the operation.
- Use one qualified signal person.
- Coordinate lifting plans with the operators, designated person, and signal person prior to beginning the lift.

- Maintain communication between all parties throughout the entire operation. If possible, provide approved radio equipment for voice communication between all parties engaged in the lift.
- Use outriggers on cranes so equipped.
- Calculate the amount of weight to be lifted by each crane and attach slings at the correct points for proper weight distribution.
- Ensure the load lines are directly over the attach points to avoid side loading and transfer of loading from one crane to the other.
- Do not travel. Lift only from a stationary position.

## Tilt-Up Panel Lifting

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

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

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

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

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

## PILE DRIVING AND EXTRACTING

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

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

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

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

- All pile driving and extracting operations shall be restricted to fully extended outriggers with all tires clear of the ground.
- The combined weight of the driver or extractor, piling, leads, attachments, etc., shall not exceed 80% of the published load chart values for on-outriggers operation.

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

## Crane Equipment

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

## Crane Inspection

- In addition to the crane's frequent and periodic inspections, dated daily records shall be maintained showing inspections were performed on the crane during the time it was used for pile driving or extraction.
- All anti-two block warning devices and RCL systems shall be inspected daily and verified to be functional.
- All areas of the crane subject to fatigue shall be inspected monthly, and before the crane is to return to lifting service.
- The boom shall be inspected daily to ensure all wear pads remain in place. Cranes which utilize pinned boom sections shall be inspected daily to ensure the pinning mechanism operates properly and to check for undue wear at the pins and pinning plates. The hoist cable shall

be inspected daily to ensure no chafing or wear is occurring.

**ELECTROCUTION HAZARD**

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

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

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



**DANGER**

**Electrocution Hazard!**

Manitowoc cranes are not equipped with all features required to operate within OSHA 29CFR1926.1408, Power Line Safety, 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.

If contact is ever accidentally made with a power line and any part of this crane, its rigging or load, **never** touch the crane or even approach or come near the crane.

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

**THIS CRANE IS NOT INSULATED.**

**DANGER**

**ELECTROCUTION HAZARD TO AVOID DEATH OR SERIOUS INJURY**

Keep ALL parts of the crane, rigging and load at least 20 feet (6 meters) away from any energized power line. You **MUST** follow the OSHA requirements set forth in 29CFR 1926.1407 through 1926.1411.

This crane is not designed or equipped for use within 10 feet (3 meters) of energized power lines [Refer to 29CFR1926.1410 Table A]. If operation within 10 feet (3 meters) of any power lines cannot be avoided, the power utility **MUST** be notified and the power lines **MUST** be de-energized and grounded **BEFORE** performing any work.

If contact is ever accidentally made with a power line and any part of this crane, its rigging or load, **NEVER** touch the crane or even approach or come near the crane.

Electrocution **CAN OCCUR** even without direct contact with the crane.

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

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

This crane is **not insulated**. Always consider all parts of the load and the crane, including the 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 crane while operating. Permit no one to lean against or touch the crane. Permit no one, including riggers and load handlers, to hold the load, load lines, tag lines, or rigging gear.

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

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

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

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

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

## Set-Up and Operation

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

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

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

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

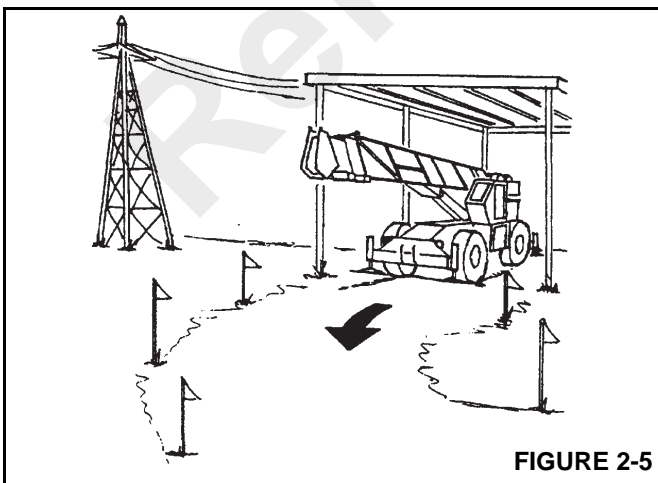


FIGURE 2-5

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

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

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

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

## Electrocution Hazard Devices

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

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

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

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

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

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

Some variables you must know and understand are:



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

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

## Electrical Contact

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

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

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

Following any contact with an energized electrical source, the Manitowoc 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 crane. Should the dealer not be immediately available, contact Manitowoc Crane Care. The crane must not be returned to service until it is thoroughly inspected for any evidence of damage and all damaged parts are repaired or replaced as authorized by your Manitowoc distributor or Manitowoc Crane Care.

## Special Operating Conditions and Equipment

Never operate the crane during an electrical thunderstorm.

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

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

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

## Earthing the Crane

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



### WARNING

#### Risk of accidents due to electric shock!

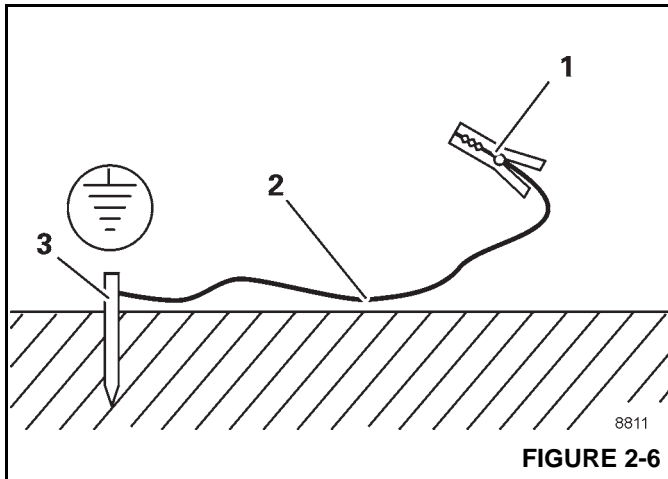
Earth the crane before you start to work with it

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

Use electrically conducting material for earthing.

1. Hammer a metal rod (3, Figure 2-6) (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 mm<sup>2</sup> (0.025 inches<sup>2</sup>).

4. Connect the free end of the cable with a clamp (1) to a good electrically conductive location on the frame.



### WARNING

#### Risk of accidents due to electric shock!

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

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

## PERSONNEL HANDLING

The American Society of Mechanical Engineers issued a new American National Standard entitled, *Personnel Lifting Systems*, ASME B30.23-2011:

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

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

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

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

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

- The platform is properly attached and secured to the load hook.
- For boom mounted platforms:
  - The platform is properly attached and secure.

To avoid death or serious injury:

- NEVER use this crane for bungee jumping or any form of amusement or sport.
- NEVER handle personnel on the loadline unless the requirements of applicable national, state and local regulations and safety codes are met.
- NEVER permit anyone to ride loads, hooks, slings or other rigging for any reason.
- NEVER get on or off a moving crane.
- NEVER allow anyone other than the operator to be on this crane while the machine is operating or traveling.
- 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, 0700-2900
- *US DOL/OSHA Rules and Regulations* are available by mail from the Superintendent of Documents, PO Box 371954, Pittsburgh, PA, 15250-7954.

## ENVIRONMENTAL PROTECTION

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

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

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

When filling and draining crane components, observe the following:

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

- Immediately clean up any spills.

## MAINTENANCE

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

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

Shut down the crane while making repairs or adjustments.

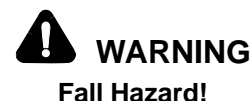
Always perform a function check after repairs have been made to ensure proper operation. Load tests should be performed when structural or lifting members are involved.

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

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

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

## Service and Repairs



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

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

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

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

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

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

**Hydraulic Fluid:**

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



**WARNING**

**Pressurized Fluid Hazard!**

Hydraulic pressure may still be present in portions of the hydraulic system due to accumulators or trapped circuitry.

- Hot hydraulic fluid will cause severe burns. Wait for the fluid to cool before disconnecting any hydraulic lines.
- Hydraulic fluid can cause permanent eye injury. Wear appropriate eye protection.

**Moving Parts:**

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

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

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

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

After maintenance or repairs:

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

**Lubrication**

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

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

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

## Tires



### WARNING

#### Possible equipment damage and/or personal injury!

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

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

Ensure all lug nuts are properly torqued.

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

## HOIST ROPE

### Synthetic Hoist Rope

For detailed information concerning synthetic hoist rope, refer to KZ100 Synthetic Crane Hoist Line Manual P/N 9828100734 available by contacting Manitowoc Crane Care.

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

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

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

**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 Manitowoc as indicated on the crane's *Capacity Chart*. Substitution of an alternate hoist rope may require the use of a different permissible line pull and, therefore, require different reeving.

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

## Wire Rope

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

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

- Wire ropes wear out. The strength of a rope begins to decrease when the rope is put to use and continues to decrease with each use. Rope will fail if worn-out, overloaded, misused, damaged or improperly maintained.
- The nominal strength, sometimes called catalog strength, of a 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 wire 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 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.

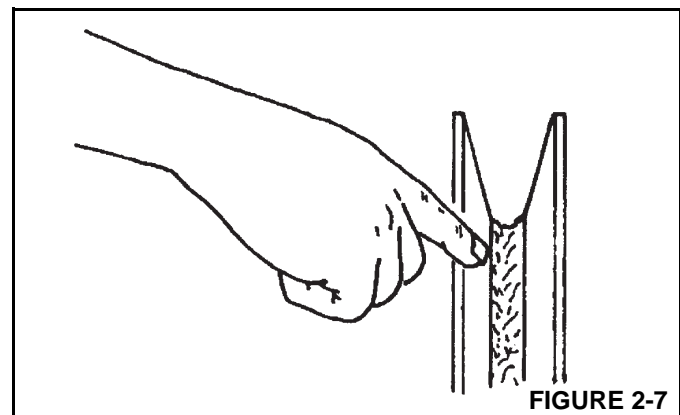
When installing a new rope:

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

When using a wedge socket:

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

## Sheaves



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

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

To attain maximum 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 hoist 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. For cranes with a Cummins engine using an engine ECM:
  - a. Ensure that the key switch has been off for 2 minutes.
  - b. Turn the battery disconnect switch to the OFF position.
  - c. Remove the ECM power fuse.
  - d. Remove negative battery cables.
- 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.
- If applicable, maintain battery electrolyte at the proper level. Check the electrolyte with a flashlight.
- If applicable to your crane, check battery test indicator on maintenance-free batteries.
- Check battery condition only with proper test equipment. Batteries shall not be charged except in an open, well-ventilated area that is free of flame, smoking, sparks, and fire.

## Super Capacitor (If Equipped)

Capacitor 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 capacitor, exercise the following procedures and precautions:

- Wear safety glasses when servicing.
- If equipped, disconnect battery with the battery disconnect switch before disconnecting the ground battery cable. For cranes with a Cummins engine using an engine ECM:
  1. Ensure that the key switch has been off for 2 minutes.
  2. Turn the battery disconnect switch to the OFF position.
  3. Remove the ECM power fuse.
  4. Remove negative battery cables.
  5. Remove positive capacitor cable.
- Do not short across the capacitor posts to check charge. Short circuit will cause capacitor terminal damage. Spark or flame could cause capacitor explosion.
- Check capacitor charge level with proper test equipment. Engine

## General Maintenance

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

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

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

Shut down the engine and disconnect the battery before performing maintenance. If unable to do so for the task

required, keep hands clear of the engine fan and other moving parts while performing maintenance.

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

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

The engine can enter into a engine exhaust cleaning mode where the exhaust temperature can be high, ensure the exhaust is not pointed at materials that can melt, burn or explode.

## TRANSPORTING THE CRANE

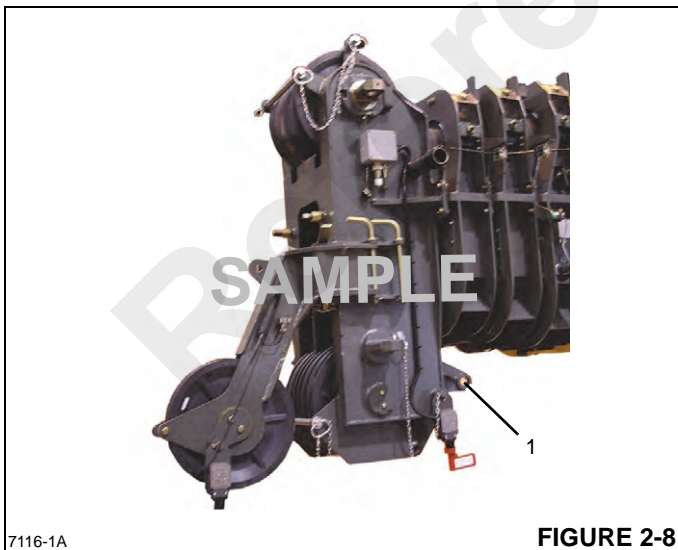
Before transporting the crane, check the suitability of the proposed route with regard to the crane height, width, length, and weight.

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

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

Ensure the crane is adequately secured to the transporting vehicle.

Do not use the dead end lug (1, Figure 2-8) 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.



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**FIGURE 2-8**

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

Either the hook block may be reeved over the main boom nose or the headache ball may be reeved over the main boom nose or auxiliary boom nose; the other must be removed. If the hook block or headache ball remains reeved

on the boom, it must be secured at the tie down on the carrier to prevent swinging.

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

## TRAVEL OPERATION

Only the crane operator shall occupy the crane when traveling.

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

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

RT and Industrial cranes are manufactured with no axle suspension system. 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.

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

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

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

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

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

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

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

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

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

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



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

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

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

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

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

Stay alert at the wheel.

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

Slopes:

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

## WORK PRACTICES

### Personal Considerations

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

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

### Crane Access



#### WARNING

##### Fall Hazard!

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

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

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

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

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

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

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

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

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

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

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

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

### Job Preparation

Before crane use:

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

- Check for proper functioning of all controls and operator aids (for example, RCL).
- Check all braking (for example, wheel, hoist, and swing brakes) and holding devices before operation.

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

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

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

## Working

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

Know the location and function of all crane controls.

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

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

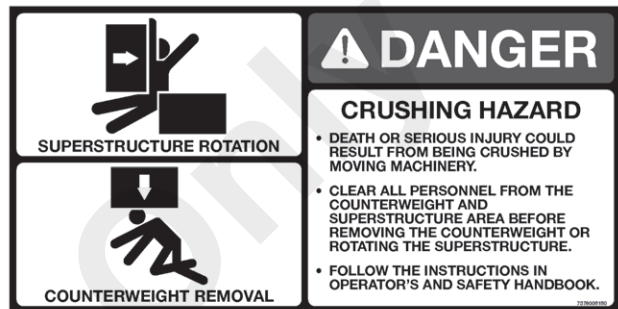
Carbon monoxide fumes from the engine exhaust can cause suffocation in an enclosed area. Good ventilation is very important when operating the crane.

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

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

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

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



Keep unauthorized personnel clear of the working area during operation.

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

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

Operate the crane only from the operator's seat. Do not reach in a window or door to operate any controls.

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

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

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

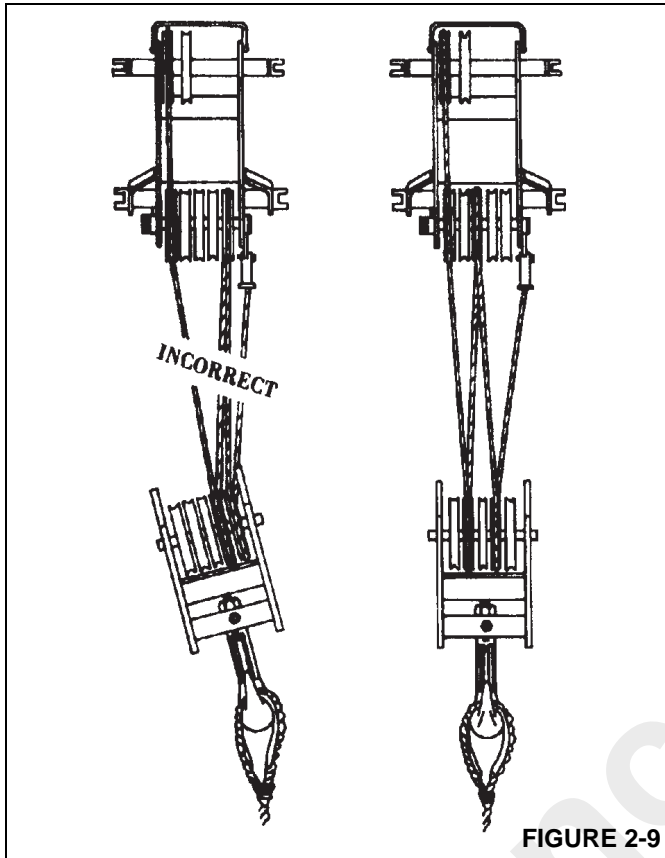


FIGURE 2-9

## 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 wire rope** should remain on the hoist drum. **No less than eight wraps of synthetic rope** should remain on the hoist drum. When slings, ties, hooks, etc., are used, make certain they are correctly positioned and secured before raising or lowering the loads.

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

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

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

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

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

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

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

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

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

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

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

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

Stop the hook block from swinging when unhooking a load.

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

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

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

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

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

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

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

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

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

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

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

### Hand Signals

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

- Working in the vicinity of power lines.
- The crane operator cannot clearly see the load at all times.

- Moving the crane in an area or direction in which the operator cannot clearly see the path of travel.

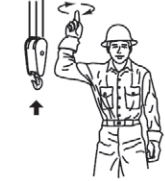
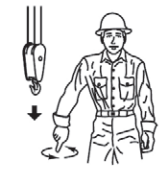

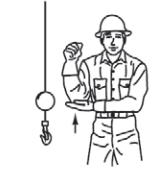

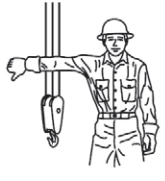

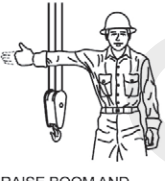

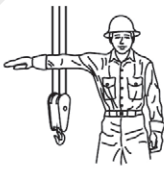



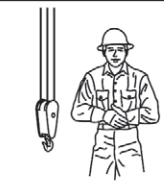



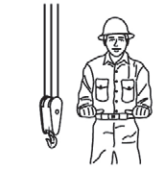


At all times use standardized hand signals - previously agreed upon and completely understood by the operator and signal person.

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

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

Obey a signal to stop from anyone.

Reference Only

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

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FIGURE 2-10

## 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 jib is properly pinned and secured on front and rear stowage brackets.



### DANGER

#### Boom Extension Hazard!

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

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

Properly inspect, maintain, and adjust jib and mounting.

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

Stay outside of jib sections and lattice work.

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

## PARKING AND SECURING



### DANGER

#### Tipping Hazard!

When parking the crane and leaving it unattended follow the instructions in Section 3 of this manual.

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

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

Section 3 of this manual provides instructions for parking and securing a crane when it is to be left unattended. These instructions are intended to allow the crane to be placed in the most stable and secure position. However, Manitowoc recognizes that certain jobsite conditions may not permit the boom and jib of a crane to be fully lowered to the ground. When a qualified person at a jobsite determines that it is not practical to lower the boom to the ground, we recommend the following additional instructions be followed:

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

## SHUT-DOWN

Use the following steps when shutting down the crane:

- Engage the parking brake.
- Fully retract and lower the boom.
- Engage the swing lock pin or 360 degree swing lock (if equipped).
- Place crane function power switch to OFF (if equipped).
- Place controls in neutral position.
- Shut down the engine and remove the ignition key.
- Turn the battery disconnect switch to the OFF position.
- Chock the wheels, if not on outriggers.
- Lock the operator's cab (if applicable) and install vandal guards, if used.

## COLD WEATHER OPERATION

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

Check operating procedures in this manual for cold weather starting.

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

Clean the crane of all ice and snow.

Allow at least 30 minutes of engine run time for hydraulic oil to warm up.

Plastic components (battery casings, heater controls, dash controls, etc.) are extremely brittle in extreme cold. Use caution handling and operating these components in sub-zero temperatures, avoiding shock loading.

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

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

If applicable to your crane, always handle propane tanks according to the supplier's instructions.

Never store flammable materials on the crane.

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

## TEMPERATURE EFFECTS ON HOOK BLOCKS

The following information applies to Gunnebo Johnston crane hook blocks:

**Never use a hook block in extreme temperatures...**Sudden failure can occur.

Hook blocks shall not be heated above 82°C (180°F). Hook Block Working Load Limit is valid between 82°C (180°F) and service temperature given on the identification tag with normal lifting precautions.

Additional lifting precautions are required below the service temperature given on the identification tag because cold temperature begins to affect the hook block material properties.

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

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

## TEMPERATURE EFFECTS ON HYDRAULIC CYLINDERS

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

The change in the length of a cylinder is proportional to the extended length of the cylinder and to the change in temperature of the oil in the cylinder. For example, a cylinder extended 7.6 m (25 ft) in which the oil cools 15.5°C (60°F) would retract approximately 196 mm (7 3/4 in) [see Table 2-9 and Table 2-8]. The rate at which the oil cools depends on many factors and will be more noticeable with a larger difference in oil temperature verses the ambient temperature.

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

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

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

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

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

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

Coeff. = 0.00043 (in <sup>3</sup> /in <sup>3</sup> /°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<sup>3</sup>/in<sup>3</sup>/°F) X 12 in/ft

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

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

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

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

## OVERLOAD INSPECTION

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

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



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

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

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

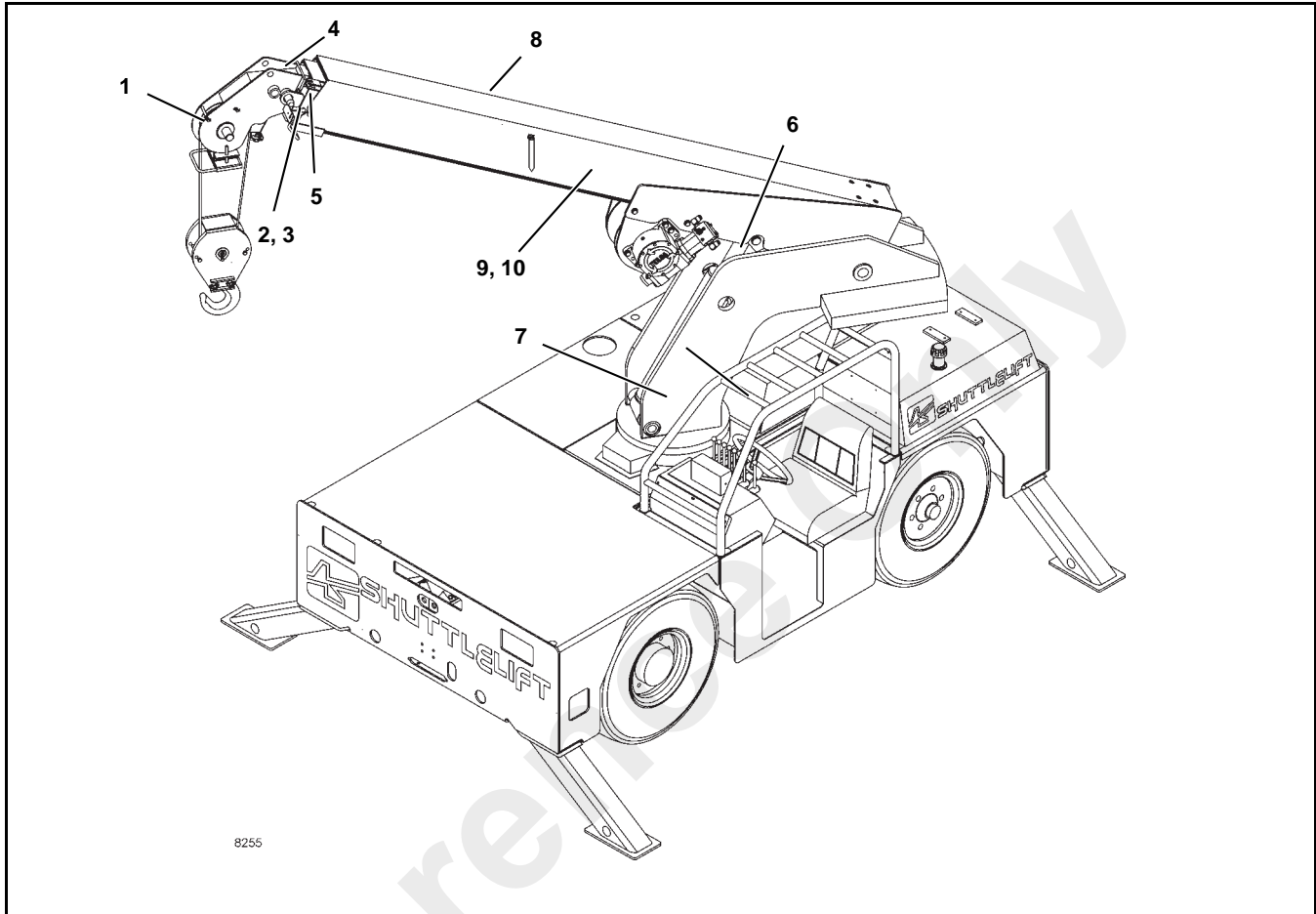
**WARNING****Overload Hazard!**

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

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

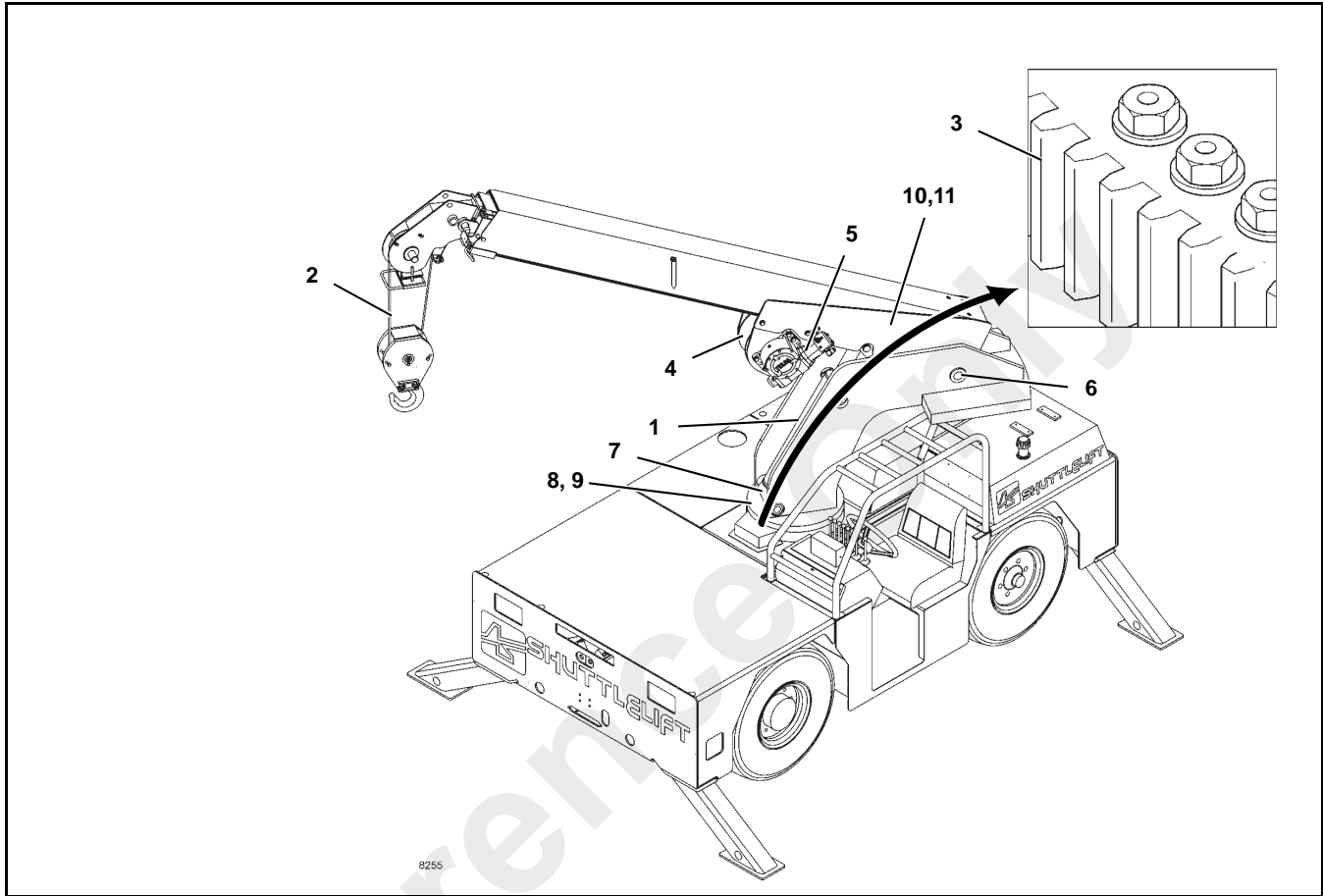
Reference Only

Boom Inspection



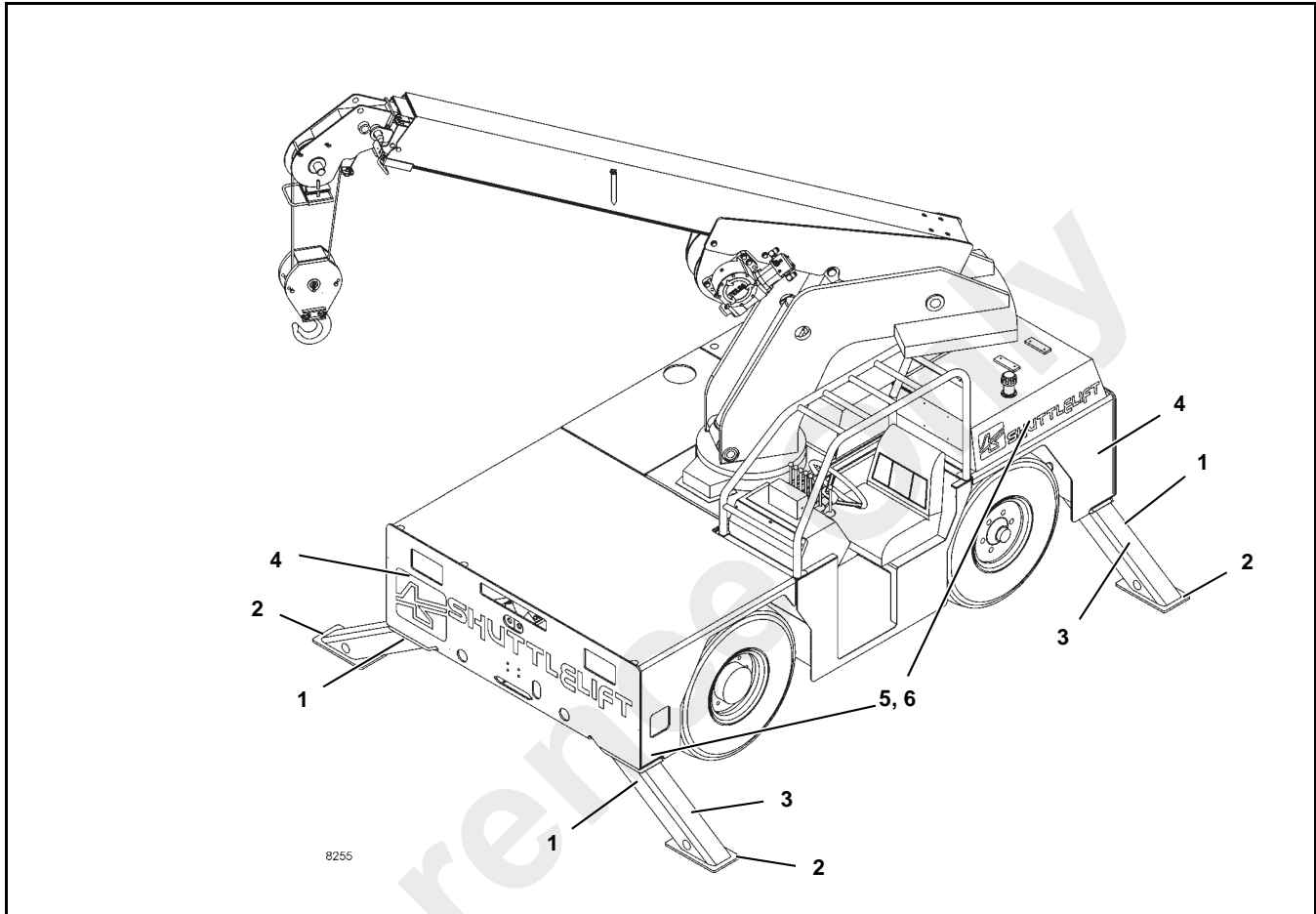
Overload less than 25%			
1	Sheaves, Rope Guides	Inspect all for damage.	
2	Collar-Wear Pads, Pad Retainers	Inspect for damage.	
Overload from 25% to 49%			
1	Sheaves, Rope Guides	Inspect all for damage.	
2	Collar-Wear Pads, Pad Retainers	Inspect all for damage.	
3	Collar-welds	Inspect all for damage.	
4	Pinning Areas	Inspect all for cracks.	
5	Telescopic Sections	Inspect for bent or twisted sections. Check the boom for straightness.	
6	Lift Cylinder Head Area	Inspect for bends or cracked welds.	
7	Turret-Base Section	Inspect for cracked welds.	
8	Jib Section	Inspect for bent or twisted section. Check for straightness.	
9	Welds	Inspect for cracks.	
10	Paint	Inspect for cracked paint which could indicate twisted, stretched, or compressed members.	

Superstructure Inspection



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

Carrier Inspection



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

Reference Only

Reference Only

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## SECTION 3 OPERATING CONTROLS AND PROCEDURES

### SECTION CONTENTS

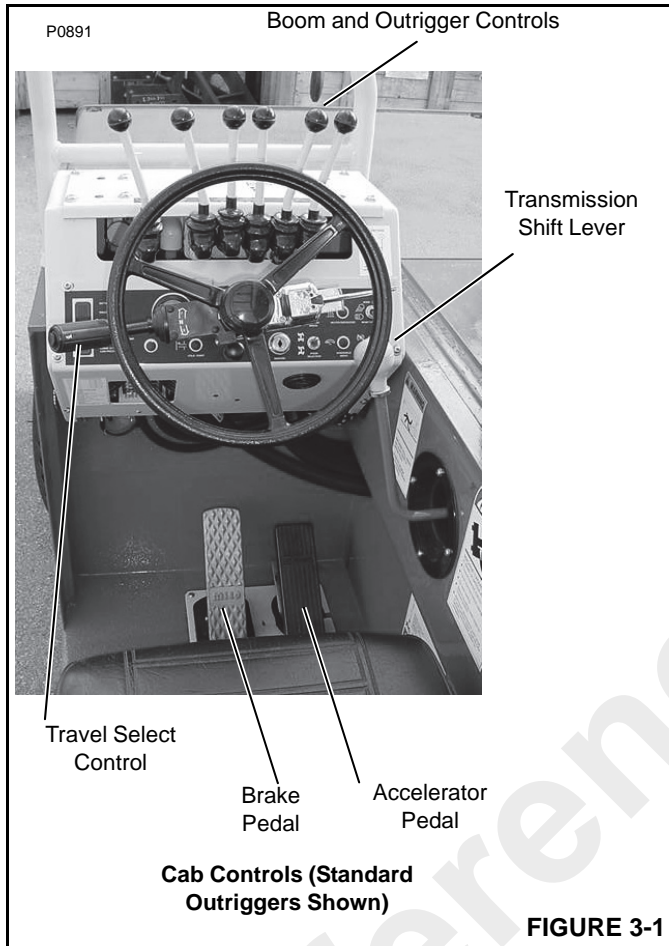
<b>Controls, Switches, and Gauges</b> . . . . .	<b>3-2</b>	Proper Leveling of the Crane . . . . .	3-16
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Reference



**CONTROLS, SWITCHES, AND GAUGES**

**Cab Controls**



**Brake Pedal** (See Figure 3-1)

Pressing down on the brake pedal applies the service brakes, which slows and stops the crane travel movement.

**Accelerator Pedal** (See Figure 3-1)

Controls the travel speed and hydraulic work function speeds of the crane. Pressing down on the accelerator pedal increases the engine speed. The pedal is spring-loaded to return to idle speed.

**Travel Select Lever** (See Figure 3-1)

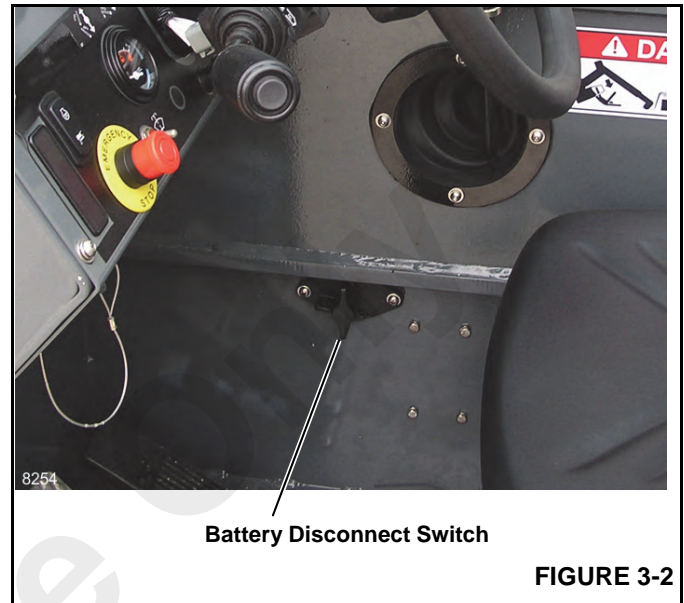
Selects the forward and reverse travel of the crane. For more information, see *Traveling with the Crane*.

**Transmission Shift Lever** (See Figure 3-1)

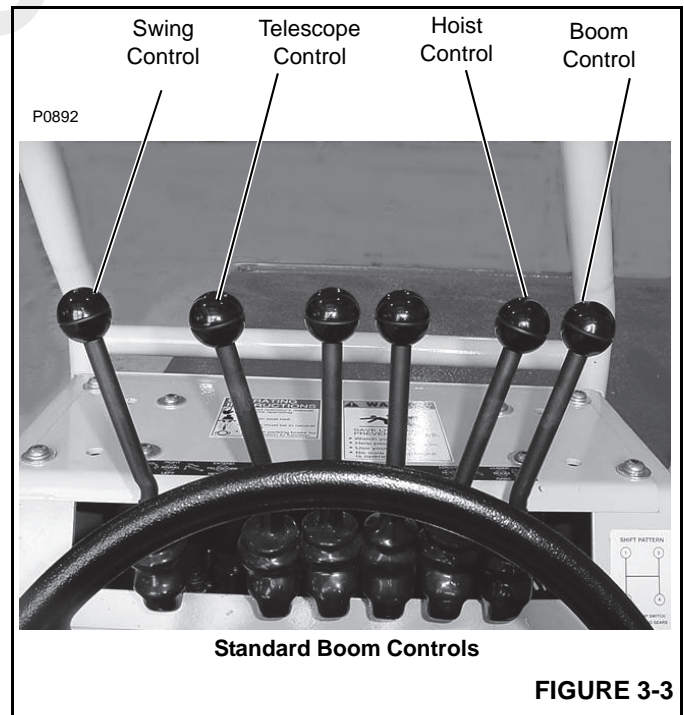
The transmission shift lever manually shifts the transmission to any one of four gear ratios. For more information, see *“Shifting Gears (Travel Speed)”* on page 3-14.

**Battery Disconnect Switch**

Turn the switch to OFF to disconnect the batteries, turn to ON to connect the batteries.



**Boom Controls** (See Figure 3-3)



**Swing Control** (See Figure 3-3)

The swing control operates the boom/mast rotation function. The boom and mast will rotate continuously through a full 360° circle.

**Telescope Control** (See Figure 3-3)

The telescope control extends and retracts the boom sections.

**Hoist Control** (See Figure 3-3)

The hoist control raises and lowers the drop block or hook and ball.

**Boom Control** (See Figure 3-3)

The boom control raises or lowers the boom assembly.

**Outrigger Controls** (See Figure 3-4 and Figure 3-5)

This set of controls extends and retracts the outriggers. For more information, see "Operating the Outrigger Controls" on page 3-16.

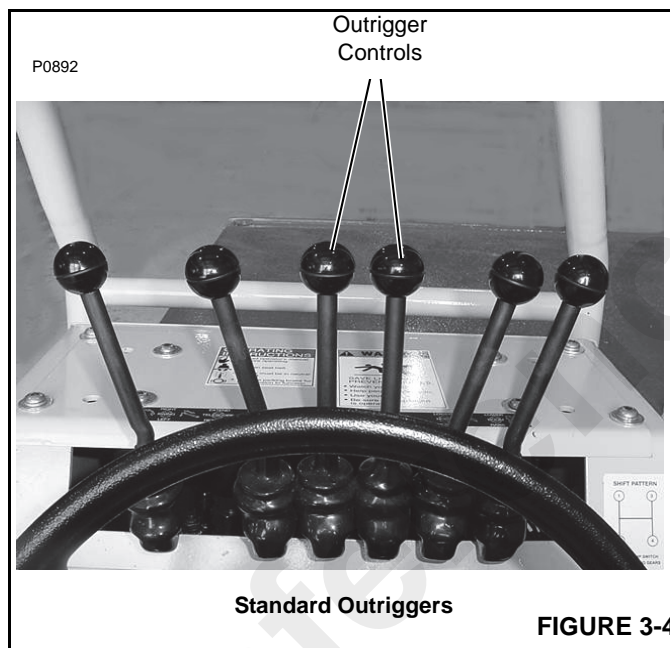


FIGURE 3-4

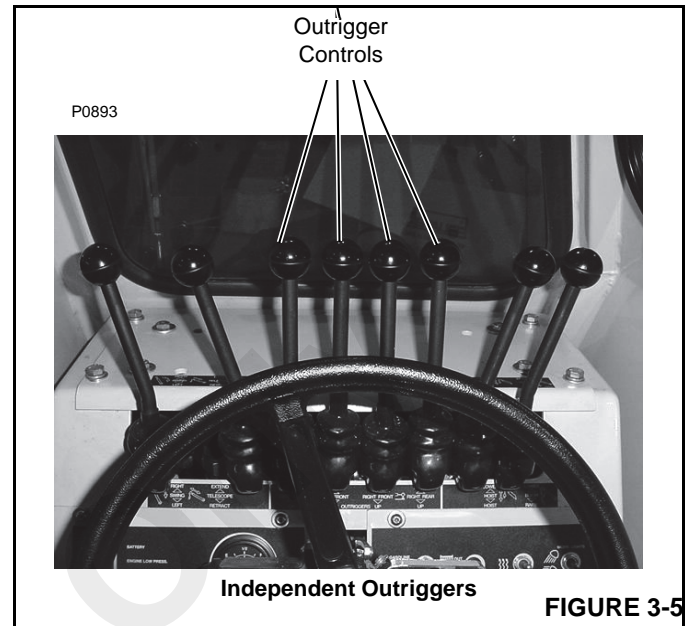


FIGURE 3-5

**Panel Switches****Work Light/Head Light Switch** (See Figure 3-6)

A three-position switch controls the crane's lights.

- **Up position** illuminates the work lights, head and tail lights, and the instrument panel lights.
- **Center position** turns off all lights.
- **Down position** illuminates the head lights, tail lights and the instrument panel lights.

**Parking Brake Switch** (See Figure 3-6)

The parking brake switch is used to engage and disengage the parking brake.

- To **ENGAGE** the parking brake, move the switch lever down.
- To **DISENGAGE** the parking brake, move the switch lever up.

**Auxiliary Winch Switch (Optional)** (See Figure 3-6)

This switch operates the optional winch attached to the front end of the crane.

- To **UNWIND** rope from the winch drum, hold the switch lever up.
- To **WIND** rope on the winch drum, hold the switch lever down.

**Windshield Wiper Switch (Optional)** (See Figure 3-6)

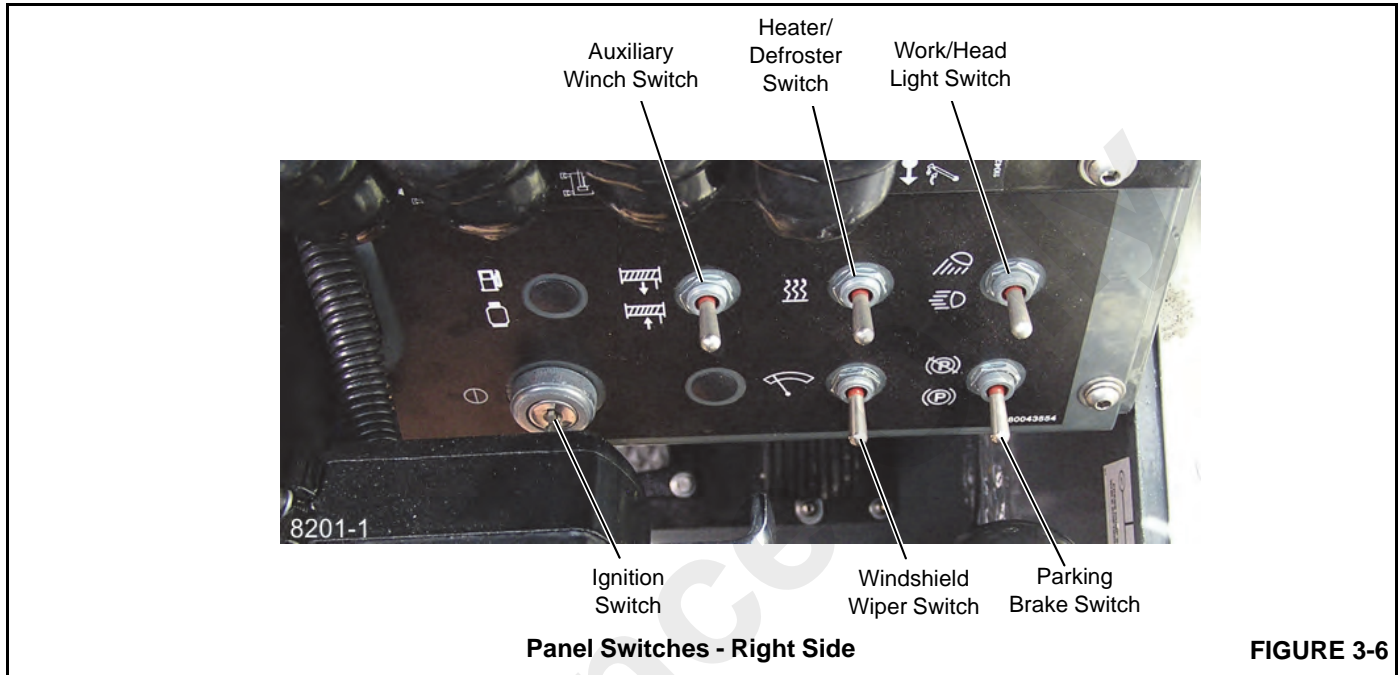
Move the switch lever down to turn on the front and rear windshield wiper motors.

**Heater/Defroster Switch (Optional)** (See Figure 3-6)

This switch is used to simultaneously start both the heater and defroster fans. It is a three-position switch.

- The up position is for **SLOW** fan speed.

- The center position is **OFF**.
- The down position is for **FAST** fan speed.



Panel Switches - Right Side

FIGURE 3-6

**Ignition Switch** (See Figure 3-6)

The key included with this machine is necessary for operation of the ignition switch.

Turn the key clockwise to the first position (RUN) to energize the electrical system.

Turn the key fully clockwise (START) to engage the engine starting motor to crank the engine when the travel select lever is in the (N) Neutral position. The switch is spring loaded to return from the START position to the RUN position and must be held in place for normal starting.

**Steering Selection Switch**

This switch (1, Figure 3-7) is used to select one of three steering modes in which the crane can be steered.

- Four-Wheel Steer
- Two-Wheel Steer
- Crab Steer (Optional)

**Wait-to-Start Lamp**

The Wait-to-Start Lamp (2, Figure 3-7) is illuminated when the ambient temperature is low and the grid heater in the engine air intake is on. Wait to start the engine until this lamp goes out.

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

The Outrigger Monitoring System (OMS) aids the operator by using an indicator (3, Figure 3-7) on the control panel that lights when all outriggers are fully deployed.

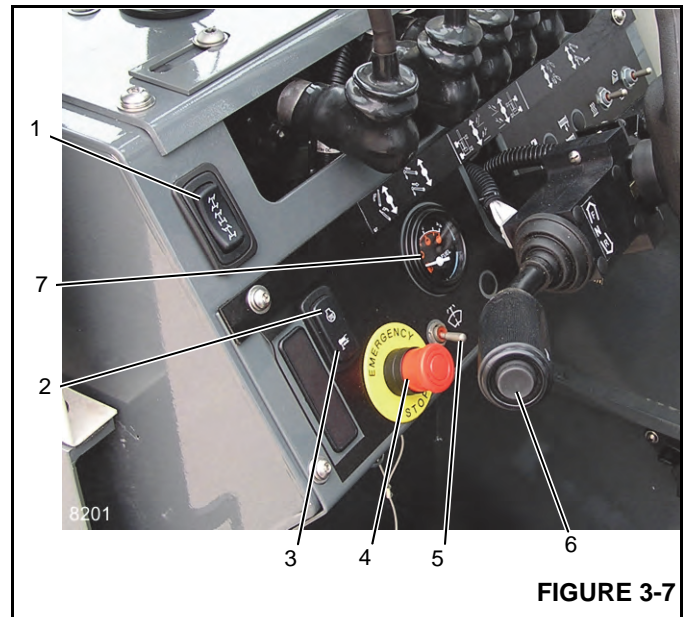


FIGURE 3-7

**Windshield Washer Switch**

Use the Windshield Washer Switch (5, Figure 3-7) to squirt washer fluid on the windshield.

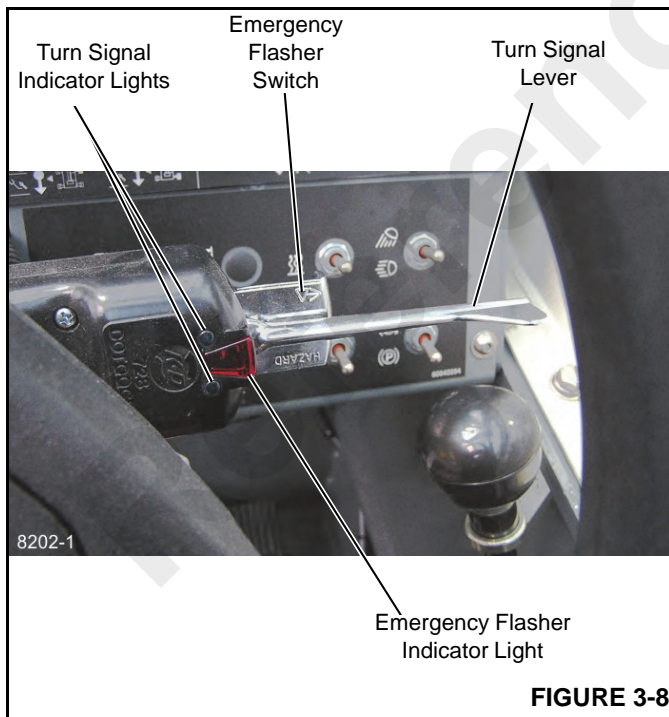
**Turn Signal Switch (See Figure 3-8)**

The turn signal lever switch is used to illuminate the right and left turn signal lamps. Moving the switch lever up, illuminates the left turn signals and the green, left indicator light on the switch casing. Moving the switch lever down, illuminates the right turn signals and the green, right indicator light on the switch casing.

To simultaneously place all four turn signals in the flashing (emergency) mode. Pull the emergency switch out. In the out position, it will be locked in place and all turn signals will flash on and off, as well as the red emergency flasher light on the turn signal control will flash on and off. To release the emergency flasher switch, move the turn signal lever either up or down (left or right signal lights).

**Emergency Stop Switch**

The Emergency Stop Switch (4, Figure 3-7) is used to stop the engine in an emergency. Push the switch to stop the engine, turn the switch to allow power to the engine.



**FIGURE 3-8**

**Horn Button**

Press the button (6, Figure 3-7) on the end of the travel selector lever to sound the horn.

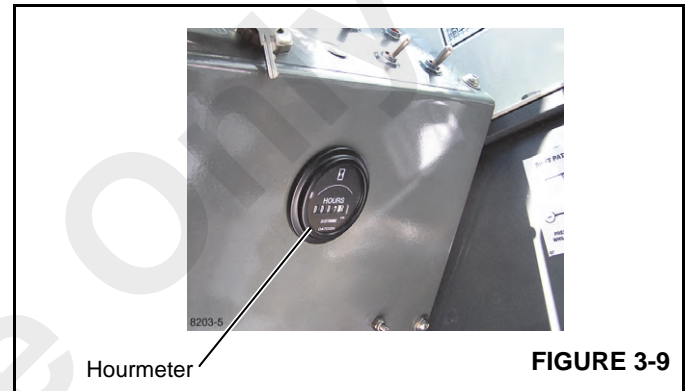
**Gauges and Indicators**

**Fuel Gauge**

The gauge (7, Figure 3-7) indicates the amount of fuel in the fuel tank.

**Hourmeter**

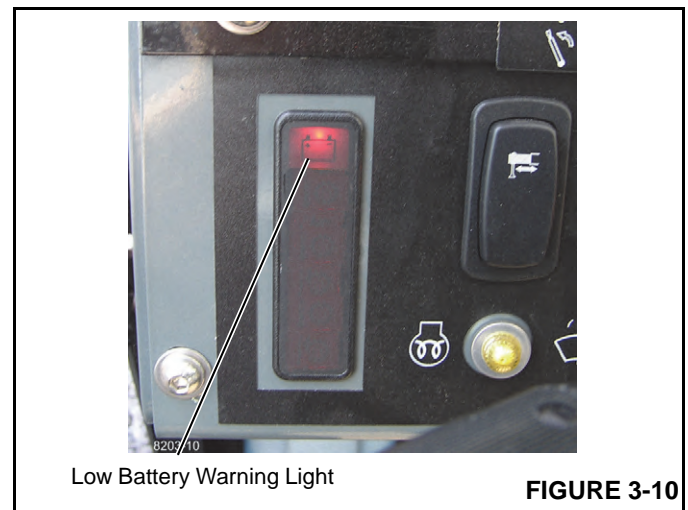
The hourmeter (Figure 3-9) registers the total hours the engine has been operating. Use this gauge to perform preventive maintenance scheduling.



**FIGURE 3-9**

**Low Battery Warning Light (See Figure 3-10)**

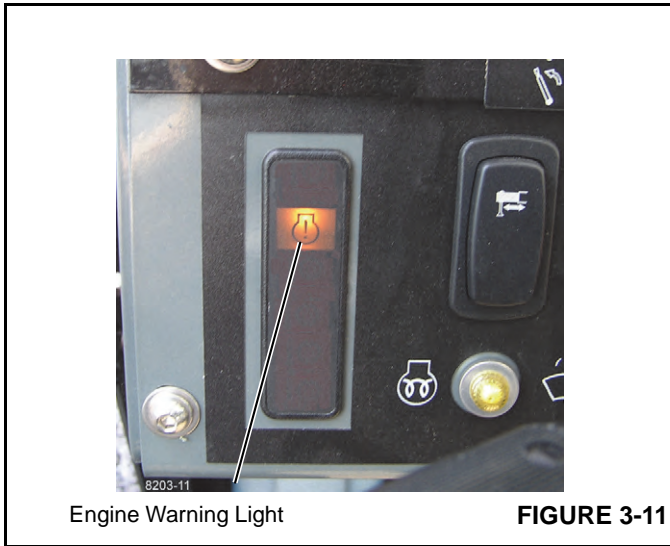
When this light is illuminated it is an indication that the electrical system is not being supplied with enough voltage by the alternator. Either the alternator is malfunctioning or the fan belt is broken, slipping, etc.



**FIGURE 3-10**

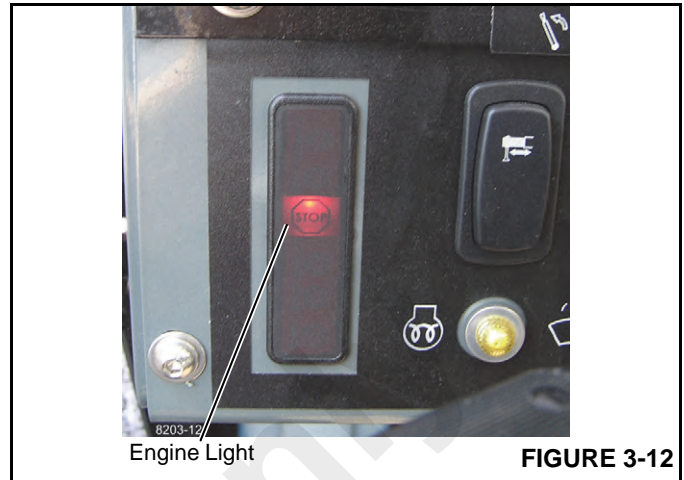
**Engine Warning Light (See Figure 3-11)**

The ECM illuminates the lamp for the following circumstances: non-critical fault active, idle shutdown approaching, idle shutdown override, confidence test, maintenance faults, water-in-fuel. If the Warning Lamp illuminates for a maintenance fault, the crane should be serviced as soon as convenient.



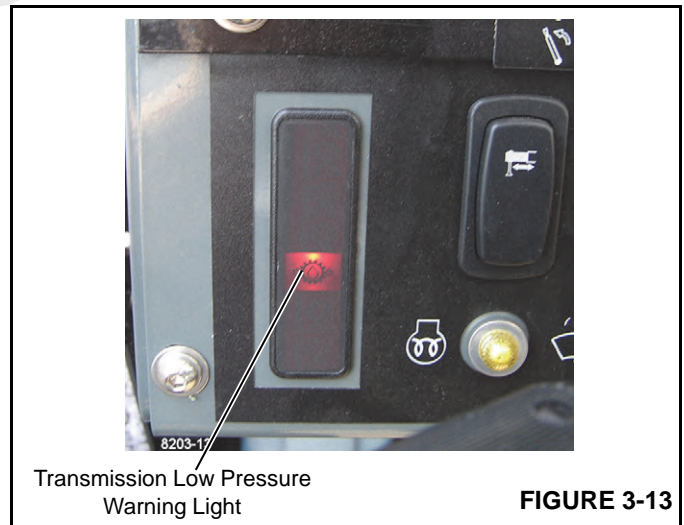
**Emergency Stop Light** (See Figure 3-12)

The ECM illuminates the lamp for the following circumstances: serious fault detected, engine protection shutdown approaching, engine protection shutdown override activated, confidence test and diagnostics. If the Stop Lamp illuminates, cease operation of the vehicle and engine as quickly as safely possible to reduce damage to the engine.



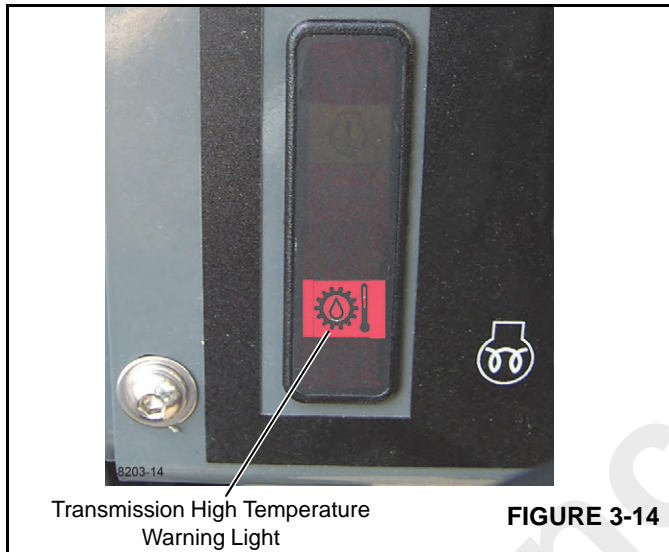
**Transmission Low Oil Pressure Warning Light** (See Figure 3-13)

When this light is illuminated it is an indication that the transmission oil pressure is lower than what is recommended for proper operation of the transmission. The transmission could be damaged if it is run with low oil pressure. If this light illuminates during operation, immediately shut down the engine and have the transmission serviced.



**Transmission High Temperature Warning Light** (See Figure 3-14)

When this light is illuminated it is an indication that the transmission temperature is above the proper operating temperature. High operating temperature could cause serious damage to the transmission. If this light illuminates during operation, immediately shut down the engine and have the transmission and/or the transmission cooling system serviced.

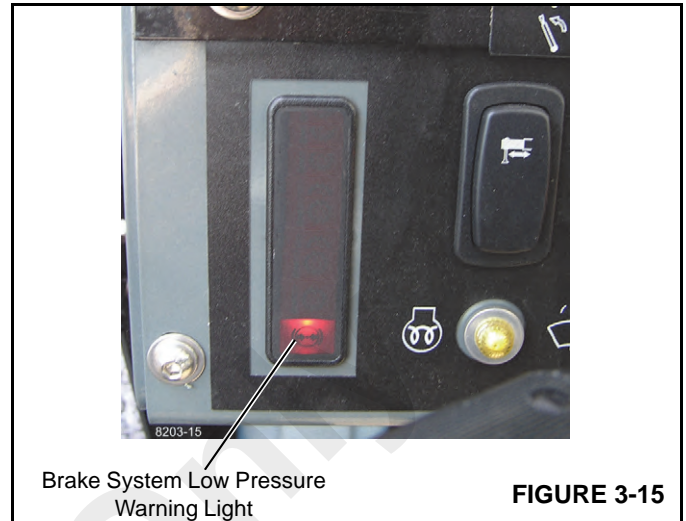


Transmission High Temperature Warning Light

FIGURE 3-14

**Brake System Low Pressure Warning Light** (See Figure 3-15)

When illuminated, the light indicates that there is a loss in brake pressure. At this point there is still enough pressure to stop the crane. Immediately stop the crane and shut off the engine. Do not drive the crane until the problem has been repaired. The light will illuminate briefly when the brake system charges during operation.

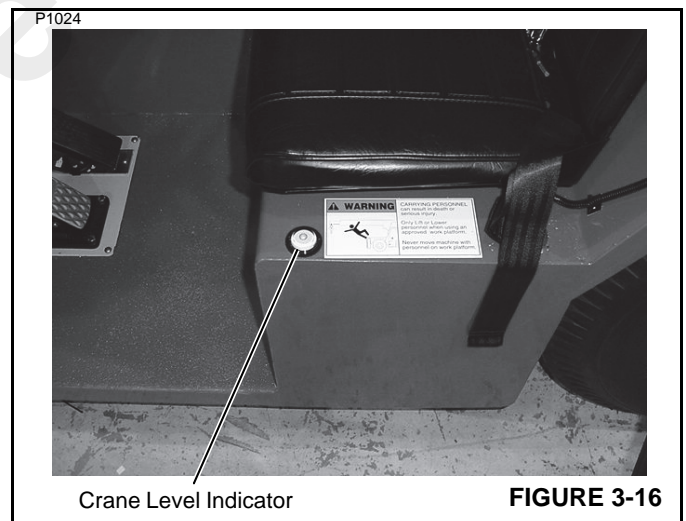


Brake System Low Pressure Warning Light

FIGURE 3-15

**Crane Level Indicator** (See Figure 3-16)

This is a bubble-type indicator that allows the operator to level the crane when using the outrigger controls.



Crane Level Indicator

FIGURE 3-16



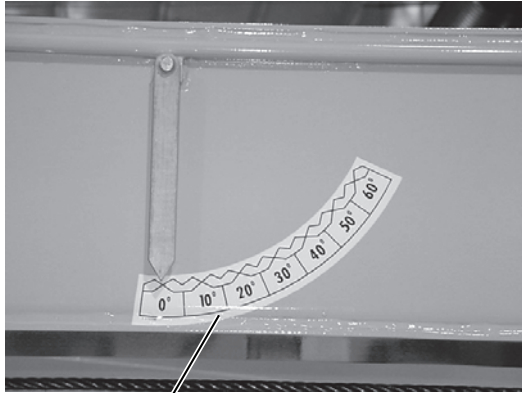
**WARNING**

When the low brake pressure warning light is illuminated, immediately stop and shutdown the crane. **DO NOT** drive the crane with the warning light illuminated. Brake failure is possible and the result could be serious personal injury and property damage.

**Boom Angle Indicator** (See Figure 3-17)

The boom angle indicator is a plumb arrow and a decal with angular graduations from 0° to 60°. It is located on both sides of the boom and is visible from the operator's cab in most boom positions. Use the indicator to determine the boom angle when reading the capacity chart. (See Section 4.)

P1032



Boom Angle Indicator

FIGURE 3-17



Load Indicator / Rated Capacity Limiter Indicator Panel

FIGURE 3-18

**LSI Load Indicator Display Panel**

The load indicator panel (see Figure 3-18) displays load and capacity related information and warns the operator when a limit is exceeded. The operator is warned by a flashing light on the display panel.

In conjunction with the display panel (receiver), there is a transmitter and load pin attached to the boom head that sends the load information to the display panel.

For operating instructions and battery changing instructions, see the LSI Universal Users Manual supplied with the crane.

See transmitter changeover instructions in Section 5 for moving the transmitter to the down haul block when single part line is used.

**Optional Rated Capacity Limiter Display Panel (Wylie)**  
(See Figure 3-19)

Provides visual indications of angle, load, radius, capacity, etc. and allows the operator to set limits on these indications.

For operating instructions, see the WYLIE RCL Operator Manual furnished with the crane.



Rated Capacity Limiter- Wylie

FIGURE 3-19



**OPERATOR'S CAB**

**Seat Belt**

The operator's seat is equipped with a seat belt. Use this belt at all times when operating the machine.



**Seat Adjustment**

Adjust the operator's seat correctly. Full foot pedal control must be obtained with your back firmly against the seat back.

**SEAT FORE & AFT ADJUSTMENT** - To adjust the seat, move the control lever (Figure 3-20) to the right. Move the seat to proper position and then move the control lever back to the left to lock the seat position.



**Cab Door (Enclosed Cab)**

**Opening the Cab Door from the Outside (Enclosed Cab)**

Pull the door latch out to release the cab door latch (Figure 3-21).



**Opening the Cab Door from the Inside (Enclosed Cab)**

Pull the door handle back to release the cab door latch (Figure 3-22).



**Opening the Left Sliding Side Window (Enclosed Cab)**

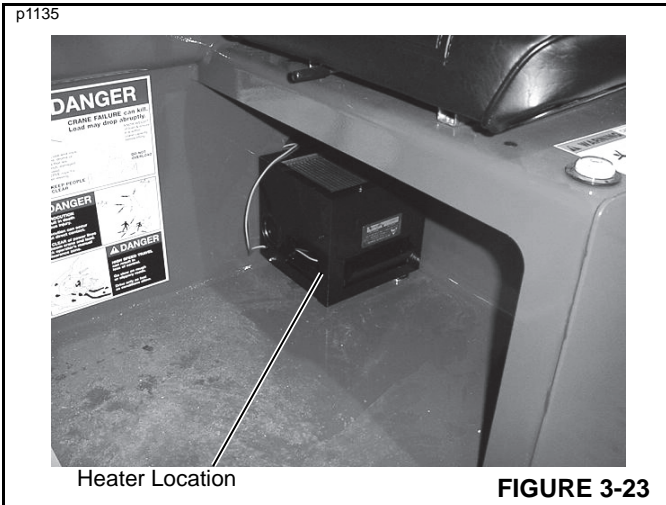
To open the window, pull the front portion of the side window toward the rear. To close the window, push the window forward in place.

**Heater, Air Conditioner and Defroster**

The cab heater (furnished as an option with enclosed cabs) is located under the operator's seat (Figure 3-24).

The cab heater/air conditioner (furnished as an option with enclosed cabs) is located under the operator's seat (Figure 3-24).

The windshield defroster vent is located in the lower right corner of the front windshield (Figure 3-25).

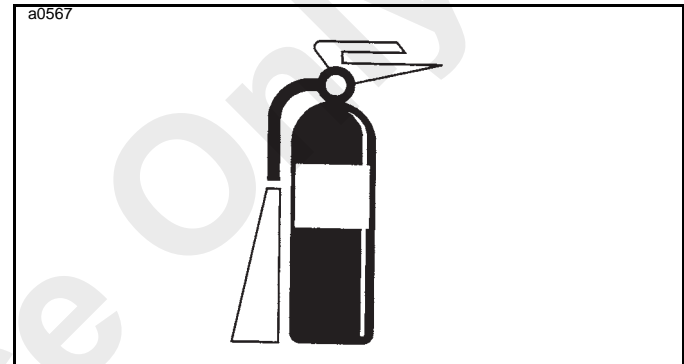


To operate the heater and defroster, use the heater and defroster switch located on the instrument panel. Select the desired fan speed.

Position the vent (Figure 3-24) on the heater for desired amount of air flow.

**Fire Extinguisher**

The fire extinguisher is located in the cab and is attached to the left and rear of the operator's seat. Study the manufacturer's instructions printed on the fire extinguisher for its proper use.



**MACHINE OPERATION**

**Starting the Engine**

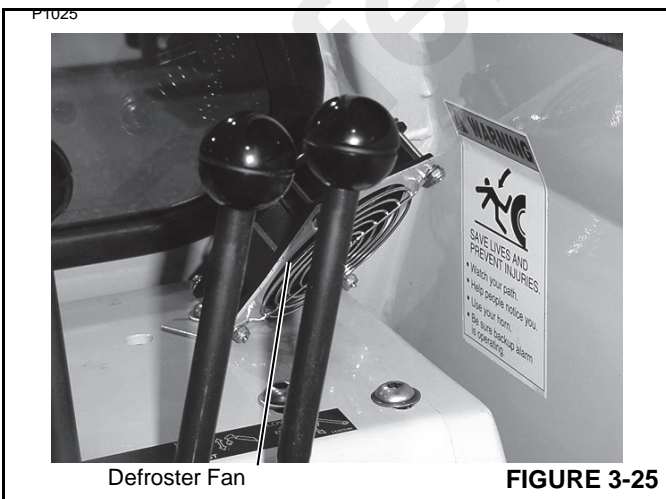
*Normal Engine Starting*

**CAUTION**

Never leave the engine running while the crane is unattended. Shut off the engine to prevent unauthorized persons from operating the controls.

Walk around the crane and warn all personnel who may be servicing the crane or are in the crane's path prior to starting. Do not start until all personnel are clearly away from the crane.

1. Enter the cab and adjust the operator's seat for comfortable operation.
2. Fasten the seat belt.
3. Turn the Battery Disconnect switch to ON, if required.
4. Check that the parking brake is engaged.
5. Place the travel select lever in the neutral position (Figure 3-26).



**CAUTION**

Be sure the shut-off valve in the hot water supply line is open. The shut-off valve is located on the engine.

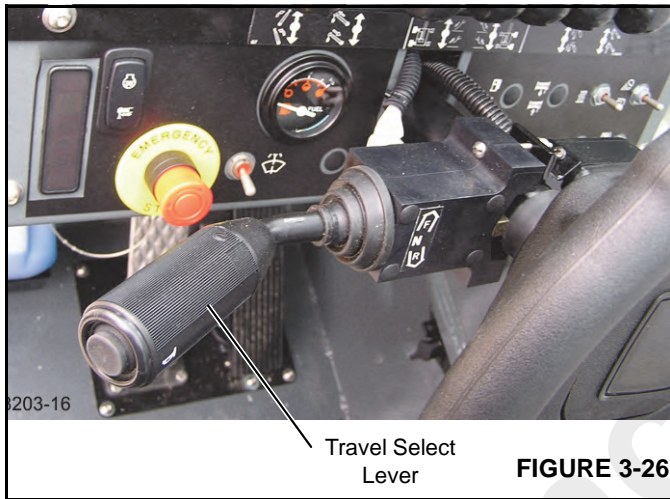


FIGURE 3-26

**CAUTION**

Do not bypass the crane's neutral-start system. The neutral start system must be repaired if it malfunctions.

6. Start the engine. Follow the engine starting procedures below.

**CAUTION**

Should the engine start but will not keep running, check to see if the engine oil low pressure or engine high temperature warning light is illuminated. If it is, either the engine oil pressure is low or the engine cooling system temperature is high. The engine will not start until the problem is repaired.

7. Check the engine oil pressure warning light. If the warning light is illuminated, shut down the engine immediately. Have the engine serviced before placing the crane in service.
8. Check the brakes, steering and all controls for proper operation. If a malfunction is found, shut down the engine immediately and park the crane until the malfunction is corrected or the crane can be safely towed.

9. Disengage the parking brake before you travel with the crane. See Travel Instructions.

**Engine Starting Procedure**

**CAUTION**

**DO NOT** crank the starter motor continuously for more than 30 seconds. Damage to the starter motor could occur.

**DO NOT** operate the engine at full RPM or apply a full load until the engine is warm. During cold weather, it may be necessary to run the engine at a higher speed to keep the correct operating temperature.

1. If necessary, wait for the Wait-to-Start Lamp to go out before starting the engine. See Figure 3-7.
2. Depress the accelerator pedal halfway to the floor.
3. Turn the ignition switch to the START position to crank the engine. Release the switch when the engine starts. If the engine fails to start on the first try, wait until the starter motor comes to a complete stop; then again crank the engine with the ignition key.

**Warm-up Procedures by Component**

**Cummins Engine**

All temperature ranges:

Idle the engine for 3 to 5 minutes before operating with a load.

After starting a cold engine, increase the engine speed slowly to provide adequate lubrication to the bearings and to allow the oil pressure to stabilize.

**Dana Transmission**

All temperature ranges:

For full load functionality, a minimum sump temperature of 20°C (68°F) is required. Before reaching 20°C (68°F) sump temperature only neutral gear or unloaded driving is allowed, not exceeding 1500 engine RPM and not exceeding half throttle.

Warm-up procedure: Engage the park brake and apply the service brake. Shift the transmission into the highest gear and increase the engine speed to 1500 RPM for 15 seconds. Drop back to idle for 15 seconds. Repeat this sequence until the transmission sump reaches 20°C (68°F).

Alternative warm-up procedure: With the machine on outriggers, engage the transmission and allow it to run at idle until the transmission sump reaches 20°C (68°F).

**Braden Hoist**

A warm-up procedure is recommended at every start up and is essential at ambient temperatures below 4°C (40°F):

With hoist control valve in neutral position warm up the hydraulic system. Then operate the hoist in both directions at low speeds several times to prime all lines with warm hydraulic oil, and to circulate gear lubricant through the planetary gear sets.

### Kaydon Turntable Bearing

For ambient temperatures above  $-7^{\circ}\text{C}$  ( $20^{\circ}\text{F}$ ): prior to normal operation rotate the superstructure at a speed less than one RPM for at least one complete revolution in one direction, then reverse directions and rotate the superstructure at a speed less than one RPM for at least one complete revolution. Setup the crane on fully extended outriggers, with the boom retracted and near maximum lift angle with no live load during the warm-up.

For ambient temperatures below  $-7^{\circ}\text{C}$  ( $20^{\circ}\text{F}$ ): prior to normal operation rotate the superstructure at a speed less than one half RPM for at least two complete revolutions in one direction, then reverse directions and rotate the superstructure at a speed less than one half RPM for at least two complete revolutions. The boom should be retracted and near maximum lift angle with no live load during the warm-up.

### CAUTION

Check the engine oil pressure warning light immediately after the engine starts. If the oil pressure warning light is illuminated, stop the engine and have the engine serviced.

### Cab Heater Warm-up

An Intermediate Speed Control (ISC) function of the Engine Control Unit (ECU) is programmed to raise the idle speed to 1200 RPM when it gets a signal from the machine electrical system. This may occur when the crane sets at idle without operating the crane functions for extended periods of time.

Three conditions are required in order to provide this signal:

1. "The engine coolant temperature is less than  $71^{\circ}\text{C}$  ( $160^{\circ}\text{F}$ ).
2. "The transmission is in neutral.
3. "The Crane Function Switch is in the off position.

If any of these conditions change, the signal is lost, the ISC function is turned off, and the idle returns to 800 RPM.

**NOTE:** The brake must be applied in order to engage transmission.

### Towing or Pushing the Crane to Start the Engine

If the battery is discharged, **DO NOT** try to start the engine by towing or pushing the crane. Damage to the transmission will occur. Instead use booster batteries to jump start the engine.

### Jump Starting the Engine

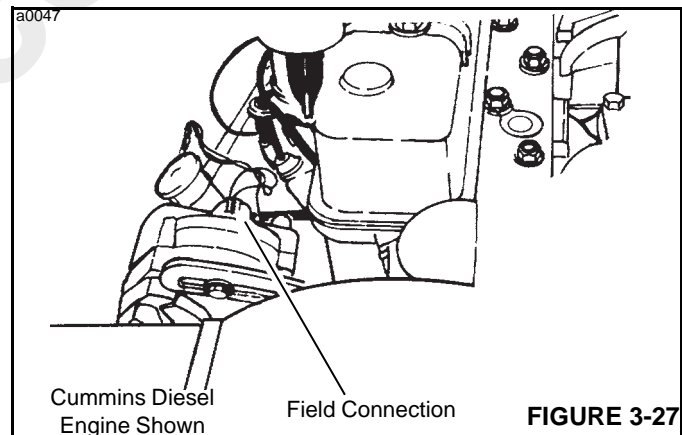
Follow the recommended jump starting procedure below when using booster batteries to start the engine.

1. Engage the parking brake.
2. Place the travel select lever in the Neutral (N) position.
3. Stop all electrical loads (lights, heaters, etc.)
4. Lift the engine cover.



### WARNING

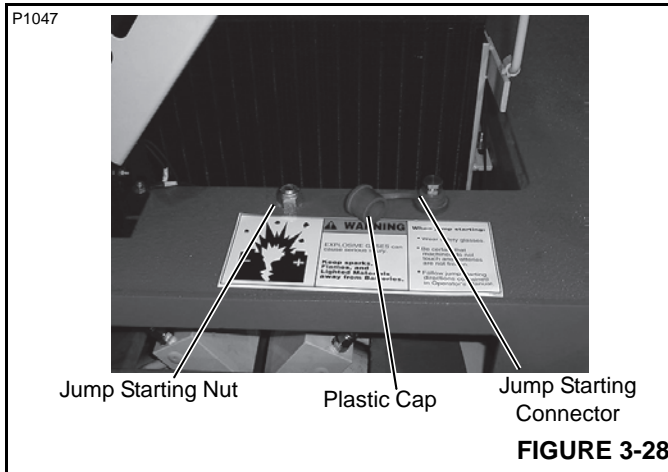
**NEVER** jump start the engine directly to the starter or starter solenoid. Serious injury could result from the crane moving forward or back and running over the person performing the jump starting procedure.



### CAUTION

If a battery charger is used, disconnect the field connection from the alternator before connecting the battery charger to the battery. Do not install the field connection until the battery charger is removed.

5. If a booster battery is used, it must be a 12 Volt battery. If a vehicle is used, it must have a negative ground electrical system.
6. Remove the plastic cap (Figure 3-28) from the jump start connector, located in front of the radiator.



**FIGURE 3-28**

7. Connect one end of the positive (+) jumper cable (usually red) to the jump start connector.
8. Connect the other end of the positive cable to the positive (+) post on the booster battery.
9. Connect one end of the negative (-) jumper cable (usually black) to the negative (-) post on the booster battery.
10. Connect the other end of the negative cable to the jump starting nut (Figure 3-28).
11. Follow the steps under “Normal Starting.”
12. When the engine starts, remove the jumper cables in reverse order (that is, negative ground cable first, etc.).

**Traveling with the Crane**



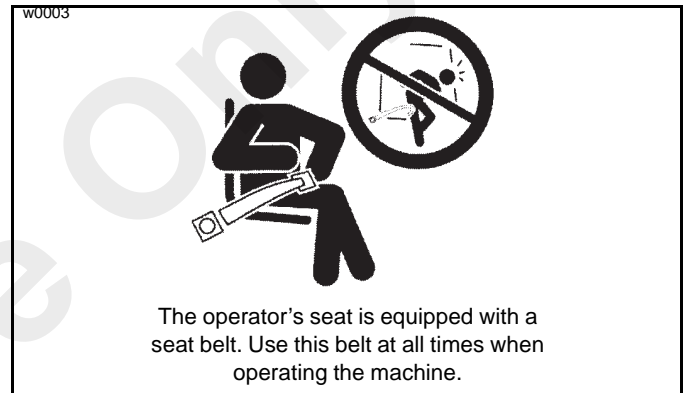
1100255

**CAUTION**

If travel sight is restricted, do not attempt to travel with the crane until a signalman gives a signal that the crane is clear of obstacles in the wheel path. Remove any obstacles from the wheel path before moving.

To help prevent accidents, use a “Slow Moving Vehicle Sign and a flashing strobe light (where legal) for traveling on highways or public roads.

1. Enter the operator’s cab, close the door, if equipped, and fasten the seat belt.



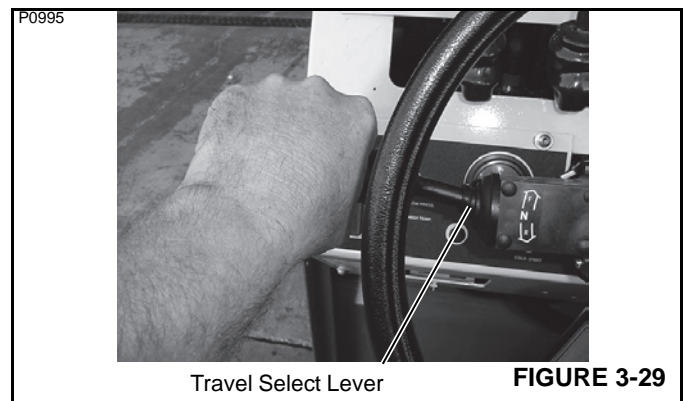
The operator’s seat is equipped with a seat belt. Use this belt at all times when operating the machine.

2. Start the engine and disengage the parking brake.

**CAUTION**

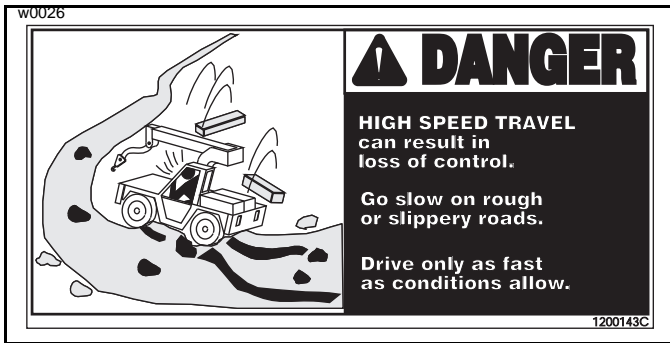
To avoid damage to the parking brake and crane, do not apply the parking brake while traveling.

3. Select either the Forward (F) or Reverse (R) travel position on the travel select lever (see Figure 3-29). Pull the handle back and then move it up or down to select travel direction.



Travel Select Lever

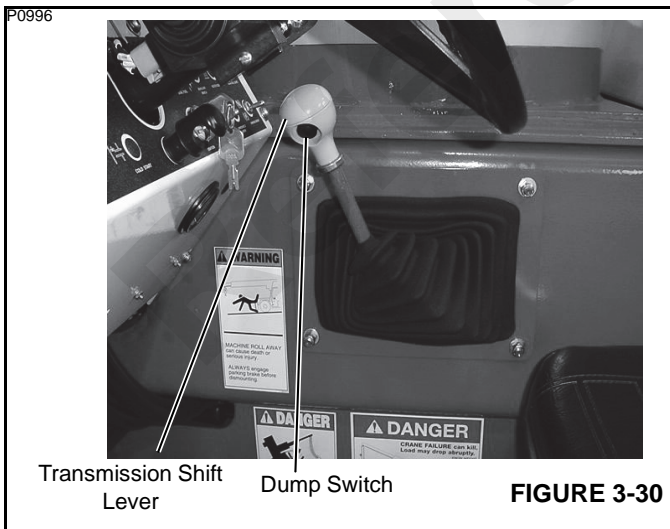
**FIGURE 3-29**



- The crane has no axle suspension. Traveling at high speeds, especially on rough roads, can create a bouncing effect that can result in loss of control. Personal injury, death and property damage could result. Reduce speed if bouncing occurs.
- 4. Start out traveling from a stopped position in 1st speed. Travel speed may be shifted from 1st to 2nd, 2nd to 3rd, 3rd to 4th when the crane is moving. See “Shifting Gears”, below. Avoid operating at too high of speed when moving a heavy load, as this may cause “lugging” on the engine. Use a lower gear when moving a heavy load; higher gear when moving a lighter load. **SELECTING THE CORRECT TRAVEL SPEED WILL PROLONG ENGINE LIFE.**

**Shifting Gears (Travel Speed)**

1. When the crane’s engine is shut off, the transmission can be shifted into any gear without first pressing and holding the dump switch (Figure 3-30).

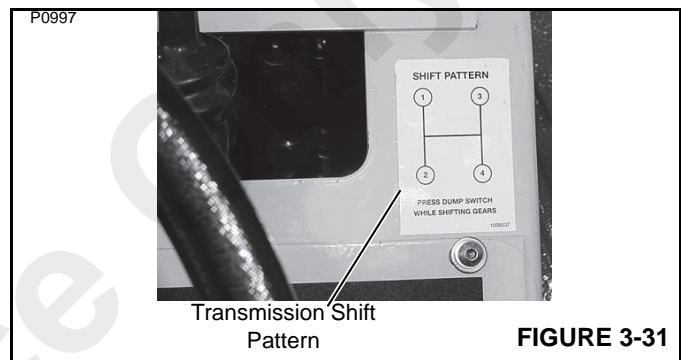


2. Up shifting to the next gear (travel speed) may be done at any engine speed, while the crane is in motion, but first ease up on the accelerator pedal and press and hold the dump switch.

**CAUTION**

Do not shift the transmission to the next gear without first pressing and holding the dump switch. Serious damage to the transmission could occur.

3. To shift to the next gear, move the shift lever to the desired gear position. See shift pattern in Figure 3-31.



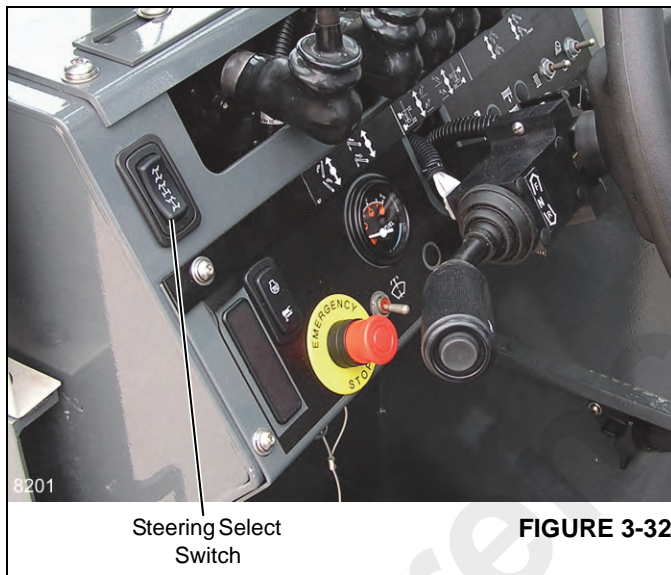
4. When downshifting, do not over-rev the engine. Allow the crane’s engine to slow down before pressing and holding the dump switch and shifting to the next lower gear.

**Steering the Crane**

The crane can be operated in three steering modes; Two-Wheel Steer, Four Wheel Steer and Crab Steering Mode.

These modes are selected using the Steering Selector Switch shown in Figure 3-32. Before switching to a different steering mode all tires must first be aligned in a straight forward position. If they are not, steering may not index properly. Should the steering not be indexed, see Four-Wheel Steering Indexing Procedure below.

**NOTE:** An optional self alignment feature is available that automatically indexes the wheels.

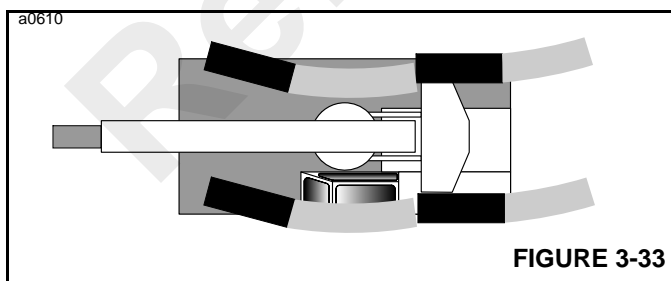


Steering Select Switch

**FIGURE 3-32**

**1. Two-Wheel Steer Mode**

See Figure 3-33. The front wheels steer the crane. The rear wheels remain in the fixed forward position. This mode must be used for highway travel and traveling at higher speeds.



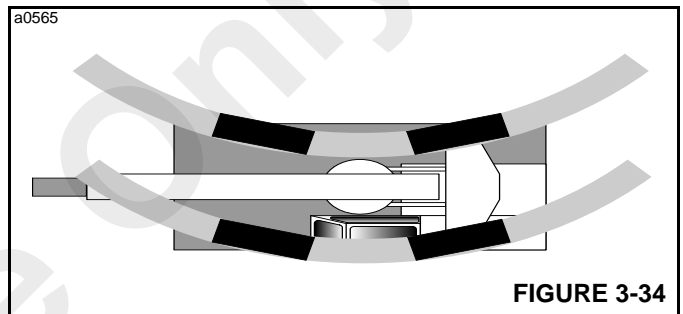
**FIGURE 3-33**

**2. Four-Wheel Steer Mode.**

**CAUTION**

**DO NOT** travel at high speed with the crane in the four-wheel steer mode. Possible tipping may occur when turning.

See Figure 3-34. The front wheels steer in the direction that the steering wheel is turned and rear wheels turn in the opposite direction. This mode allows for an extremely short turning radius. It enables the rear wheels to follow the track of the front wheels. This is an advantage in muddy or sandy conditions.



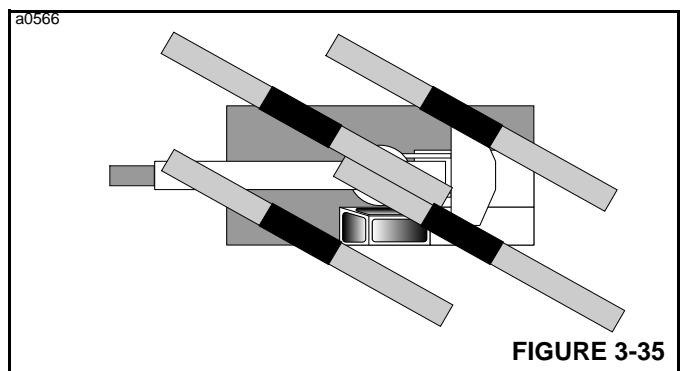
**FIGURE 3-34**

**3. Crab Steer Mode**

**CAUTION**

**DO NOT** travel at high speed with the crane in the crab steer mode. Possible tipping may occur when turning.

See Figure 3-35. All of the wheels steer in the same direction. This mode permits the operator to move the crane sideways for short distances. This feature is especially helpful in repositioning the crane in tight areas.



**FIGURE 3-35**

**Four-Wheel Steering Indexing Procedure**

1. Place the steering select switch in the four-wheel steer mode.
2. Turn the steering wheel until the rear wheels are in a straight forward position.

3. Place the steering select switch in the two-wheel steering mode and align the front steering wheels in a straight forward position.
4. The crane should now be properly indexed and the steering select switch can now be placed in the four-wheel steering mode or the crab steering mode.

### Changing Travel Direction

1. The crane **must** come to a complete stop before changing travel direction.
2. Move the travel select lever to the opposite travel direction.

---

### CAUTION

To avoid possible damage to the transmission **DO NOT** attempt to start the engine by pushing or towing with another vehicle. The power train does not allow starting this way, and transmission damage may occur.

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### CAUTION

The following practices could result in transmission failure:

- Shifting between forward and reverse while the engine is at high speed or heavy throttle, such as when the driving wheels are in mud or snow -- commonly called rocking.
  - Shifting to reverse or forward while operating the engine at high speed in neutral.
  - Operating the transmission at or near "stall speed" for more than 10 seconds at a time. "Stall condition" is when the engine runs at high speed while the transmission is in forward or reverse and the drive wheels are not moving. For example, when the wheels are mired in deep sand or mud, or when the crane is against a fixed barrier.
  - Continually downshifting and over-revving the engine.
- 

### Stopping Travel

1. Apply the service brakes and downshift as necessary to slow the crane until it comes to a complete stop.
2. Place the travel select lever in Neutral (N) and engage the parking brake.
3. Turn the ignition switch to the OFF position to stop the engine.
4. If the crane is parked and unattended, remove the ignition key.

## Operating the Outrigger Controls

### Proper Leveling of the Crane

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

To properly level the crane, the boom must be positioned over the front of the crane, fully lowered to horizontal and fully retracted (for cranes fitted with a boom rest, the boom shall be stowed onto the rest). Raise and level the crane using the outriggers; refer to *Operating the Outrigger Controls*, page 3-16.

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 *Operating the Outrigger Controls*, page 3-16.

### 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. If it is suspected that the bubble level indicator is out of adjustment, verify and adjust the bubble level using the procedures under Bubble Level Adjustment, page 3-16.

### Standard Outriggers

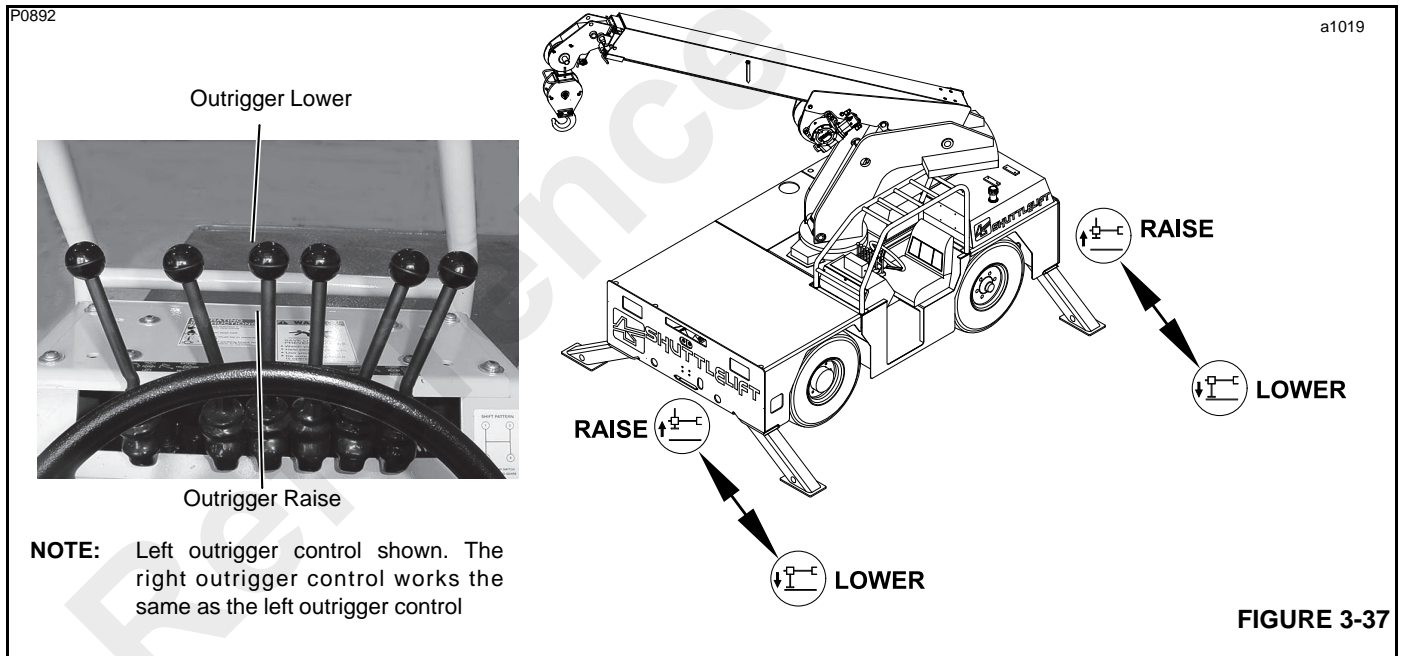
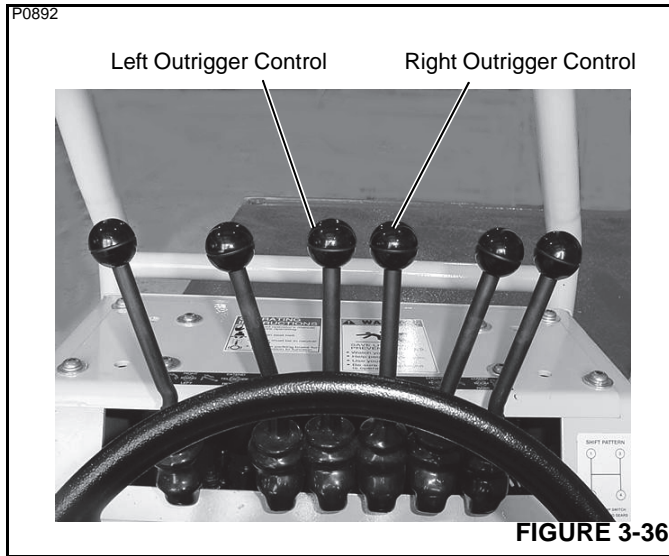
#### To Raise and Lower the Outriggers

On cranes equipped with standard outrigger controls, the left outriggers are controlled by the left control lever and the right outriggers are controlled by the right control lever. See Figure 3-36. When operating the left or right outrigger control lever, both left or right outriggers simultaneously raise or



lower. All four outriggers may be raised or lowered simultaneously by actuating both control levers.

1. Determine which outriggers are to be raised or lowered; left, right or all.
2. To Lower - (Figure 3-37) Run the engine at idle speed (accelerator pedal released). Move the control lever forward to the LOWER position and hold it in position. Press the accelerator pedal to increase the engine speed, which will accelerate the outward movement of the outriggers. Release the accelerator pedal and the outrigger control lever when the outriggers are fully extended.
3. To Raise - (Figure 3-37) Pull back on the control lever and hold it in the RAISE position. Press the accelerator pedal to increase the engine speed, which will accelerate the retracting speed of the outriggers. Release the accelerator pedal and the control lever when the outriggers are fully raised.

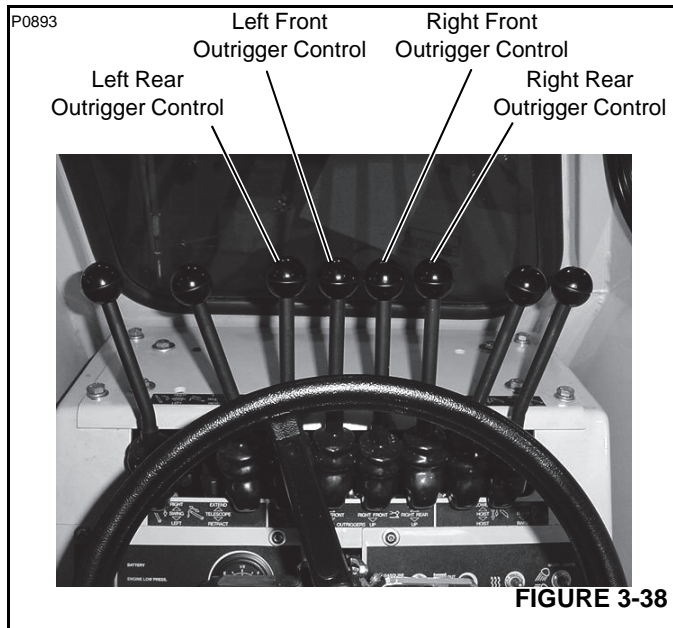


**Independent Outriggers**

**To Raise and Lower the Outriggers**

On cranes equipped with independent outrigger controls, each outrigger is independently controlled (Figure 3-38).

Two or more outriggers may be simultaneously lowered or raised by simultaneously actuating the controls for each of the outriggers.



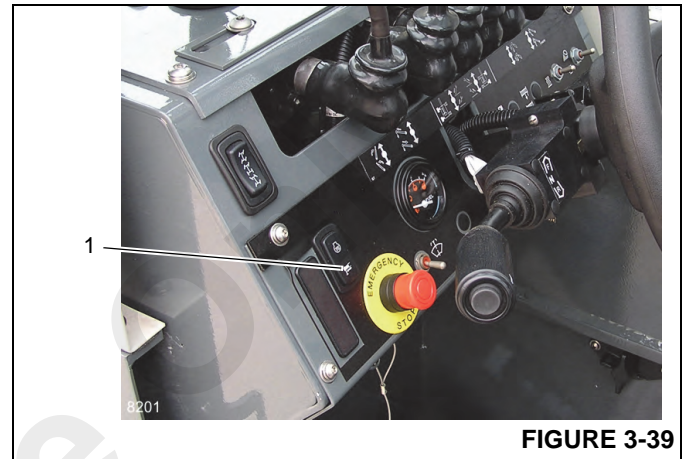
1. Determine which outriggers are to be raised or lowered; left, right or all.
2. To Lower - (Figure 3-40) Run the engine at idle speed (accelerator pedal released). Move the control lever forward to the LOWER position and hold it in position. Press the accelerator pedal to increase the engine speed, which will accelerate the outward movement of the outrigger. Release the accelerator pedal and the outrigger control lever when the outrigger is extended.
3. To Raise - (Figure 3-40) Pull the control lever back to the RAISE position and hold it in position. Press the accelerator pedal to increase the engine speed, which will accelerate the retracting speed of the outrigger. Release the accelerator pedal and the control lever when the outrigger is fully raised.

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

The Outrigger Monitoring System (OMS) aids the operator by using an indicator (1, Figure 3-39) on the control panel that lights when all outriggers are fully deployed. The OMS

uses four proximity sensors, one per outrigger beam, to identify when an outrigger beam is fully extended.

Set up of the outriggers is the same for cranes equipped with OMS; refer to "Operating the Outrigger Controls" on page 3-16. The OMS indicator only indicates the fully extended position of the outrigger beam and should not be used to deploy the beam.



Outriggers fully retracted or outriggers fully extended are the only outrigger positions documented on the *Load Charts*.

Each proximity switch senses the presence of its respective outrigger beam until the beam reaches its fully extended position.

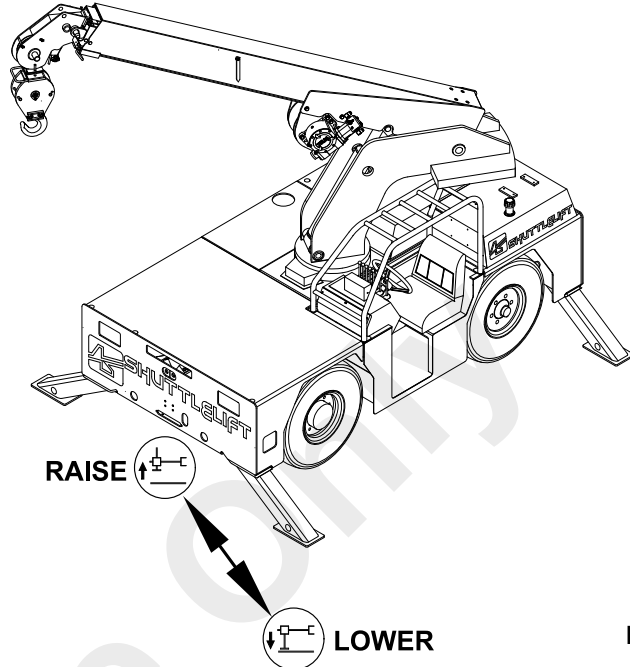
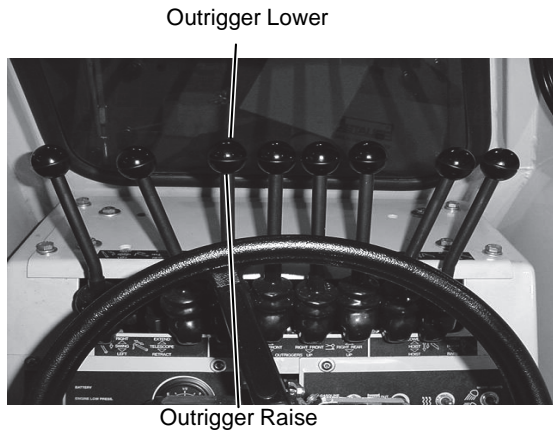
Proximity switch outputs are wired in series such that when all outrigger beams are fully extended, each proximity switch will no longer sense presence of its outrigger beam, the output contact will then close illuminating the green indicator on the control panel signaling all outriggers are fully extended and lifts can be made per "outriggers fully extended" *Load Chart*.

Any outrigger beam not fully extended or functional failure of any proximity switch will cause the indicator to not illuminate, indicating outrigger beams are not fully extended and lifts can only be made per the "outriggers retracted" or "on rubber" *Load Charts*.

Outrigger beam position monitor is not interfaced with the load monitoring system (if equipped), the machine operator is responsible for selecting the correct load chart.

P0893

a1020



**NOTE:** Left front outrigger control shown. The remaining outrigger controls work the same as the left front outrigger control

FIGURE 3-40

### Operating the Boom Controls

Four levers in the operator's cab control the boom functions. See Figure 3-41. These levers are connected directly to the main control valves.

When operating each control, press the accelerator pedal to increase engine speed to maximum RPM. Slowly move the control lever. The further the control lever is moved the faster the function will operate. To stop function movement, move the control lever to the neutral position, then lower the engine speed to idle.

### Anti-Double Blocking System

This system inhibits the hook block from being pulled into the boom head during extension of the booms, raising of the booms and during hoist operation. If the hook block touches the anti-double block bracket (Figure 3-42) under the boom head, a switch is actuated. This switch stops hydraulic oil flow to telescope out, boom lift and hoist raise functions. An alarm is activated to give a warning to the operator in all cases. Before operation can resume, the hoist block must be first lowered away from the boom head.

P0892

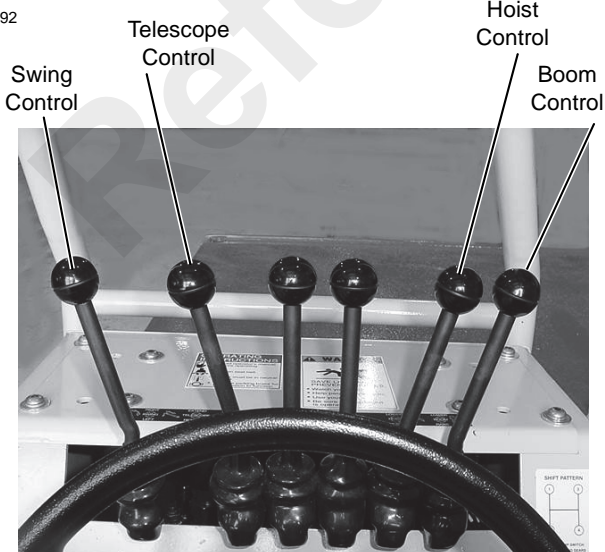
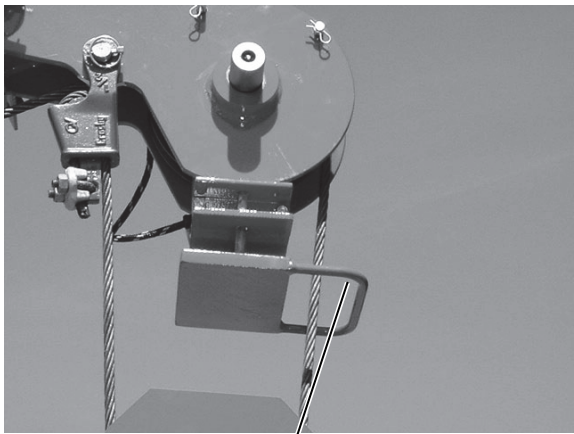


FIGURE 3-41

### CAUTION

**DO NOT** disconnect the anti-double block system. Possible damage to the boom, hoist or crane could result.

P0998



Anti-Double Block Bracket

FIGURE 3-42

**Boom Swing Operation**

w0022



1100262

Before rotating the mast, be sure there is enough clearance on all sides and that all persons are away from the area. A pinch point between the operator's cab and mast can cause injury or death.

**To Rotate the Mast to the Left (Counterclockwise)**

Press the accelerator pedal to increase the engine speed to maximum RPM. Slowly pull back on the swing control lever (Figure 3-43) until the desired swing speed is obtained. The further the control is pulled back the faster the mast will rotate.

**To Stop Rotation**

Slowly move the control lever to the neutral position and decrease the engine speed to idle.

**To Rotate the Mast Right (Clockwise)**

Press the accelerator pedal to increase the engine speed to maximum RPM. Slowly push forward on the swing control lever (Figure 3-43) until the desired swing speed is obtained. The further the control is pushed forward the faster the mast will rotate.

---

**CAUTION**

Never put side loads on the boom. Side loads can damage the swing gearbox. Move the boom so that it is directly above the load before lifting the load.

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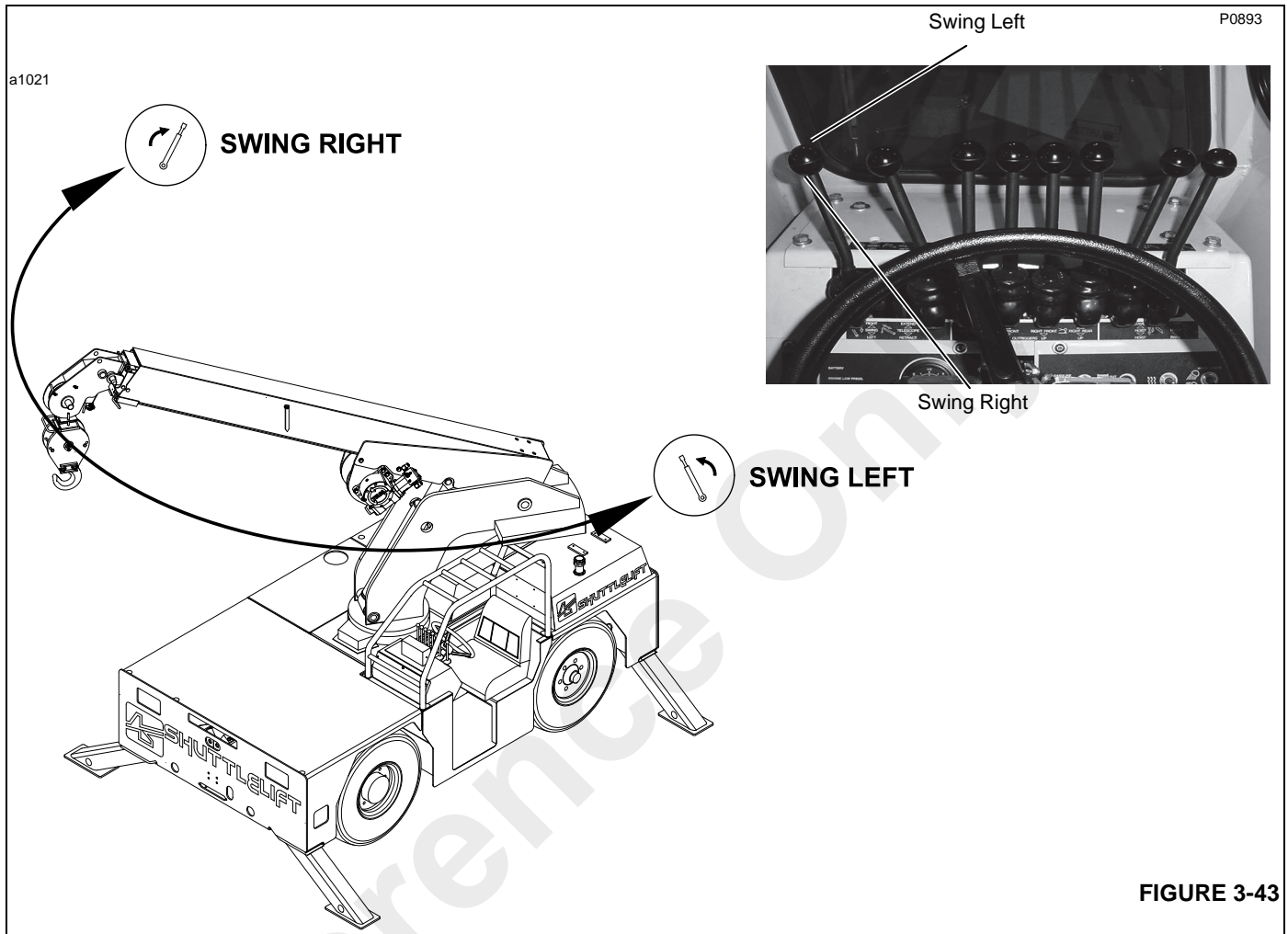


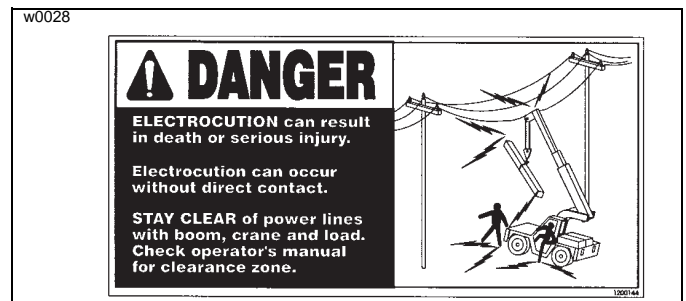
FIGURE 3-43

**Boom Telescope Operation**

**CAUTION**

Always operate the hoist control to unwind the wire rope when extending the boom. Do not let the drop block touch the boom head. An automatic cutout device is installed on this crane to inhibit the drop block from being pulled into the boom head. When the drop block touches the anti-double blocking bracket (Figure 3-42) hanging from the boom head, a switch is activated and the hydraulic flow to extend the telescope cylinder is stopped. A horn will sound, warning the operator that the block has touched the bracket. The operator must then lower the drop block to stop the horn and allow for the extension of the boom.

The above information also pertains when a boom extension is attached to the boom.



**CAUTION**

Look for overhead obstructions before raising the boom. Possible damage or electrocution could occur if the boom comes in contact with over head power lines.

**To Extend the Booms**

Press the accelerator pedal to increase the engine speed to maximum RPM. Slowly push forward on the telescope control lever (Figure 3-44) until the desired extend speed is

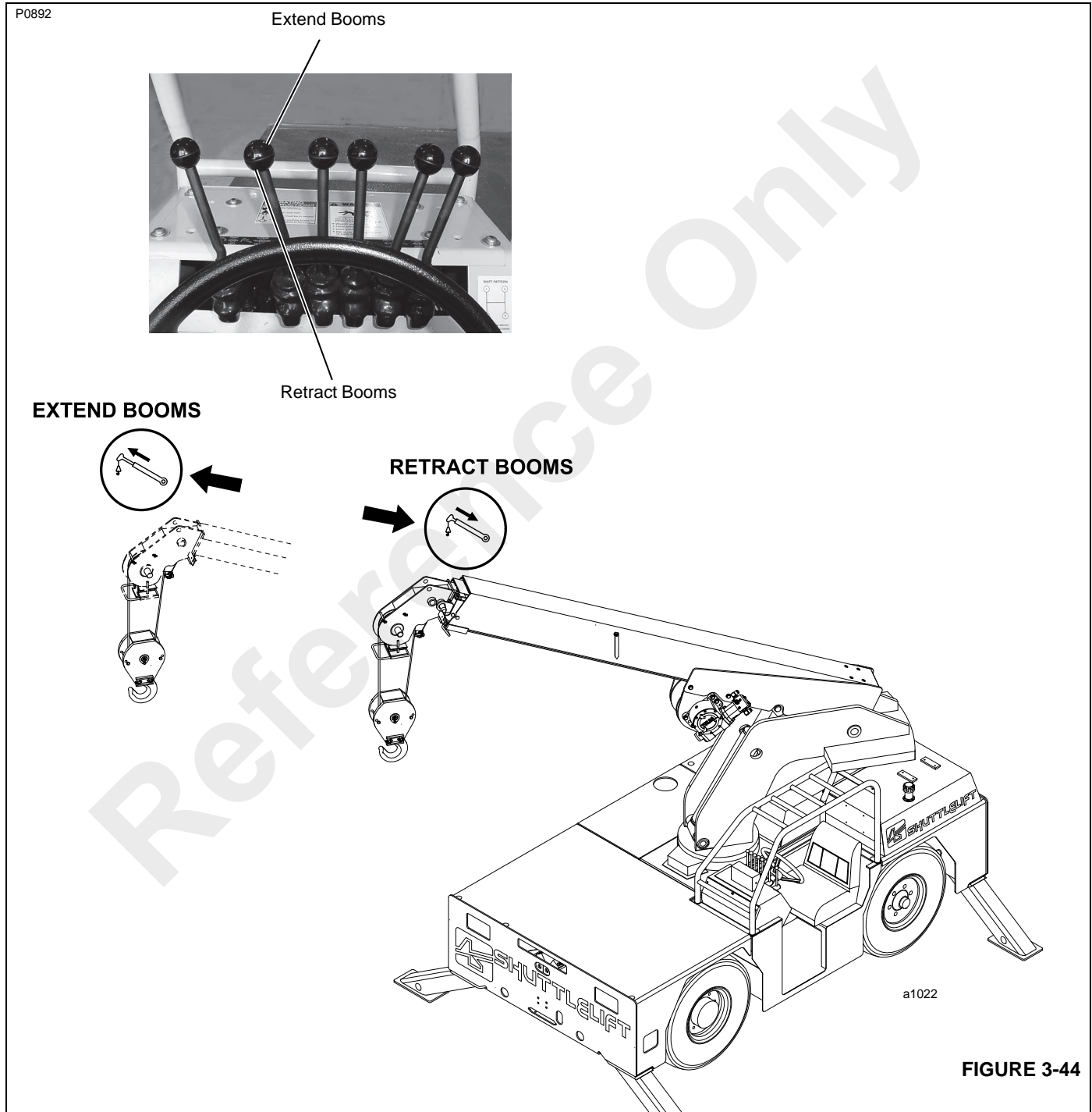
obtained. The further the control is pushed forward the faster the boom will extend.

**To Stop Extension/Retraction**

Slowly move the control lever to the neutral position and decrease the engine speed to idle.

**To Retract the Booms**

Press the accelerator pedal to increase the engine speed to maximum RPM. Slowly pull back on the telescope control lever (Figure 3-44) until the desired retract speed is obtained. The further the control is pulled back the faster the boom will retract.



**Boom Lift Operation**

w0030

**DANGER**

**MACHINE TIPOVER can result in death or serious injury.**

- Consult capacity chart for load limits.
- Level machine before raising load.
- No side loading.
- Before traveling rotate boom to forward position.
- With boom attachments such as jib or work platform boom must be fully retracted and forward unless on outriggers.

1100254

- Know the capacity of the crane. The operator must be familiar with the crane's capacity chart before lifting a load. See how to read the capacity chart in Section 4. A falling load or machine tip-over can cause injury or death.

w0028

**DANGER**

**ELECTROCUTION can result in death or serious injury.**

Electrocution can occur without direct contact.

**STAY CLEAR** of power lines with boom, crane and load. Check operator's manual for clearance zone.

**CAUTION**

Look for overhead obstructions before raising the boom. Possible damage or electrocution could occur if the boom comes in contact with over head power lines.

**CAUTION**

Always operate the hoist control to unwind the wire rope when raising the boom. Do not let the drop block touch the boom head. An automatic cutout device is installed on this crane to inhibit the drop block from being pulled into the boom head. When the drop block touches the anti-double blocking bracket (Figure 3-42) hanging from the boom head, a switch is activated and the hydraulic flow to extend the lift cylinder is stopped. A horn will sound, warning the operator that the block has touched the bracket. The operator must then lower the drop block to stop the horn and allow for the raising of the boom.

The above information also pertains when a boom extension is attached to the boom.

**To Raise the Boom**

Press the accelerator pedal to increase the engine speed to maximum RPM. Slowly pull back on the boom control lever (Figure 3-45) until the desired raising speed is obtained. The further the control is pulled back the faster the boom will raise.

**CAUTION**

If the crane is equipped with an RCL system, **DO NOT** fully raise the boom and dead end the cylinder. If the cylinder dead ends, the RCL will sense an overload situation and shutdown the hoist operation. The bypass switch on the RCL must then be actuated in order to resume operation.

**To Stop Boom Movement**

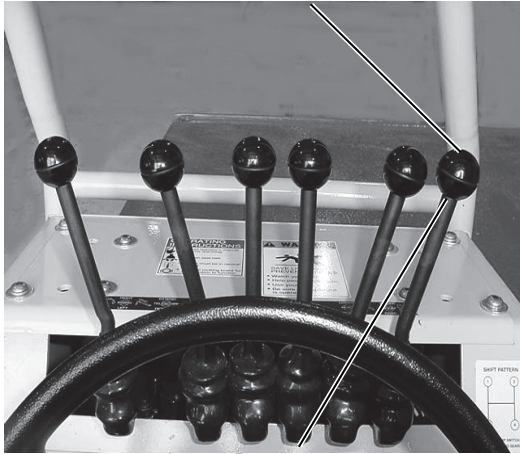
Slowly move the control lever to the neutral position and decrease the engine speed to idle.

**To Lower the Boom**

Press the accelerator pedal to increase the engine speed to maximum RPM. Slowly push forward on the boom control lever (Figure 3-45) until the desired lowering speed is obtained. The further the control is pushed forward the faster the boom will lower.

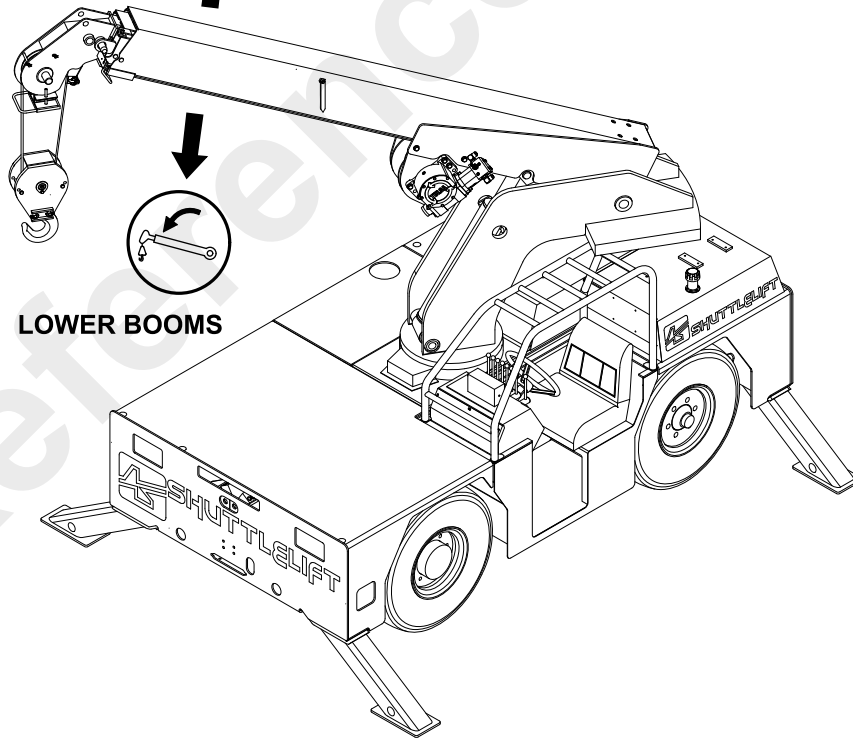
P0892

Raise Booms



Lower Booms

**RAISE BOOMS**



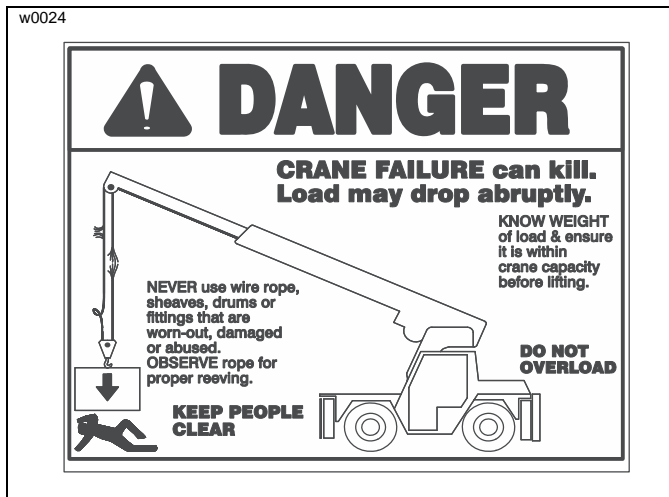
**LOWER BOOMS**

a1023

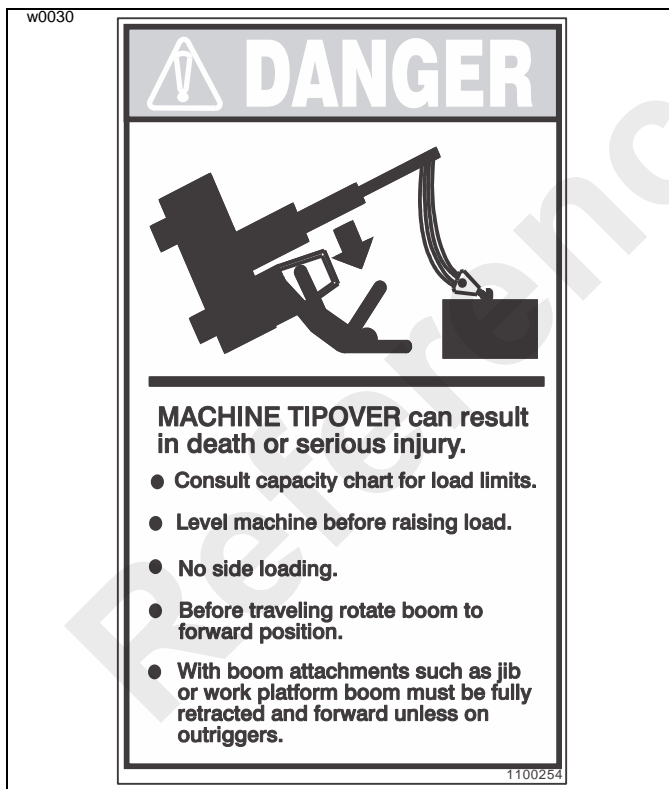
FIGURE 3-45



**Hoist Operation**



- Before making a lift, be sure all persons are clear of the load. A falling load can cause injury or death.



- Know the capacity of the crane. The operator must be familiar with the crane's capacity chart before lifting a load. See how to read the capacity chart in Section 4. A

falling load or machine tip-over can cause injury or death.

**WARNING**

When lifting a load, keep your eyes on the load at all times. If you must look away, stop the movement of the load first. A moving load can cause injury or death.

Always have a flagman give assistance if you can not see a moving load. Be sure you can see the flagman at all times. Agree in advance to hand signals to be used (see *Hand Signals*, page 2-36). A moving load can cause injury or death and/or property damage.

**CAUTION**

Do not let the drop block touch the boom head. An automatic cutout device is installed on this crane to inhibit the drop block from being pulled into the boom head. When the drop block touches the anti-double blocking bracket (Figure 3-42) hanging from the boom head, a switch is activated and the hydraulic flow to raise the drop block is stopped. A horn will sound, warning the operator that the block has touched the bracket. The operator must then lower the drop block to stop the horn and allow for other boom functions.

The above information also pertains when a boom extension is attached to the boom.

**To Raise the Drop Block**

Press the accelerator pedal to increase the engine speed to maximum RPM. Slowly pull back on the hoist control lever (Figure 3-46) until the desired raising speed is obtained. The further the control is pulled back the faster the drop block will raise

**To Stop Drop Block Movement**

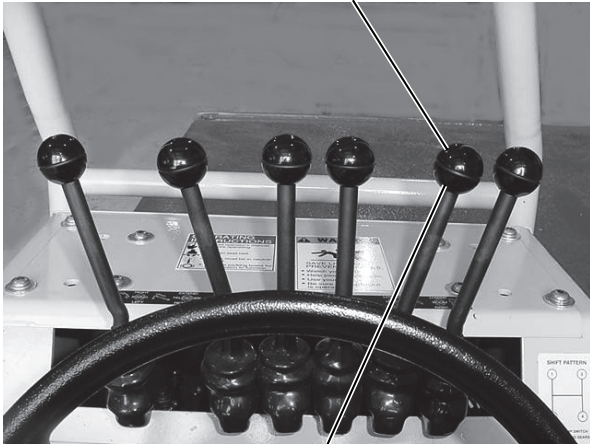
Slowly move the control lever to the neutral position and decrease the engine speed to idle.

**To Lower the Drop Block**

Press the accelerator pedal to increase the engine speed to maximum RPM. Slowly push forward on the hoist control lever (Figure 3-46) until the desired lowering speed is obtained. The further the control is pushed forward the faster the drop block will lower.

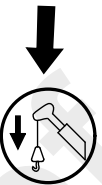
P0892

Lower Drop Block

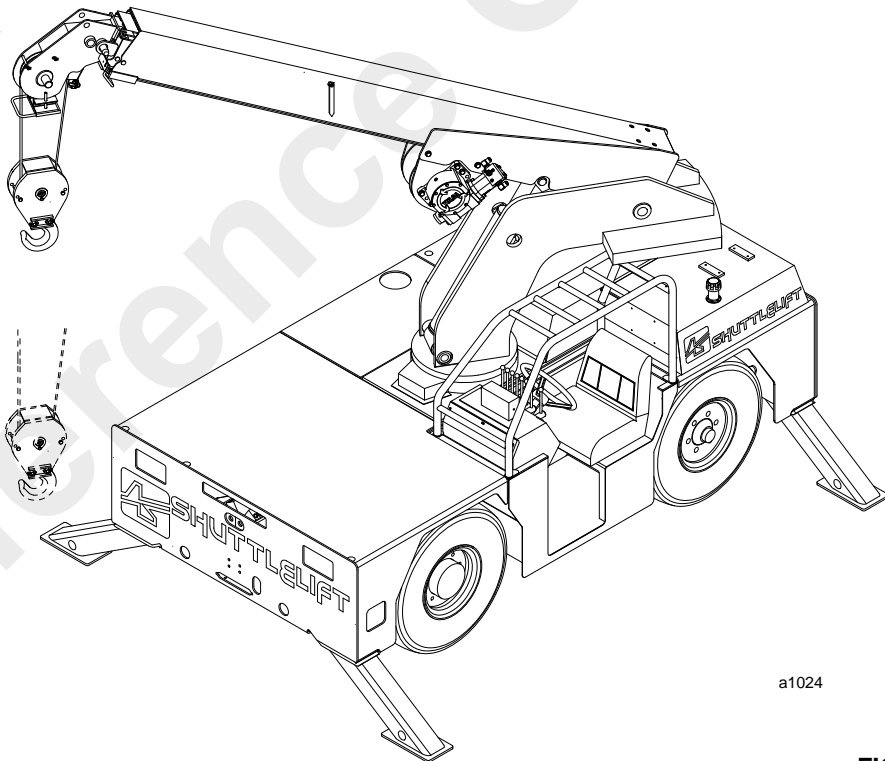


Raise Drop Block

**RAISE  
DROP  
BLOCK**



**LOWER  
DROP  
BLOCK**



a1024

**FIGURE 3-46**

Optional Controls Operation

Auxiliary Winch

w0031

<p><b>WIRE ROPE</b> can whip if rope breaks or load unhooks. <b>STAND BACK</b></p>	<p><b>WARNING</b></p> 	<p><b>ROLLERS</b> can pinch or grab when winch is operating. <b>KEEP HANDS &amp; CLOTHING AWAY</b></p>
--	---	--

- Always keep hands and clothing clear of the fairlead rollers and front opening while the winch is operating. Keep persons away from the area. Injury can be caused if the wire rope breaks or the hook becomes disconnected.

**CAUTION**

The optional auxiliary winch is only intended for intermittent use. Prolonged operation may cause excessive drain of the batteries.

**To Extend the Wire Rope**

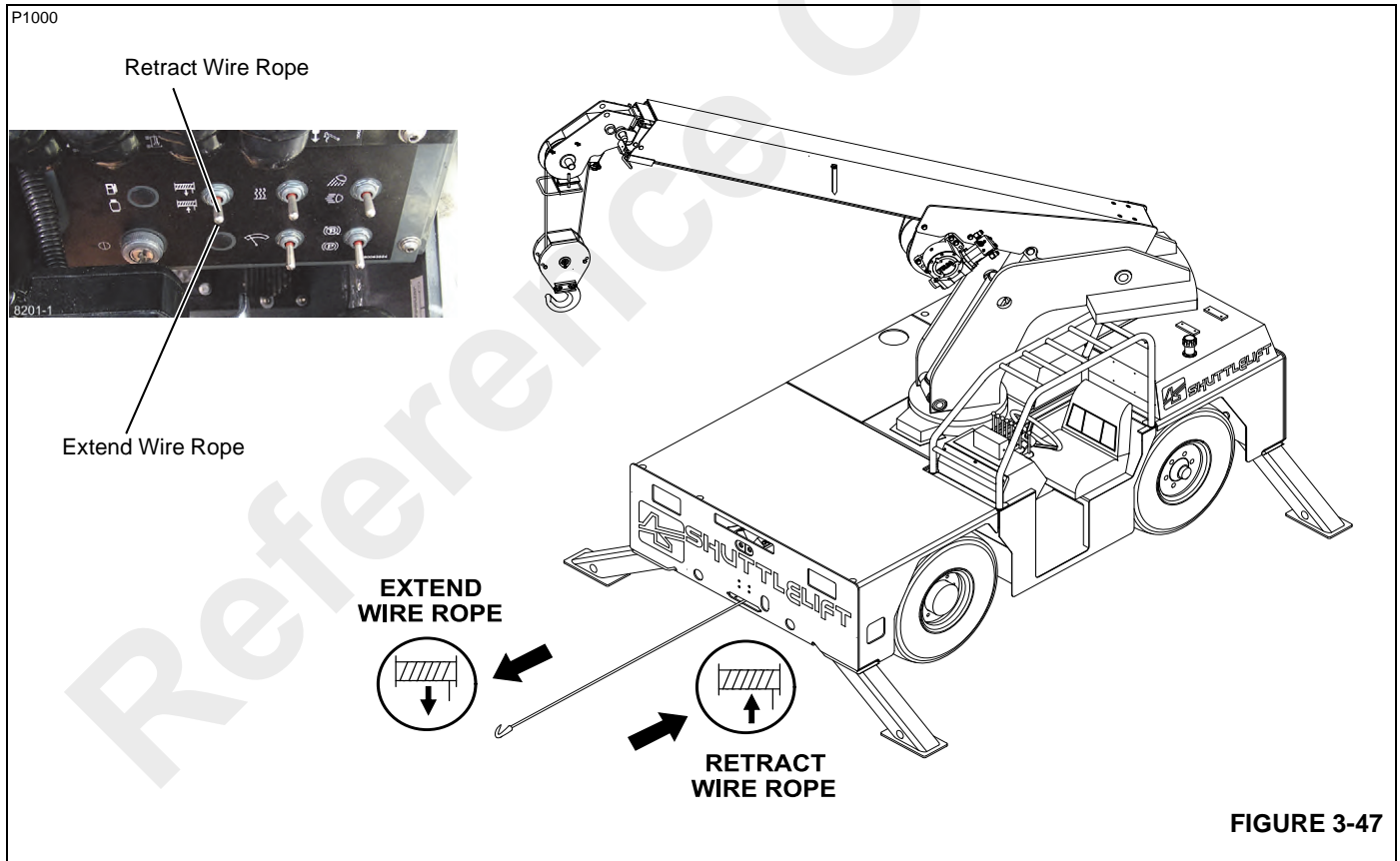
Hold the toggle switch in the up position (Figure 3-47). Keep tension on the wire rope to inhibit twisting of the wire rope on the winch drum.

**To Stop the Winch**

Release the toggle switch.

**To Retract the Wire Rope**

Hold the toggle switch in the down position (Figure 3-47).



## OPERATING PRACTICES

### Handling a Load

The crane must not be loaded beyond the specifications of the rated load chart. The load being lifted must be within the rated capacity of the crane.

When loads which are not accurately known are to be lifted, the operator of the crane must ascertain that the weight of the load does not exceed the crane ratings at the radius at which the load is being lifted.

### Attaching the Load

The hoist rope must not be wrapped around the load as the wire rope will be damaged.

The load must be attached to the hook by means of slings or other devices of sufficient capacity.

### Holding the Load

The operator must not leave the controls while a load is suspended. An exception to this is under those circumstances where a load is to be held suspended for a period of time exceeding normal lifting operations, the operator may leave the controls provided that, prior to that time, the appointed individual and operator establish the requirements for restraining the boom hoist, telescope, load, swing and outrigger functions, and provide notices, barricades or whatever other precautions may be necessary.

No person should be permitted to stand or pass under a suspended load.

### Moving the Load

1. The person directing the lift must see that:
  - a. The crane is level and where necessary, blocked.
  - b. The load is well secured and balanced in the sling or lifting device before it is lifted more than a few inches.
  - c. The lift and swing path is clear of obstructions.
2. Before starting to lift the load, the following conditions should be noted:
  - a. That the boom when extended, is laterally straight
  - b. That the hoist rope is not kinked or damaged.
  - c. That multiple-part lines are not twisted around each other.
  - d. That the hook is brought over the load in such a manner as to minimize swinging.

- e. If there is a slack condition in the wire rope, it must be determined that the rope is seated on the hoist drum and in the sheaves as the slack is removed.
  - f. The effect of ambient wind on the load and crane stability.
3. During lifting operations care must be taken that:
    - a. There is no sudden acceleration or deceleration of the moving load.
    - b. Load, boom and other parts of the crane do not contact any obstruction.
  4. The load must not be lowered below a point where less than three full wraps of rope remain on the hoist drum.
  5. When two or more cranes are used to lift one load, one designated person shall be responsible for the operation. That person must analyze the operation and instruct all personnel involved in the proper positioning, rigging the load and the movements to be made. Decisions such as the necessity to reduce crane ratings, load positions, boom location, ground support and speed of movement must be in accordance with this determination.
  6. When rotating the boom with a load, sudden starts and stops must be avoided. Rotational speed must be such that the load does not swing out beyond the radius at which it can be controlled. A tag or restraint line must be used when rotation of the load is hazardous.

### Traveling with a Load (Pick and Carry)

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#### CAUTION

Pick and carry is not allowed when the boom extension is attached and used to lift the load.

---

When traveling with a load, a designated person must be responsible for the operation. Decisions, such as the necessity to reduce crane ratings, load position, boom location, ground support, travel route and speed of movement must be in accordance with that person's determination. Specified tire pressure must be maintained. The boom should be carried in line with the direction of travel. Sudden starts and stops should be avoided. Tag and restraint lines should be used to control swinging of the load.

### Turning Clearances

The front end of the boom extends beyond the end of the frame (Figure 3-48). The operator must be aware of the maximum sweep of the boom when turning and allow for adequate clearance between boom and other objects.

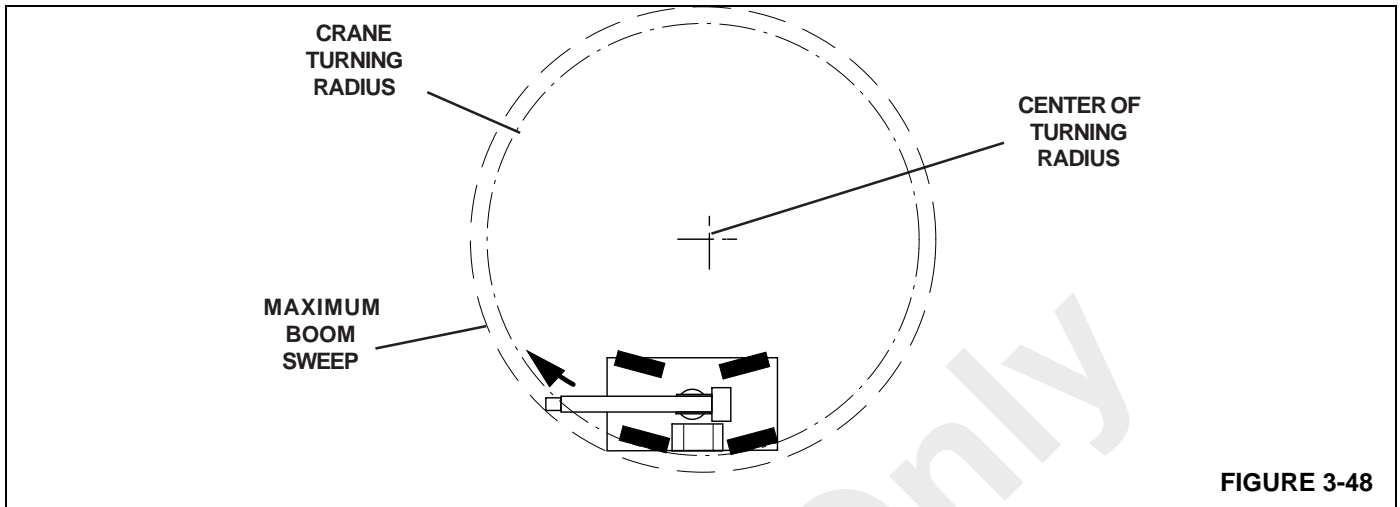


FIGURE 3-48

**Machine Shutdown**

1. Park the crane on level ground.
2. Place the travel select lever in Neutral (N) and engage the parking brake.
3. Lower any load to the ground and fully retract and lower the boom.
4. Turn the ignition switch to the OFF position and remove the key.

**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.

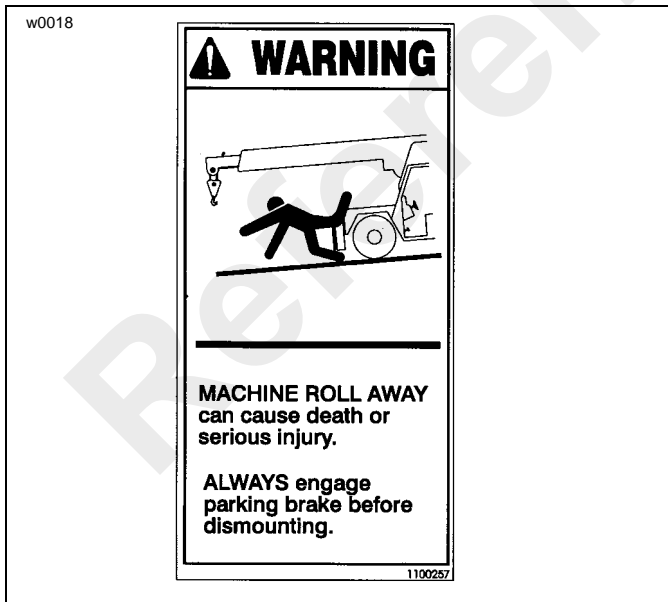
Failure to comply with these instructions may cause death or serious injury.

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

**Towing a Disabled Machine**

If the crane becomes disabled and can not be moved under engine power, the crane may be towed for a distance of 1.5 km (one mile) by another piece of equipment, which is designed for towing. Always use a rigid tow bar and ensure that the travel select lever and the transmission are in Neutral (N). Restrict the travel to 25 kmph (15 mph).

If it is necessary to tow the crane for a distance in excess of 1.5 km (one mile), the drive shafts must be disconnected to inhibit damage to the transmission system.



Reference Only

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## SECTION 4 CAPACITY CHART

### SECTION CONTENTS

<p>Using the Capacity Chart ..... 4-1</p> <p>Determining Operating Radius ..... 4-1</p> <p>Determining Lift Capacity ..... 4-1</p>	<p>Considerations ..... 4-1</p> <p><b>Determining Lifting Capacity at the Boom</b></p> <p>  Extension ..... 4-2</p> <p>  Pick and Carry Ranges ..... 4-2</p>
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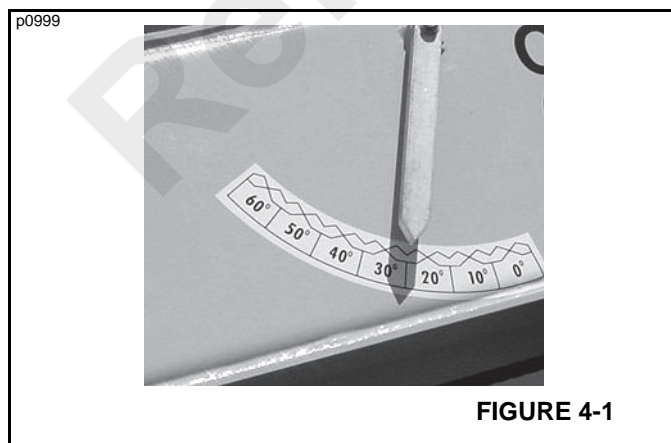
### USING THE CAPACITY CHART

The capacity chart for this crane is located on the inside of the operator's cab to the right of the seat. The chart provides maximum loads that can be safely lifted and gives conditions under which these maximum lifts can be made.

### DETERMINING OPERATING RADIUS

Operating radius is the distance from the centerline of rotation to the center of the drop block hook or the down haul weight, depending on which is installed.

Located on both sides of the boom is an indicator that gives the angle at which the boom is positioned (see Figure 4-1). This angle along with the amount the boom is extended can be applied to the range diagram in the Load Rating Chart to determine the approximate lifting operating radius of the boom. For example, if the boom is at a 60° angle and is fully extended with the 4th section extended, the lifting radius is approximately 17 feet (5.181 m). See sample chart in Figure 4-3.



**FIGURE 4-1**

**NOTE:** To determine the exact lifting radius, use a tape measure and measure from the center rotation of the mast to the center of the hook on either the

drop block or the down haul weight, depending on which is installed.

### DETERMINING LIFT CAPACITY

Lift capacity is the weight that can safely be raised or lowered by the crane. It is determined by two factors; structural strength of the boom and boom extension, and crane stability.

Located on the Load Rating and Range Diagram Chart are the Main Boom Load and Boom Extension Ratings. Find the approximate radius in the chart. Always use the next highest radius if the actual radius is not on the chart. Read across the line to the appropriate column to determine what can be lifted at that radius.

**NOTE:** Exceeding the capacity is dangerous and voids the crane's warranty.

### CONSIDERATIONS

1. The rated loads are the maximum lift capacities as determined by operating radius, boom length and boom angle. The operating distance is the horizontal distance from a projection of the axis of rotation to the supporting surface, before loading, to the center of the vertical hoist line or tackle with load applied.
2. The rated loads shown in the Load Rating and Range Diagram Chart **on outriggers** do not exceed **85%** of actual tipping. The rated loads shown **on rubber** do not exceed **75%** of actual tipping. These ratings are based on freely suspended loads with the crane leveled, standing on a firm, uniform supporting surface. Practical working loads depend on supporting surface, operating radius and other factors affecting stability. Hazardous surroundings, climatic conditions, experience of personnel and proper handling must all be taken into account by the operator.
3. The weights of all load handling devices such as hooks, hook blocks, slings, etc., except the hoist rope, shall be







# LOAD RATING and RANGE DIAGRAM

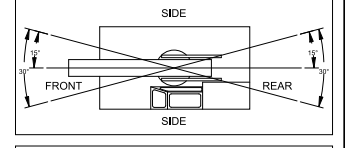
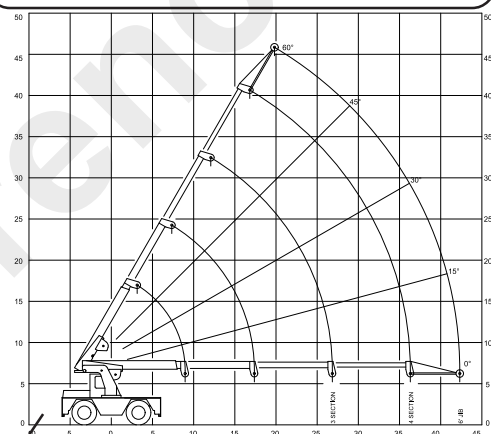
OPERATING RADIUS	3-SECTION BOOM OR 4-SECTION BOOM WITH 4TH RETRACTED				OPERATING RADIUS	4-SECTION BOOM WITH 4TH EXTENDED			
	ON OUTRIGGERS		ON RUBBER			ON OUTRIGGERS		ON RUBBER	
	FRONT	360°	FRONT	360°		FRONT	360°	FRONT	360°
5.0 ft	17000 lbs	17000 lbs	10000 lbs	10000 lbs	5.0 ft	-	-	-	-
6.0 ft	15700 lbs	14400 lbs	9500 lbs	8200 lbs	6.0 ft	-	-	-	-
8.0 ft	12400 lbs	10800 lbs	8000 lbs	5600 lbs	8.0 ft	4900 lbs	4900 lbs	4900 lbs	4900 lbs
10.0 ft	10200 lbs	8500 lbs	5400 lbs	3800 lbs	10.0 ft	4300 lbs	4300 lbs	4300 lbs	4250 lbs
12.0 ft	8500 lbs	6900 lbs	3800 lbs	2700 lbs	12.0 ft	3800 lbs	3800 lbs	3800 lbs	3300 lbs
14.0 ft	7100 lbs	5800 lbs	2750 lbs	1950 lbs	14.0 ft	3400 lbs	3400 lbs	3400 lbs	2600 lbs
16.0 ft	6000 lbs	4850 lbs	2150 lbs	1450 lbs	16.0 ft	3100 lbs	2900 lbs	2900 lbs	2100 lbs
18.0 ft	5200 lbs	3800 lbs	1800 lbs	1150 lbs	18.0 ft	2900 lbs	2900 lbs	2400 lbs	1700 lbs
20.0 ft	4450 lbs	3150 lbs	1500 lbs	950 lbs	20.0 ft	2900 lbs	2900 lbs	1950 lbs	1350 lbs
22.0 ft	3800 lbs	2700 lbs	1300 lbs	800 lbs	22.0 ft	2900 lbs	2900 lbs	1600 lbs	1050 lbs
24.0 ft	3300 lbs	2350 lbs	1100 lbs	650 lbs	24.0 ft	2900 lbs	2650 lbs	1350 lbs	850 lbs
26.0 ft	2900 lbs	2050 lbs	950 lbs	550 lbs	26.0 ft	2900 lbs	2300 lbs	1100 lbs	700 lbs
27.0 ft	2750 lbs	1900 lbs	850 lbs	500 lbs	27.0 ft	2900 lbs	2150 lbs	1000 lbs	650 lbs
28.0 ft	2525 lbs	1775 lbs	800 lbs	475 lbs	28.0 ft	2750 lbs	2000 lbs	950 lbs	600 lbs
30.0 ft	2275 lbs	1600 lbs	700 lbs	400 lbs	30.0 ft	2450 lbs	1800 lbs	800 lbs	500 lbs
32.0 ft	2025 lbs	1425 lbs	600 lbs	325 lbs	32.0 ft	2200 lbs	1600 lbs	700 lbs	400 lbs
33.5 ft	1875 lbs	1300 lbs	525 lbs	275 lbs	33.5 ft	1950 lbs	1400 lbs	625 lbs	325 lbs
36.0 ft	-	-	-	-	36.0 ft	1750 lbs	1250 lbs	550 lbs	250 lbs
38.0 ft	-	-	-	-	38.0 ft	1625 lbs	1125 lbs	475 lbs	225 lbs
40.0 ft	-	-	-	-	40.0 ft	1475 lbs	1025 lbs	400 lbs	200 lbs
42.0 ft	-	-	-	-	42.0 ft	1350 lbs	925 lbs	350 lbs	150 lbs
43.0 ft	-	-	-	-	43.0 ft	1300 lbs	875 lbs	325 lbs	125 lbs

JIB STRUCTURAL CAPACITIES @ MAIN BOOM ANGLE (ALSO DO NOT EXCEED CAPACITIES IN ABOVE CHART)

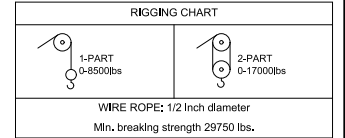
0°	15°	30°	45°	60°
2200 lbs	2400 lbs	2700 lbs	3000 lbs	3400 lbs

- determined by operating radius only. Any combination of boom lengths and angles may be used to obtain operating radius. The operating radius is the horizontal distance from a projection of the axis of rotation to the supporting surface, before loading, to the center of vertical hoist line or tackle with load applied.
- The rated loads shown on outriggers do not exceed 85% of actual tipping. The rated loads shown on rubber do not exceed 75% of actual tipping. These ratings are based on freely suspended loads with the machine leveled, standing on a firm, uniform supporting surface. Practical working loads depend on supporting surface, operating radius, and other factors affecting stability. Hazardous surroundings, experience of personnel and proper handling must all be taken into account by the operator.
  - The weights of all load handling devices, such as hooks, hook blocks, slings, etc., except the hoist rope, shall be considered as part of the load. See reduction chart.
  - Ratings on outriggers are with outriggers fully extended.
  - Ratings on rubber depend on tire capacity, condition of tires, and proper inflation pressure (100 psi). Loads on rubber may be transported at a maximum speed of 2.5 mph on a smooth hard level surface with boom retracted to the shortest length possible and centered over front.
  - For operating radius not shown, use load rating of the next larger radius.
  - The maximum combined total boom and deck load is 12,000 lbs. For deck loads only, the maximum load is 14,000 lbs with 10:00 x 15 tires. Tire inflation at 100 psi.
  - Do not induce external side loads to boom or jib.

## SAMPLE ONLY



	FROM MAIN BOOM RATINGS	FROM JIB RATINGS
MAIN BLOCK	140 lbs	N/A
HOOK & BALL	100 lbs	100 lbs
JIB, STOWED	0 lbs	N/A
JIB, DEPLOYED	150 lbs	0 lbs



RANGE DIAGRAM

FIGURE 4-3

Reference Only

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## SECTION 5 ATTACHMENTS

### SECTION CONTENTS

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### HOIST BLOCK

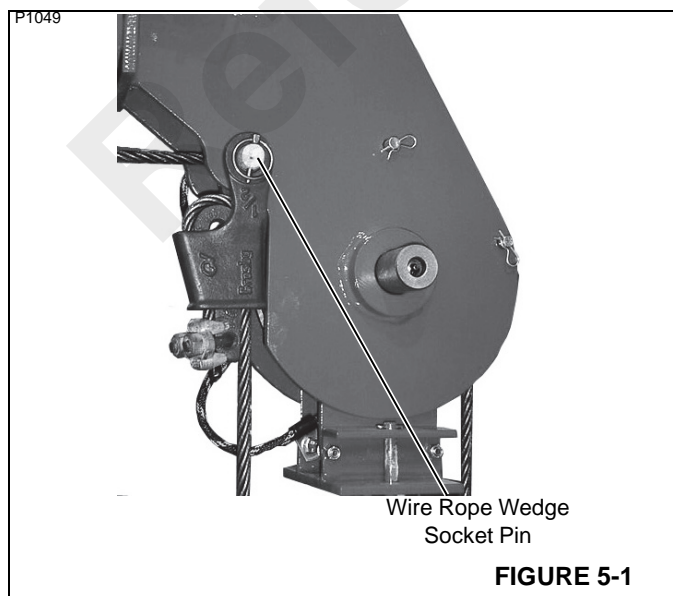
#### Removing the Hoist Block

1. Carefully lower the hoist block to the ground to place slack in the wire rope.

**CAUTION**

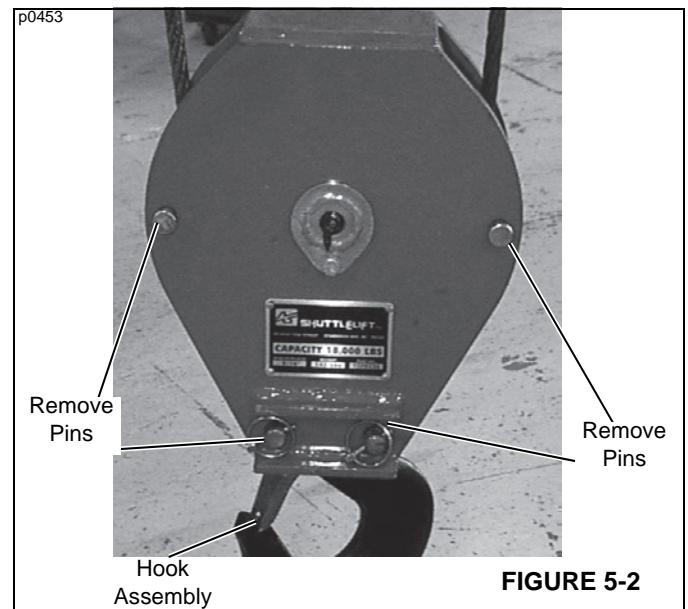
Ensure that the hook assembly's safety latch (Figure 5-2) does not get damaged.

2. Remove the pin (Figure 5-1) securing the rope wedge socket to the boom head. Remove the wire rope dead end socket.



**NOTE:** When removing the hoist block to install the hook and ball assembly, the wire rope dead end assembly does not have to be disassembled.

3. Remove the four pins as indicated in Figure 5-2. Remove the hook assembly.
4. Remove the wire rope from the hook block sheave.
5. Install the hook assembly and four pins.



## Installing the Hoist Block

1. Remove the four pins and hook assembly from the hoist block assembly. See Figure 5-2.
2. Thread the wire rope through the hoist block so it is under the hoist block sheave.
3. Install the hook assembly and four pins to the hook block assembly.
4. Attach the wire rope wedge assembly to boom head.
5. Lift the hoist block off of the ground. Be sure the wire rope is engaged in the sheave grooves in the boom head, hoist block, and hoist drum.

## FOURTH BOOM SECTION

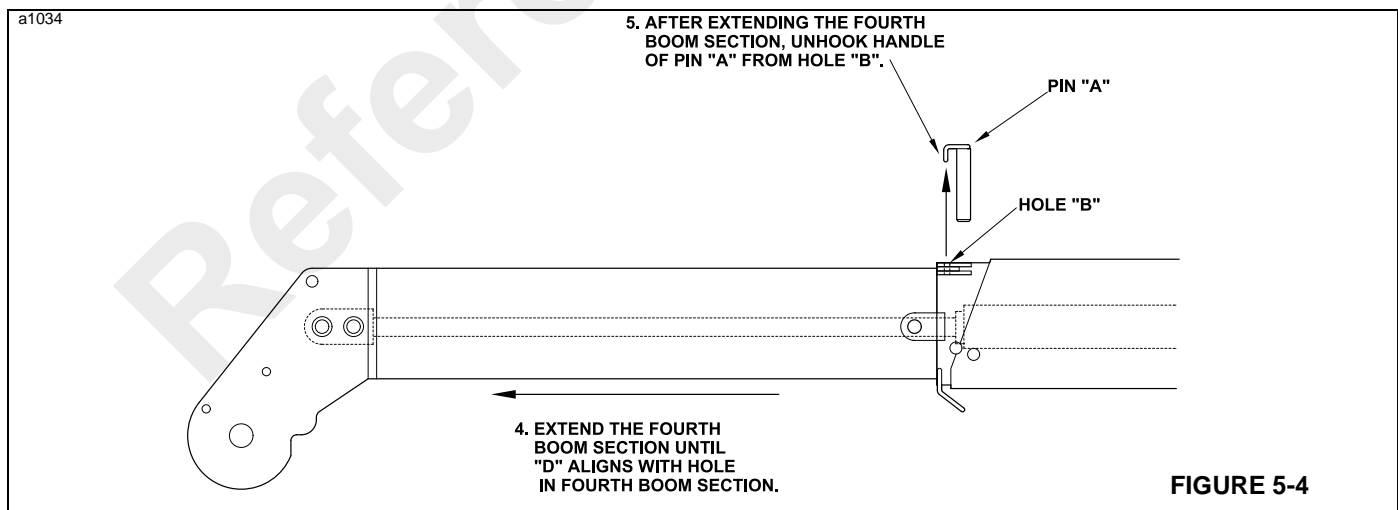
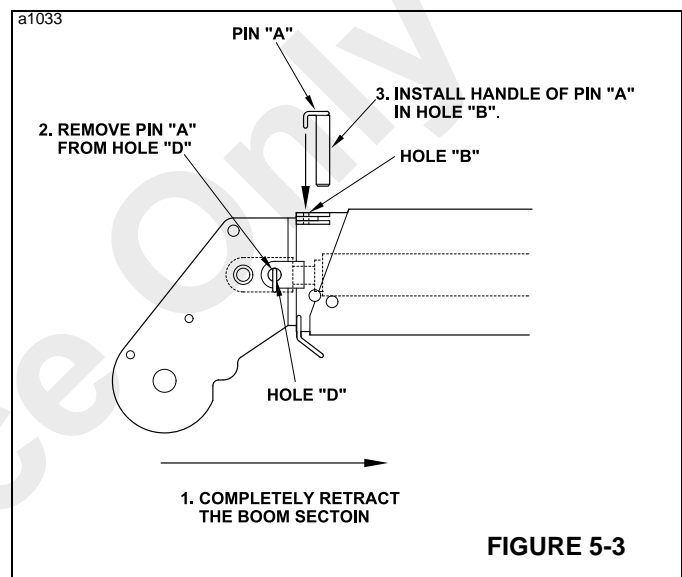
The fourth boom section is an optional feature on this crane. Use the following procedure to extend and retract the fourth boom section.

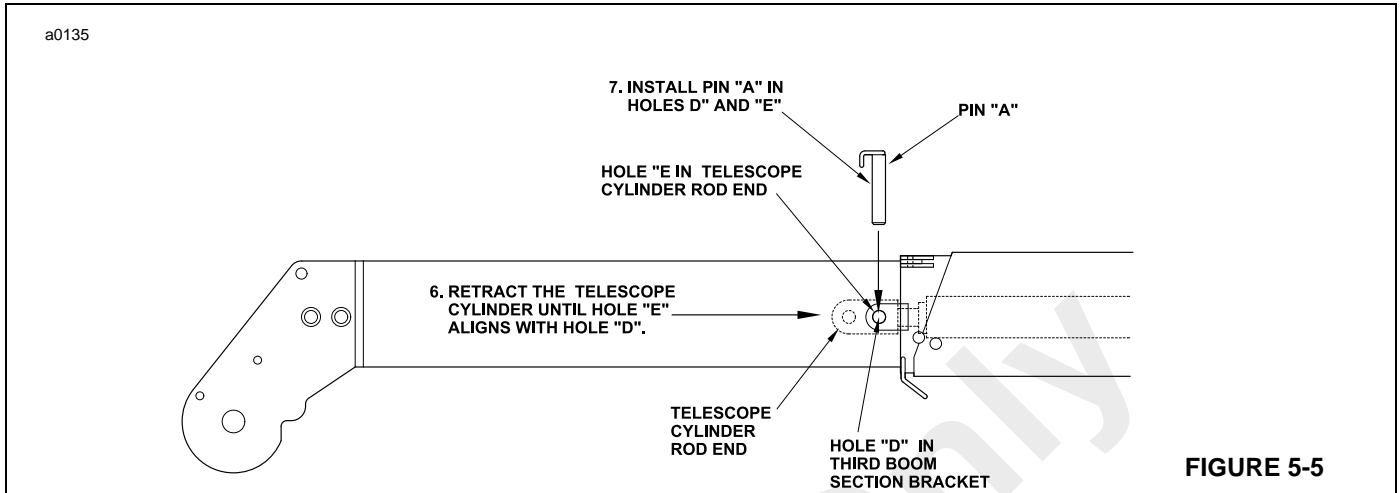
### Extending the Fourth Boom Section

1. Extend the outriggers.
2. Completely retract the boom.
3. On the left side of the boom, remove pin "A" (Figure 5-3) from hole "D" by first removing the snapper pin retaining pin "A" and then the pin. Hook the handle of the pin "A" in hole "B".
4. Extend the fourth boom section, by actuating the telescope control lever in the cab, until hole "D" aligns with hole "B".

(Figure 5-4) in the third section bracket aligns with the hole in the fourth boom section. Unhook the handle of pin "A" from hole "B".

5. Retract the telescope cylinder (fourth section will remain in the extended position) until the second hole "E" (Figure 5-5) in the end of the telescope cylinder rod end aligns with the hole "D" at the end of the fourth boom section and the third section bracket. Install pin "A" into holes "D" and "E". Install the snapper pin to retain pin "A".

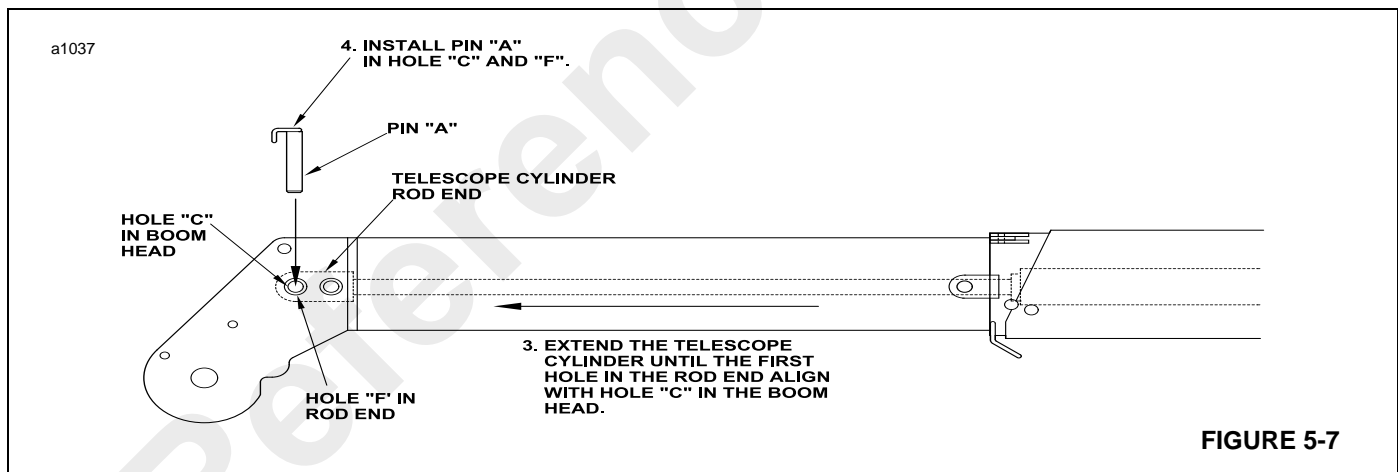
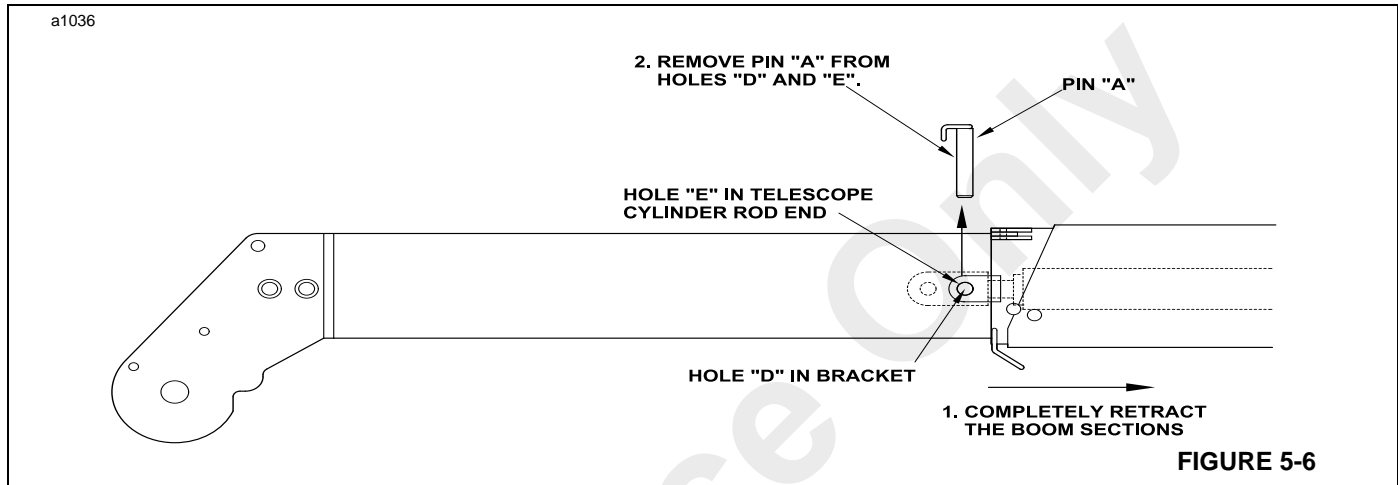


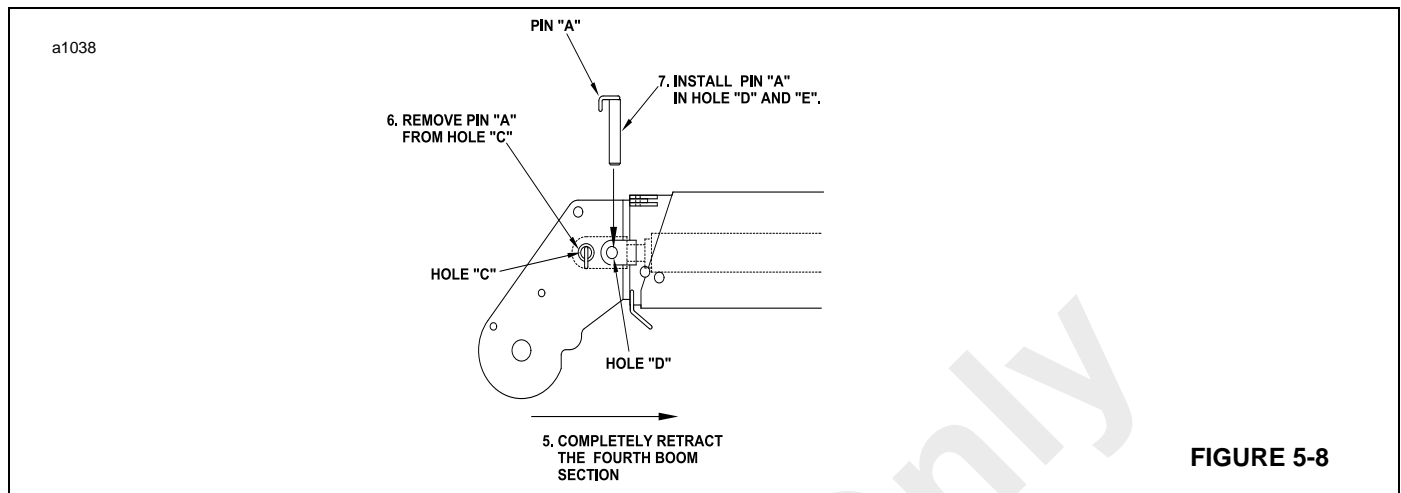


Reference Only

## Retracting the Fourth Boom Section

1. Extend the outriggers.
2. Completely retract the boom.
3. Remove the snapper pin retaining pin "A" (Figure 5-6) Remove pin "A" from the holes "D" and "E" at the rear of the fourth boom section and the bracket on the third boom section.
4. Extend the telescope cylinder by actuating the telescope lever in the cab, until the first hole "F" (Figure 5-7) in the telescope cylinder rod end aligns with the hole "C" in the boom head. Install pin "A" into holes "C" and "F".
5. Completely retract the fourth boom section until pin "A" (Figure 5-8) can be removed. Remove pin "A" and install it in hole "D". Install the snapper pin to retain pin "A".





## BOOM EXTENSION

### Installing the Jib

To use the jib it must be attached to the boom head. The jib can be attached by performing the following procedure:

1. Completely retract the boom.
2. Remove the jib and the suspension cable assembly from their storage positions.
  - a. Remove the retaining pin (Figure 5-9) securing the suspension cable bracket to the bracket on the boom.
  - b. Remove the hair cotter pins from the three connection pins.
  - c. Lift the jib and suspension cable from the support brackets.
  - d. Install the hair cotter pins to the three pins on the boom extension for safe keeping.
3. Install the jib onto the boom head.
  - a. Remove the two lynch pins and cable ends (Figure 5-9) from the sheave mounting pin. Place the cable assembly on the ground.
  - b. Remove the two hair cotter pins and the two retainer pins from the base end of the jib.
  - c. Place the base end of the jib over the sheave pin on the boom head.
  - d. Install the two retainer pins and hair cotter pins.
  - e. Install the suspension cable bracket onto the boom head using the pin removed in step 2a.
  - f. Lift the jib until the two cable ends and lynch pins can be installed onto the sheave pin. Install the cable ends and lynch pins.

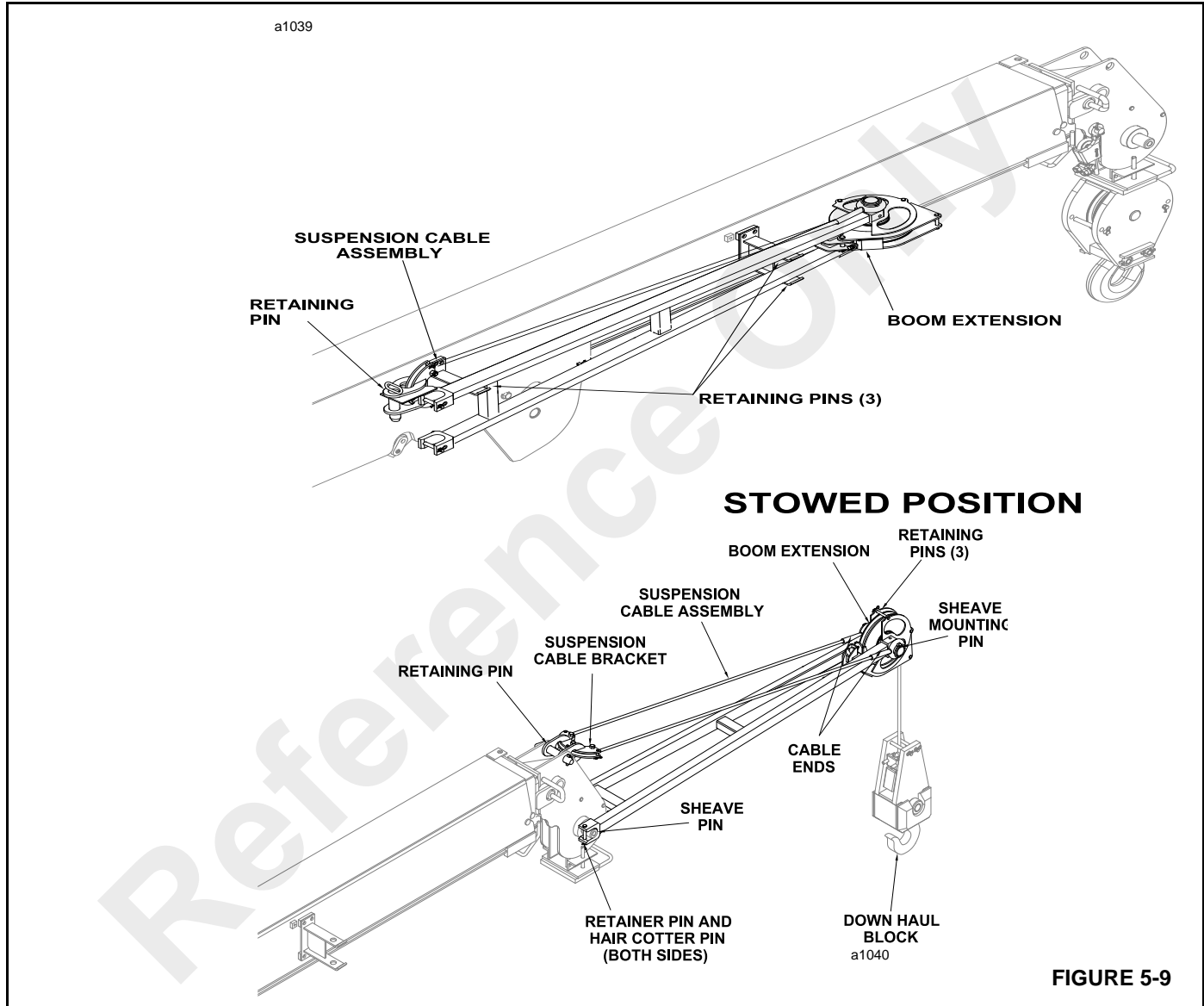
- g. Disconnect the wire assembly from the anti-double blocking switch on the boom head. Connect the wire assembly to the wire assembly on the jib.

4. Install the down haul block.
  - a. Remove the hoist block from the hoist wire rope.
  - b. Remove the wire rope from the boom head sheave. Operate the hoist control to release enough wire rope to extend over the sheave of the jib.
  - c. Remove the retaining pins from the sheave end of the jib. Place the wire rope over the jib sheave. Install the removed retaining pins.
  - d. Attach the down haul block to the wire rope using instructions in the section titled "Down Haul Weight, page 5-8."

### Stowing the Jib

1. Remove the down haul block.
2. Remove the three retaining pins from the sheave end of the jib (Figure 5-9). Remove the wire rope from the sheave. Operate the hoist control to wind the wire rope onto the hoist drum. Install the three retaining pins.
3. Disconnect the anti-double blocking switch wires at the boom extension and connect them to the boom head switch.
4. Support the jib and remove the lynch pins and suspension cable assembly ends from the jib sheave pin. Lower the jib sheave end to the ground.
5. Remove the retaining pin and suspension cable bracket from the boom head.
6. Support the jib and remove the two hair cotter pins and two retaining pins from the base end of the jib. Remove the jib from the boom head. Install the two retaining pins

- and hair cotter pins in the base end of the jib for safe keeping.
7. Remove the retaining pins from the three connection pins on the jib. Install the boom extension onto the two support brackets on the boom assembly. Install the three retaining pins.
  8. Attach the suspension cable ends and lynch pins to the sheave pin on the boom extension. Install the suspension cable bracket to the boom bracket using the retaining pin removed in step 5.





## SEARCHER HOOK ASSEMBLY

The searcher hook is a fixed hook that mounts to the boom nose. The searcher hook has a maximum capacity of 6000 lb (2722 kg).



### CAUTION

Do not exceed the crane stability rating shown on the load chart in the cab.

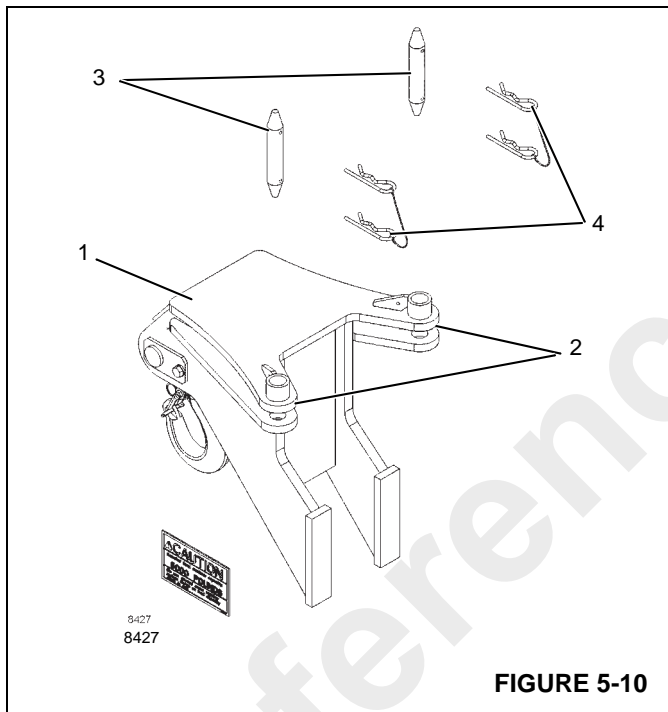


FIGURE 5-10

## Installation

1. Using a suitable lifting device raise the searcher hook (1, Figure 5-10) in front of the boom nose and align the mounting tabs (2) with the lugs on the boom nose.
2. Install the mounting pins (3) and secure with the retaining clips (4).

## Removal

1. Attach a suitable lifting device to the searcher hook assembly.
2. Remove the lower retaining clips from the mounting pins and remove the pins from the mounting tabs.
3. Remove the searcher hook assembly from the boom nose.
4. Install the mounting pins into the mounting tabs and secure with the retaining clips.

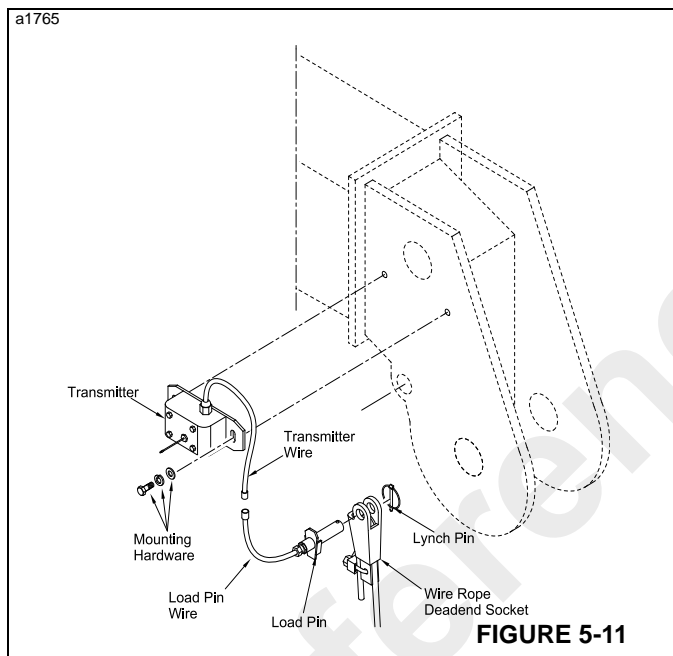
## DOWN HAUL WEIGHT

### Installing the Down Haul Weight

Whenever a single part line is used on a crane to lift a load, the load indicator transmitter must be removed from the boom head and installed onto the down haul weight. Without the transmitter installed and attached to the load pin, the load indicator receiver in the cab will not register the weight being lifted by the single part line.

To install the load indicator transmitter in the down haul block perform the following steps:

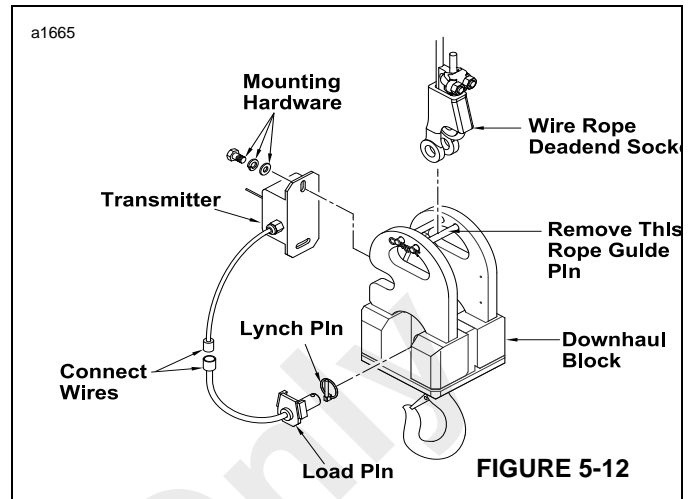
1. Disconnect the transmitter wire and load pin wire (Figure 5-11).



2. Remove the transmitter from the boom head by removing the transmitter mounting hardware (2 each - bolts, lockwashers and flat washers).
3. Follow instructions in Removing the Hoist Block and remove the hoist block.
4. Using the hardware removed when removing the load indicator transmitter, install the transmitter onto the down haul weight (see Figure 5-12).
5. Remove the rope guide pin indicated in Figure 5-12 from the down haul weight.

**NOTE:** The down haul weight may have a sleeve in it for use with a ½ inch becket. If using a 5/8" becket, the sleeve will have to be removed, by being pressed out, to allow for the larger pin.

6. Attach the wire rope dead end socket to the down haul weight using the load pin removed when removing the wire rope socket. Install the lynch pin.



7. Install the rope guide pin. Be sure the wire rope is placed between the two pins.
8. Connect the transmitter wire to the load pin wire.
9. Lift the hoist block off of the ground. Be sure the wire rope is engaged in the sheave grooves in both the boom head and hoist block and is wrapping on the hoist drum properly.

### Removing the Down Haul Weight

Whenever the down haul block is removed, the load indicator transmitter must be removed from the down haul block and installed onto the boom head. Without the transmitter installed and attached to the load pin, the load indicator receiver in the cab will not register the weight being lifted by the crane.

To install the load indicator transmitter to the boom head perform the following steps:

1. Lower the down haul block to the ground.
2. Disconnect the transmitter load pin wire (Figure 5-12) from the transmitter wire.
3. Remove the rope guide pin indicated in Figure 5-12.
4. Remove the lynch pin and the load pin from down haul weight. Remove the wire rope dead end socket. Install the rope guide pin in the down haul weight.
5. Remove the transmitter from the downhaul weight. Retain the hardware.
6. Install the transmitter to the boom head (Figure 5-11) using the existing hardware.
7. Install the hoist block using instructions in Installing the Hoist Block. Install the load pin.
8. Connect the transmitter wire (Figure 5-12) and the load pin wire to the jumper wire.

**INSTALLING CABLE ON THE HOIST**

**CAUTION**

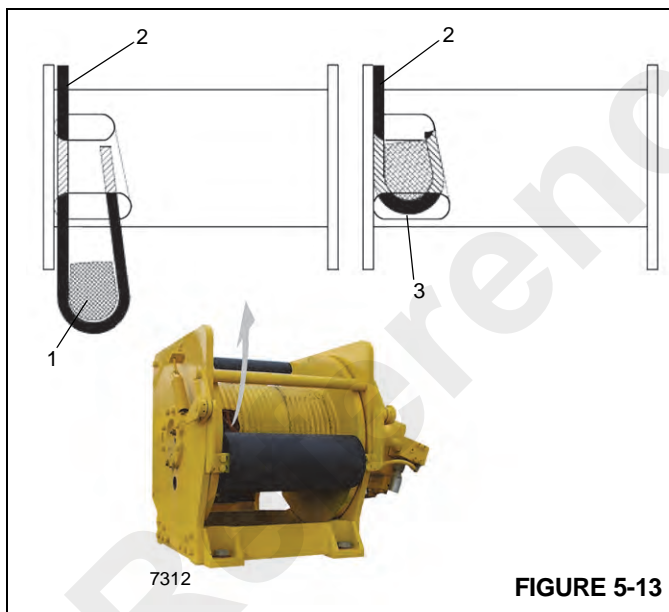
If cable is wound from the storage drum, the reel should be rotated in the same direction as the hoist.

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

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

1. Position the cable over the boom nose sheave and route to the hoist drum.
2. Position the hoist drum with the cable anchor slot on top.
3. Insert the cable through the slot and position around the anchor wedge (1) Figure 5-13.

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



**FIGURE 5-13**

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

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



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

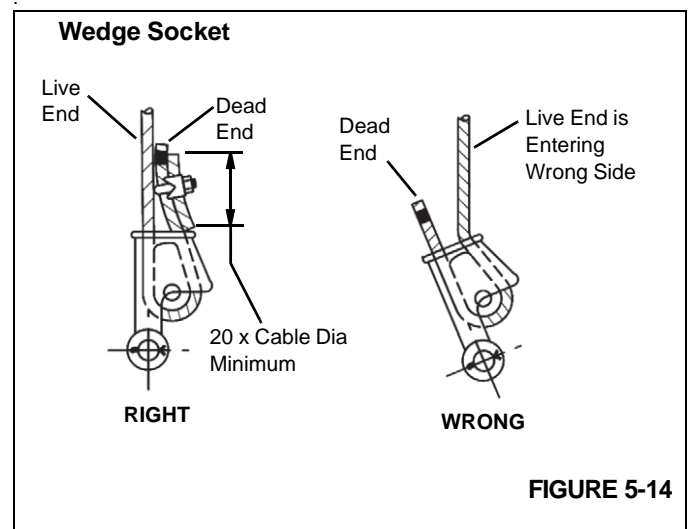
**WIRE ROPE WEDGE SOCKET**

Inspect the wedge and socket. Remove any rough edges and burrs.

**DANGER**

Loads may fall if the wedge socket is not properly installed. A falling load can injure or kill.

1. 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.
2. Make sure the live-end (Figure 5-14) of the rope is directly in line with the ears of the socket and the direction of pull to which the rope will be subjected. If the rope is loaded into the socket incorrectly, under a load the rope will bend as it leaves the socket, and the edge of the socket will wear into the rope causing damage to the rope and eventual failure.



**FIGURE 5-14**

3. 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 5-14) 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.
4. 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.

5. After final pin connections are made, increase the loads gradually until the wedge is properly seated.
6. The wire rope and wedge must be properly secured inside the socket before placing the crane into lifting service. It is the wedge that secures the wire rope inside the socket. The dead-end treatment is used to restrain the wedge from becoming dislodged from the socket should the rope suddenly become unloaded due to the headache ball or hook block striking the ground, etc.

Sketches A through F (Figure 5-15) illustrate various ANSI approved methods for treating the dead-ends of wire ropes which exit a wedge socket assembly. While use of the loop-back method is acceptable, care must be exercised to avoid the loop becoming entangled with tree branches and other components during crane transport and with the anti-two block system and other components during use of the crane.

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

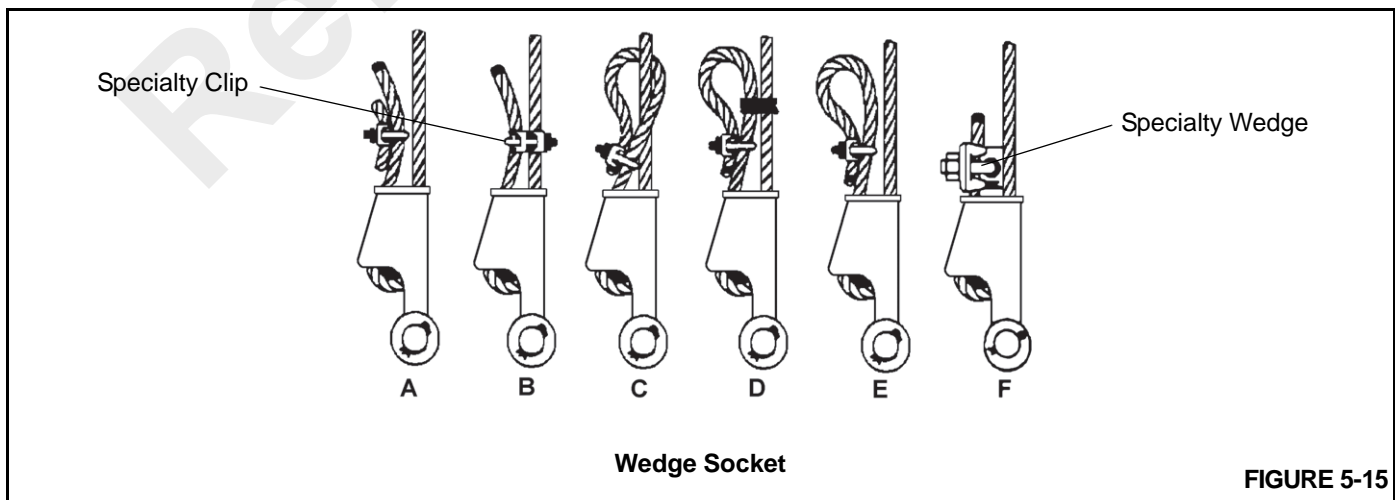
When using method A, place a wire rope clip around the dead end by clamping a short extra piece of rope to the rope dead end. **DO NOT CLAMP THE LIVE END.** The U-bolt should bear against the dead end. The saddle of the clip should bear against the short extra piece. Torque the U-bolts according to the table titled Wire Rope Clip Torque Values (Table 5-1).

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

Table 5-1

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

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## SECTION 6 MAINTENANCE

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## INTRODUCTION

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### CAUTION

Do not use gasoline or other flammable fluids to clean component parts. Fire or explosion may occur causing bodily burns.

Use eye protection when performing service or maintenance tasks. Propelled and/or dropped items can cause eye injury.

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### WARNING

If maintenance or adjustments must be performed with the engine running, have a person at the controls while another person performs the work to prevent accidental movement which could cause injury or death.

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Preventive maintenance is necessary to keep the crane in working condition as long as possible. Adjust the maintenance schedule to your operation, according to the type of work, size of loads, temperature conditions and frequency of equipment use.

The intervals in the Maintenance Schedule are for average operating conditions, and must be understood as the **MINIMUM** maintenance necessary for the crane. Decrease these intervals if the crane is operated in conditions that are below average (for example, in dust, in high or low

temperatures, with heavy loads or frequent starting and stopping).

Use the hourmeter and a calendar to make sure that all necessary maintenance is done according to the schedule.

**NOTE:** When performing service on the crane, put a tag on the key switch or remove the key to prevent operation of the crane.

### Spark Arresting Mufflers

**NOTE:** Codes of some states or provinces may require that this crane be equipped with a SPARK ARRESTING MUFFLER. The State of California as an example, is one state which has such regulations for agricultural and forestry applications, plus a regulation for construction applications in forest covered, brush covered, or grass covered lands.

### Safety List

Inspect the following safety equipment daily:

**SAFETY BELT** - Check for frayed or cut webbing, damaged buckles or loose mounting hardware.

**SAFETY DECALS** - Check condition of decals. Replace if worn, damaged or missing. See Section 2.

**COVERS** - Keep all protective covers in place.

**PARKING BRAKE** - Check operation. Have unit repaired if brake is not functioning properly.

**ENGINE** - Check operation. Remove all dirt or debris, and all flammable materials before running engine.

**LUBRICANTS**

It is not the policy of Manitowoc Cranes, Inc. to publish lists of approved lubricants or guarantee lubricant performance. The responsibility for the quality rests completely with the distributor or manufacturer of the lubricant.

In various paragraphs in this maintenance section, statements may be found, “use (lubricant brand name) or equivalent.” This statement does not constitute an unconditional guarantee of performance of the brand of

lubricant mentioned. It is intended only as a guide to the type of lubricant recommended for a given application.

**MAINTENANCE RECORDS**

Dated records must be kept for inspection of critical components such as, brakes, crane hooks, wire ropes, hydraulic cylinders and relief valve pressure settings. These records must be kept where they can be easily obtained and reviewed.

**SPECIAL MAINTENANCE**

**Delivery Inspection**

- Fuel Tank..... Fill with correct fuel.
- Engine..... Check oil in crankcase. Fill if level is low.  
..... Remove water from fuel filter.
- Cooling System..... Check coolant level. Fill if level is low.
- Hydraulic Tank..... Check oil level. Fill if level is low.
- Drive Axles..... Check axle housing lubricant level and wheel  
..... hub lubricant level. Fill if levels are low.
- Hoist Gearbox..... Check oil level. Fill if level is low.
- Tires..... Check tires for correct air pressure.
- Wire Rope Cable Clamps and Connections..... Check for loose or missing parts.
- Anti-Double Block System..... Check that the system is working properly.
- Controls..... Check that all controls are working properly.

**After First 50 Hours of Operation (New Cranes)**

- Engine..... Replace the engine oil and filter.
- Transmission..... Replace the transmission oil filter.
- Swing Gearbox..... Check and tighten mounting bolts.
- Hoist Gearbox..... Check and tighten mounting bolts.
- Swing Gear Pinion and Swing Gear..... Lubricate.
- Grease Fittings..... Apply grease to all grease fittings.
- Wheel Mounting Nuts..... Check Torque.

**Cranes Not in Regular Use**

A crane which has been idle for a period of one month or more, but less than six months, must be given an inspection by a qualified person. This person should use the daily through monthly inspections.

A crane which has been idle for a period of over 6 months must be given a complete inspection covering all inspections through one year, by a qualified person.

Standby cranes must be inspected using the daily through monthly inspection, by a qualified person.



**PREVENTIVE MAINTENANCE**

**Maintenance Schedule and Checklist**

Hour intervals in each maintenance chart show the correct time for service. The hourmeter located in the operator's cab indicates the total hours the crane has been running.

In addition to the following scheduled maintenance, perform the scheduled maintenance suggested in the engine manual furnished with the crane.

When performing maintenance, do the required maintenance interval as well as all previous interval maintenance. For example, when performing the 250 Hour (Monthly) maintenance interval, perform all the tasks required for Daily, 50 Hour and 100 Hour maintenance.

Service/Check	Interval (Whichever Occurs First) <sup>1</sup>						
	Daily Before Operation	50 Hours (Weekly)	100 Hours (Two Weeks)	250 Hours (Monthly)	500 Hours (Three Months)	1000 Hours (Six Months)	2000 Hours (Yearly)
Inspect the Anti-Double Blocking System	X						
Inspect the Wire Rope	X						
Inspect the Reeving, Clamps, and Connectors	X						
Inspect the Lifting Hook	X						
Inspect Safety Devices	X						
Check Controls Operation	X						
Check Transmission Oil Level	X						
Check Engine Crankcase Oil Level	X						
Check Engine Coolant Level	X						
Check Fuel Level	X						
Check Hydraulic Oil Level	X						
Check Tire Pressure	X						
Drain Water from Engine Fuel Filter/ Water Separator	X						
Check Air Cleaner Restriction Indicator	X						
Inspect Wire Rope and Sheaves		X					
Apply Grease to All Lubrication Fittings		X					
Lubricate Boom Slides		X					
Clean/Inspect Air Cleaner Dust Baffle		X					
Inspect the Engine Fan Belts			X				
Check Wheel Nut Torque			X				
Lubricate the Swing Gear and Pinion				X			
Lubricate the Wire Rope				X			
Inspect All Hydraulic Hoses				X			
Replace the Engine Crankcase Oil <sup>2</sup>				X			
Replace the Engine Oil Filter <sup>2</sup>				X			
Clean Radiator Fins and Core				X			
Clean Battery and Connections				X			
Torque Critical Bolts				X			



Service/Check	Interval (Whichever Occurs First) <sup>1</sup>						
	Daily Before Operation	50 Hours (Weekly)	100 Hours (Two Weeks)	250 Hours (Monthly)	500 Hours (Three Months)	1000 Hours (Six Months)	2000 Hours (Yearly)
Check Axle Wheel Lubricant Level (2)					X		
Check Axle Housing Lubricant Level					X		
Check Hoist Gearbox Lubricant Level					X		
Lubricate the Outrigger Slides					X		
Add Grease to Swing Gearbox					X		
Replace the Fuel Filter					X		
Inspect the Parking Brake Pads					X		
Inspect Tires for Damage					X		
Add Rust Inhibitor to Engine Cooling System					X		
Replace the Air Cleaner Element <sup>2</sup>					X		
Lubricate the Axle Bearings (Rear Axle)						X	
Check Swing Gear to Pinion Backlash						X	
Replace the Transmission Oil and Filter						X	
Replace the Axle Wheel Hub Lubricant (2)						X	
Replace the Axle Housing Lubricant						X	
Replace the Hoist Gearbox Lubricant						X	
Replace the Hydraulic Oil						X	
Replace Spark Plugs (Gasoline Engine)						X	
Replace the Engine Coolant							X
Inspect the Crane Structure and Booms for Damage							X
Test the Rated Capacity Limiter (RCL) Option							X

<sup>1</sup> Maintenance should be performed using either the hourly or calendar dates, whichever occurs first.

<sup>2</sup> Under extremely dust conditions, the engine oil, oil filter, and air cleaner element may require replacement more frequently.

**Lubrication Points**

Apply grease to the following fittings after every 50 hours of operation. Use a Lithium Base, E.P. No.2 bearing grease or equivalent. Apply enough grease to remove the old grease.

**Booms and Main Frame**

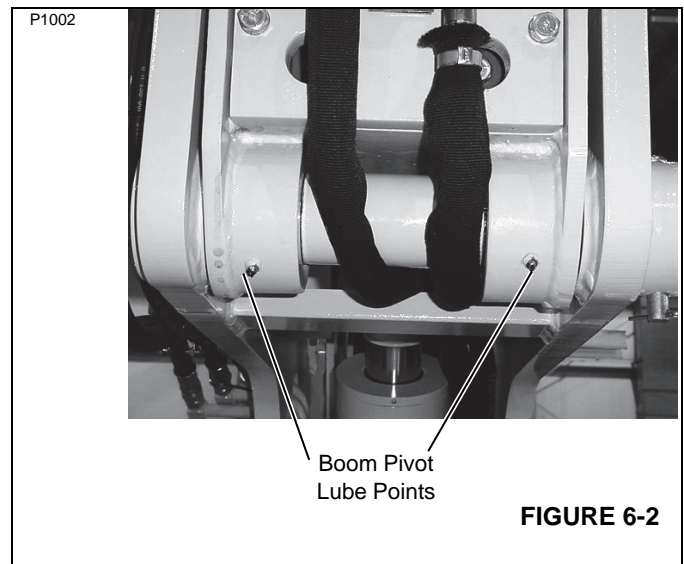
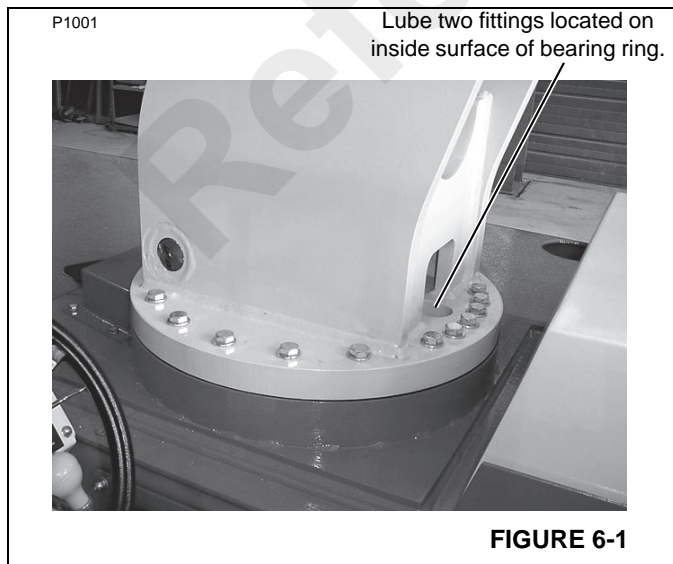
No.	Location	Qty
1	Mast Bearing (See Figure 6-1)	2
2	Boom Pivot (See Figure 6-2)	2
3	Boom Head Sheaves and Pivot (See Figure 6-3)	2
4	Lift Cylinder Pivots (See Figure 6-4)	2

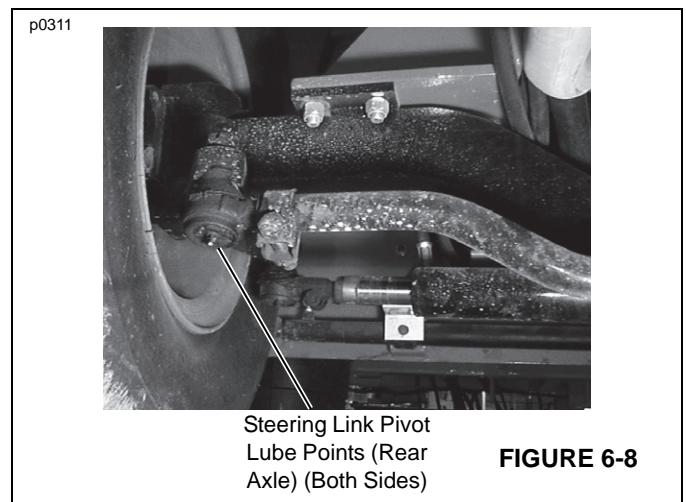
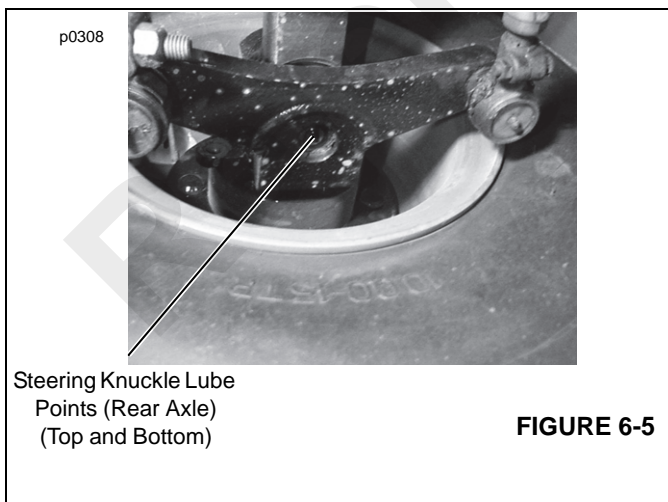
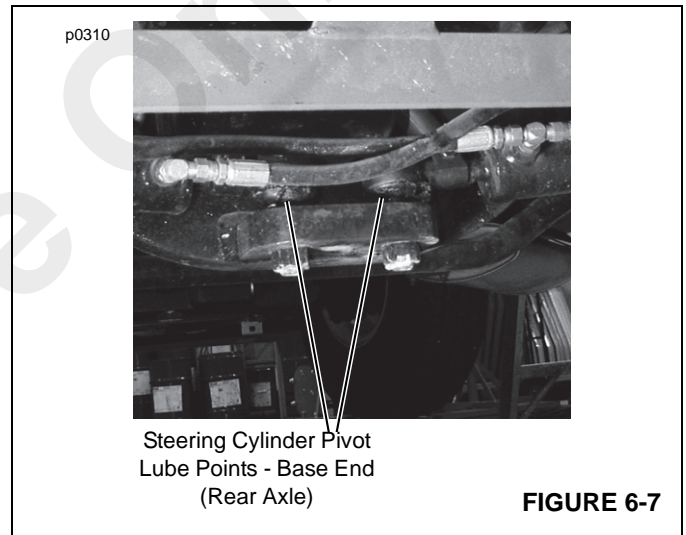
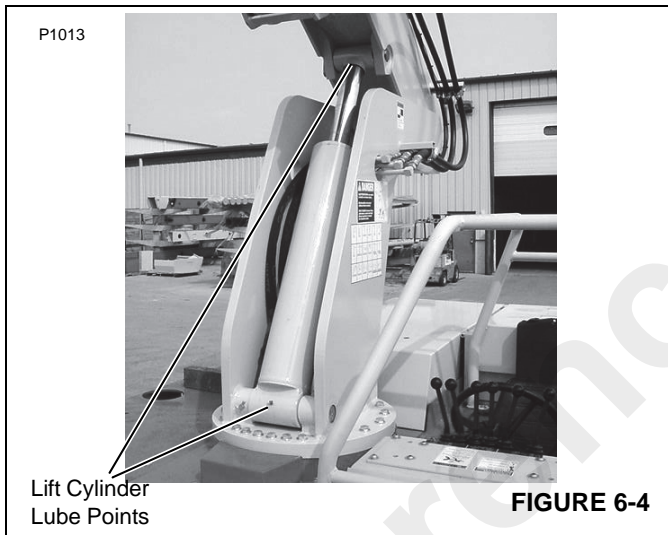
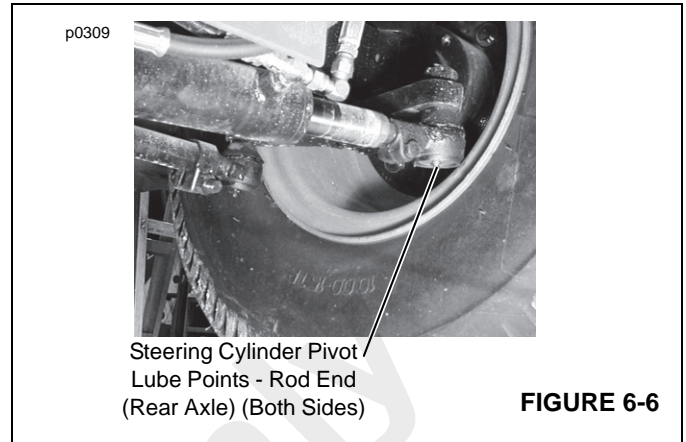
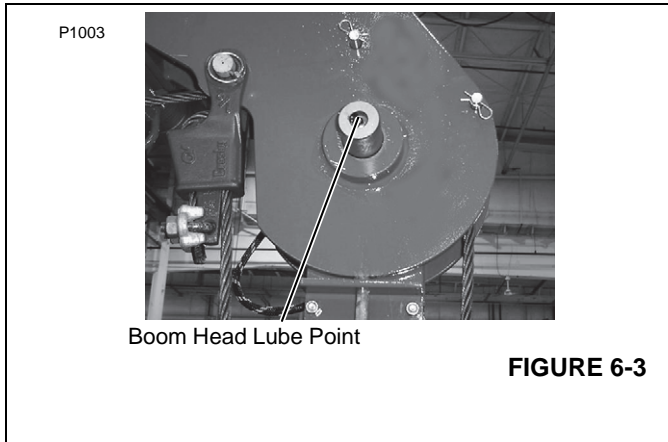
**Drive Train**

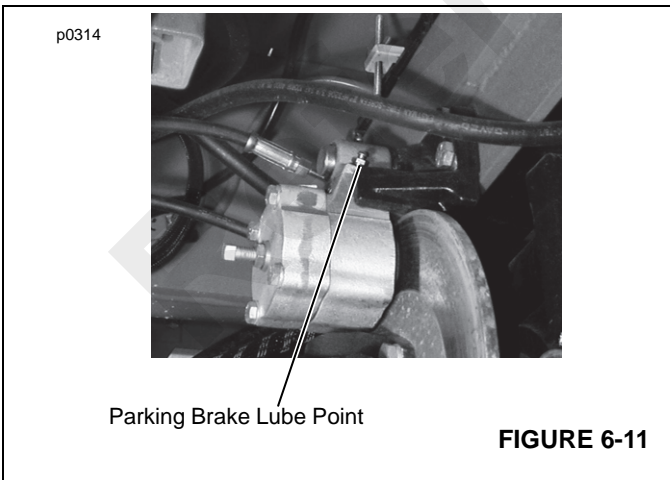
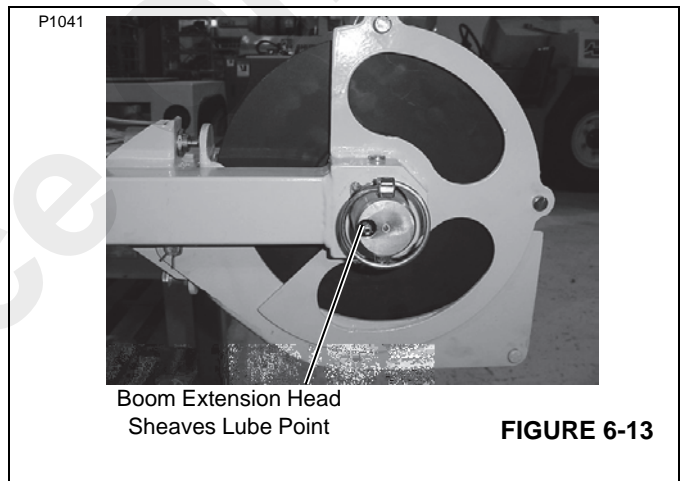
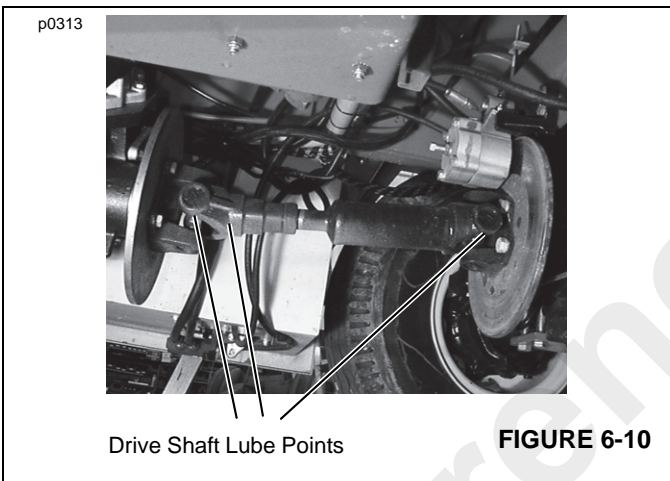
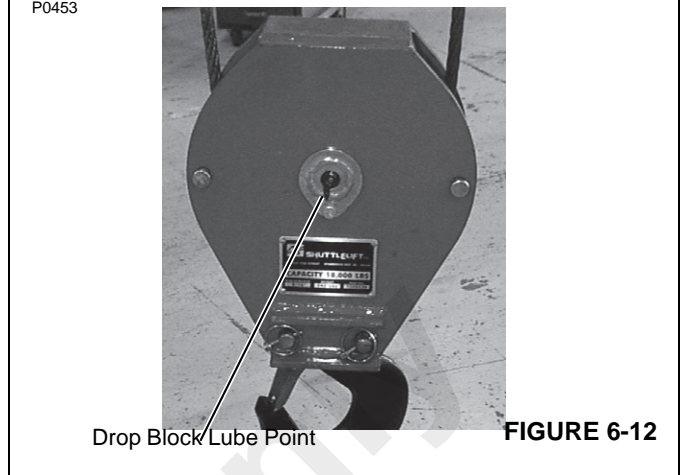
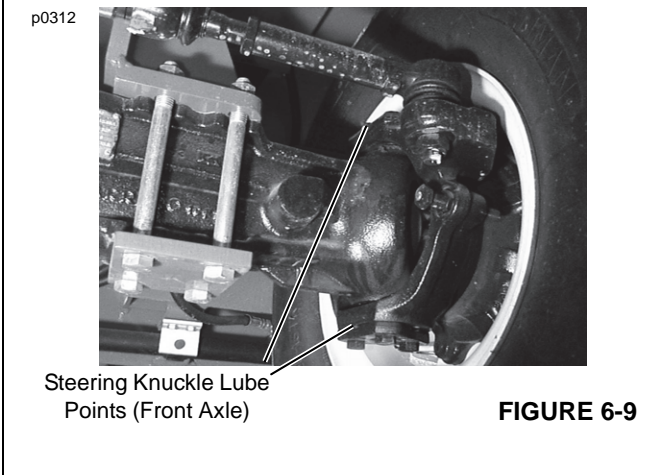
No.	Location	Qty
5	Steering Knuckles - Rear Axle (See Figure 6-5)	2
6	Steering Cylinder Pivot Ends - Rear Axle (See Figure 6-6 and Figure 6-7)	2
7	Steering Link Pivot Ends - Rear Axle (See Figure 6-8)	2
8	Steering Knuckles - Front Axle (See Figure 6-9)	4
9	Drive Shaft (See Figure 6-10)	3
10	Parking Brake (See Figure 6-11)	1

**Optional Equipment and Accessories**

No.	Location	Qty
11	Drop Block (See Figure 6-12)	1
12	Boom Extension Head Sheave (See Figure 6-13)	1







**SCHEDULED MAINTENANCE: DAILY (WALK-AROUND) INSPECTION**

**NOTE:** You must read and understand the warnings and basic safety rules, found in Section 2 of this manual, before performing any operation or maintenance procedures.

For additional engine maintenance guidelines, see the engine manual furnished with this crane.

**Inspections**

**Inspect the Anti-Double Blocking System**

**CAUTION**

**DO NOT** operate the crane with the anti-double block system disconnected. Damage to boom and/or hoist could result.

Test the anti-double block system daily before beginning operation to make sure it is functioning properly.

Raise the drop block until it touches the anti-double blocking bracket under the boom head. An alarm should sound and the raising of the hoist block should stop.

Lower the hoist block and the alarm will stop.

If there is a malfunction in the system, DO NOT operate the crane. Have the malfunction corrected.

**Inspect the Wire Rope**

Each day before beginning operation, visually inspect the wire rope for damage. See 50 Hour Scheduled Maintenance for examples of damage that can be visually inspected. If any damage is found, do not operate the crane. The wire rope must be changed out for a new rope before operation can resume.

**Inspect Reeving, Clamps, and Connectors**

**WARNING**

Loads may fall if the wedge and socket is not installed properly or has damage. A falling load can injure or kill.

Each day before beginning operation, inspect for correct reeving of the boom and drop block.

Inspect the terminal ends of the wire rope for damaged parts, loose clamps or wrong installation.

Do not operate the crane if any of the above is found. Only after correcting the problem should the crane be put back in service.

**Inspect the Lifting Hook**

**WARNING**

Loads may fall if the lifting hook is damaged or loose. A falling load can injure or kill.

Daily before beginning operation, inspect the lifting hook for damage; cracks, deformation, loose retaining hardware, etc. If any damage is found, **DO NOT** operate the crane until the damage is repaired.

**Inspect All Safety Devices**

Daily before beginning operation, check all safety devices for proper operation. Examples of safety devices include, backup alarms, horn, and beacon lights.

If any are found to be malfunctioning, correct the problem before placing the crane in service.

**Check Controls Operation**

Each control should be checked for proper operation after the previous inspections have been completed. Do not place the crane in service if any control is not functioning properly.

**Component/System Checks**

**Check Fuel Level**

Check the fuel supply daily before operation. Turn the ignition key to the RUN position and view the fuel gauge on the instrument panel. If necessary, fill the tank with recommended fuel.

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**WARNING**

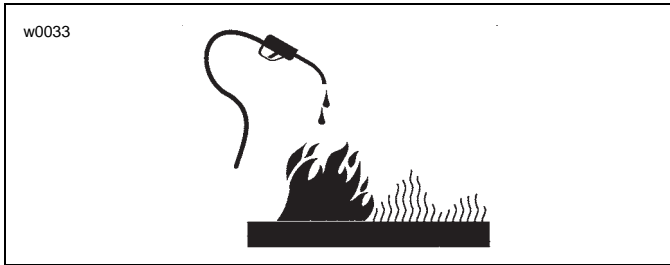


**FIRE HAZARD**

Engine fuel is flammable and can cause a fire or explosion. Death or personal injury could occur.

- Do not put fuel in tank with engine running.
- Keep open flames away.
- Do not use smoking materials during refueling or servicing.

Engine fuel is **flammable** and can cause a fire and/or explosion. Avoid personal injury or death by keeping sparks, open flames, and smoking materials away from the crane and fuel during refueling or fuel system servicing. Know the location of the fire extinguishers on the job site and how to use them.



Maintain control of the hose nozzle when filling the fuel tank. Do not allow fuel to spill. Clean up spilled fuel immediately. Dispose of clean up materials properly.

Do not fill the fuel tank to capacity. Allow room for fuel expansion.

Tighten the fuel cap securely. If the cap is lost, replace only with original equipment.

**Check the Engine Crankcase Oil Level**

1. If the engine has been running, level the crane, engage the parking brake and shut off the engine. Wait approximately 15 minutes after the engine was shut off to check the oil level.
2. Lift the engine compartment cover and prop it in place using the furnished prop rod.
3. Remove the engine oil dipstick and check the oil level. Oil should be present within the low and high marks.
4. If the oil is low, add recommended oil to bring the level between the marks on the dipstick. **DO NOT OVERFILL** the engine. When full, install the dipstick and close the engine compartment cover. For more information see the engine manual furnished with the crane.

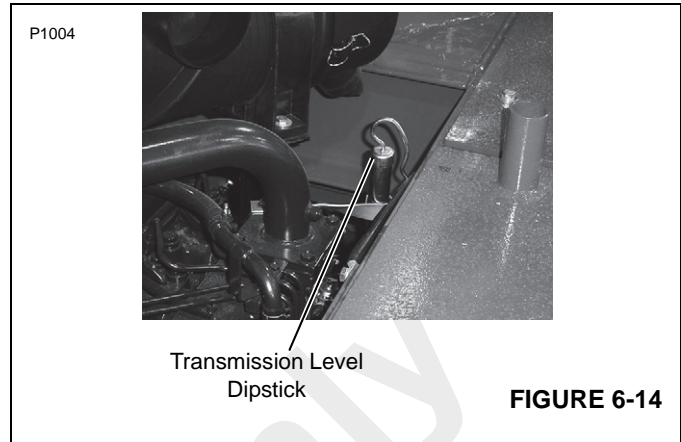
**Check the Transmission Oil Level**

1. Check the oil when the oil is cold.

**CAUTION**

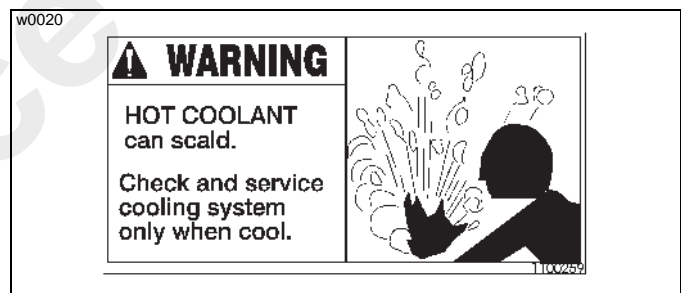
If the engine has been running, wait approximately five minutes to allow oil to drain from the torque converter before checking the oil level.

2. Level the crane, engage the parking brake and shut off the engine.
3. Open and support the engine compartment cover. Remove the transmission dipstick (Figure 6-14) and check the oil level. Oil should be between the two marks on the dipstick.



4. If oil has to be added, add only recommended oil until it is between the two marks. **DO NOT OVERFILL.**
5. Install the dipstick and close the engine compartment cover.

**Check Engine Coolant Level**



- Never remove the radiator cap while the cooling system is hot. Check coolant level only when the coolant temperature is cool. The system is under pressure and the coolant can cause severe burns or eye injury. Wear protective clothing and safety glasses. Always turn the cap slowly to the first stop and allow the pressure to escape before removing the cap completely.
1. Level the crane, engage the parking brake and shut off the engine.
  2. Open the engine compartment cover and prop in place. **BE SURE THE ENGINE IS COOL**, then slowly loosen the radiator cap to the first stop. Allow all pressure to release. Remove the radiator cap and check the fluid level. Coolant should be visible in the radiator.
  3. If level is low, add only a 50-50 mixture of glycol antifreeze and water, do not add only water as this could cause rust to form in the radiator and engine.

**CAUTION**

For more details on proper radiator checking and maintenance procedures, see the engine manual furnished with the crane.

**Drain Water from Engine Fuel Filter/Water Separator (Diesel Engine)**

1. Shut off the engine and engage the parking brake.
2. See the engine manual furnished with the crane and follow the water draining instructions.

**Check Hydraulic Oil Level**

If the hydraulic oil is constantly low, check for leaks in the hydraulic system.



**FIGURE 6-15**

**CAUTION**

The pump used on this crane requires clean hydraulic oil for proper operation. **Contaminated oil can cause damage to the pump.** Before adding any hydraulic oil to the hydraulic system, be sure the oil has been filtered through a 10-micron (absolute), or less, filter.


**Check the Air Cleaner Restriction Indicator**

The air cleaner is equipped with a filter restriction indicator (Figure 6-16). The air cleaner element needs cleaning or replacing if the indicator's red flag is visible in the indicator's window.

To check, open the engine compartment cover and prop in place, then visually inspect the indicator. If the indicator's red flag is visible, service the element.

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**WARNING**

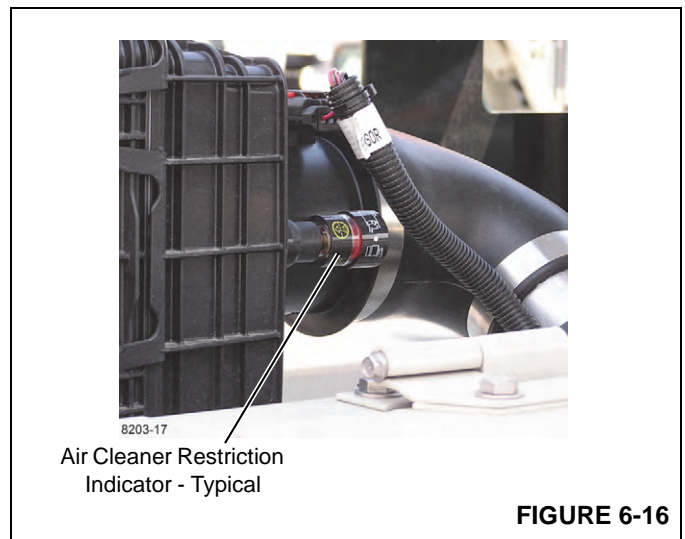


**DO NOT GO NEAR HYDRAULIC OIL LEAKS**

- When checking for hydraulic system leaks, observe only.
- Never use your hands to check for leaks.
- Hydraulic oil from a pin hole leak can puncture your skin and cause serious injury, gangrene, or death.
- If injured by hydraulic oil under pressure, seek medical attention immediately.
- Oil can be hot and can cause severe burns.

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1. Be sure the boom is fully retracted and lowered and the outriggers are retracted and up.
2. Level the crane, engage the parking brake and shut off the engine.
3. Check the oil level in the sight gauge (Figure 6-15) on the side of the tank. Oil should be visible in the gauge. If not, add recommended oil to the tank until oil is visible in the gauge.



**FIGURE 6-16**

**Removing the Element**

**CAUTION**

Service the air cleaner only with the engine shut down. Dirt and debris can enter the engine and cause damage if the engine is operated with the air cleaner element removed.

1. Unlatch and remove the service cover of the air cleaner. Make sure the latches are folded back against the cover so that they do not hinder filter removal and installation.
2. The filter fits tightly over the outlet tube, creating the critical seal on the inside diameter of the filter end cap. The filter should be removed gently to reduce the amount of dust dislodged. There will be some initial resistance, similar to breaking the seal on a jar. Gently move the end of the filter back and forth to break the seal.
3. Gently pull the filter element off the outlet tube and out the housing. Avoid knocking the filter against the housing.
4. Use a clean water dampened cloth to wipe the sealing surface. Dust on the outside diameter of the outlet tube could hinder an effective seal and cause leakage. Make sure that all contaminants are removed before the new or cleaned filter is installed.
5. Carefully wipe the inside of the outlet tube with a clean cloth. Dirt accidentally transferred to the inside of the outlet tube will reach the engine and cause wear. Be careful not to damage the sealing surface of the tube.

**Inspecting the Element**

1. Don't be fooled by the appearance of the element, it should look dirty.
2. Check the element for uneven dirt patterns. The dirty element is a valuable clue to dust leakage or gasket sealing problems. A dust trail or pattern on the element clean side is a sign that the element gasket was not firmly sealed or that a dust leak exists. Make sure the cause of the leak is identified and rectified before replacing the element.

**Cleaning the Element**



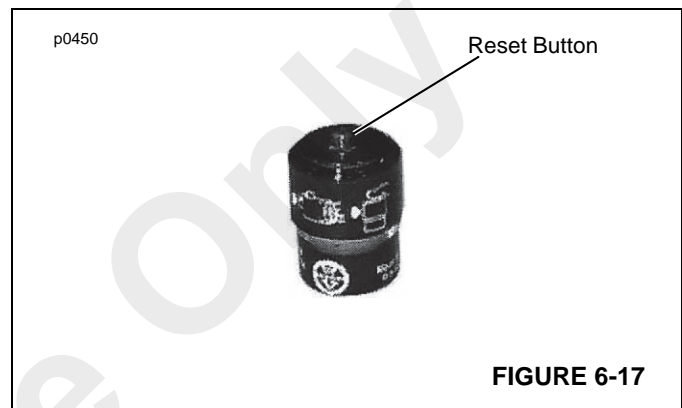
**CAUTION**

To prevent personal injury, always wear safety glasses when using compressed air.

Air cleaner elements must be replaced after six cleanings or after every 500 hours of operation, whichever occurs first.

1. Clean the filter with compressed air. Use 2.1 bar (30 psi) maximum pressure at the nozzle.
2. With the air nozzle inside the element direct the air towards the outside and then move the nozzle up and down, while rotating the element.

**Installing the Element**



**FIGURE 6-17**

1. Inspect the new filter carefully, paying attention to the inside of the open end, which is the sealing area. **NEVER** install a damaged filter.
2. Carefully insert the filter into the air cleaner housing. Seat the filter by hand, making certain it is completely into the air cleaner. To complete a tight seal, apply hand pressure at the outer rim of the filter, not the flexible center. Avoid pushing on the center of the urethane end cap. Install the cover. If the cover hits the filter before it is fully in place, remove the cover and push (by hand) the filter further into the air cleaner and try again. The cover should go on with no extra force.

Never use the latches on the cover to force the filter into the air cleaner. Using the latches to push the filter into the air cleaner could cause damage to the housing and will void the warranty.

3. Reset the air cleaner restriction indicator by pushing in the reset button (Figure 6-17).
4. If a cleaned air cleaner element was installed, start the engine and run at high idle. If the air cleaner restriction indicator's red flag becomes visible again, shut down and replace the air cleaner element with a new element.

**Check Tire Pressure**

Check the air pressure in the crane's four tires. Correct pressure is 8.62 bar (125 psi). This pressure will differ from the recommended tire pressure from the tire manufacture.

Also, check for broken studs, rim damage, loose nuts, cracks and other tire damage.



## SCHEDULED MAINTENANCE: 50 HOURS OF OPERATION (WEEKLY)

**NOTE:** You must read and understand the warnings and basic safety rules, found in *Safety Information*, page 2-1 of this manual, before performing any operation or maintenance procedures

For additional engine maintenance guidelines, see the engine manual furnished with this crane.

### Clean/Inspect the Air Cleaner VacValve

Inspect the VacValve (Figure 6-18) for damage. Replace if any of the following is found.

- It remains open.
- It is cracked.
- It is torn.
- It is missing.

If any of the above conditions are found, replace the VacValve. Dust particles that are normally expelled can deposit themselves onto the filter and will shorten the air filter service life.

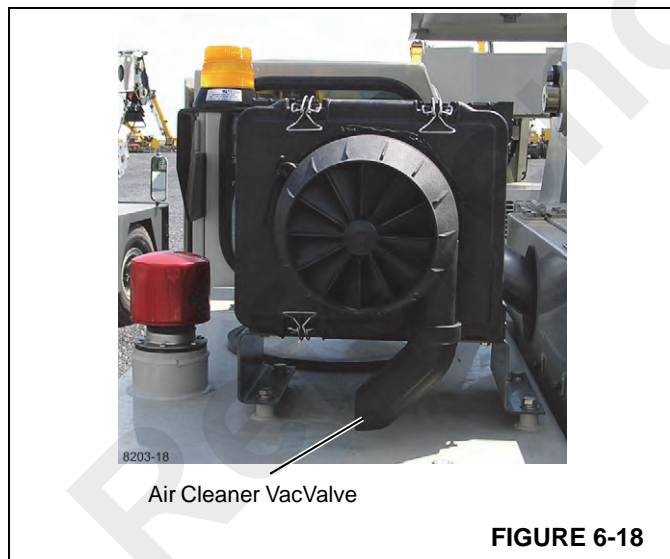


FIGURE 6-18

### Wire Rope Inspection

All wire ropes wear out eventually and lose work capability throughout their service life. That's why periodic inspections are critical. SAE J959, Lifting Crane, Wire-Rope Strength Factors, requires that a thorough inspection be performed and recorded on the wire rope not less often than weekly when the crane is in continuous service.

Regular inspection of wire rope and equipment should be performed for three good reasons:

- It reveals the rope's condition and indicates the need for replacement.
- It indicates if you are using the most suitable type of rope.
- It makes possible the discovery and correction of faults in equipment or operation that can cause costly accelerated rope wear.

### Inspection

Inspections should be carried out by a person who has learned through special training or practical experience what to look for and who knows how to judge the importance of any abnormal conditions they may discover. It is the inspector's responsibility to obtain and follow proper inspection criteria for each application inspected.

If you are not familiar with wire rope inspection, information on how to inspect wire rope, sheaves and drums is available from your distributor.

### General Inspection



### CAUTION

Always wear gloves when working with wire rope to inhibit hand injuries.

1. Wire Rope - Inspect for damage, rust or wear to the wire rope. Keep a record of each inspection. Replace the

wire rope if any of the conditions in Figure 6-19 are present.

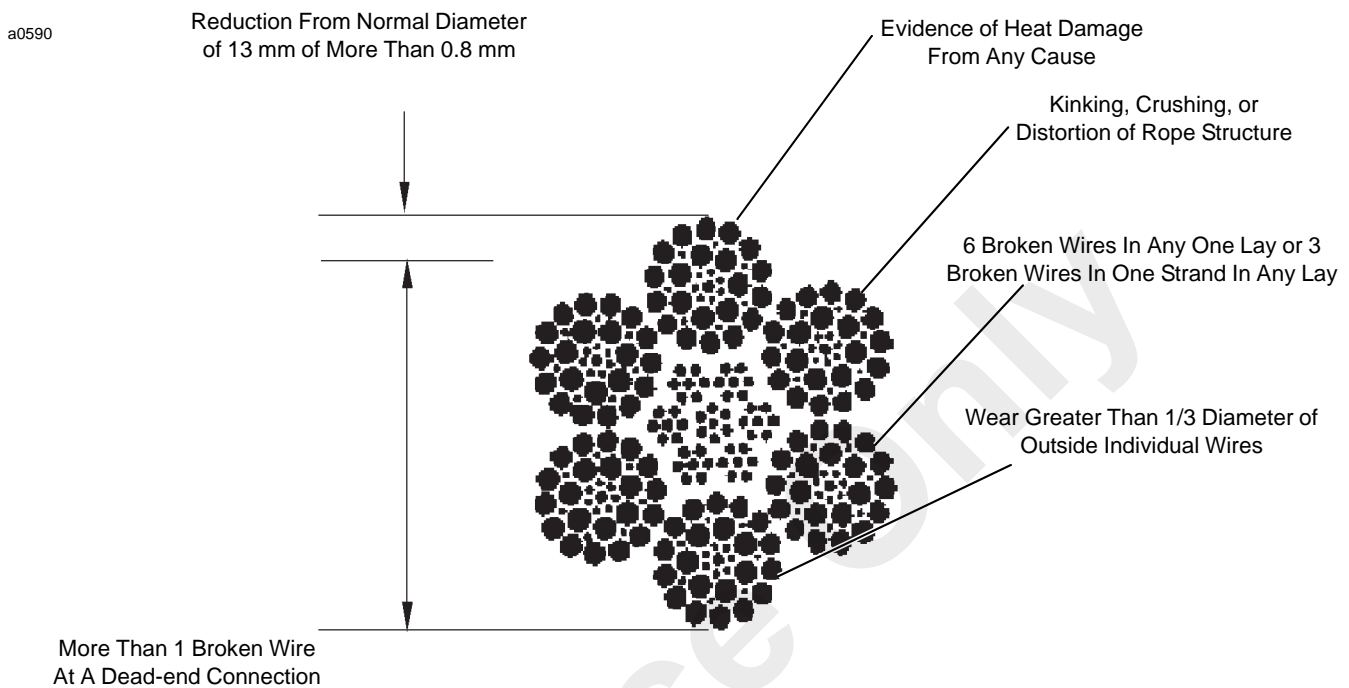


FIGURE 6-19

2. Sheaves - Inspect sheaves for damage and/or wear. The sheave grooves must be smooth and a little larger than the wire rope. Use a sheave gauge to check the size of the sheave groove. Rough edges, narrow or worn grooves will cause damage to the wire rope. Replace any worn or damaged sheaves.

**CAUTION**

As a sheave wears, the groove for the wire rope becomes smaller. The tracks on the sheave are caused by the wire rope. Yet, the wire rope will continue to engage these tracks, for example as a chain engages a sprocket. As the wire rope turns and twists on the sheave, the wire rope will move out of the worn track. This will cause increased wear on the wire rope and the sheave.

**Grease Fittings**

Lubricate all points indicated under the heading "Lubrication Points".

**Lubricate the Boom Slides**

1. Lower the boom and then extend it to its maximum out position.
2. Engage the parking brake and shut off the engine.
3. Clean the old lubricant from the booms.
4. Apply bronze anti-seize, or equivalent, to the boom sliding surfaces (Figure 6-20) on the boom sections. Only use a small amount of lubricant for best results.

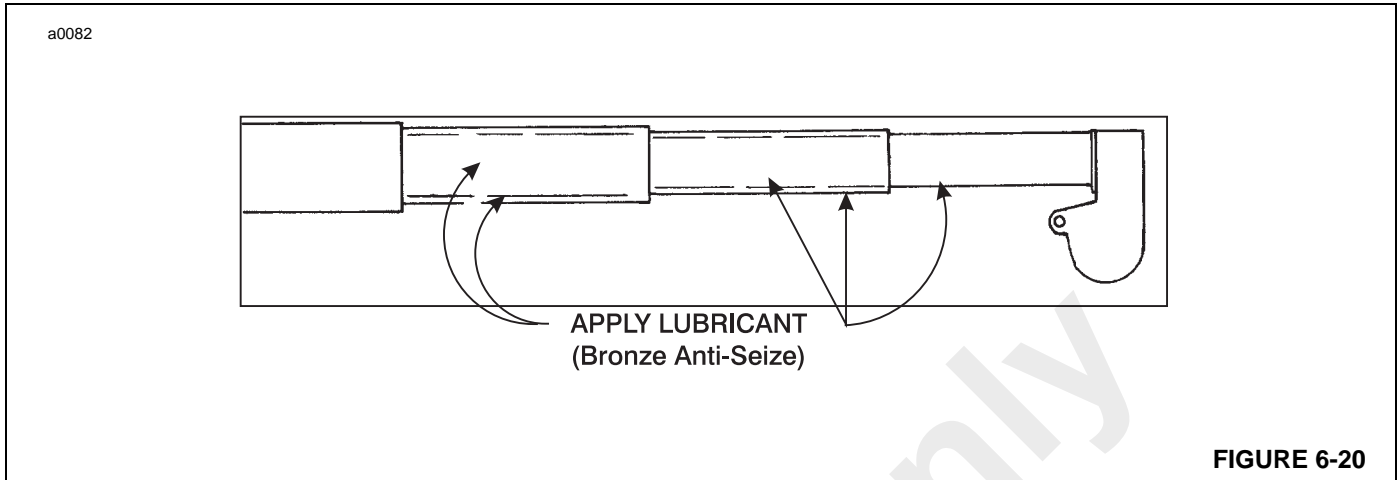


FIGURE 6-20

**SCHEDULED MAINTENANCE: 100 HOURS OF OPERATION (EVERY TWO WEEKS)**

**NOTE:** You must read and understand the warnings and basic safety rules, found in *Safety Information*, page 2-1 of this manual, before performing any operation or maintenance procedures

For additional engine maintenance guidelines, see the engine manual furnished with this crane.

**Check Wheel Nut Torque**

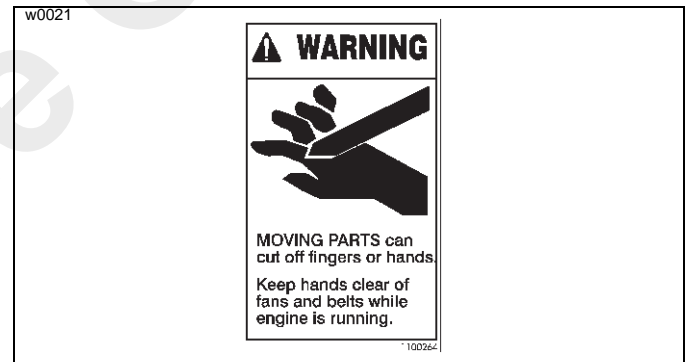
Check the torque on the wheel nuts in a criss-cross pattern. Wheel nut torque should be 305 Nm (225 lb-ft).

**Inspect the Fan Belts**

**Check Belt Tension**

Keep the engine and accessory belts properly tensioned for maximum engine performance and fuel economy. Proper

belt tension minimizes slippage and increases belt life. See the engine manual furnished with the crane.



Belts that are too loose see excessive vibration and increased wear. Belts that are too tight produce wear on the belts and the bearings of the pulleys it travels around.

**Inspect for Damage**

Check ribbed belts for intersecting cracks. Cracks across the belt are acceptable. Cracks along the length of a ribbed belt are not acceptable. Ribbed belts with cracks along their length or intersecting cracks should be replaced. See Figure 6-21.

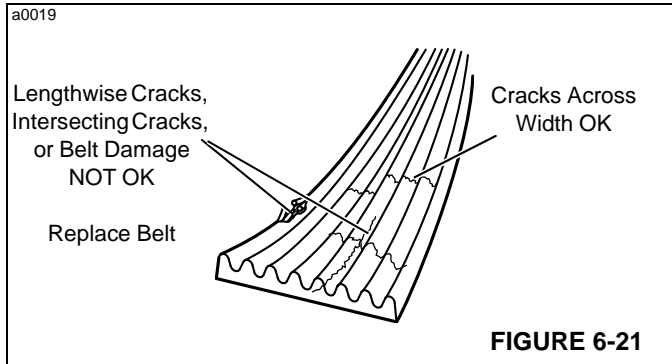


FIGURE 6-21

Any cracking on V-belts is not acceptable. Replace any V-belt that has cracking. See Figure 6-22.

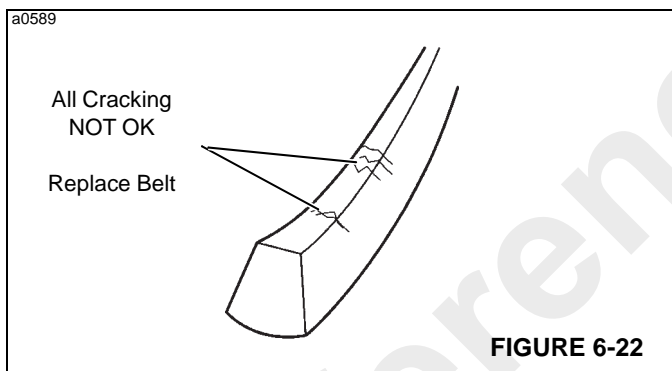


FIGURE 6-22

**SCHEDULED MAINTENANCE: 250 HOURS OF OPERATION (MONTHLY)**

**NOTE:** You must read and understand the warnings and basic safety rules, found in *Safety Information*, page 2-1 of this manual, before performing any operation or maintenance procedures

For additional engine maintenance guidelines, see the engine manual furnished with this crane.

**Inspect Hydraulic Hoses**

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**WARNING**

**DO NOT GO NEAR HYDRAULIC OIL LEAKS**

- When checking for hydraulic system leaks, observe only.
- Never use your hands to check for leaks.
- Hydraulic oil from a pin hole leak can puncture your skin and cause serious injury, gangrene, or death.
- If injured by hydraulic oil under pressure, seek medical attention immediately.
- Oil can be hot and can cause severe burns.

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Inspect hydraulic hose assemblies for leaks, damaged fittings and worn exterior. Do not use your hands to check for hydraulic leaks. Hydraulic oil under pressure can cause serious injury or possible death. Use a piece of cardboard or other material as a deflector to detect leaks. Replace any problem hose before beginning work.

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**Check hoses carefully. Do not use your bare hands to check for leaks. Tighten all connections to recommended torque. Replace if any of the following are found:**

- End fittings damaged or leaking.
- Outer covering chafed or cut and wire reinforcing exposed.
- Outer covering ballooning locally.
- Hose shows evidence of kinking or crushing.

**FIGURE 6-23**

**Clean Battery and Cables**

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**WARNING**

EXPLOSIVE GASES can cause serious injury.

**Keep sparks, Flames, and Lighted Materials away from Batteries.**

**When jump starting:**

- Wear safety glasses.
- Be certain that machines do not touch and batteries are not frozen.
- Follow jump starting directions contained in Operator's Manual.

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### WARNING

It is necessary to climb under the crane to clean the battery and cables. Be sure engine is shut off, the ignition key is removed, parking brake is engaged and chock blocks are in place before climbing under the crane.

1. Tighten all battery mounting hardware to keep the battery securely in place.
2. Disconnect the battery cables.
3. Sprinkle the top of the battery with baking soda. Apply water to wash the baking soda from battery. Be careful not get any of solution into the battery.
4. Clean the battery posts and cable ends with a battery brush.
5. Coat the battery posts with petroleum jelly and reinstall the battery cables.

### Clean the Radiator

### CAUTION

To inhibit personal injury, always wear safety glasses when using compressed air.

Clean the radiator fins using compressed air or a water hose to remove all foreign materials. If these materials are not removed, the engine may overheat due to blocked air through the radiator fins and core.

### Lubricate the Wire Rope

Apply lubricant to the hoist wire rope to inhibit rust, corrosion and wear.

1. Unwind the wire rope from the hoist drum.
2. Thoroughly clean the wire rope prior to application of any lubricant. Use a wire brush and compressed air to remove all foreign matter and old lubricant.

### CAUTION

To inhibit personal injury from compressed air, always wear safety glasses when using compressed air for cleaning.

3. After cleaning, apply a good grade of wire rope lubricant to the entire length of the wire rope. Or apply a light

weight oil that has been preheated to temperature of between 18° to 36°C (60° to 100°F). Use a brush or cloth to apply the oil.

### CAUTION

Be sure the lubricant enters the strands of the wire rope for proper lubrication. Do not use grease to lubricate the wire rope.

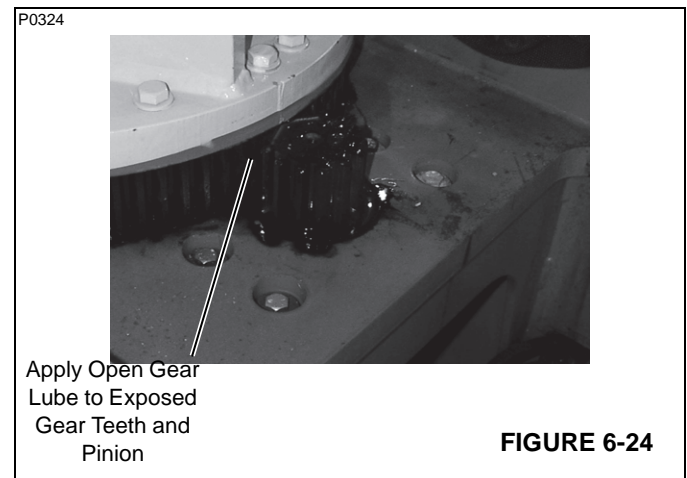
### Lubricate the Swing Gear and Pinion

1. Engage the parking brake and shut off the engine.
2. Remove the guard covering the swing gear and pinion.



Rotating gears can cause injury. Keep hands clear of rotating pinion and gear while the mast is rotating.

3. Using a brush, apply open gear lube to the pinion and swing gear teeth (Figure 6-24).



4. Start the engine and rotate the mast until a non-lubricated portion of the swing gear is exposed. Keep hands and clothing away from the rotating gear and pinion. Shut off the engine.
5. Using a brush, apply lubricant to the swing gear and pinion.

## Replace the Engine Crankcase Oil and Filter



### CAUTION

Avoid prolonged and repeated skin contact with used engine oils. Such prolonged and repeated contact can cause skin disorders or other bodily injury. Wash thoroughly after contact with used engine oils. Keep oil out of reach of children.

## ENVIRONMENTAL PROTECTION

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

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

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

When filling and draining crane components, observe the following:

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

Change the engine oil more frequently if operating under difficult conditions, for example in high or low temperatures, dusty surroundings or frequent starting and stopping.



### WARNING

It is necessary to climb under the crane to change the engine oil and replace the engine oil filter. Be sure engine is shut off, the ignition key is removed, parking brake is engaged and chock blocks are in place before climbing under the crane.

Drain the engine oil only when it is hot and the contaminants are in suspension.



### CAUTION

Hot oil can cause personal injury.

1. Operate the engine until the engine oil is hot.
2. Shut off the engine.
3. Place a suitable container under the engine oil drain plug. Remove the oil drain plug and drain the engine oil into the container. Install the drain plug.
4. Clean the area around the engine oil filter head.
5. Remove the filter and clean the gasket surface of the filter head.

### CAUTION

The O-ring can stick on the filter head. Make sure it is removed before installing the new filter.

6. Fill the new filter with clean recommended lubricating oil (See *Lubricants and Capacities*, page 8-1).
7. Apply a small amount of clean engine oil to the gasket of the new oil filter. Turn the filter clockwise to tighten it until the gasket makes contact. Then, tighten the filter 1/2 to 3/4 turn to get correct seal.
8. Fill the engine crankcase with clean recommended lubricating oil.
9. Operate the engine at idle and inspect for leaks at the filter and drain plug.

## Torque Critical Bolts

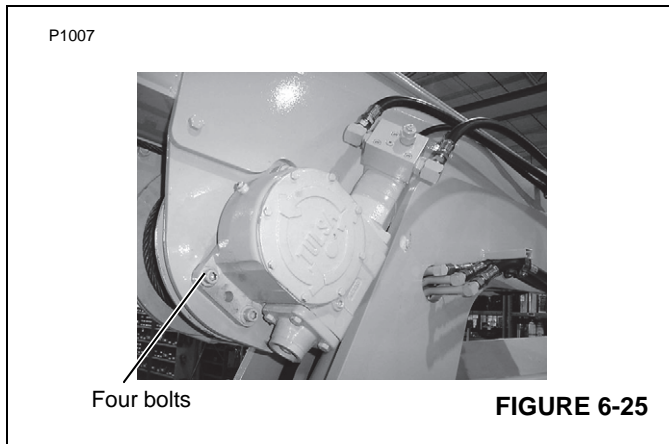


### CAUTION

Maintain correct torque on all bolts. Failure to do so may result in severe damage to the machine and/or personal injury.

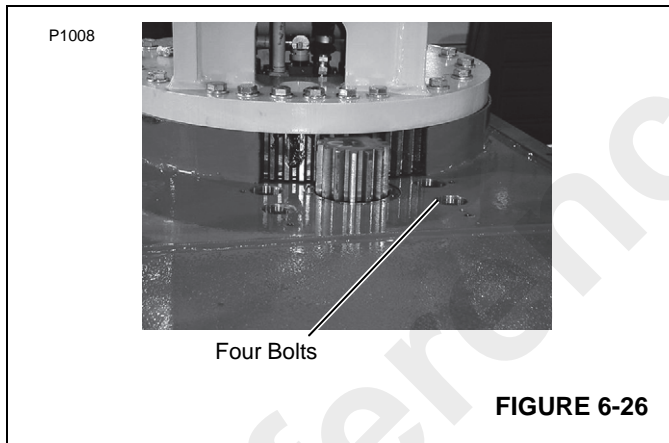
### Hoist Gearbox Mounting Bolts

Torque the 5/8" mounting bolts (4) to 216 Nm (159 lb-ft). See Figure 6-25.



**Swing Gearbox Mounting Bolts**

Torque the 1/2" gearbox mounting bolts (4) to 117 Nm (86 lb-ft). See Figure 6-26. If the bolts are loose, check the gear backlash.



**Mast Mounting Bolts**

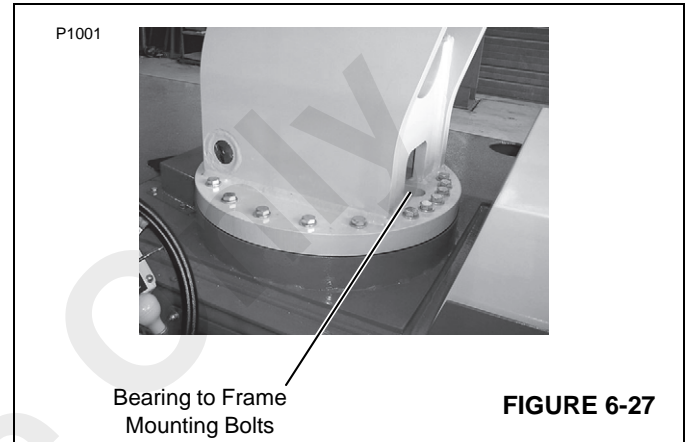
Because of the cyclic loading on the mast bolts, it is important that these bolts be checked at regular intervals.

Make a record of any loose bolts. If any bolt does not hold to correct torque after the second check, remove and replace the bolt. A loose bolt indicates possible failure of the bolt.

Use the torque sequence shown in Figure 6-29 when checking the torque on the bolts.

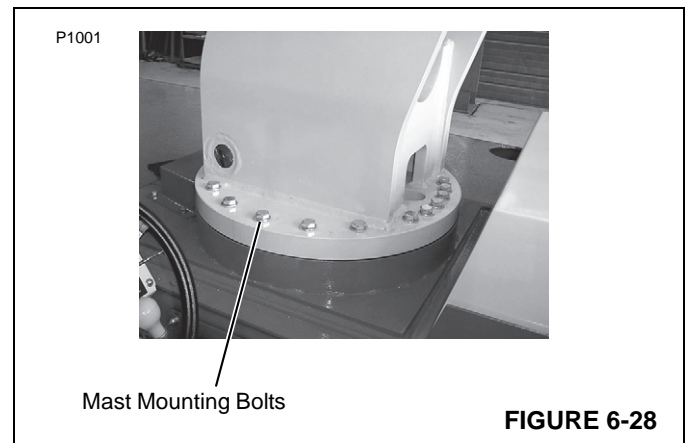
**Swing Bearing to Frame Bolts**

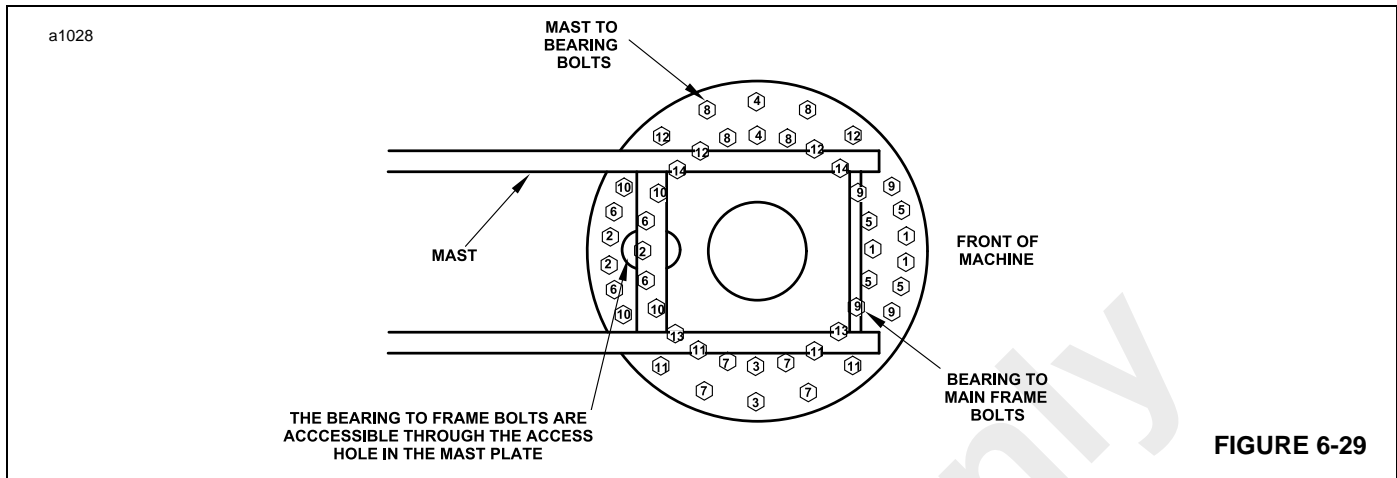
Torque the 3/4" bearing to frame mounting bolts (24) to 384 Nm (282 lb-ft). To gain access to the bolts, rotate the mast until a bolt is visible in the access hole in the mast mounting plate (Figure 6-27). Rotate the mast as needed and tighten each bolt in criss-cross pattern (Figure 6-29) until all bolts are checked.



**Mast to Swing Bearing Mounting Bolts**

Tighten the 5/8" mast to bearing mounting bolts (22) to 245 Nm (180 lb-ft). See Figure 6-28. Tighten each bolt in a criss-cross pattern (Figure 6-29).





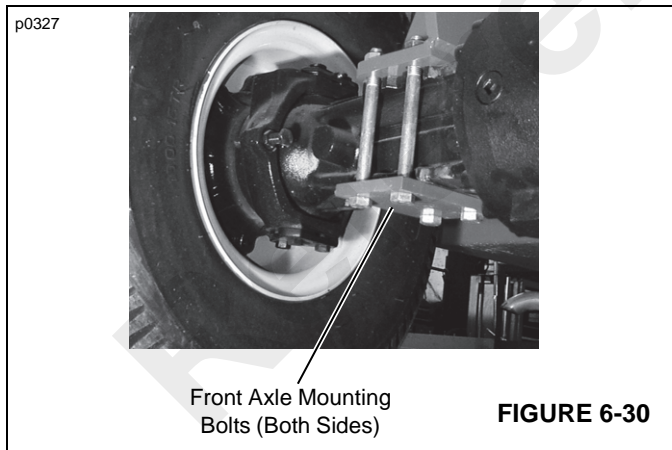
**Front Axle Mounting Bolts**

Torque the 5/8" axle mounting bolts (8) to 245 Nm (180 lb-ft). See Figure 6-31

**CAUTION**

It is necessary to climb under the crane to check the axle mounting bolts. Be sure engine is shut off, the ignition key is removed, parking brake is engaged and chock blocks are in place before climbing under the crane.

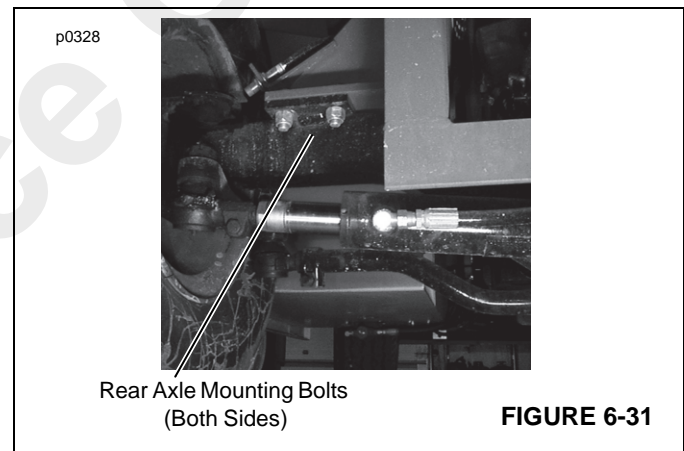
Torque the 3/4" axle mounting bolts (8) to 362 Nm (266 lb-ft). See Figure 6-30.



**Rear Axle Mounting Bolts**

**CAUTION**

It is necessary to climb under the crane to check the axle mounting bolts. Be sure engine is shut off, the ignition key is removed, parking brake is engaged and chock blocks are in place before climbing under the crane.



**SCHEDULED MAINTENANCE: 500 HOURS OF OPERATION (EVERY THREE MONTHS)**

**NOTE:** You must read and understand the warnings and basic safety rules, found in *Safety Information*, page 2-1 of this manual, before performing any operation or maintenance procedures

For additional engine maintenance guidelines, see the engine manual furnished with this crane.

**Inspect Tires for Damage**

Inspect the tires for any signs of damage, such as cracks, large gouges, deterioration, etc. If damage is found, it must be carefully analyzed to determine if the tire is safe to use. Replace all tires that are unsafe.



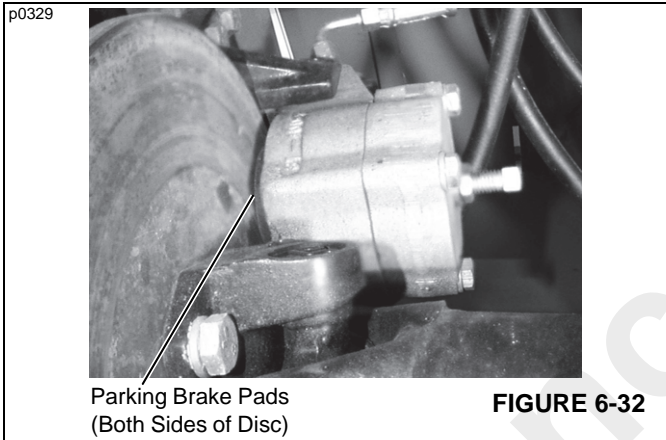
### Inspect Parking Brake Pads



**CAUTION**

It is necessary to climb under the crane to check the parking brake pads. Be sure engine is shut off, the ignition key is removed, parking brake is engaged and chock blocks are in place before climbing under the crane.

Inspect the thickness of the brake pads (Figure 6-32). Replace the brake pads if they are 7.1 mm (0.28 in) thick or less.



**FIGURE 6-32**

### Replace Fuel Filter

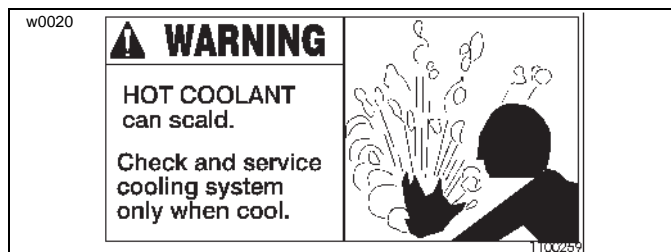
See the engine operator manual furnished with the crane and follow the replacement procedures.

**NOTE:** If the filter is not filled with fuel prior to installation, the engine will not start due to air in the fuel system. The fuel system will have to be bled as instructed in the engine operator manual furnished with the crane.

### Replace Air Cleaner Element

See *Check the Air Cleaner Restriction Indicator*, page 6-11 for filter element removal and installation procedures.

### Add Rust Inhibitor to Engine Cooling System



Outrigger Lubrication  
(Lubricate Entire Top Surface)

**FIGURE 6-33**

For maximum protection of the engine cooling system, add a corrosive inhibitor to the radiator. When the engine is cold, remove the radiator cap and pour the inhibitor in the radiator reservoir.

### Lubricate the Outrigger Slides

1. Lower the outriggers.
2. Clean the top of the outrigger with a suitable solvent.
3. Apply Mobil EP grease, or equivalent, to the entire top surface of the outrigger (Figure 6-33). Do not over lubricate. Raise and lower the outrigger several times to spread the grease.

### Add Grease to the Swing Gearbox

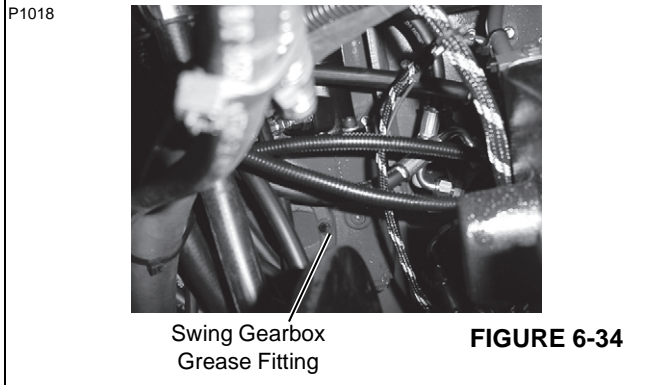


**CAUTION**

It is necessary to climb under the crane to add grease to the swing gearbox. Be sure engine is shut off, the ignition key is removed, parking brake is engaged and chock blocks are in place before climbing under the crane.

The grease fitting for adding grease to the swing gearbox can only be reached from under the crane. It may be necessary to use a light to see the fitting.

1. Lower the boom, engage the parking brake and shut off the engine. Remove the ignition key.
2. Clean the grease fitting (Figure 6-34), located on the swing gearbox housing.
3. Apply a Lithium base, EP No. 2 bearing grease to the fitting. Fill gear box until grease exits the vent on top of the gearbox.

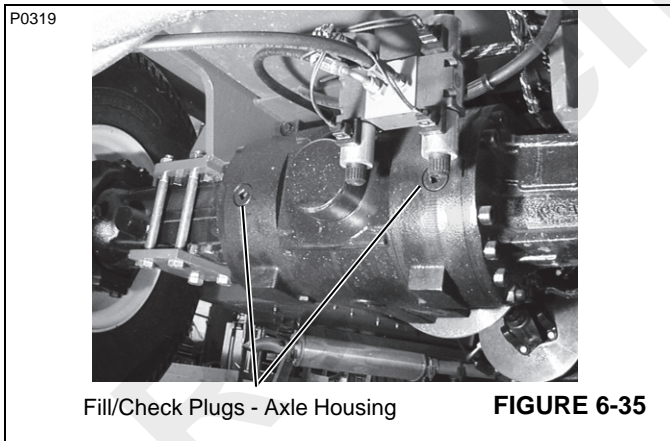


**Check the Axle Housing Lubricant Level**



It is necessary to climb under the crane to check the axle housing lubricant level. Be sure engine is shut off, the ignition key is removed, parking brake is engaged and chock blocks are in place before climbing under the crane.

1. Clean around both fill/check plugs (Figure 6-35) in the axle brake housings and remove the plugs.

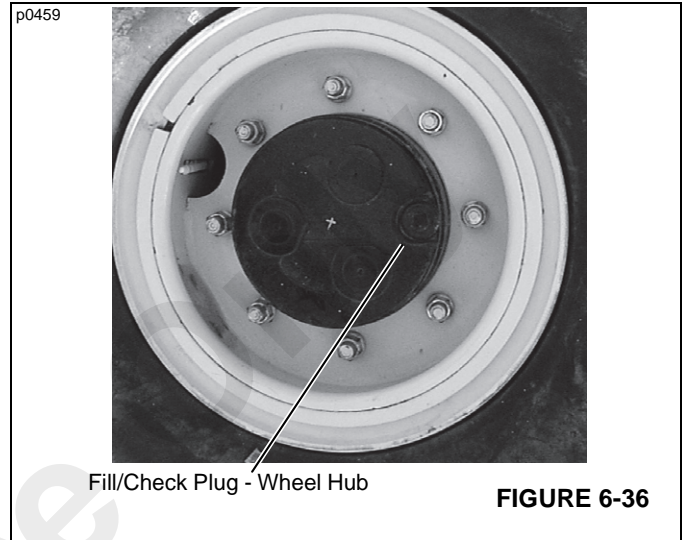


2. Check the lubricant level, which should be even with the bottom of each fill/check hole.
3. If necessary, add oil to fill the housings to the recommended level.

**Check the Wheel Hub Lubricant Level**

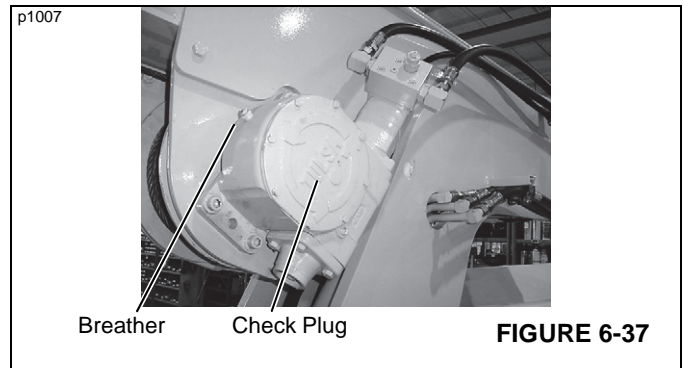
1. Position the wheel so that the fill/check plug and the center of the hub are horizontal with the ground (Figure 6-36).
2. Clean around the plug and then remove it.

3. Check the lubricant level which should be even with the bottom of the hole.
4. If necessary, add oil to fill the hub to the recommended level.
5. Repeat Steps 1 through 4 for the other wheel hub.



**Check the Hoist Gearbox Lubricant Level**

1. Lower the boom to its lowest position.
2. Engage the parking brake and shut off the engine.
3. Clean around the gearbox check plug (Figure 6-37). Remove the check plug.
4. Check the lubricant level, which should be even with the bottom of the check plug hole.
5. If necessary, add SAE 140 EP gear lube through the breather hole to fill to the bottom of the check plug hole.



**SCHEDULED MAINTENANCE: 1000 HOURS OF OPERATION (EVERY SIX MONTHS)**

**NOTE:** You must read and understand the warnings and basic safety rules, found in *Safety Information*,

page 2-1 of this manual, before performing any operation or maintenance procedures

For additional engine maintenance guidelines, see the engine manual furnished with this crane.

**Replace the Transmission Oil and Filter**

1. Engage the parking brake and shut off the engine. Remove the ignition key.

**CAUTION**

It is necessary to climb under the crane to drain the transmission oil. Be sure engine is shut off, the ignition key is removed, parking brake is engaged and chock blocks are in place before climbing under the crane.

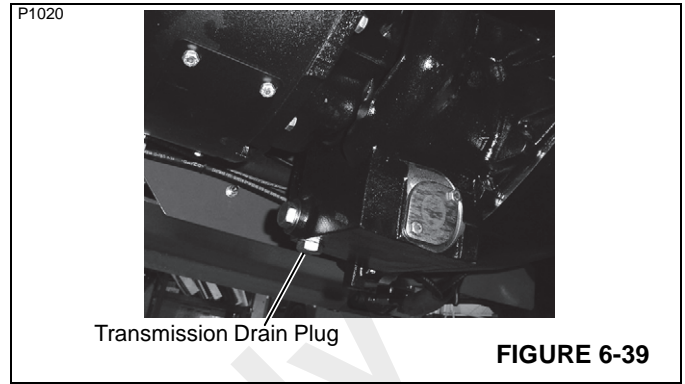
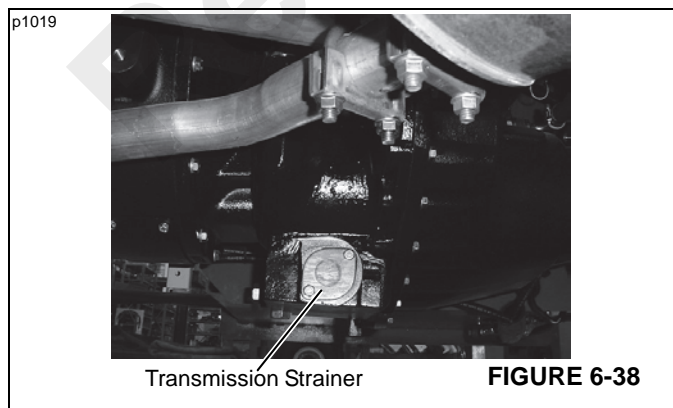
**CAUTION**

When the strainer is loosened/removed, oil will gush out. Keep to one side when you remove the strainer.

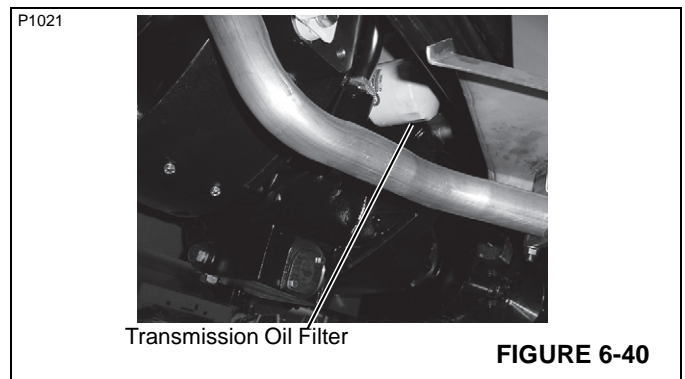
2. Place a suitable container under the strainer (Figure 6-38). Remove the strainer and gasket and drain the oil into the container. Discard the gasket.

**NOTE:** Before removing the strainer, be sure you have a new strainer gasket. The old strainer gasket will be damaged during removal of the strainer, and if it is installed with the strainer, leakage will occur. It is recommended that three gaskets be kept in supply at all times. This will cover a year's maintenance and one for emergency maintenance.

3. Place the container under the drain plug and remove the drain plug (Figure 6-39). Drain any oil left in the transmission into the container. Install the drain plug.



4. Clean the strainer in a suitable solvent.
5. Install the cleaned strainer and new gasket. Tighten the strainer mounting bolts to a torque of 10 Nm (7.4 lb-ft).
6. Remove the transmission oil filter by unscrewing it from the transmission housing (Figure 6-40). Properly discard the filter.
7. Coat the seal of the new filter with clean transmission oil.
8. Screw on the transmission filter until it touches the filter head. Then, turn the filter another 3/4 of a turn minimum to seat the seal.



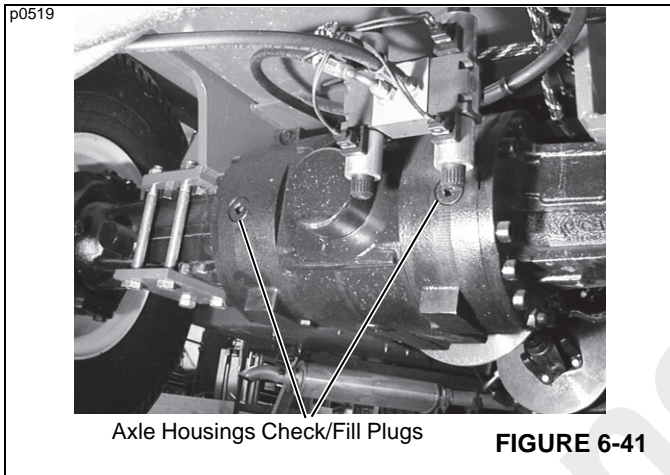
9. Fill the transmission with Mobil ATF 210, or equivalent, transmission fluid to the upper mark on the dipstick (approximately 13 l [3.43 gal]).
10. Start the engine and let it run at idle speed for a period not exceeding five minutes. This allows the oil to fill the transmission filter, torque converter and hoses.
11. Stop the engine, wait approximately one minute and then check oil level. If low, add oil to the upper mark on the transmission dipstick. **DO NOT OVERFILL.**

## Replace the Axle Housing Lubricant

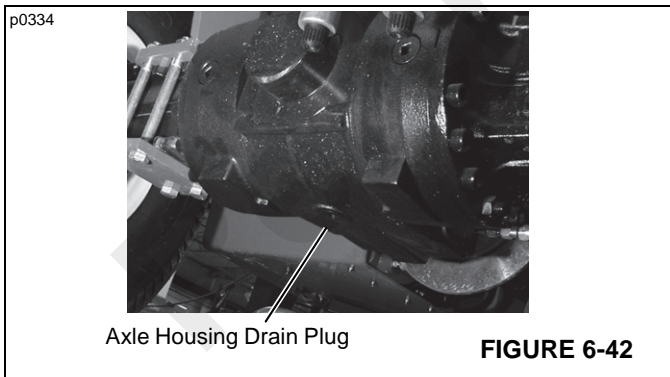
### CAUTION

It is necessary to climb under the crane to drain the axle housing oil. Be sure engine is shut off, the ignition key is removed, parking brake is engaged and chock blocks are in place before climbing under the crane.

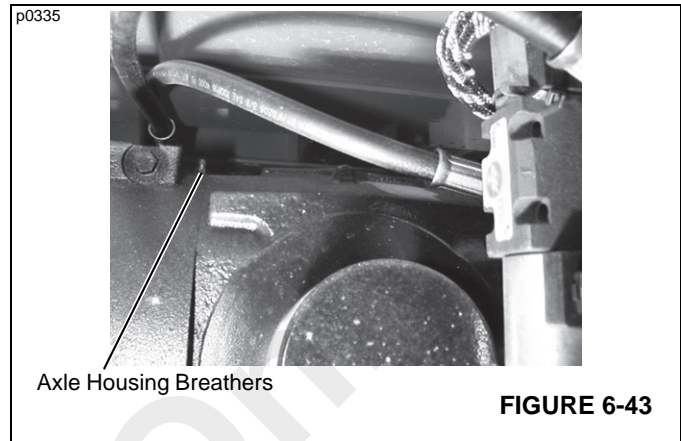
1. Clean around the two check/fill plugs in the axle brake housings (Figure 6-41). Remove both plugs.



2. Place a container under the differential drain plug (Figure 6-42). Remove the drain plug and drain the fluid into the container. Install the drain plug.



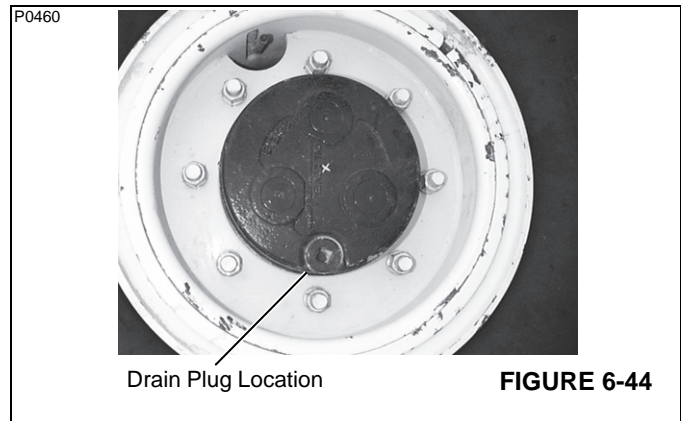
3. Remove the axle housing breather (Figure 6-43) and clean them in a suitable solvent. When clean install the breather back into the axle housings.



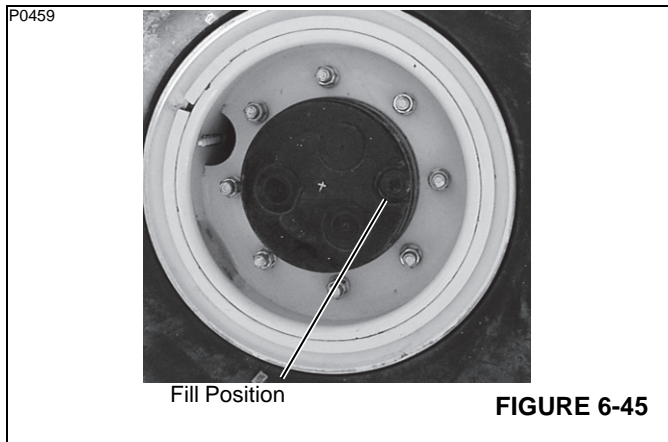
4. Fill the differential and brake housings with appropriate oil through both check/fill plugs. Fill until the oil reaches the bottom of each fill hole.
5. Install both check/fill plugs.

## Replace Axle Wheel Hub Lubricant

1. Drive the crane until one of the front axle wheel hub drain plugs is located at the bottom of the wheel hub (Figure 6-44).



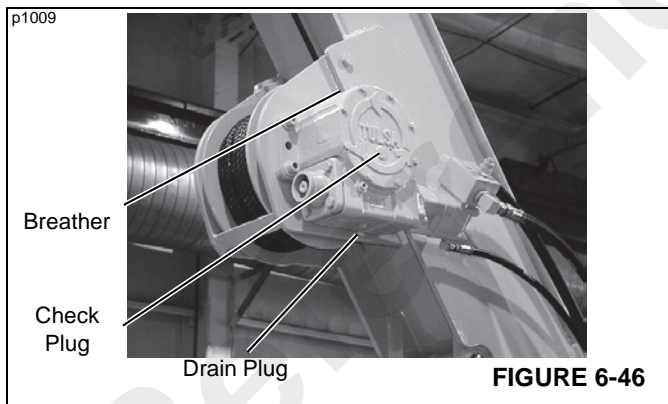
2. Clean around the drain plug and then remove it. Drain the wheel hub oil into a suitable container.
3. Drive the crane until the drain hole is horizontal (Figure 6-45).



4. Fill the wheel hub with appropriate oil through the exposed hole until the oil reaches the bottom of the hole.
5. Install the plug.
6. Repeat the above procedure for the other wheel hub.

### Replace the Hoist Gearbox Lubricant

1. Raise the boom until the drain plug on the gearbox is directly underneath the gearbox (Figure 6-46), engage the parking brake and shut off the engine.



2. Clean around the gearbox breather and drain plug. Remove the breather and clean it in a suitable solvent.
3. Place a suitable container under the drain plug and remove the drain plug. Completely drain the gearbox and install the drain plug.
4. Completely lower the booms.
5. Remove the check plug.
6. Fill the gearbox through the breather hole with EP140 gear oil until it reaches the bottom of the check plug hole.
7. Install the breather and check plug.

### Lubricate the Rear Axle Bearings

The rear axle wheel bearings should be lubricated with grease by a qualified technician. The hubs have to be removed to gain access to the wheel bearings.

### Replace the Hydraulic Oil

**NOTE:** ISO (international Standards Organization) #46/68 Hydraulic Oil (Mobil Fluid #424) is recommended for year-round use in the hydraulic system.

In very cold temperatures, SAE 5W or SAE 5W-20 oils can be used if the viscosity of the oil will not be less than 60 SUS (Saybolt Universal Seconds) at maximum operating temperature. It may be necessary to use a pre-heater and a longer than normal warming period at low operating speed to heat the oil to operating temperature.

### CAUTION

The main hydraulic pump used on this crane requires clean hydraulic oil for proper operation. **Contaminated oil can cause damage to the pump and other components.** Before adding any hydraulic oil to the hydraulic system, be sure the oil has been filtered through a 10-micron (absolute), or less, filter.

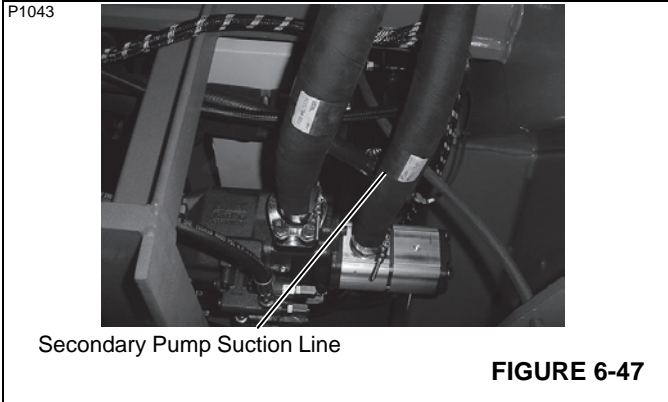
To change the hydraulic oil:

1. Fully retract and lower the booms.
2. Retract all outriggers.
3. Operate the hydraulic system until the hydraulic oil is warm.

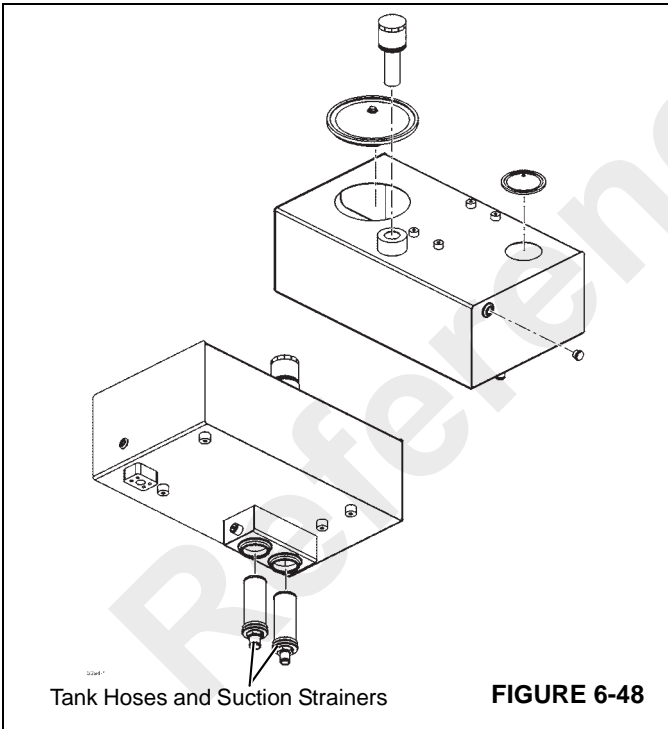
### CAUTION

It is necessary to climb under the crane to drain the hydraulic oil. Be sure engine is shut off, the ignition key is removed, parking brake is engaged, and chock blocks are in place before climbing under the crane.

4. Engage the parking brake, shut off the engine and remove the ignition key.
5. Place a suitable container under the hydraulic pump, located in front of the engine.
6. Loosen the suction hose at the secondary hydraulic pump (Figure 6-47) and let the oil drain from the hydraulic tank into the container. **DO NOT** remove the suction hose from the main pump.



7. When the tank is drained, connect the suction line to the secondary pump. Be sure the suction hose clamp is tight.
8. Disconnect all hoses from hydraulic tank (Figure 6-48). Secure the main pump suction line so that the hydraulic oil in the hose will not drain out.



**CAUTION**

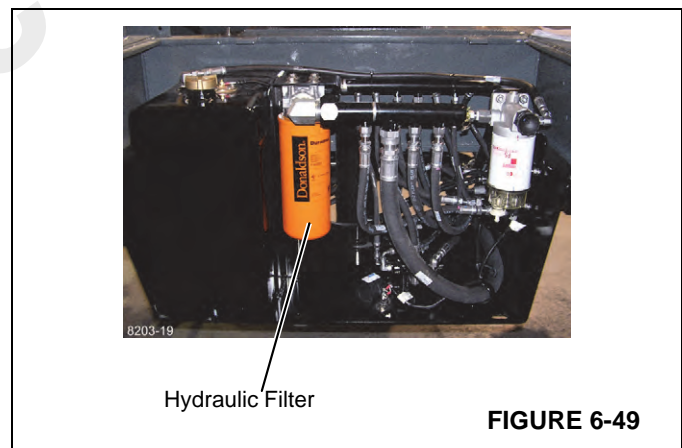
**DO NOT** lower the main pump suction line lower than the pump. The pump requires that it be full of oil at start-up. Lowering the hose lower than the pump will drain the oil from the pump and cause damage to the pump when it is started.

9. Remove the suction strainers from the hydraulic tank and clean them in a suitable solvent.

10. Remove the fill strainer from the fill tube and clean it in a suitable solvent.
11. Clean the inside of the hydraulic tank and remove any sediment.
12. Install the fill strainer, suction strainers, suction hoses and return hose to the hydraulic tank.
13. Replace the hydraulic oil filter. See next subject.
14. Fill the hydraulic tank with Mobil #424 hydraulic oil until it is visible in the sight gauge
15. After the tank is filled, start the engine and operate each function until all the cylinders and lines are filled.
16. Fully retract and lower the boom and retract the outriggers. Check the hydraulic oil level. Oil must be visible in the sight gauge. Add hydraulic oil if necessary.
17. Visually check for leaks.

**Replace the Hydraulic Filter**

1. Engage the parking brake and shut off the engine.
2. Remove the side panel to expose the hydraulic compartment and the hydraulic filter (Figure 6-49).



3. Remove the filter:
  - a. Using a filter wrench, turn the filter counterclockwise to loosen and remove the filter. Properly discard the removed filter.
  - b. Clean the mounting surface on the filter head for the filter seat.
4. Install the filter:
  - a. Apply a small amount of clean hydraulic oil to the gasket of the new hydraulic filter. Install the filter to the filter head by turning it clockwise until the filter gasket makes contact. Then, tighten the filter 1/2 to 3/4 turn to achieve a tight seal.
  - b. Start the engine and check for leaks around the filter.

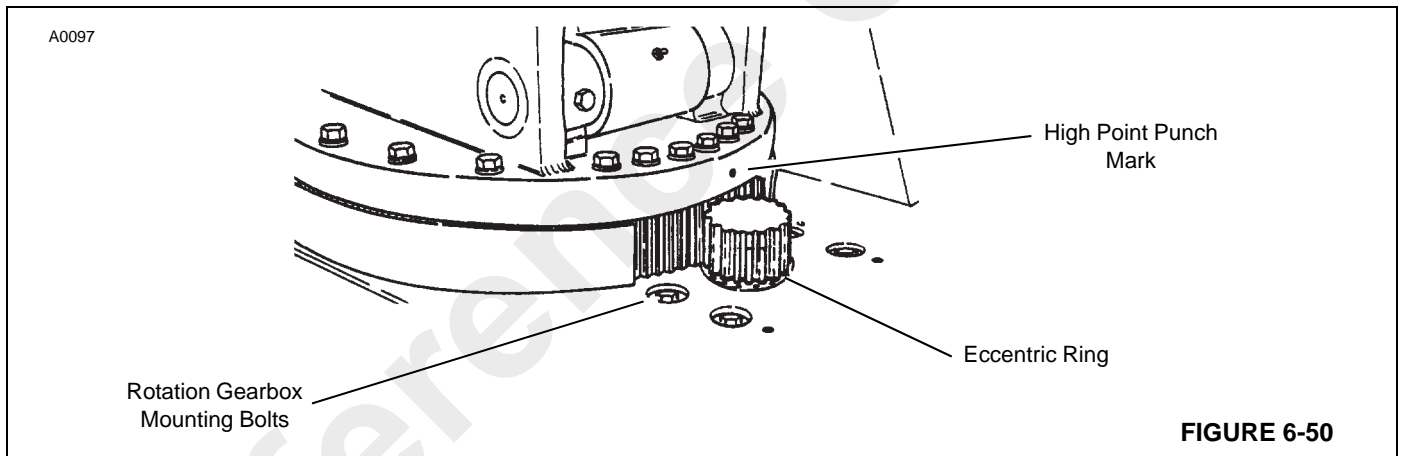
**Check Swing Gear/Pinion Backlash**

1. Remove the cover to expose the swing pinion and ring gear.



Rotating gears can cause injury. Keep hand clear of rotating pinion and gear while the mast is rotating.

2. Start the engine and rotate the mast until the high point on the swing gear is in alignment with the pinion. The high point is punch-marked on the edge of the mast base plate (Figure 6-50).
3. Using a feeler gauge, check the backlash between the gear and pinion. There should be no clearance between the swing gear tooth and the pinion tooth. If there is any clearance, adjust the backlash. See Section 6, Adjustments.



**SCHEDULED MAINTENANCE: 2000 HOURS OF OPERATION (YEARLY)**

**NOTE:** You must read and understand the warnings and basic safety rules, found in *Safety Information*, page 2-1 of this manual, before performing any operation or maintenance procedures

For additional engine maintenance guidelines, see the engine manual furnished with this crane.

**Replace the Engine Coolant**

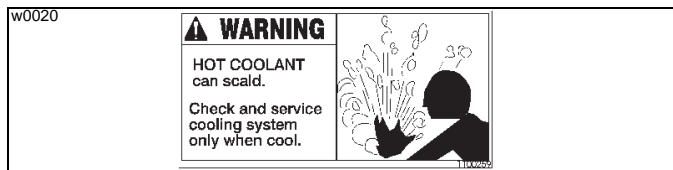


Avoid prolonged and repeated skin contact with used antifreeze. Such prolonged and repeated contact can cause skin disorders or other bodily injury. Wash thoroughly after contact with used antifreeze. Keep antifreeze out of reach of children.

**CAUTION**

**PROTECT THE ENVIRONMENT:** Handling and disposing of used antifreeze is subject to federal, state and local laws and regulations. Use authorized disposal facilities, including civic amenity sites and garages providing authorized facilities for receipt of used antifreeze. If in doubt, contact state and local environmental authorities or the Environmental Protection Agency for guidance as to proper handling and disposal of used antifreeze.

1. Open the engine compartment and prop in place.
2. **BE SURE THE ENGINE IS COOL** and follow the cooling system draining and filling procedures in the Engine Operation and Maintenance Manual furnished with the crane.



3. After the coolant is replaced, close the engine compartment cover.

**Inspect the Crane Structure and Booms for Damage**

Thoroughly inspect the crane structure and booms for the following:

- Inspect for loose mounting hardware. Tighten any loose hardware.
- Inspect for cracked or broken welds. Do not operate the crane if a critical weld is cracked or broken until the weld is repaired. Contact your distributor regarding any critical weld damage.
- Inspect for missing or unreadable warning decals. Replace if necessary.
- Inspect for excessive rust or corrosion on crane structure and booms. Paint any areas with excessive rust or corrosion
- Inspect for missing items. Replace if necessary.
- Inspect the crane for any damage that might inhibit safe operation of the crane. Repair any damage.

**Test the Rated Capacity Limiter (Optional)**

See the Rated Capacity Limiter manual furnished with this crane and test the indicator according to instructions in the manual.

**MISCELLANEOUS MAINTENANCE**

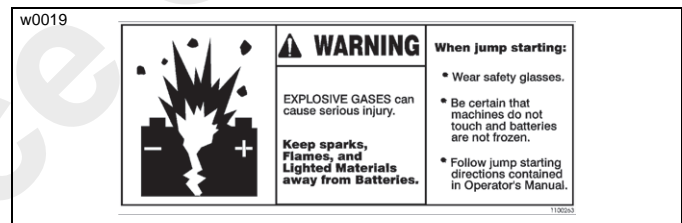
**Batteries/Charging System**



**CAUTION**

Lead-acid batteries produce flammable and explosive gases. To avoid personal injury, when checking, testing or charging batteries:

- **DO NOT** use smoking materials near batteries.
- Keep arcs, sparks and flames away from batteries.
- Provide ventilation and wear safety glasses.
- Never check battery charge by placing a metal object across the posts. The sparks could explode battery gases and cause injury or death. Use a voltmeter or hydrometer.



**Checking the Charging System**

If the battery warning light on the dash illuminates, check the voltage reading using a volt/ohm meter. Connect the meter to the jumper connections in front of the radiator. Normal voltmeter readings are as follows:

**Normal Operating Range**

- Engine above idle - 14 to 16 volts
- Engine stopped - 10 to 14 volts
- A reading of less than 10 volts with the engine at low idle indicates a low battery charge
- A reading of less than 14 volts with the engine speed above low idle indicates a problem in the charging system. The system should be checked out by a qualified service technician.

**Charging the Battery**

Under normal conditions, the engine's alternator will have no problem keeping a charge on the battery. The only condition in which the battery may cause a problem is when it has been completely discharged for a long period of time. Under this condition the alternator may not be able to recharge the battery and a battery charger will be required for charging the battery.



Before using a battery charger, an attempt can be made to recharge the battery using the engine alternator by first jump starting the crane (See *Jump Starting the Engine*, page 3-12) and letting the engine run.

**DO NOT** charge a frozen battery; it may explode and cause injury. Let the battery warm up before attaching a charger.

Charging rates between 3 to 50 amperes are satisfactory if no excessive gassing or spewing of electrolyte occurs or the battery does not feel excessively warm (over 52°C [125°F]). If spewing or gassing occurs or temperatures exceed 52°C (125°F), the charging rate must be reduced or temporarily stopped to permit cooling.

**Replacing the Battery**

**! WARNING**

The fluid in an electric storage battery contains sulfuric acid, which is a **POISON** and can cause **SEVERE CHEMICAL BURNS**. Avoid all contact of fluid with eyes, skin or clothing. Use proper protective gear when handling a battery. **DO NOT** tip any battery beyond a 45° angle in any direction. If fluid contact does occur, perform the following First Aid suggestions.

**Battery Electrolyte First Aid:**

- **External Contact** - Flush with water.
- **Eyes** - Flush with water for at least 15 minutes and get immediate medical attention.
- **Internal** - Drink large quantities of water. Follow with Milk of Magnesia, beaten egg or vegetable oil. Get immediate medical attention.

**NOTE:** In case of internal contact, **DO NOT** give fluids that would induce vomiting.

**! CAUTION**

It is necessary to climb under the crane to replace the battery. Be sure engine is shut off, the ignition key is removed, parking brake is engaged and chock blocks are in place before climbing under the crane.

Remove the battery very carefully to avoid spillage of battery fluid. Properly dispose of the battery.

**Fuel System**

W0015

**! WARNING**



**FIRE HAZARD**

Engine fuel is flammable and can cause a fire or explosion. Death or personal injury could occur.

- Do not put fuel in tank with engine running.
- Keep open flames away.
- Do not use smoking materials during refueling or servicing.

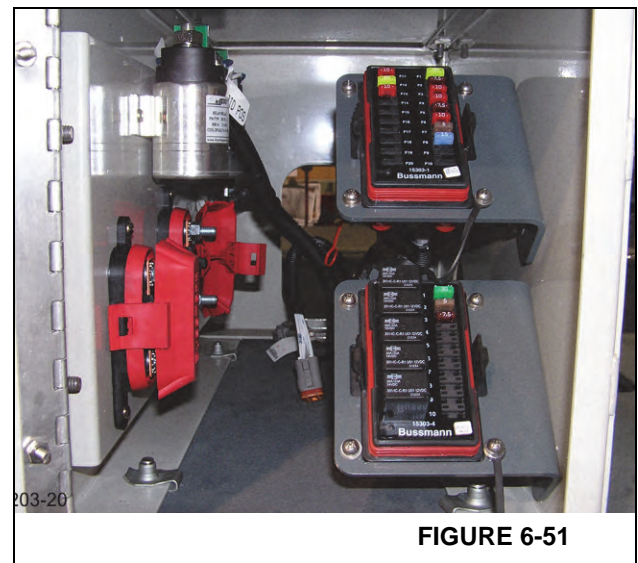
**Fuel Storage**

Storage of fuel for an extended period causes accumulation of sediment, dirt, water and other foreign materials in the fuel. Many engine problems are caused by dirty fuel and long storage periods

Keep fuel in an outside location. Use a shelter to keep the fuel as cool as possible. The water from condensation must be removed at regular intervals from the storage tank.

**Fuse Replacement**

The fuses are located on two fuse blocks in the fuse/relay compartment (Figure 6-51).



**FIGURE 6-51**

Reference Only

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## SECTION 7 ADJUSTMENTS

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### SECTION CONTENTS

All adjustments must be performed by a qualified mechanic. ....	7-1	Refer to the Service Manual for the proper procedures. ....	7-1
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**ALL ADJUSTMENTS MUST BE PERFORMED BY A QUALIFIED MECHANIC.**

Refer to the Service Manual for the proper procedures.

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## SECTION 8 SPECIFICATIONS

### SECTION CONTENTS

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### LUBRICANTS AND CAPACITIES

**NOTE:** The following list of lubricants does not constitute an unconditional guarantee of the performance of

the lubricant mentioned. It is intended solely as a guide to the type of lubricant recommended for a given application.

COMPONENT	CAPACITY	LUBRICANT/FLUID TYPE
Engine Crankcase — Diesel Engine Without Filter Change With Filter Change	7.0 l (7.4 qt) 8.0 l (8.5 qt)	See <i>Engine Oil Specifications</i> , page 8-2
Fuel Tank	64.4 l (17 gal)	Ultra low sulfur diesel fuel only.
Cooling System (Approximate)	14.0 l (15 qt)	50/50 Mixture of Glycol Antifreeze & Water
Supplemental Coolant Additive (SCA)		6829012858 Fleetguard DCA4 Fleetguard DCA2 Penray Pencool 3000
Hydraulic Tank	147.6 l (39 gal)	Mobil Fluid 424, or equivalent (ISO 46/68) <b>Very Cold Temperatures:</b> SAE 5W or SAE 5W-20 oil if the viscosity will not be less than 60 SUS at maximum operating temperature.
Transmission (Approximate)	13.0 l (3.43 gal)	Mobil ATF 210, Conoco ATF, Dextron 3 or equivalent
Front Axle Housing	7.9 l (2.1 gal)	Mobil Fluid 424, or equivalent (ISO 46/68)
Front Axle Wheel Hubs (2)	2.0 l (2.1 qt)	Mobil Fluid 424, or equivalent (ISO 46/68)
Swing Gearbox	As required	Multipurpose EP Lithium Base grease or equivalent
Hoist Gearbox	1.89 - 2.13 l (2 - 2-1/4 qt)	SAE 140 EP gear lubricant, or equivalent
Swing Gear Pinion	As required	Open gear lube

**ENGINE OIL SPECIFICATIONS**

**Cummins Oil Registration List**

Cummins has a program that lists engine oils that it has tested to meet its engineering specifications. Listing of recommended oils is on QuickServe® Online. Log on to quickserve.cummins.com and login with a current username and password or create a new account by selecting “Create an Account” under information, choose Limited Owners Plan and register. Once logged in, click on the “Service” Tab in the top red bar, “Service Tools” mini-tab and “Oil Registration Lists” link within the Service Tools list. This will load a list of the different Cummins Engineering Specification numbers. Select the one that applies to your engine to view the registered oils.

**Oil Performance Recommendations**

The use of quality engine lubricating oils combined with appropriate oil and filter change intervals are critical factors in maintaining engine performance and durability.

It is recommended that a high quality SAE 15W-40 heavy duty engine oil which meets the American Petroleum Institute (API) performance classification CJ-4.

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**Oil Viscosity Recommendations**

The use of multi-viscosity lubricating oil has been found to improve oil consumption control and improve engine cranking in cold temperatures while maintaining lubrication at high operating temperatures.

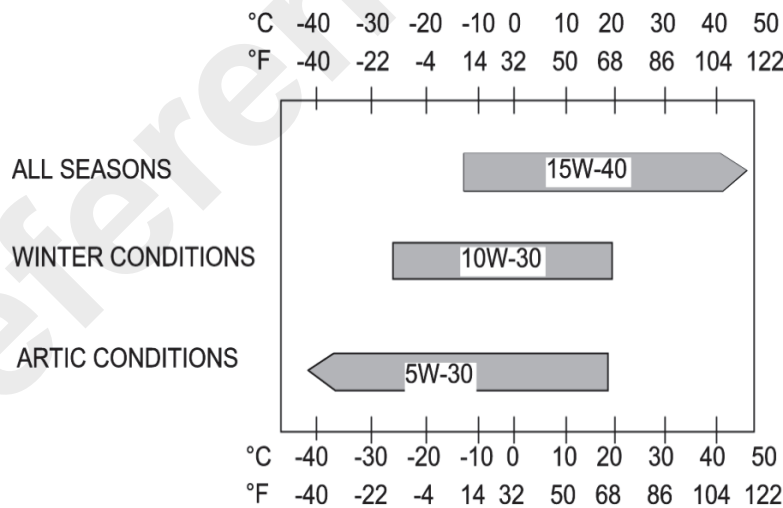
While 15W-40 oil is recommended for most climates, see the viscosity recommendations for extreme climates (Figure 8-1).

**CAUTION**

Limited use of low viscosity oils, such as 10W-30 may be used for easier starting and providing sufficient oil flow at ambient temperatures below -5°C (23°F). However, continuous use of low viscosity oils can decrease engine life due to wear.

**New Engine Break-In Oils**

Do not use special “break-in” lubricating oils for new or rebuilt engines. Use the same type of oil during the “break-in” as that which is used in normal operation.



**FIGURE 8-1**

**DIESEL FUEL**

The Cummins Diesel Engine operates most efficiently with No. 2 ultra low sulfur diesel fuel in temperatures above 0°C (32°F). When operating in temperatures below 0°C (32°F), use No. 1 ultra low sulfur diesel fuel, or a blend of No. 1 and No. 2 diesel fuels, most commonly known as “Winterized”

No. 2 diesel. Use ASTM No. 2 diesel fuel with a minimum Cetane number of 40. No. 2 diesel fuel gives the best economy and performance under most operating conditions. Fuels with Cetane numbers higher than 40 may be needed in high altitudes or extremely low ambient temperatures to prevent misfires and excessive smoke.

## GENERAL SPECIFICATIONS

<b>Engine</b>	
Make and model	Cummins QSB3.3 Tier 4 Diesel
Type of aspiration	Turbocharged
Horsepower	74.6 kw (100 hp) @ 2600 rpm
Low idle speed	800 rpm
Intermediate Speed Control (ISC) Idle Speed	1200 rpm - Coolant Temperature is less than 71° C (160° F)
Maximum engine speed	2600 rpm
<b>Tires</b>	
Size	10:00 x 15, 12 ply rated, pneumatic
Type	Bias Ply
Air Pressure	6.89 bar (125 psi)
Wheel nut torque	
Rear	305 Nm (225 lb-ft)
Front	305 Nm (225 lb-ft)
<b>Electrical System</b>	
Rating	12 VDC negative ground
Number and type of batteries:	
Standard	One - maintenance free
With optional cold weather start or optional auxiliary winch	Two - maintenance free
Battery rating	90 amp/hr
Alternator	120 amps
<b>Boom</b>	
Boom angle:	
Maximum	60°
Minimum	0°
<b>Wire Rope (Main Hoist)</b>	
Size	13 mm 8 x 25 Galvanized. EIPS-IWRC
Length:	
Short Boom	29.6 m (97 ft)
Long Boom	39.6 m (130 ft)
<b>Hydraulic System</b>	
Hydraulic pressure settings	Refer to the Service Manual
Filters	10 micron return line filter 30 mesh suction filter in tank
<b>Weight</b>	
Crane with short boom	6078 kg (13,400 lb)
Crane with long boom	6885 kg (15,180 lb)

<b>Travel Speeds</b>	
Two-wheel steer:	
1st gear	7.44 km/hr (4.62 mph)
2nd gear	11.68 km/hr (7.26 mph)
3rd gear	21.48 km/hr (13.35 mph)
4th gear	35.65 km/hr (22.15 mph)
<b>Turning Dimensions</b>	
Two-wheel steer:	
Outside turning radius (to center line of outside tires)	4.47 m (14 ft 8 in)
Four-wheel steer:	
Outside turning radius (to center line of outside tires)	3.10 m (10 ft 2 in)
<b>Maximum Gradeability (Paved Surface)</b>	
No load	57%
5443 kg (12,000 lb) load	31%

**NOTE:** Gradeability is a measure of tractive effort only and does not represent grades on which the machine can operate.



DIMENSIONS 3330F & 4409

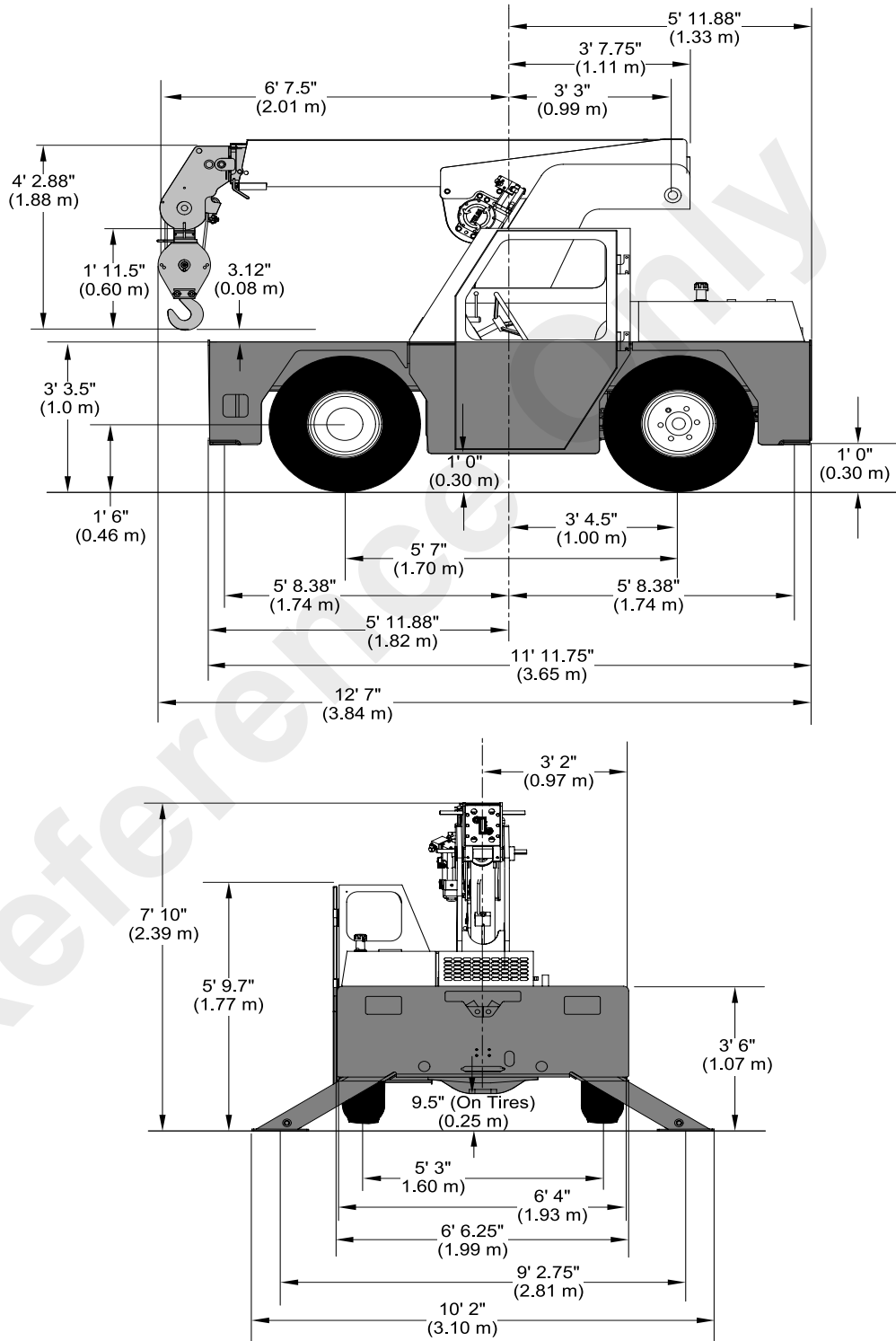


FIGURE 8-2

DIMENSIONS 3330FL & 4409XL

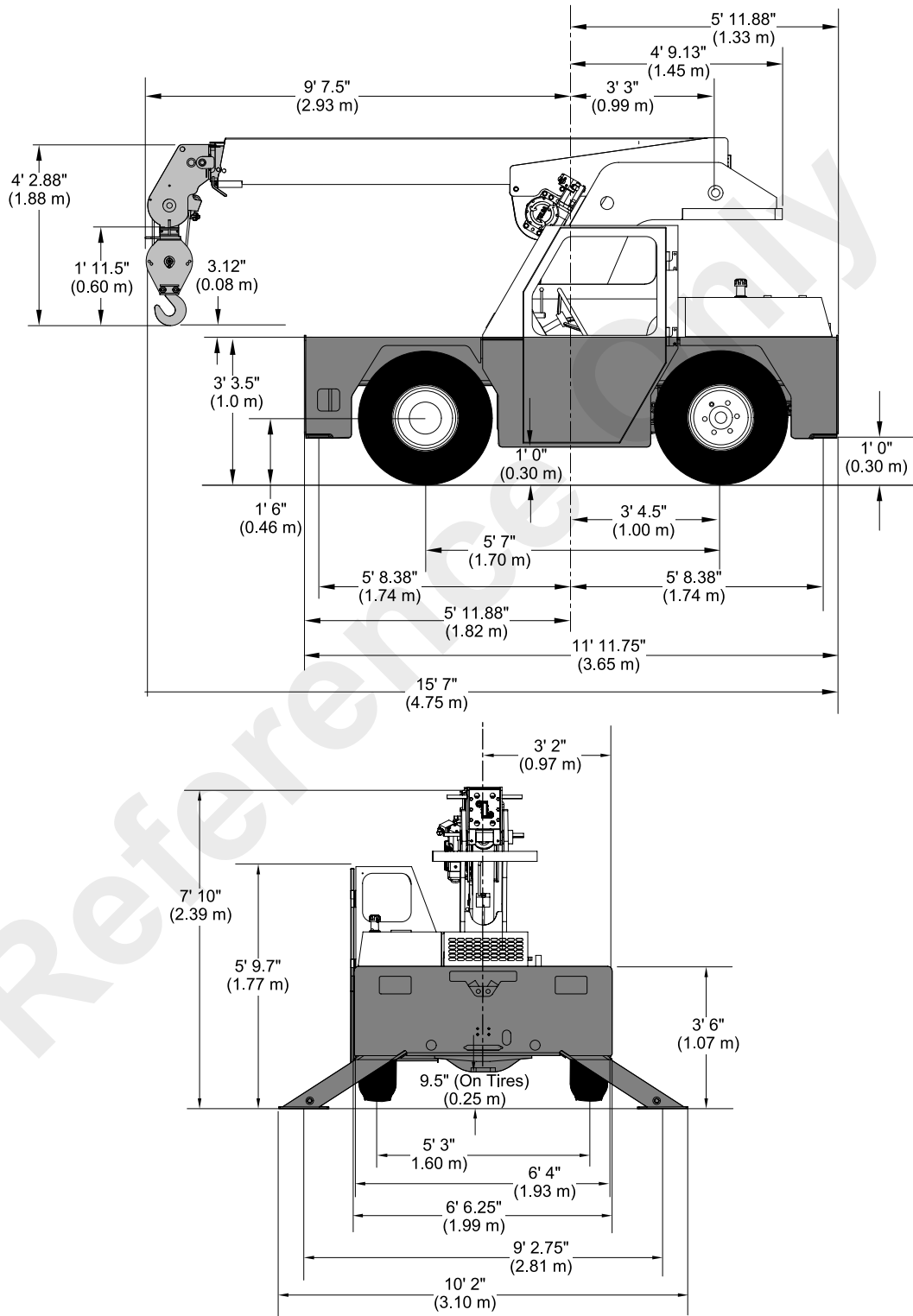


FIGURE 8-3

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