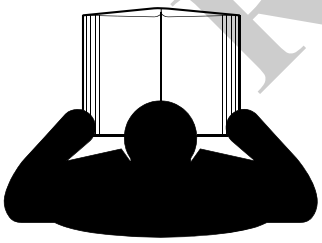
OPERATOR MANUAL

Supplement

Operational Device - RCL Override

For Reference Only



⚠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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Published 04-25-2019, Control # 695-00

This Supplement provides recommendations in the event there is a malfunction to the rated capacity limiter (RCL)/Anti 2 Block (A2B) operational aid.

OPERATIONAL AID MALFUNCTION

When crane operational aids such as the RCL/A2B system are inoperative with the display malfunctioning, override capabilities will be unavailable. All crane operations must be shut down until the problem is corrected. Contact a technician for consultation and repair. Repair and recalibrate the system before returning the crane to lifting service.

For Reference Only

CD09

Operator Manual

8688

For Reference Only

Grove Manitowoc National Crane Potain

Manitowoc

WARNING

California Proposition 65

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

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

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

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

California Spark Arrestor

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

For Reference Only

The original language of this publication is English.

OPERATOR MANUAL

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

CD09

Crane Model Number

This Manual is divided into the following sections:

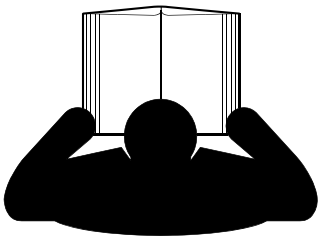
SECTION 1 INTRODUCTION
SECTION 2 SAFETY INFORMATION
SECTION 3 OPERATING CONTROLS AND PROCEDURES
SECTION 4 CAPACITY CHART
SECTION 5 ATTACHMENTS
SECTION 6 MAINTENANCE
SECTION 7 ADJUSTMENTS
SECTION 8 SPECIFICATIONS

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.

For Reference Only



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THE MANUAL

This operator manual provides the information you need to correctly operate and maintain the CD09 crane.

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 DECAL

For easy reference, when contacting the Manitowoc distributor/Crane Care Customer Service about this crane, record the crane's serial number in the space provided in the next column. The numbers are printed on the serial number decal 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 of this product with anything other than a Crane Care Customer Service authorized replacement part may adversely affect the performance, durability, or safety of this product and will void the warranty. Crane Care Customer Service assumes no liability for unauthorized replacement parts which adversely affect the performance, durability, or safety of this product.

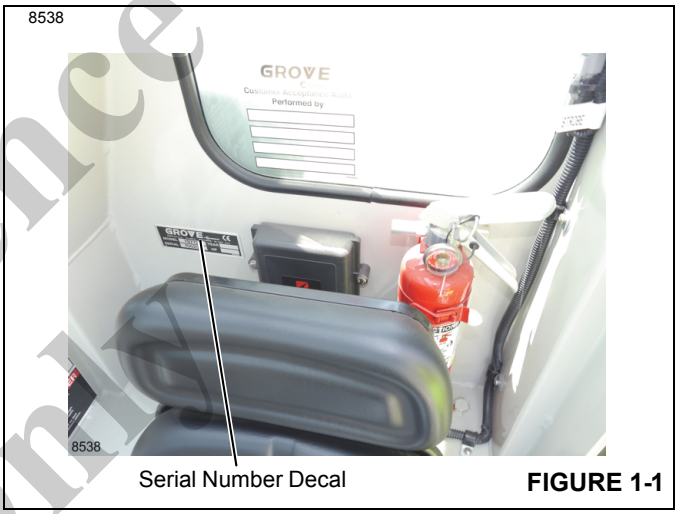

FIGURE 1-1

Serial Number _____

REPORTS

NOTE: A Delivery Report form must be filled out by the Grove distributor, signed by the purchaser, and returned to Crane Care Customer Service 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 Grove distributor has returned the report to Crane Care Customer Service. An engine warranty form must also be filled out, signed and returned to the engine manufacturer for full warranty coverage.

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Noise Level Test Results

When equipped with the CE certification package, the guaranteed sound power level is LWA 105 dB/1 pW per the Outdoor Noise Directive 2000/14/EC. The sound level at the crane operator's position is 80 dB(A) as measured per Annex G.1 of EN 13000:2010+A1:2014. For noise reduction during use, keep windows and door closed (if compatible with safety needs) and actuate controls smoothly.

Vibration Level Test Results

At the operator's station with closed cab operation, vibration levels are less than 0.5 m/s^2 for Whole Body Vibration exposure and are less than 2.5 m/s^2 for Hand Arm Vibration exposure.

The value of vibrations transmitted by the crane operator's seat do not exceed the limiting values specified in EN ISO 7096 and ISO 2631-1. The vibration transmitted at the crane operator's handles / armrests are measured and valued according to EN ISO 5349-1 and EN ISO 5349-2.

DISCLAIMER

Crane Care Customer Service reserves the right to make improvements in design or changes in specifications at any time without incurring any obligation to install them on cranes 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.

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

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

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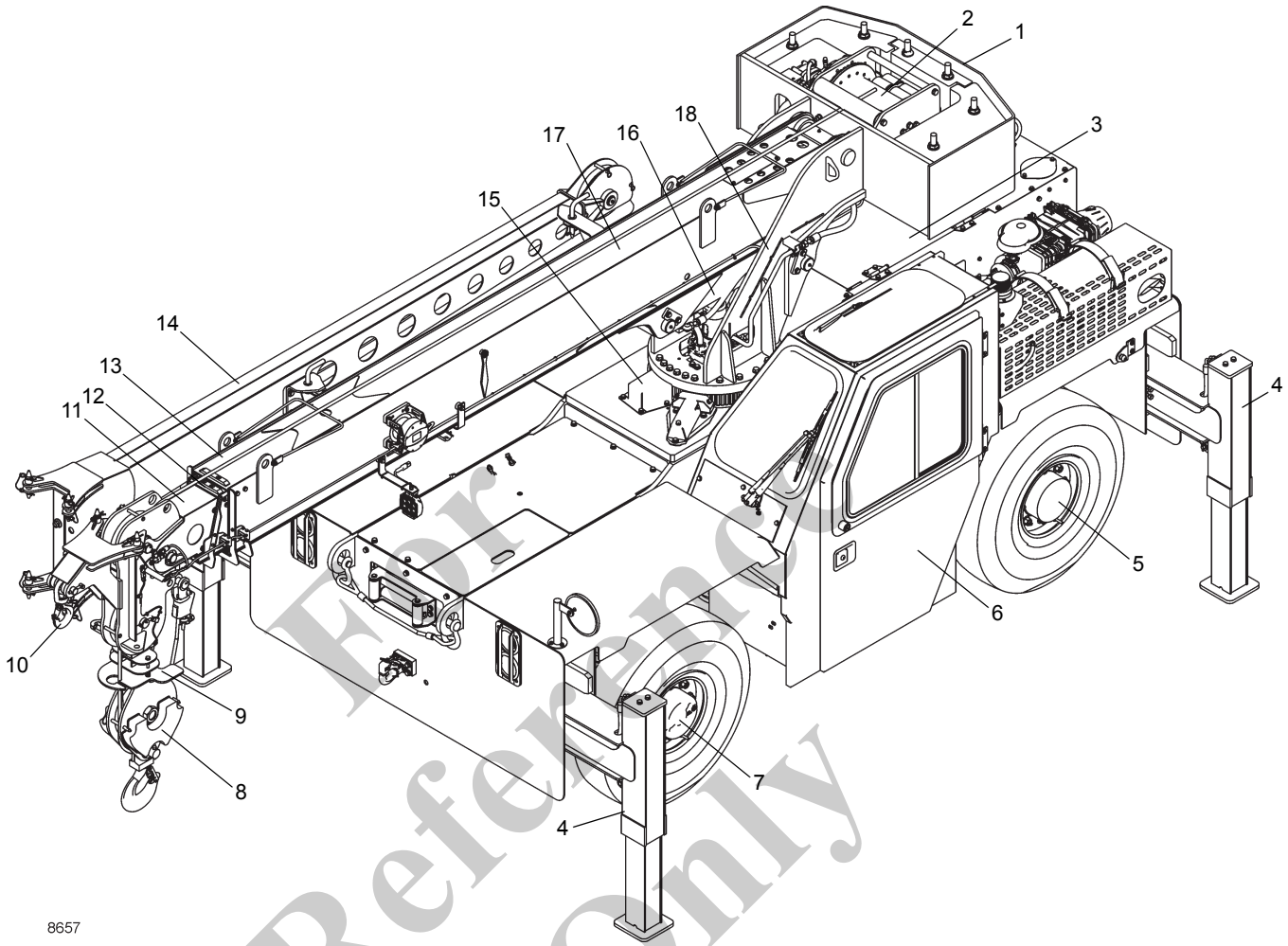
NOMENCLATURE



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Item	Description	Item	Description
1	Counterweights Location	10	Searcher Hook Assembly
2	Main Hoist Location	11	3rd Boom Section, 12.5 m (41 ft) (Standard)
3	Engine Location	12	2nd Boom Section
4	Outriggers (4)	13	1st Boom Section
5	Rear Axle	14	Boom Extension
6	Operator's Cab	15	Swing Motor and Gearbox Location
7	Front Axle	16	Lift Cylinders
8	Hook Block	17	Crowd Assembly Location (Inside Boom)
9	Anti-Double Blocking System or RCL system	18	Mast

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.

Safety Decals

Refer to the *Parts Manual* for a drawing indicating the location of Safety Decals on the crane.

ACCIDENTS

Following any accident or damage to equipment, the Industrial Crane 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 Industrial Crane distributor and/or Manitowoc Crane Care.

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

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

Phone: 888-777-3378 (888-PSR.DEPT)
717-597-8121
Fax: 717-593-5152
E-mail: product.safety@manitowoc.com

OPERATOR INFORMATION

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

For Reference Only

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

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

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

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

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

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

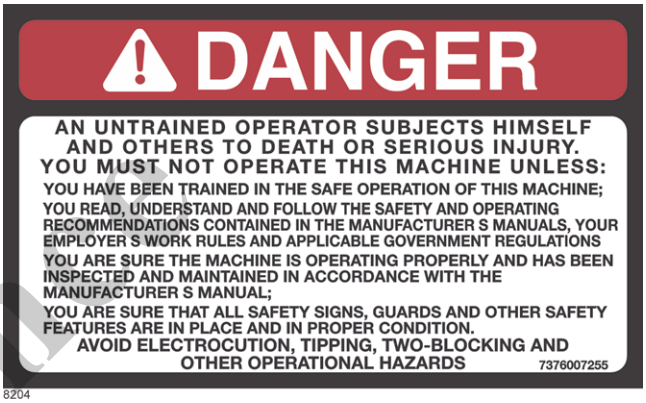
OPERATOR QUALIFICATIONS

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

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

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

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



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

You must not operate this 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 decals, guards, and other safety features are in place and in proper condition.

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

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

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

For Reference Only

impair physical, visual and mental reactions, and capabilities.

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

OPERATIONAL AIDS

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

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

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

Rated Capacity Limiter (RCL) Systems (If Equipped)

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

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

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

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

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

For detailed information concerning the operation and maintenance of the RCL system installed on the crane, see the appropriate section later in this manual or 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 safe load indicator (SLI); Industrial Crane refers to these systems as a rated capacity limiter (RCL) throughout its *Operator* and *Service Manuals*.

Anti-Two-Blocking Device

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

Two-blocking occurs when the load block (hook block, headache ball, rigging, etc.) comes into physical contact with the boom (boom nose, sheaves, boom extension, etc.). Two-blocking can cause hoist rope (wire rope or synthetic rope), rigging, reeving, and other components to become highly

Reference Only

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 boom extension nose respectively. An operator, concentrating on the specific line being used, may telescope or lower the boom allowing the other hoist line attachment to contact the boom or boom extension nose, thus causing damage to the sheaves, or causing the 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.

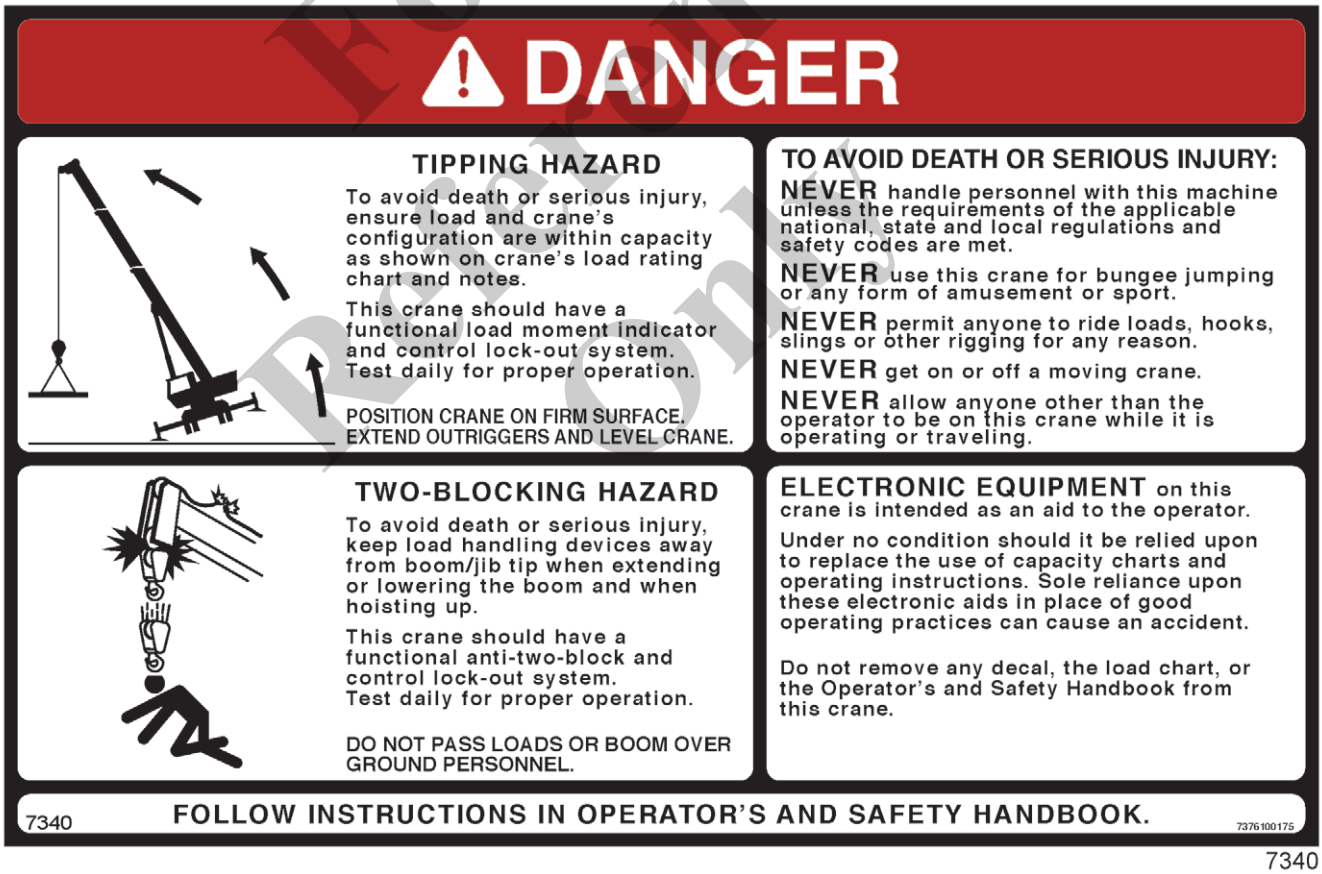
Never interfere with the proper functioning of operational aids or warning devices.

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.

For Reference Only



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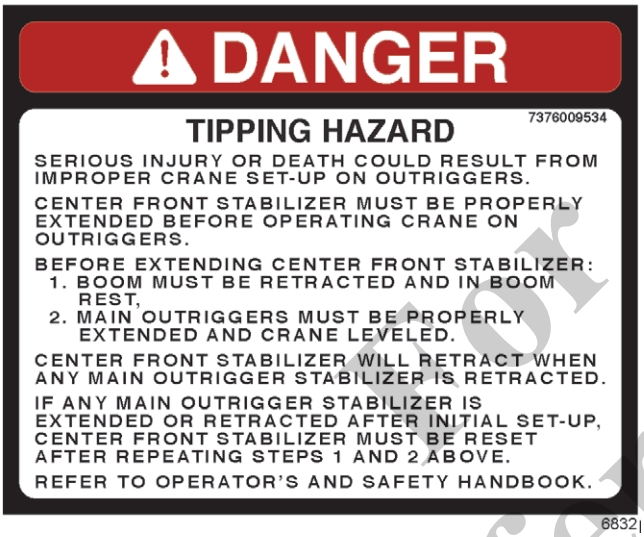
CRANE STABILITY/STRUCTURAL STRENGTH

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.

Reference Only

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.

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. Industrial Crane recommends that a lift not be made if the wind can cause a loss of control in handling the load.

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

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

Table 2-1 Beaufort Wind Scale

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

For Reference Only

Wind Speeds

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

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

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

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

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

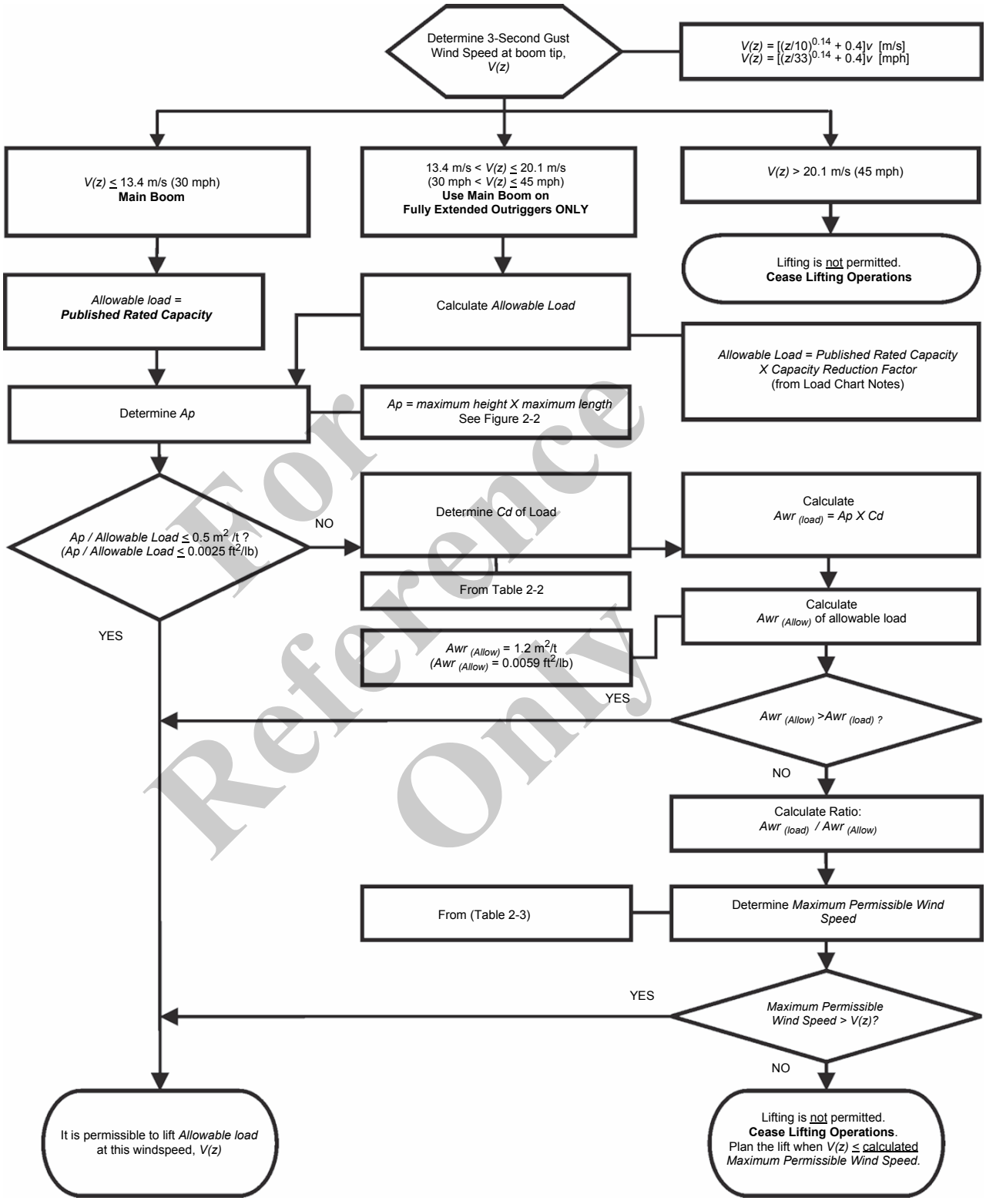
c) If ***V(z)*** is > 20.1 m/s (45 mph), then lifting is NOT permitted. Cease lifting operations and lower and retract the boom.

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

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

For Reference Only

Simplified Method to Determine Maximum Permissible Wind Speed



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

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

FIGURE 2-1

For Reference Only

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

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

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

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

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

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

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

where:

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

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

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

V = 7.9 m/s (17.7 mph)

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

then:

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

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

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

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

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

Size and Shape of the load:

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

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

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

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

where:

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

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

Cd - wind drag coefficient.

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

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

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

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

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

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

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

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

For Reference Only

Calculation of Projected Wind Area (Ap):

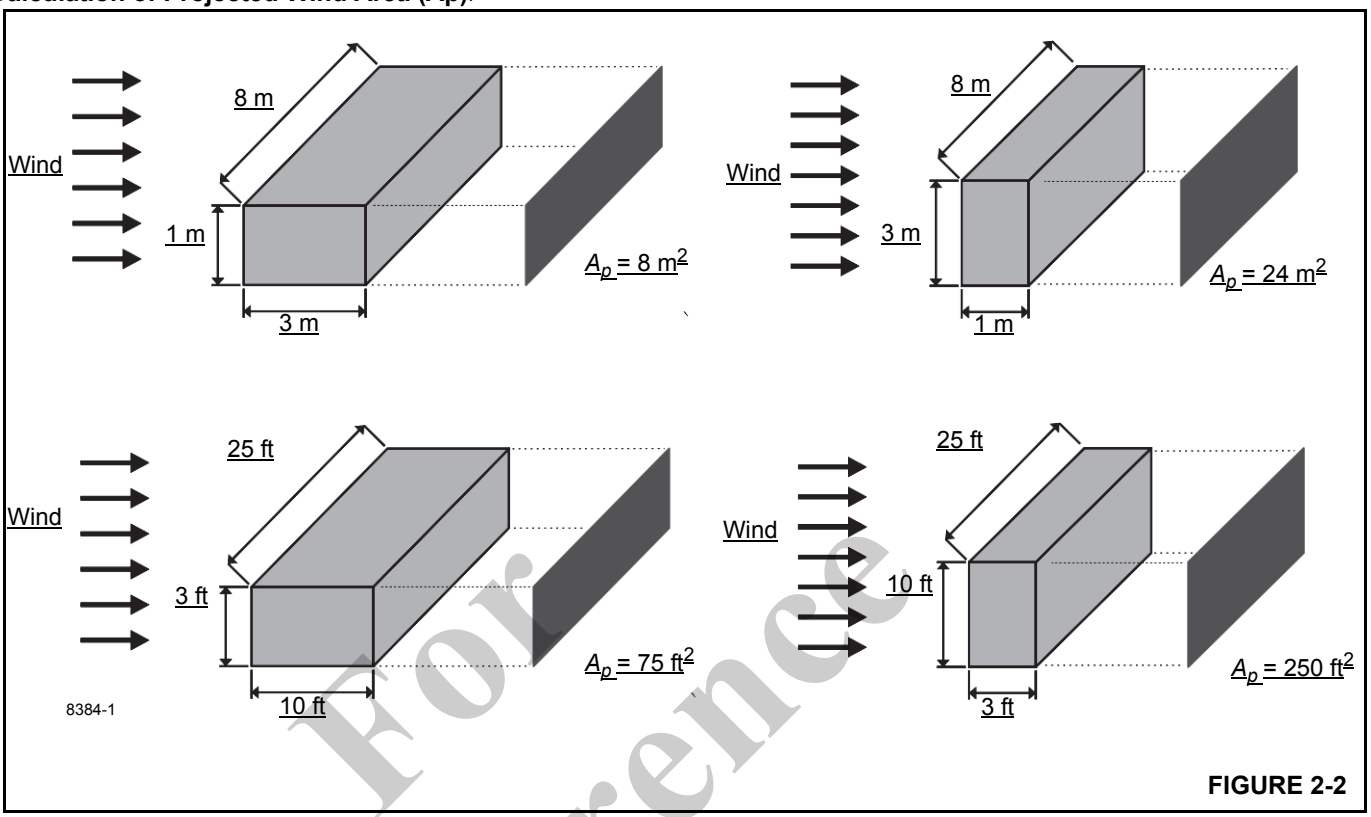


FIGURE 2-2

Determining Wind Drag Coefficient (Cd)

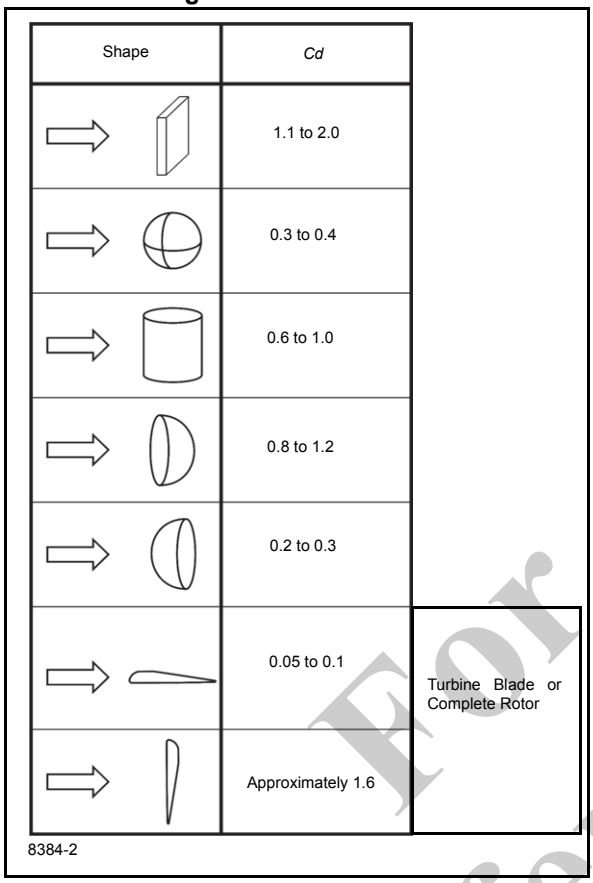
Table 2-2 shows the typical Shapes and corresponding Wind Drag Coefficient ***(Cd)*** values.

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

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

For Reference Only

Table 2-2 Wind Drag Coefficient



Maximum Permissible Wind Speed

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

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

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

For Reference Only

Rated Load Chart Example - Metric

RATED LIFTING CAPACITIES IN KILOGRAMS
10.9 m - 33.5 m BOOM

ON OUTRIGGERS FULLY EXTENDED - 360°

Radius in Meters	#0001								
	Main Boom Length in Meters								
	10.9	12.2	15.2	**18.4	21.3	24.4	27.4	30.5	33.5
3	+60,000 (69.5)	40,950 (72)	40,950 (76)						
3.5	53,000 (66.5)	40,950 (69.5)	40,950 (74)	28,350 (78)					
4	47,450 (63.5)	40,950 (66.5)	40,950 (72)	28,350 (75.5)	*18,225 (78)				
4.5	42,875 (60.5)	40,950 (64)	40,950 (70)	28,350 (73.5)	18,225 (76)				
5	39,050 (57.5)	39,025 (61.5)	38,300 (67.5)	28,350 (72)	18,225 (75)	*18,225 (78)			
6	32,950 (50.5)	32,925 (55.5)	32,825 (63.5)	28,350 (68.5)	18,225 (72)	18,225 (75)	*18,225 (78)		
7	28,325 (42.5)	28,300 (49)	28,225 (59)	26,250 (65)	18,225 (69)	18,225 (72)	18,225 (74.5)	*16,725 (78)	*11,400 (78)
8	24,150 (32.5)	24,150 (42)	23,975 (54.5)	23,275 (61)	18,225 (66)	18,225 (69.5)	16,575 (72)	15,250 (74.5)	11,400 (76)
9	20,600 (16.5)	20,550 (33.5)	20,375 (49.5)	20,250 (58)	18,225 (63)	16,575 (67)	15,050 (70)	13,875 (72.5)	11,400 (74.5)
10		17,200 (20.5)	17,175 (43)	17,175 (54)	17,325 (60)	15,175 (64.5)	13,725 (67.5)	12,700 (70.5)	11,400 (72.5)
12			12,025 (30)	12,025 (45.5)	12,575 (53.5)	12,575 (59)	11,600 (63)	10,725 (66.5)	10,050 (69)
14				9,000 (35)	9,360 (46)	9,730 (53.5)	9,955 (58.5)	9,205 (62)	8,620 (65)
16				6,750 (19)	7,175 (37.5)	7,525 (47)	7,920 (53)	7,980 (57.5)	7,470 (61.5)
18					5,525 (29)	5,960 (39.5)	6,340 (47.5)	6,525 (53)	6,530 (57.5)
20						4,755 (30.5)	5,145 (41)	5,320 (48)	5,495 (53)
22						3,790 (16.5)	4,210 (33.5)	4,380 (42.5)	4,545 (48.5)
24							3,435 (23.5)	3,620 (36)	3,780 (43.5)
26								2,975 (28)	3,150 (37.5)
28								2,400 (16)	2,620 (31)
30									2,135 (22)
Minimum boom angle (°) for indicated length (no load)									0
Maximum boom length (m) at 0° boom angle (no load)									33.5

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

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

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

REMOVED SAMPLE ONLY

8383-1

FIGURE 2-3

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

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

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

	Main Boom Length in Meters								
Wind Speed *V(z)* > 13.4 m/s ≤ 20.1 m/s	10.9	12.2	15.2	18.4	21.3	24.4	27.4	30.5	33.5
Factor	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.7	0.6

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

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

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

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

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

Example and Sample Calculations (metric)

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

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

Example 1: Crane Configuration:

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

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

The maximum allowable wind resistance area of load is

$$Awr_{(allow)} = 0.0012 \times m_{(load)} \quad (2.4)$$
$$Awr_{(allow)} = 0.0012 \times 15{,}050 = 18.06\ m^2$$

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

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

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

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

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

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

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

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

For SAMPLE Reference Only

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

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

Load example 1.1:

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

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

wind resistance area of load can be estimated as

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

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

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

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

Load example 1.2:

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

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

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

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

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

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

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

Load example 1.3a:

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

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

the wind resistance area of load can be estimated as:

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

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

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

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

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

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

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

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

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

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

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

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

Load example 1.3b:

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

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

the wind resistance area of load can be estimated as

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

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

For Reference Only

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

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

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

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

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

For Reference Only

Rated Load Chart Example - Non-metric

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

ON OUTRIGGERS FULLY EXTENDED - 360°

Radius in Feet	#0001								
	Main Boom Length in Feet								
	36	40	50	**60	70	80	90	100	110
10	130,000 (69.5)	90,300 (71.5)	90,300 (75.5)	*62,500 (78)					
12	112,500 (65.5)	90,300 (68.5)	90,300 (73)	62,500 (76.5)	*40,200 (78)				
15	93,250 (60)	90,300 (63.5)	90,250 (69.5)	62,500 (73.5)	40,200 (76)	*40,200 (78)			
20	71,550 (49.5)	71,500 (55)	71,300 (63)	62,500 (68)	40,200 (71.5)	40,200 (74.5)	40,200 (78)	*36,900 (78)	
25	56,650 (36.5)	56,600 (45)	56,350 (56)	53,650 (63)	40,200 (67)	40,200 (70.5)	37,950 (73)	34,900 (75)	*25,150 (78)
30	43,500 (11.5)	44,300 (32)	43,950 (48.5)	43,650 (57.5)	40,200 (62.5)	[illegible]	32,750 (69.5)	30,200 (72)	25,150 (74)
35			33,550 (40)	33,700 (51.5)	34,700 (58)	[illegible]	[illegible]	26,400 (69)	24,700 (71.5)
40			25,800 (28)	26,150 (44.5)	[illegible]	[illegible]	25,200 (62.5)	23,300 (66)	21,800 (68.5)
45				[illegible]	[illegible]	22,300 (54)	22,400 (59)	20,700 (62.5)	19,400 (65.5)
50				[illegible]	[illegible]	18,25[illegible] (49.5)	19,100 (55)	18,550 (59.5)	17,350 (62.5)
55					14,300 (33.5)	[illegible] (44)	16,000 [illegible]1)	16,400 (56)	15,600 (60)
60					[illegible]	12,700 (38.[illegible]	13,550 (46.5)	13,950 (52.5)	14,100 (56.5)
65						[illegible]00 (31.5)	11,550 (41.5)	11,950 (48.5)	12,300 (53.5)
70						9,010 (22.5)	9,920 (36)	10,250 (44)	10,650 (50)
75							8,510 (29.5)	8,890 (39.5)	9,250 (46)
80							7,260 (21)	7,690 (34.5)	8,050 (42.5)
85								6,620 (28.5)	7,010 (38)
90								5,630 (20)	6,100 (33)
95									5,240 (27)
100									4,480 (19.5)
Minimum boom angle (°) for indicated length (no load)									0
Maximum boom length (ft.) at 0° boom angle (no load)									110

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

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

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

8382-1

FOR SAMPLE ONLY

FIGURE 2-4

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

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

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

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

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

Maximum allowable wind resistance area in ft^2, ***Awr*** $_{(allow)}$ = 0.0059 x calculated reduced capacity in lb.

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

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

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

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

Example and Sample Calculations (Non-metric)

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

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

Example 2:

A crane is configured with:

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

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

The maximum allowable wind resistance area of load is:

Awr $_{(allow)}$ = 0.0059 x ***m*** $_{(load)}$ (2.5)

Awr $_{(allow)}$ = 0.0059 x 25,200 = 149 ft^2

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

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

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

m $_{(allow)}$ = 0.8 x 25,200 = 20,160 lb

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

Awr $_{(allow)}$ = 0.0059 x 20,160 = 119 ft^2

For Reference Only SAMPLE

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

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

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

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

Load example 2.1:

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

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

then the wind resistance area of load can be estimated as

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

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

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

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

Load example 2.2:

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

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

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

the wind resistance area of load can be estimated as

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

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

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

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

Load example 2.3a:

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

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

the wind resistance area of load can be estimated as:

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

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

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

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

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

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

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

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

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

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

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

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

Load example 2.3b:

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

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

the wind resistance area of load can be estimated as:

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

For Reference Only

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

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

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

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

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

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

Lifting Operations

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

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

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

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

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

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

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

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

The crane can tip over or fail structurally if:

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

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

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

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

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

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

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

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

Never push or pull with the crane boom.

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

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

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

For Reference Only

Counterweight

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

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

Outrigger Lift Off

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

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

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

Multiple Crane Lifts

Multiple crane lifts are not recommended.

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

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

Tilt-Up Panel Lifting

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

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

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

Reference Only

- 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.

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

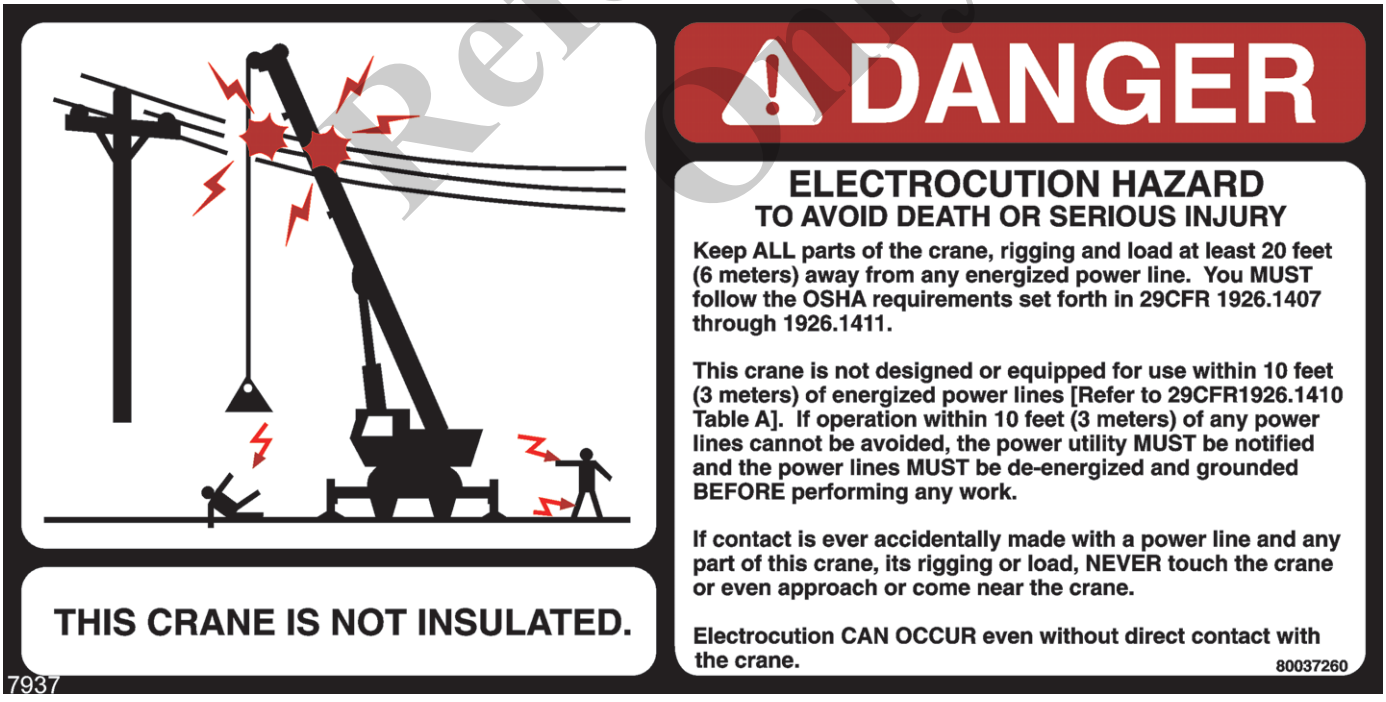
DANGER

Electrocution Hazard!

Industrial 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.

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



For Reference Only

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 (boom extensions, rigging, loads, etc.). Overhead lines tend to blow in the wind so allow for lines’ movement when determining safe operating distance.

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

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

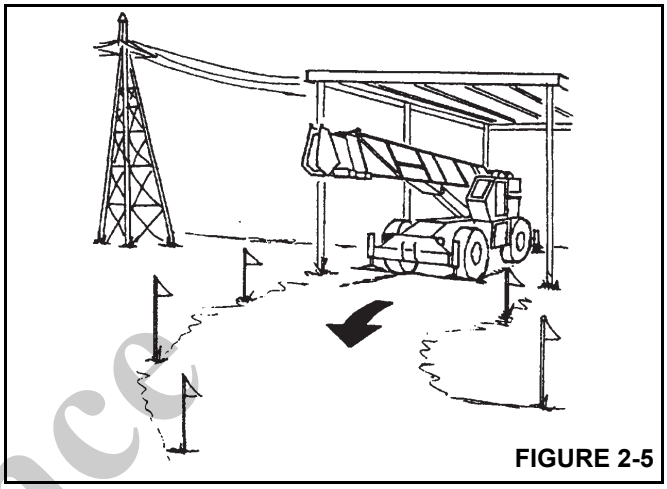


FIGURE 2-5

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 shall have no other duties while the crane is working.

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

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

Electrocution Hazard Devices

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

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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 Industrial Crane distributor must be immediately advised of the incident and consulted on necessary inspections and repairs. Thoroughly inspect the hoist rope and all points of contact on the 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 Industrial Crane distributor or Manitowoc Crane Care.

Special Operating Conditions and Equipment

Never operate the crane during an electrical thunderstorm.

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

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

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

For Reference Only

Grounding the Crane

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

WARNING

Risk of accidents due to electric shock!

Ground the crane before you start to work with it

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

Use electrically conducting material for grounding.

1. Hammer a metal rod (3, Figure 2-6) (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 mm² (0.025 inches²).
4. Connect the free end of the cable with a clamp (1) to a good electrically conductive location on the frame.

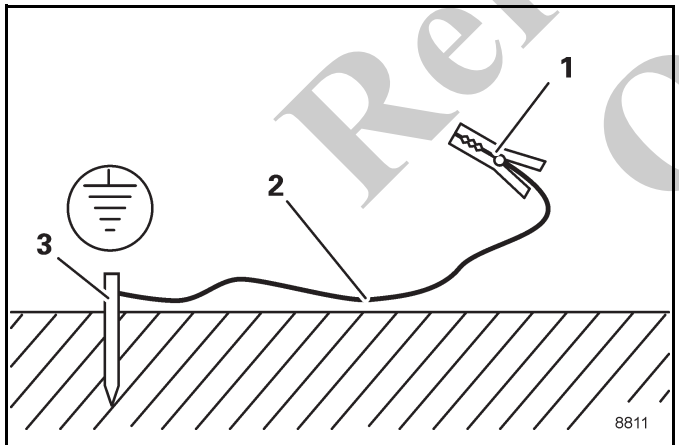

FIGURE 2-6

WARNING

Risk of accidents due to electric shock!

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

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

PERSONNEL HANDLING

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

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

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

> General requirements. The use of 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 an Industrial Crane to handle personnel is acceptable provided:

- The requirements of the applicable national, state and local regulations and safety codes are met.

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- 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, 07007-2900

  - or -

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

ENVIRONMENTAL PROTECTION

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

Potentially harmful waste used in Industrial 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.

Industrial Crane continues to recommend that cranes be properly maintained, regularly inspected and repaired as necessary. Industrial Crane reminds crane owners to ensure that all safety decals are in place and legible. Industrial Crane continues to urge crane owners to upgrade their

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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 Industrial Crane distributor.

Service and Repairs

WARNING

Fall Hazard!

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

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

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

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

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

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

Hydraulic Fluid:

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

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- 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 K100™ Synthetic Crane Hoist Line Manual P/N 9828100734 available by contacting Manitowoc Crane Care.

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

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

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

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 Industrial Crane 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.

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- 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.

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- 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

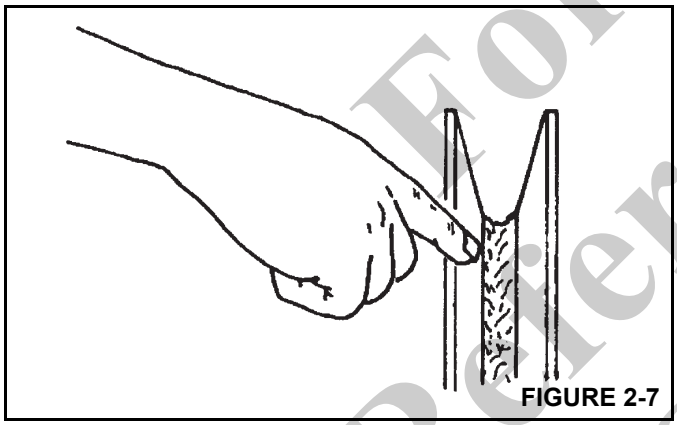

FIGURE 2-7

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

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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 an 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.

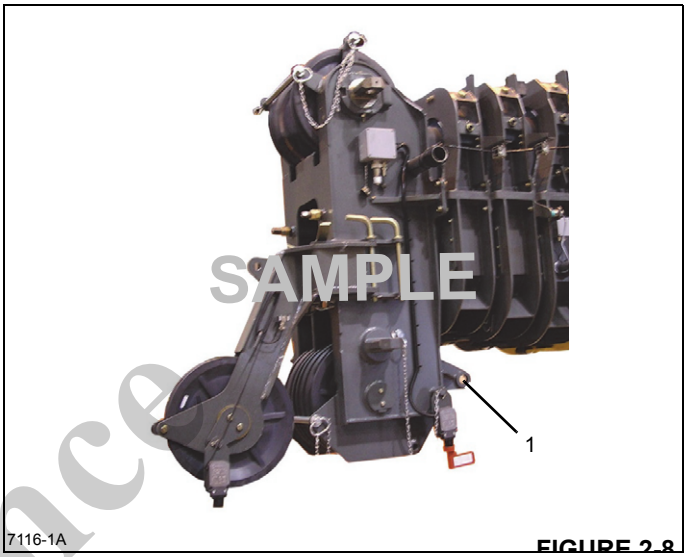

FIGURE 2-8

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.

Industrial cranes are manufactured with no axle suspension system. Traveling at high speeds, especially on rough

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ground, may create a bouncing effect that can result in loss of control. If bouncing occurs, reduce travel speed.

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WARNING

Crushing Hazard!

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

Keep Clear of revolving tires.

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

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

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

When driving the crane, ensure the cab is 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

For Reference Only

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.

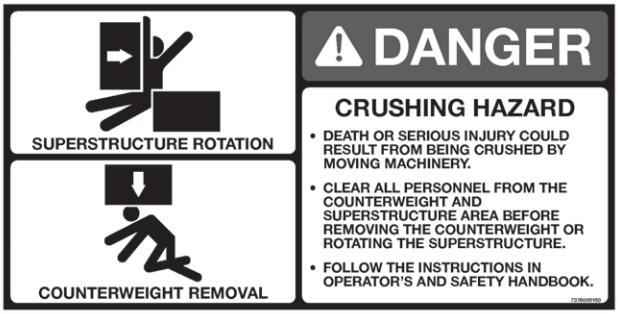
Carbon monoxide fumes from the engine exhaust can cause suffocation in an enclosed area. Good ventilation is very important when operating the crane.

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

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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.

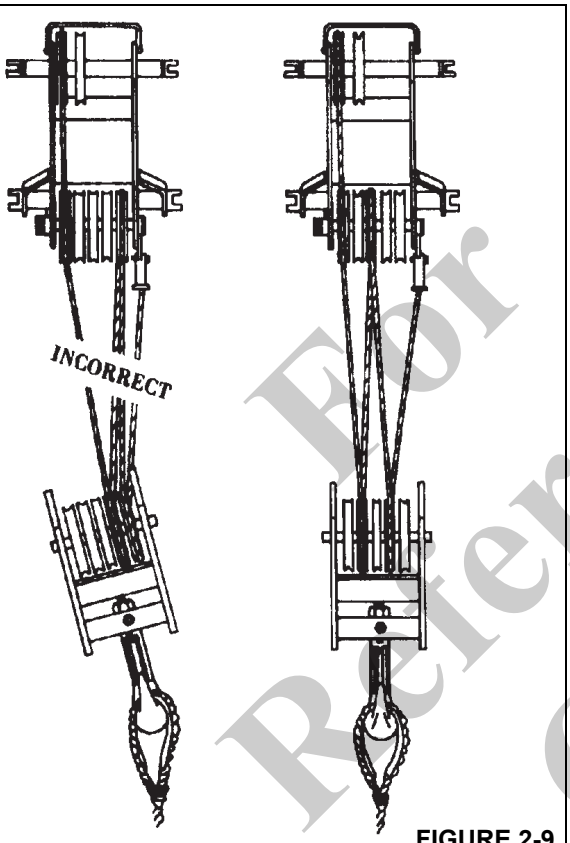

FIGURE 2-9

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 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

For Reference Only

boom is extended. Ensure weight of load is within crane's capacity on *Load Chart*.

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

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

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

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

Hand Signals

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

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

At all times use standardized hand signals (Figure 2-10) - 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.

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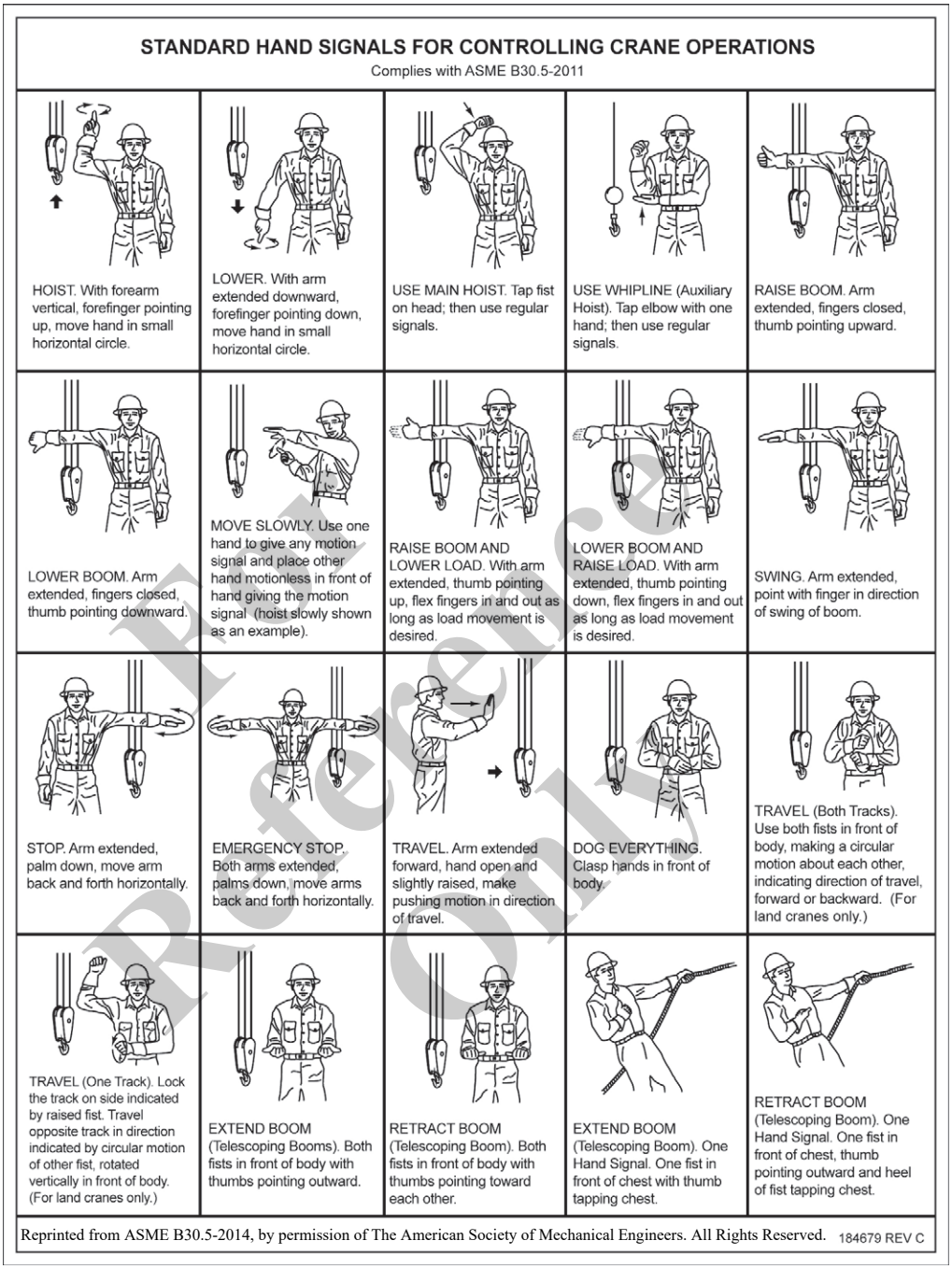

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FIGURE 2-10

BOOM EXTENSION

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

Install and secure all pins properly.

Control movement of the boom extension at all times.

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

DANGER

Boom Extension Hazard!

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

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

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

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

Stay outside of boom extension sections and lattice work.

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

PARKING AND SECURING

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, Industrial Crane recognizes that certain jobsite conditions may not permit the boom and boom extension of a crane to be fully lowered to the ground. When a qualified person at a jobsite determines that it is not practical to lower the boom to the ground, we recommend the following additional instructions be followed:

- The crane should be left in the smallest, most stable, valid operational configuration that the job site practically allows.
- The crane can not be left running, with a load on the hook, or in erection mode, or in wind conditions in excess of allowed values.
- The boom should be retracted as far as is practical, the crane configured in as stable a configuration as possible (boom angle, superstructure orientation, boom extension angle, etc.)
- In high winds the boom and boom extension 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

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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

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

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

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

TEMPERATURE EFFECTS ON HYDRAULIC CYLINDERS

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

The change in the length of a cylinder is proportional to the extended length of the cylinder and to the change in temperature of the oil in the cylinder. For example, a cylinder extended 7.6 m (25 ft) in which the oil cools 15.5°C (60°F) would retract approximately 196 mm (7 3/4 in) [see Table 2-9 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.

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

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

Length change in inches = Stroke (Ft.) X Temperature Change (°F) X Coeff. (in^3/in^3/ °F) X 12 in/ft

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

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

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

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OVERLOAD INSPECTION

This information supplements the Load Moment Indicator (LMI) manual supplied with each Grove crane.

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

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

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

WARNING

Overload Hazard!

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

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

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

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

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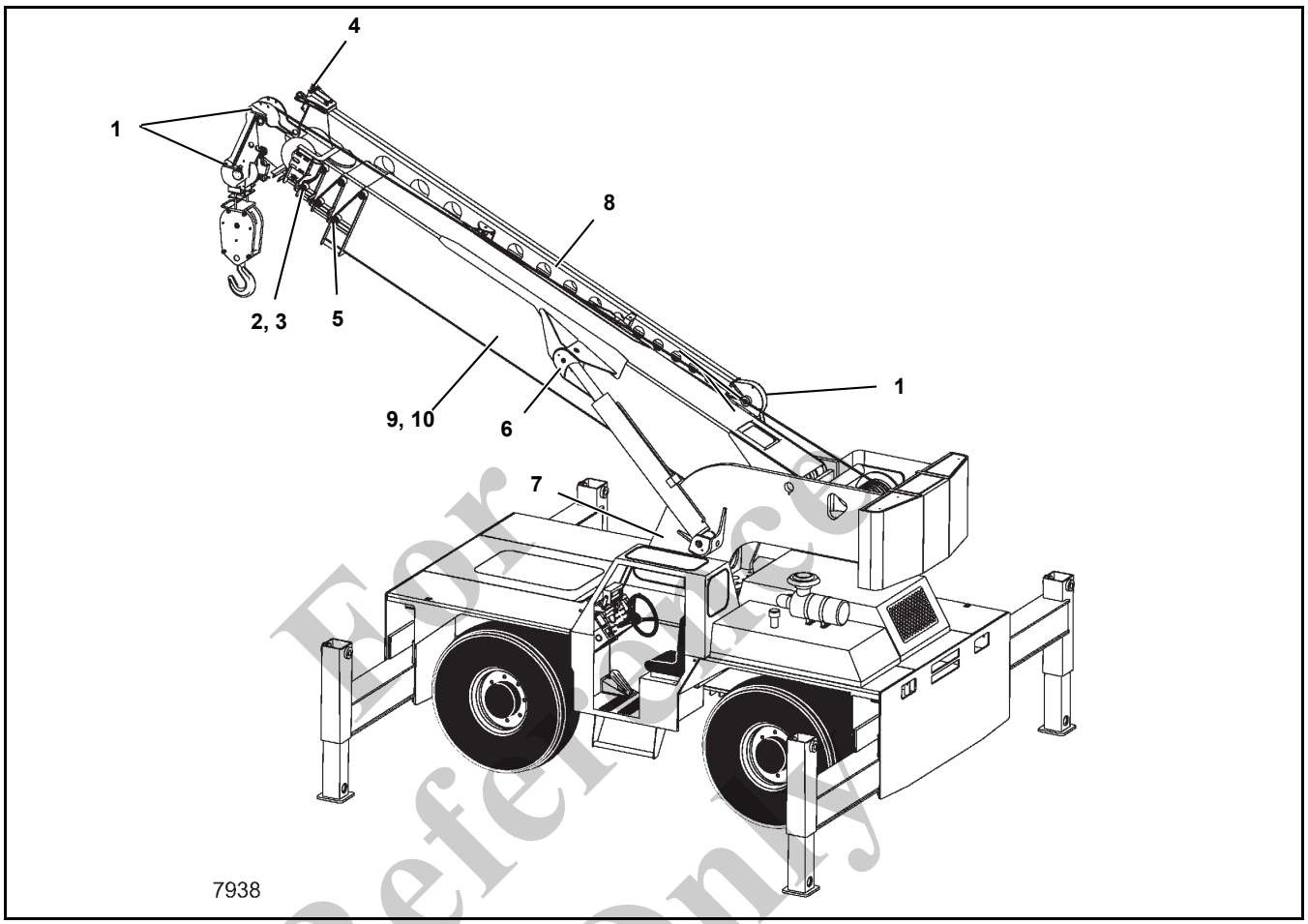
Boom Inspection



For Reference Only

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

Overload less than 25%			
1	Sheaves, Rope Guides	Inspect all for damage.	
2	Collar-Wear Pads, Pad Retainers	Inspect for damage.	
Overload from 25% to 49%			
1	Sheaves, Rope Guides	Inspect all for damage.	
2	Collar-Wear Pads, Pad Retainers	Inspect all for damage.	
3	Collar-welds	Inspect all for damage.	
4	Pinning Areas	Inspect all for cracks.	
5	Telescopic Sections	Inspect for bent or twisted sections. Check the boom for straightness.	
6	Lift Cylinder Head Area	Inspect for bends or cracked welds.	
7	Turret-Base Section	Inspect for cracked welds.	
8	Boom Extension 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.	

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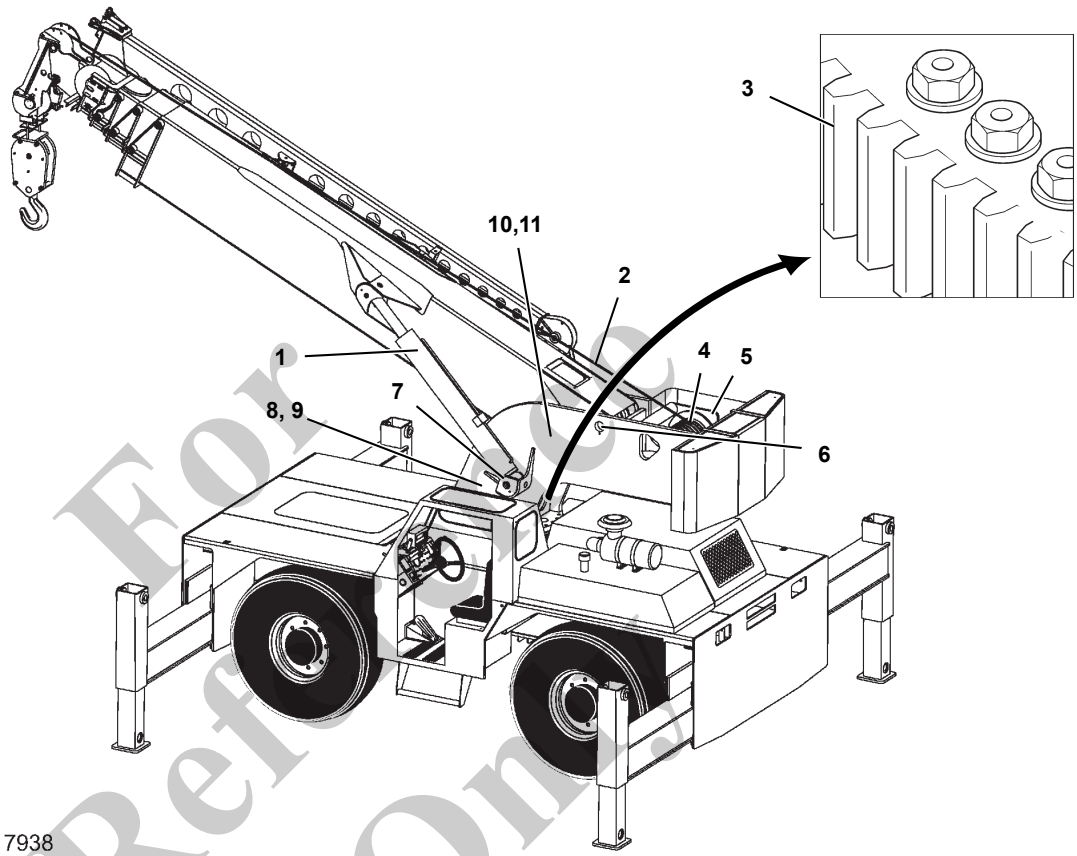
Superstructure Inspection



For Reference Only

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

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

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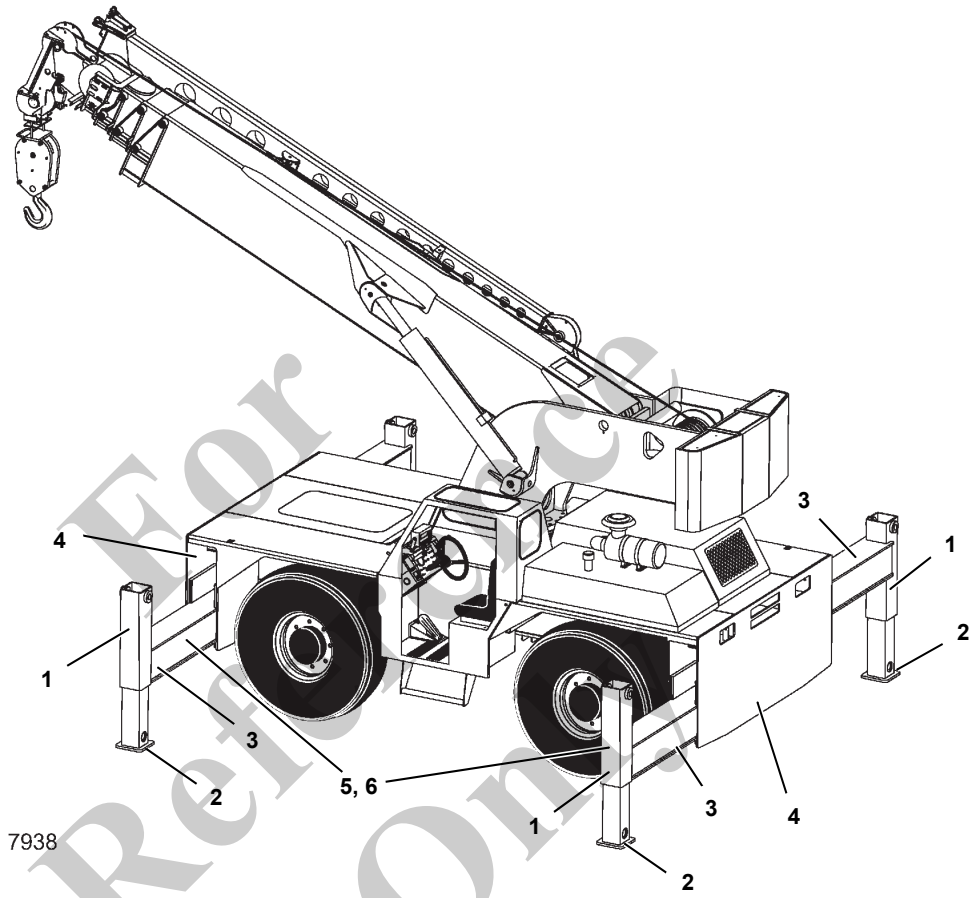
Carrier Inspection



For Reference Only

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

Overload less than 25%			
1	Jack Cylinders	Inspect for leaking.	
2	Outrigger Pads	Inspect for deformation and cracked welds.	
Overload from 25% to 49%			
1	Jack 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.	

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SECTION 3
OPERATING CONTROLS AND PROCEDURES

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CONTROLS, SWITCHES, AND GAUGES

Cab Controls

Refer to Figure 3-1.

Swing Control

The swing control (1) operates the boom/mast rotation function. The boom and mast will rotate continuously through a full 360°.

Telescope Control

The telescope control (2) extends and retracts the boom sections.

Hoist Control

The hoist control (3) raises and lowers the hookblock or headache ball.

Boom Lift Control

The boom control (4) raises or lowers the boom assembly.

Accelerator Pedal

Accelerator Pedal (5) 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.

Brake Pedal

Pressing down on the Brake Pedal (6) applies the service brakes located in the front and rear axles and slows and stops the crane.

Steering Wheel

The steering wheel (7) controls the direction of travel.

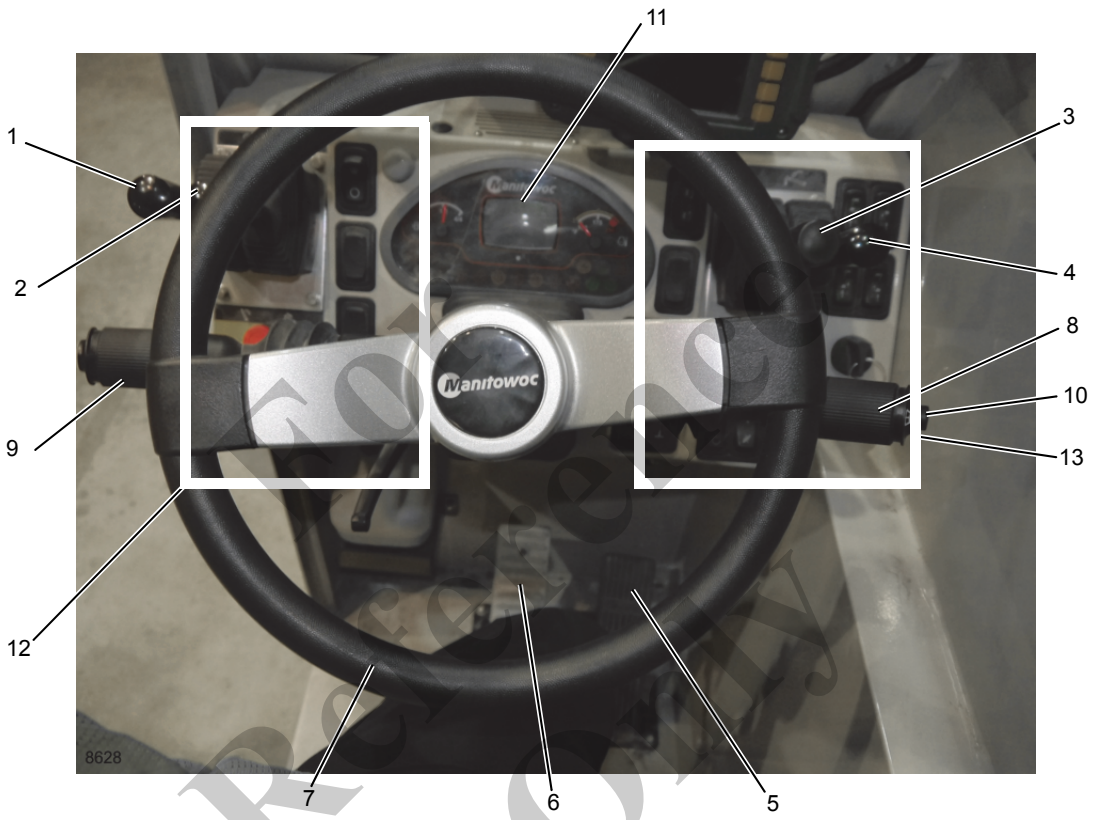


FIGURE 3-1

Item	Description
1	Swing Control Lever
2	Telescope Control Lever
3	Hoist Control Lever
4	Boom Lift Control Lever
5	Accelerator Pedal
6	Brake Pedal
7	Steering Wheel
8	Turn Signal/Windshield Wiper Lever
9	Transmission Shift Lever
10	Horn
11	Indicator and Gauge Display

Item	Description
12	Left Dash Controls
13	Right Dash Controls

Turn Signal/Windshield Wiper Lever

Used to indicate turning direction; push the lever (8) down for right turn signal and up for left turn signal.

The wiper switch has three settings; O, I, II. Rotate the switch to the desired speed.

Press on the end of the switch to operate the windshield washer.

Transmission Shift Lever

The Transmission Shift Lever (9) selects the forward and reverse travel of the crane as well as the speed ranges.

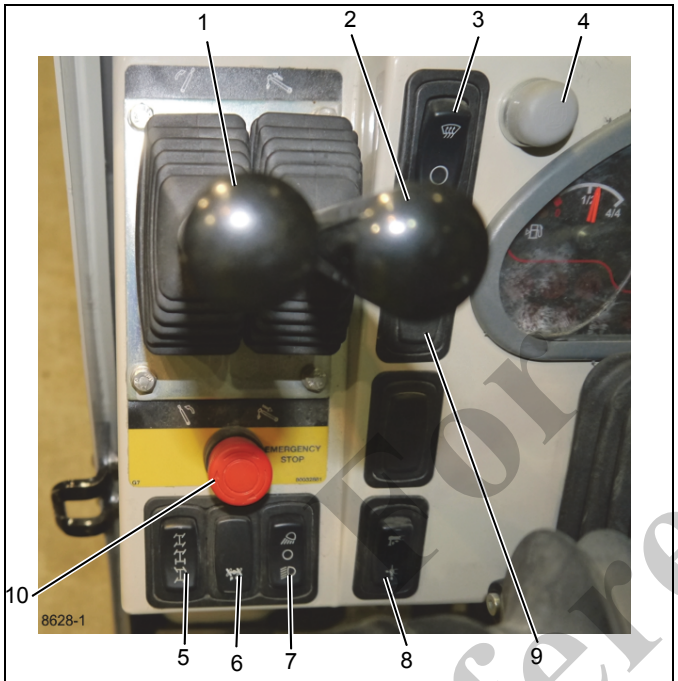
Reference Only

Horn

The Horn Button (10) on the end of the Turn Signal/ Windshield Wiper Lever is used to sound the crane's horn.

Left Dash Controls

Refer to Figure 3-2.



Left Dash Panel FIGURE 3-2

Item	Description
1	Swing Control Lever
2	Telescope Control Lever
3	Defroster Switch
4	Error Code Screen Toggle Switch
5	Steering Select Switch
6	Wheel Not Centered Indicator
7	Headlights/Work Lights Switch
8	Outrigger Extend/Retract Switch
9	Heat Only Fan Switch (Optional)
10	Emergency Stop Switch

Defroster Switch

The Defroster Switch (3) controls the windshield defroster fan.

Error Code Screen Toggle Switch

The Error Code Screen Toggle Switch (4) is a push-button switch used to scroll through the error codes shown on the LCD display, refer to *Diagnostic Fault Codes*, page 3-8.

Steering Select Switch

The Steering Select Switch (5) is used to select two-wheel steering, four-wheel steering or crab steering. Refer to *Steering Controls*, page 3-11.

Wheels Not Centered Indicator

The Wheels Not Centered Indicator (6) illuminates when the rear wheels are not centered.

Headlights/Work Lights Switch

The Headlights/Work Lights Switch (7) is a three position switch. Press the bottom of the switch to turn on the head and tail lights. Press the top of the switch to turn on the work lights. In the center position the lights are off.

Outrigger Extend/Retract Switch

The Outrigger Extend/Retract Switch (8) is used in conjunction with the outrigger select switches, refer to *Outrigger/Jack Select Switches*, page 3-4. Press the top of the switch to extend the outrigger/jack selected with the Outrigger/Jack Select Switch. Press the bottom of the switch to retract the outrigger/jack selected with the Outrigger/Jack Select Switch. Refer to *Outrigger Controls*, page 3-10.

Heat Only Fan Switch (Optional)

When the crane is equipped with the heat only (no air conditioning) option this switch (9) is used to operate the heater fan.

Emergency Stop Switch

The crane Emergency Stop Switch (10) is used to shut down the crane's engine. Push the red button in to shut down the engine. Rotate the knob and pull out to resume normal operation.

Reference Only

Right Dash Controls

Refer to Figure 3-3.

Right Dash Panel

FIGURE 3-3

Item	Description
1	Hoist Rotation Indicator
2	Hoist Control Lever
3	Boom Lift Control Lever
4	Outrigger/Jack Select Switches
5	Hazard Lights Switch
6	Crane Function Switch
7	Parking Brake Switch
8	Ignition Switch
9	Winch Switch (Optional)
10	Fuel Select Switch (Dual Fuel Engines)
11	Swing Lock Switch
12	Swing Lock Indicator
13	12 volt Accessory Outlet
14	Steer Synchronize Switch

Rated Capacity Limiter (RCL) Override Switch

The RCL Override Switch (1) (Figure 3-3) is a momentary type rocker switch, push and hold the top of the switch to disengaged the RCL controls. Releasing the switch allows the RCL controls to re-engage.

The RCL will be overridden only as long as the switch is depressed.

Pressing the top of the switch re-engages the boom down, telescope out and hoist up controls after these functions were disabled when an overload condition was sensed by the RCL. It is important to read and understand the RCL override warning information in the *RCL Operator's Manual* before using the RCL Override Switch.

Outrigger/Jack Select Switches

The Outrigger/Jack Select Switches (4) are used in conjunction with the Outrigger Extend/Retract Switch, refer to *Outrigger Extend/Retract Switch*, page 3-3. Press the top of the switch(es) to extend/retract the desired outrigger. Press the bottom of the switch(es) to extend/retract the desired jack. Refer to *Outrigger Controls*, page 3-10.

Hazard Lights Switch

The Hazard Lights Switch (5) causes all four turn signal lights to flash.

Crane Function Switch

The Crane Function Switch (6) is a two position switch. Press the top of the switch to enable all crane functions. Press the bottom of the switch to disable crane functions.

Reference Only

Parking Brake Switch

The Parking Brake Switch (7) is used to engage and disengage the parking brake. Press the top of the switch to engage the brake and the bottom of the switch to disengage the brake. The park brake must be engaged for operation of outriggers and to allow engine to start.

Ignition Switch

Turn the key (8) 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.

Winch Switch (Optional)

This switch (9) operates the optional winch mounted on the front end of the crane.

To **UNWIND** rope from the winch, press the top of the switch.

To **WIND** rope onto the winch, press the bottom of the switch.

Fuel Select Switch (Dual Fuel Engines Only)

Use the Fuel Select Switch (10) to select either gasoline or LPG fuel for the engine to run on.

When switching from either propane or gasoline, begin by first engaging the park brake. With the engine running on either propane or gasoline, place the Fuel Select Switch to the center position (fuel off). After the engine shuts down, push the Fuel Select Switch to the desired fuel type, then restart the engine.

360° Swing Lock Switch

This switch (11) engages the 360° swing lock to lock the turntable in any position. Press the bottom of the switch to engage the lock, press the top of the switch to disengage the lock.

360° Swing Lock Indicator

This indicator (12) illuminates when the swing lock is engaged.

12 volt Accessory Outlet

Use this outlet to power a 12 volt accessory with a maximum amperage of 10 amps.

Steer Synchronize Switch

Use this switch (14) to center the rear wheels if they become out of alignment when driving in two wheel drive mode.

For Reference Only

Indicator and Gauge Display-Dual Fuel

As a system check, the indicators will come on for two seconds when the ignition switch is turned to the RUN position.

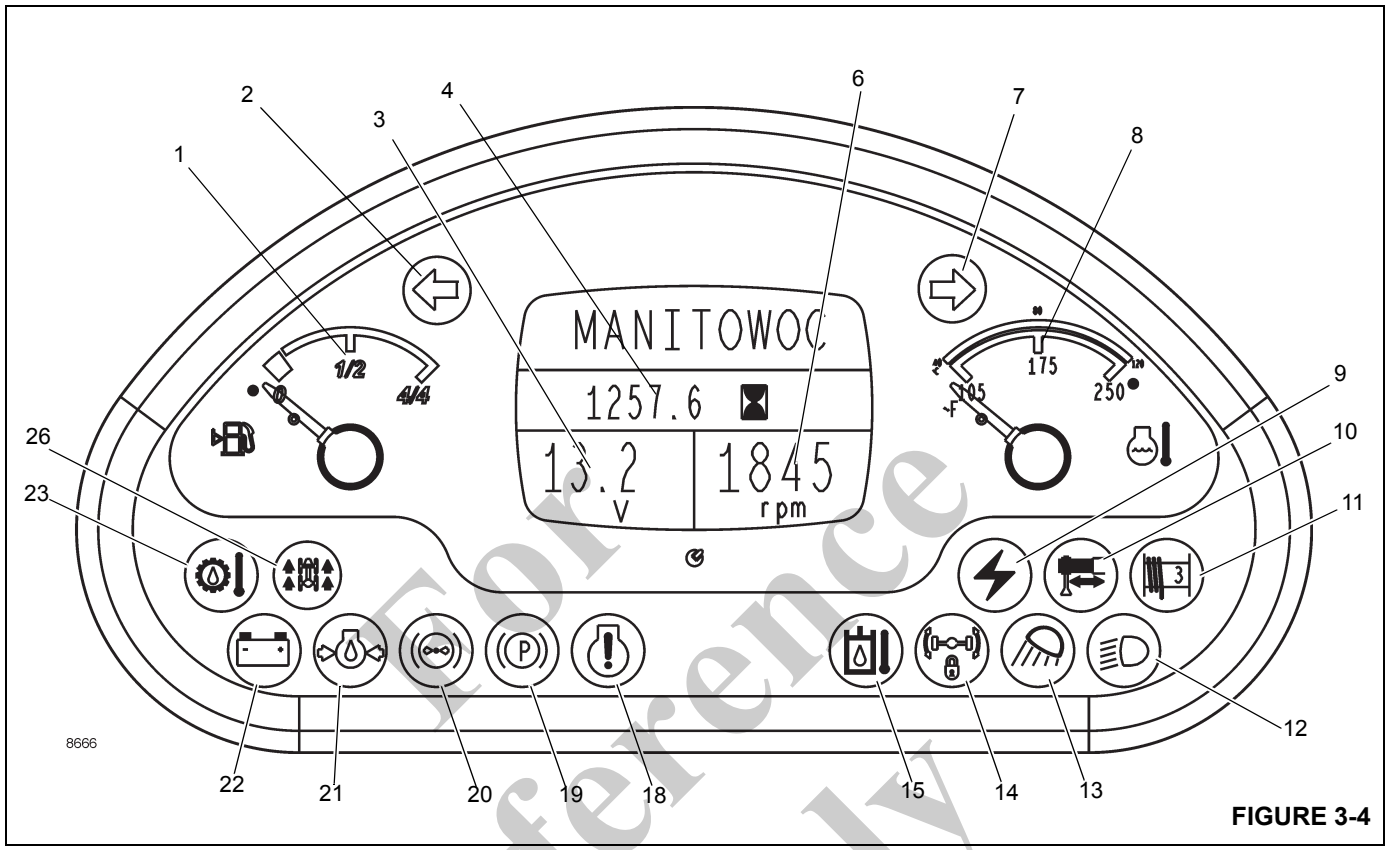


FIGURE 3-4

For Reference Only

Indicator and Gauge Display-Diesel

As a system check, the indicators will come on for two seconds when the ignition switch is turned to the RUN position.

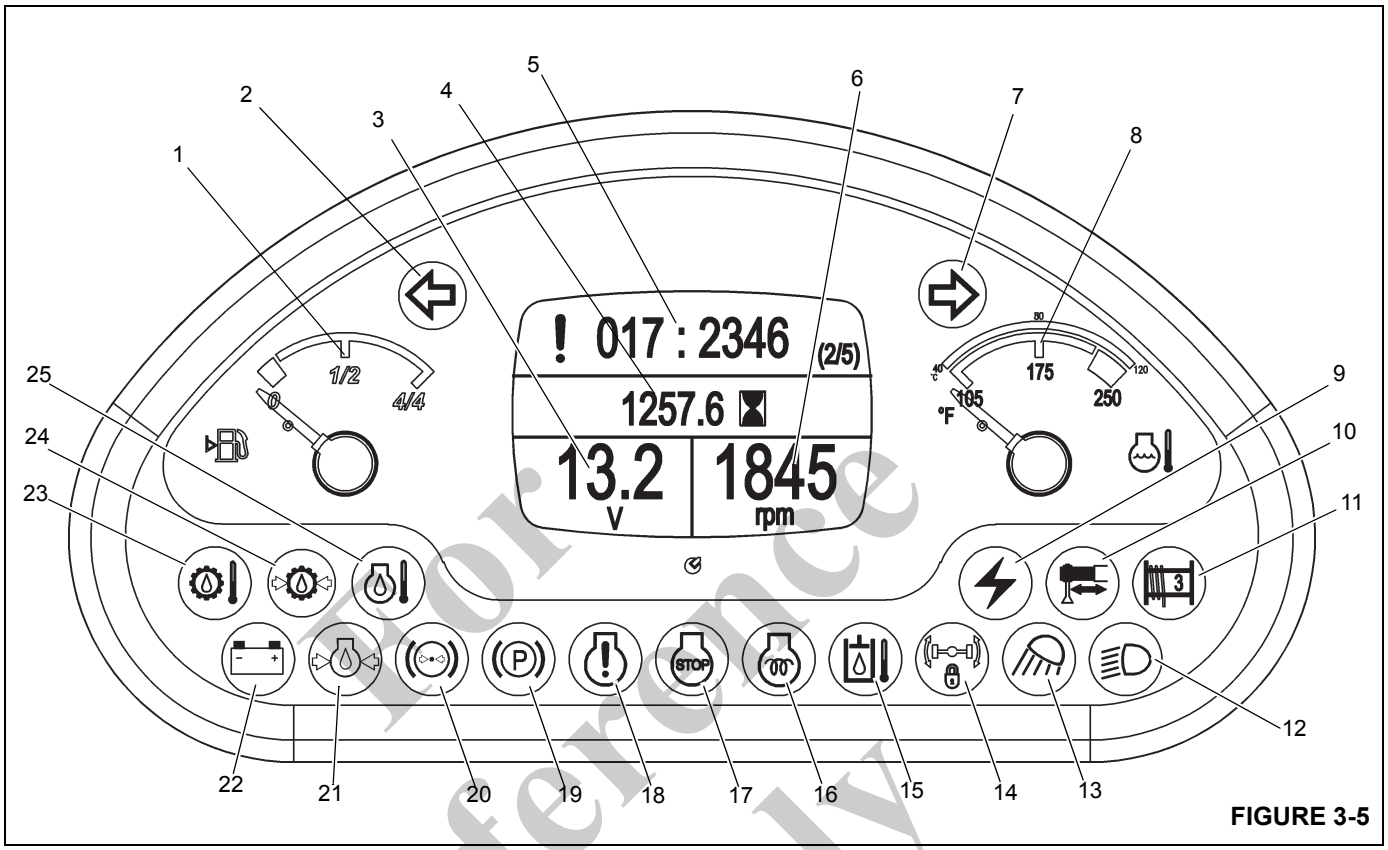


FIGURE 3-5

Figure 3-4 and Figure 3-5 Item Numbers

Item	Description
1	Fuel Gauge
2	Left Turn Signal
3	Voltmeter
4	Hour Meter
5	Error Code
6	Tachometer
7	Right Turn Signal
8	Coolant Temperature
9	Crane Functions Enabled
10	Outrigger Monitoring Indicator
11	Minimum Wrap Indicator
12	Headlights Indicator
13	Work Lights Indicator

Item	Description
14	Axle Lockout Indicator (Not Used)
15	Hydraulic Oil High Temperature Indicator
16	Engine Wait to Start Indicator
17	Engine Stop Indicator
18	Engine Warning Indicator
19	Parking Brake Indicator
20	Low Brake Pressure Indicator
21	Low Engine Oil Pressure Indicator
22	Low Battery Indicator
23	Transmission Oil High Temperature
24	Low Transmission Oil Pressure Indicator
25	Not Used
26	Four Wheel Drive Indicator

For Reference Only

Fuel Gauge

The Fuel Gauge (1) (Figure 3-5) indicates the quantity of fuel in the fuel tank and has a scale calibrated from 0 (empty) to 4/4 (full). The fuel gauge receives a signal from a sending unit in the fuel tank.

Left Turn Signal Indicator

The Left Turn Signal Indicator (2) is a green arrow light that flashes when the turn signal lever is pushed up or the Hazard Light Switch is positioned to On.

Voltmeter

The Voltmeter (battery gauge) (3) indicates the voltage being supplied to or from the batteries.

Hourmeter

The hourmeter (4) registers the total hours the engine has been operating. Use this display to determine when to perform preventive maintenance.

Diagnostic Fault Codes

The Diagnostic Fault Code display (5) indicates the current fault. The lower right numbers, i.e. 2/5, indicate the current error displayed and the total number of errors. With the ignition key in the RUN position use the Error Code Screen Toggle Switch to scroll through the current fault codes, refer to *Error Code Screen Toggle Switch*, page 3-3.

Tachometer

The Tachometer (6) displays engine RPM. The tachometer receives a signal from the engine ECM.

Right Turn Signal Indicator

The Right Turn Signal Indicator (7) is a green arrow light that flashes when the turn signal lever is pushed down or the Hazard Light Switch is positioned to On.

Engine Coolant Temperature Gauge

The Engine Coolant Temperature (water temp) Gauge (8) indicates the engine coolant temperature on a dual scale calibrated from 105 to 250°F and 40 to 120°C. The gauge receives a signal from the engine ECM and a temperature sending unit in the engine cooling system.

Crane Function Enabled Indicator

The Crane Function Enabled Indicator (9) illuminates amber when the crane functions hoist, telescope, boom lift and swing are enabled.

Outrigger Monitoring Indicator

The Outrigger Monitoring Indicator (10) illuminates green when all the outriggers have been fully extended. The jacks can be extended to level the crane.

Minimum Wrap Indicator

The Minimum Wrap Indicator (11) illuminates red when the wire rope is down to the last three wraps on the hoist drum. The hoist down, telescope out and boom lift functions will be disabled.

Headlights Indicator

The Headlights Indicator (12) illuminates green when vehicle headlights and tail lights are on.

Work Lights Indicator

The Work Lights Indicator (13) illuminates green when the work lights are on.

Axle Lockout Indicator (Not Used)

Hydraulic Oil High Temperature Indicator

The Hydraulic Oil High Temperature Indicator (15) illuminates red when the hydraulic oil temperature exceeds 93°C (200°F). When this indicator illuminates, set down the load as soon as possible, turn off the engine and try to find the cause of the high hydraulic oil temperature.

Engine Wait to Start Indicator

The Engine Wait to Start Indicator (16) illuminates amber for a period of time when the ignition switch is in the On position. The engine should not be cranked until the Wait to Start light turns Off. This light is controlled by the engine ECM.

Engine Stop Indicator

The Engine Stop Indicator (17) illuminates red when energized by a signal from the engine ECM. This indicator will stay lit until the engine fault code is cleared.

If this indicator light illuminates note the fault code and shut off the engine and refer to the *Engine Operator's Manual*.

Engine Warning Indicator

The Engine Warning Indicator (18) illuminates amber when energized by a signal from the engine ECM. This indicator will stay lit until the engine fault code is cleared.

If this indicator light illuminates note the fault code and refer to the *Engine Operator's Manual*.

Parking Brake Engaged Indicator

The Parking Brake Engaged Indicator (19) illuminates red when the crane parking brake is engaged.

For Reference Only

Low Brake Pressure Indicator

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.

The Low Brake Pressure Indicator (20) illuminates red when the pressure of the brake system falls below the operational range. Stop the crane immediately and determine the cause of the low brake pressure. Do not drive the crane until the problem has been repaired. The light will illuminate briefly when the brake system charges during operation.

Low Engine Oil Pressure Indicator

The Low Engine Oil Pressure Indicator (21) illuminates red when the engine oil pressure falls below the operational range. Lower the load to the ground and stop the engine until the cause of the low engine oil pressure is resolved.

Battery Charge Indicator

With the engine running, the Battery Charge Indicator (22) illuminates red if battery system voltage is below nine (9) volts, engine ECM voltage is below nine (9) volts, or there is no alternator charge signal present.

If the engine is running and the Battery Charge Indicator illuminates, investigate possible alternator, alternator fuse, alternator wiring, or engine drive belt problems.

When the engine is not running and the Ignition Switch is in the ACC or RUN position, the Battery Charge Indicator turns on to indicate the batteries are being drained and not being charged.

Transmission Oil Temperature Indicator

The Transmission Oil Temperature Indicator (23) illuminates red during high transmission oil temperature conditions.

Low Transmission Oil Pressure Indicator

The Low Transmission Oil Pressure Indicator (24) illuminates red during low transmission oil pressure conditions. If the light illuminates, shut down the engine immediately and do not restart it until the problem has been repaired.

Crane Level Indicator

This is a bubble-type indicator (Figure 3-6) that allows the operator to level the crane when using the outrigger controls. See *Bubble Level Adjustment*, page 3-19.

FIGURE 3-6

Engine Warning and Stop Lights

The engine warning light is part of a system that monitors engine operating conditions. When an operating condition is outside of calibration limits an engine derate results.

In operation, an engine electronic control module monitors engine operating conditions while the engine is running. If one of the critical operating conditions exceeds the engine protection limit, an engine derate will occur and the warning light will illuminate. The severity of the derate will vary according to which engine operating condition has exceeded its engine protection limit. Also, the severity of the derate may vary in relation to the severity of the event (Example: Coolant temperature is slightly above a threshold for a short period of time will result in a mild derate compared to a coolant temperature over a threshold for a longer time).

If the condition persists, the stop lamp (Figure 3-5) will flash to warn the driver that the engine should be shut down and the problem resolved before starting the engine again.

NOTE: If the engine stop light is illuminated, lower any load and shut off the engine. If the engine is not shut off, damage to the engine could occur. Before starting the engine again locate and resolve the problem.

Rated Capacity Limiter (RCL)

The RCL (1, Figure 3-7) provides information on angle, load, radius, capacity, etc. and allows the operator to set limits for these variables.

For operating instructions, refer to the RCL manual provided.

For Reference Only

FIGURE 3-7

Air Conditioning/Heater Controls

The Fan Switch (1) (Figure 3-8) is a four-position switch which controls the speed of the fan.

The A/C Thermostat Control (2) is used to regulate the temperature of the air that is delivered.

The Heater Thermostat Control (3) is used to regulate the temperature of heated air that is delivered.

The air vents (4) are used to direct the air.

The air filter (5) can be removed and cleaned. Refer to *Heater/Air Conditioner*, page 3-12.

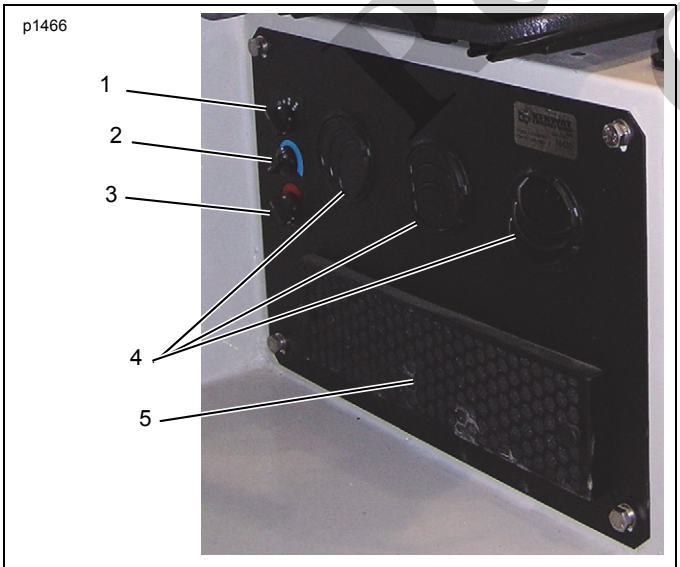


FIGURE 3-8

Boom Angle Indicator

The boom angle indicator (Figure 3-9) is a plumb arrow and a decal with angular graduations from -10° to 80°. One 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.

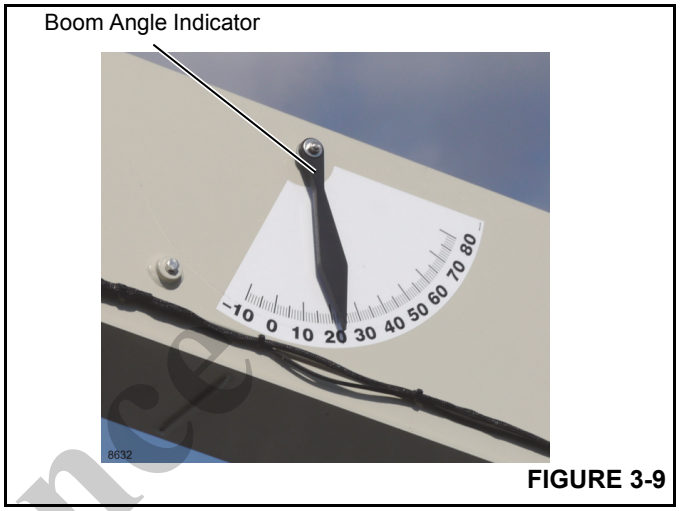


FIGURE 3-9

Outrigger Controls

DO NOT allow any persons to stand near extending or lowering outriggers. Foot crushing could occur.

NOTE: For maximum lift and stability, fully extend and lower the outriggers. Be sure the crane is level before lifting a load. The bubble indicator (1, Figure 3-10) located next to the seat is to be used to determine when the crane is level. The bubble must be in the center of the indicator circle. Use the outriggers to level the crane. If this is not possible, reposition the crane until the bubble is centered.

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 3-19.

For Reference Only

FIGURE 3-10

Steering Controls

The crane can be operated in three steering modes:

- Two-Wheel Steering Mode
- Four-Wheel Steering Mode
- Crab Steering Mode

These modes are selected using the Steering Selector Switch (1, Figure 3-11). The steering mode will not change until all four wheels are returned to center. If the front wheels are centered and the rear wheels do not align with them the rear wheels will need to be synchronized to re-align. Perform the following to synchronize the front and rear wheels.

1. Center the front wheels.
2. Place steer select switch in four wheel steer mode.
3. Push and hold the steer synchronize switch (1, Figure 3-12).
4. While holding in the steer synchronize switch, turn the steering wheel in the desired direction to center the rear wheels.
5. Continue turning the steering wheel until the rear wheels not centered indicator lamp in the dash goes out indicating the wheels are now centered.
6. Release the steer synchronize switch.
7. Place the steer selector switch in two wheel steer mode and center the front wheels.
8. With both front and rear wheels now centered the unit is now ready for desired steer mode to be selected.

FIGURE 3-11

FIGURE 3-12

The steering modes are shown in Figure 3-13, 3-14, and 3-15.

Two-Wheel Steer Mode

The front wheels steer the crane (Figure 3-13). The rear wheels remain in the fixed straight ahead position. This mode is used for highway travel and traveling at higher speeds.

For Reference Only

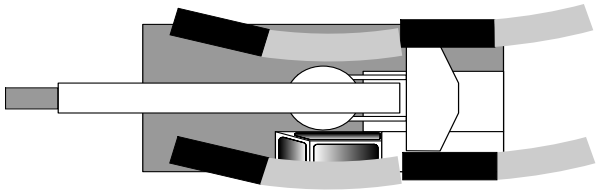


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FIGURE 3-13

Four-Wheel Steer Mode

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

The front wheels steer in the direction that the steering wheel is turned and rear wheels turn in the opposite direction (Figure 3-14). This mode allows for an extremely short turning radius. It enables the rear wheels to follow the track of the front wheels.

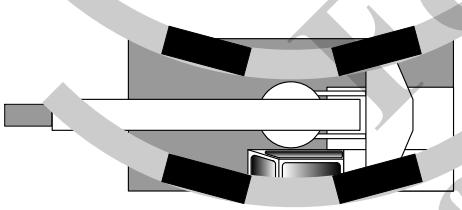

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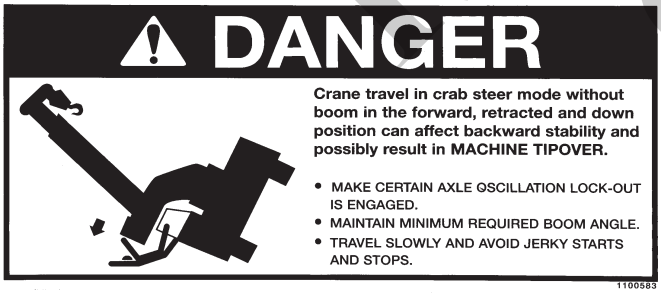
FIGURE 3-14

Crab Steer Mode



All wheels steer in the same direction (Figure 3-15). 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.

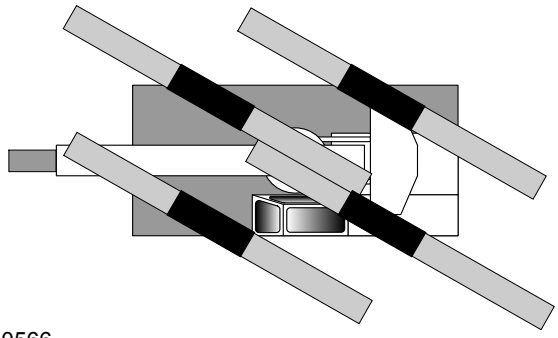


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FIGURE 3-15

OPERATOR'S CAB

Heater/Air Conditioner

The cab heater/ air conditioner (furnished as an option with enclosed cabs) is located under the operator's seat (1, Figure 3-16).

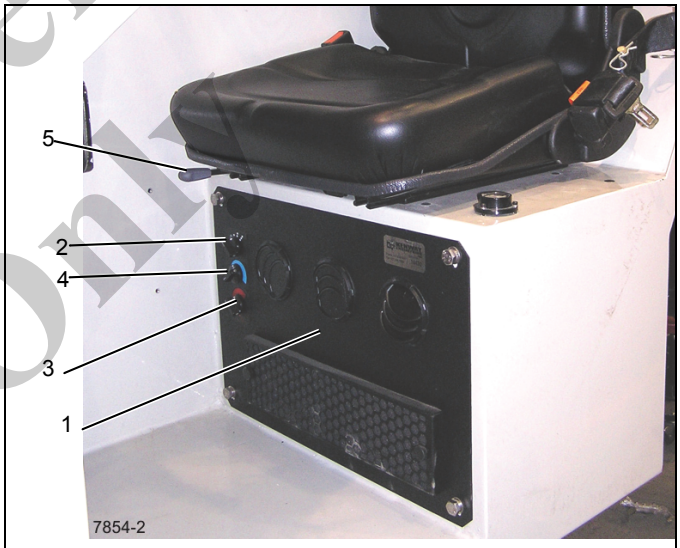

FIGURE 3-16

NOTE: When operating the heater ensure the shut-off valve (1, Figure 3-17) in the hot water supply line on the engine is open.

For Reference Only

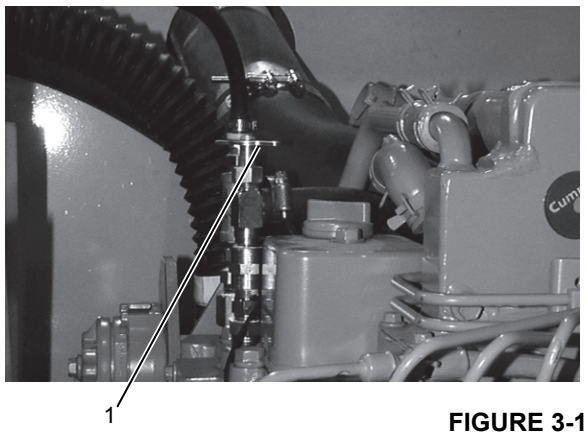

FIGURE 3-17

To operate the heater, use the fan switch (2, Figure 3-16) in conjunction with the heater control (3) to select the desired fan speed and amount of heat.

To operate the air conditioner, use the fan switch (2, Figure 3-16) in conjunction with the air conditioner control (4) to select the desired fan speed and amount of air conditioning.

Position the vents on the heater/air conditioner for desired amount and direction of air flow.

To clean the intake filter, remove the thumb screws and wash the filter element in soap and water.

Defroster

The windshield defroster vent is located on top of the instrument panel (1, Figure 3-18)

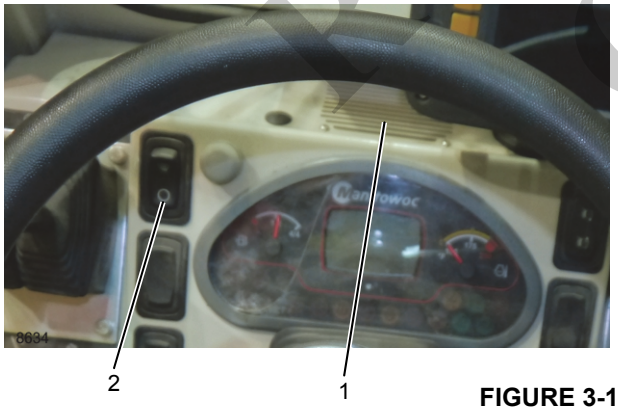

FIGURE 3-18

To operate the defroster, use the defroster switch (2) located on the instrument panel.

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 (5, Figure 3-16) to the right. Move the seat to proper position and then move the control lever back to the left to lock the seat position.

NOTE: The seat can be removed for cleaning and/or maintenance by holding the control lever and sliding the seat completely forward off the slider tracks.

Seat Belt

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

Cab Door (Enclosed Cab)

Opening the Cab Door from Outside

Pull the door handle out to release the cab door latch. (Figure 3-19).

FIGURE 3-19

Opening the Door from Inside

Pull the door handle back to release the cab door latch (Figure 3-20).

For Reference Only

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FIGURE 3-20

Locking the Cab Door

The cab door can be locked from the outside. Insert the key and turn it to the left to lock the door. Turn the key to the right to unlock the door. The door key number is stamped on the lock if additional keys are required.

Opening Side Window

The left side window is opened by pulling on the latch and sliding the window rearward.

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.

7458-4

FIGURE 3-21

CRANE OPERATION

Starting the Engine

Normal Engine Starting

NOTE: 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.

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

3. Check that the parking brake (Figure 3-22) is engaged, press the top of the switch.

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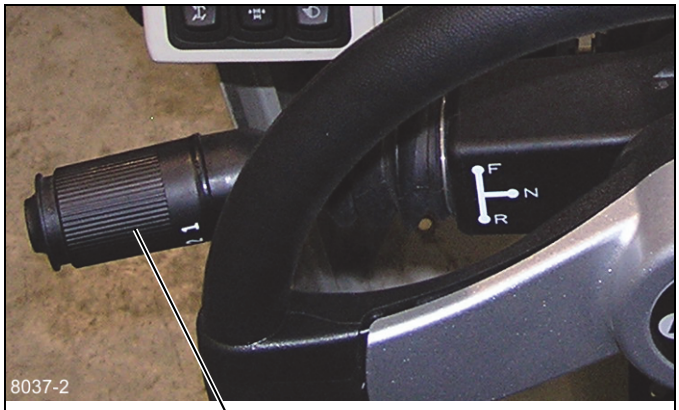
FIGURE 3-22

For Reference Only

4. Place the travel select lever (Figure 3-23) in the neutral (N) position.



Travel Select Lever

FIGURE 3-23

CAUTION

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

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

NOTE: **DO NOT** operate the engine at full RPM or apply a full load until the engine is warm.

The diesel engine in this crane is equipped with an air intake heating system. When starting the engine in cold weather the *Engine Wait to Start Indicator*, page 3-8 will illuminate. Do not attempt to start the engine until this indicator goes out.

5. Turn the ignition switch to the START position to crank the engine. Release the switch when the engine starts. Do not press the accelerator pedal, the engine ECM will determine the proper idle speed.

   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.

6. Check the engine oil pressure warning light. See Figure 3-5. If the warning light is illuminated, shut down the engine immediately. Have the engine serviced before placing the crane in service.

7. 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 (See *Towing a Disabled Crane*, page 3-30).

8. Disengage the parking brake before you travel with the crane. See *Crane Warm-up Procedures*, page 3-15.

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.

JUMP STARTING THE CRANE

Do not attempt to jump start the crane.

CAUTION

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

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

The batteries should be completely disconnected from the crane electrical system and charged using a battery charger of appropriate voltage level or replace the batteries with fully charged batteries.

Charging

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

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

COLD CLIMATE ENGINE OPERATION

NOTE: Additional information regarding cold weather operation 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.

For Reference Only

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

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

CAUTION

Crane Damage Hazard!

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

Always use Grove 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 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 Industrial Cranes:

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

Hoist

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

Warm-up Procedures:

1. Without operating the hoist function, warm the hydraulic oil (see *Hydraulic Oil System*, page 3-17).
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 3-16) and allow crane to run at idle until the temperature of the transmission sump reaches normal operating temperature.

For Reference Only

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 Grove 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.

Traveling with the Crane

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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.

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

2. Start the engine, place your foot on the brake pedal to apply the service brake and disengage the parking brake.

NOTE: The transmission will not shift into forward or reverse unless the service brake is applied.

CAUTION

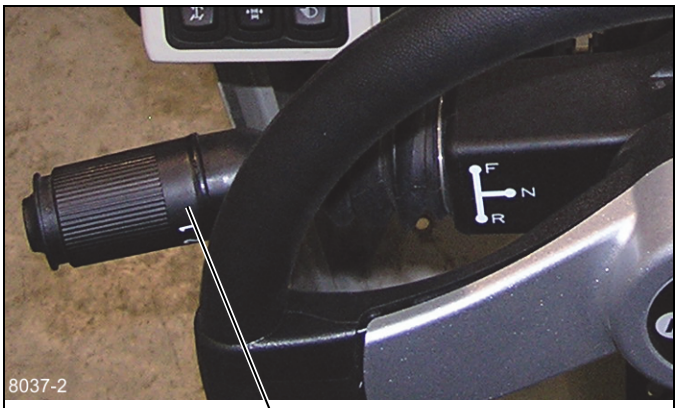
Avoid Crane Damage!

Do not engage the parking brake while the vehicle is moving. Damage to the crane can occur.

Disengage the parking brake before driving. Damage to the crane can occur.

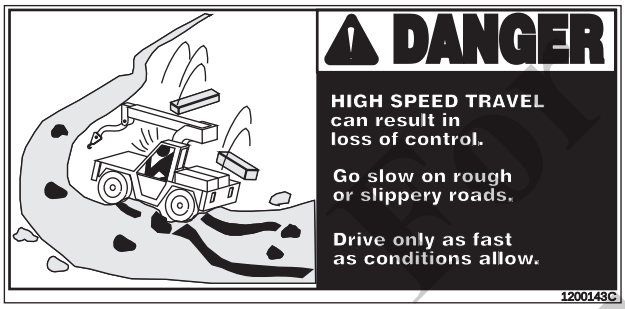
3. Select either the Forward (F) or Reverse (R) travel position on the transmission shift lever (see Figure 3-24).

For Reference Only



Travel Select Lever (Typical)

FIGURE 3-24



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- 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 gear. 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 a gear 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**.

NOTE: Check the instrument panel gauges frequently during operation. Any abnormal readings should be investigated and corrected as soon as possible.

Changing Travel Direction

1. It is recommended that the crane come to a complete stop before changing travel direction.
2. Move the travel select lever to the opposite travel direction.

Shifting Gears

NOTE: The transmission used on this crane is not an automatic transmission. It is a power shift transmission. The gears and clutches will not shift automatically. Each gear range must be shifted manually.

The service brake pedal must be depressed before a forward or reverse direction can be selected.

1. Up shifting to the next gear may be done at any engine speed, while the crane is in motion, but first ease up on the accelerator pedal.
2. When downshifting, do not over-rev the engine. Allow the crane to slow down before shifting to the next lower gear. Downshifting is subject to speed limitations. If the speed is too high a repeated double beep is sounded and will continue until the speed drops below the limit or downshift is deselected.
3. It is recommended that the crane come to a **complete stop** before shifting between forward and reverse.

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.
- Downshifting at high speeds causing the engine to over rev.

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 transmission 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.

Reference Only

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 *To Extend and Lower the Outriggers*, page 3-19.

A working crane may settle during lifting operations. Frequently check the crane for level. When rechecking the crane for level, the boom must be positioned over the front of the crane, fully lowered to horizontal and fully retracted (for cranes fitted with a boom rest, the boom shall be stowed onto the rest). If necessary, re-level the crane using the procedures under *To Extend and Lower the Outriggers*, page 3-19.

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. Engage the park brake and 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.

To Extend and Lower the Outriggers

The most common way of extending and retracting the outriggers is to extend and retract the four outriggers at the same time. Individual operation is accomplished by selecting the desired Outrigger/Select Switch.

NOTE: The outriggers will not operate unless the park brake is engaged.

Extending the outriggers

1. Place the Outrigger/Jack selector switches (1, Figure 3-26) in the outrigger position—push the top of the switch.
2. Run the engine at idle speed (accelerator pedal released).
3. Push the top of the Extend/Retract Switch (2).
4. Press the accelerator pedal to increase the engine speed, which will accelerate the outward movement of the outriggers (Figure 3-25). Release the accelerator pedal and the switch when the outriggers are fully extended.

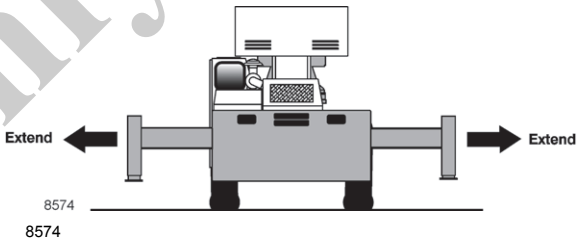

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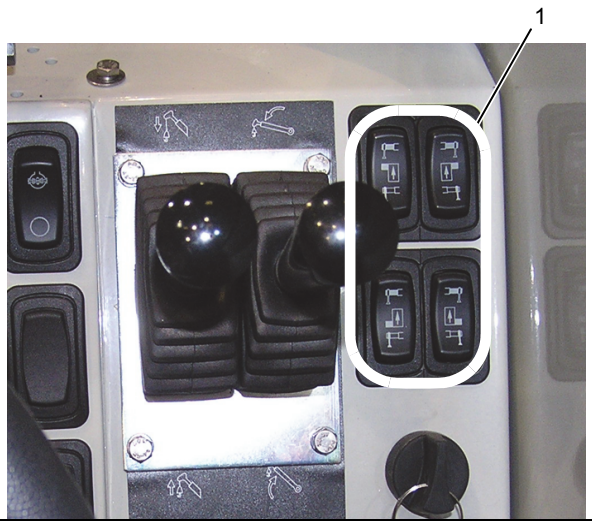
FIGURE 3-25

For Reference Only



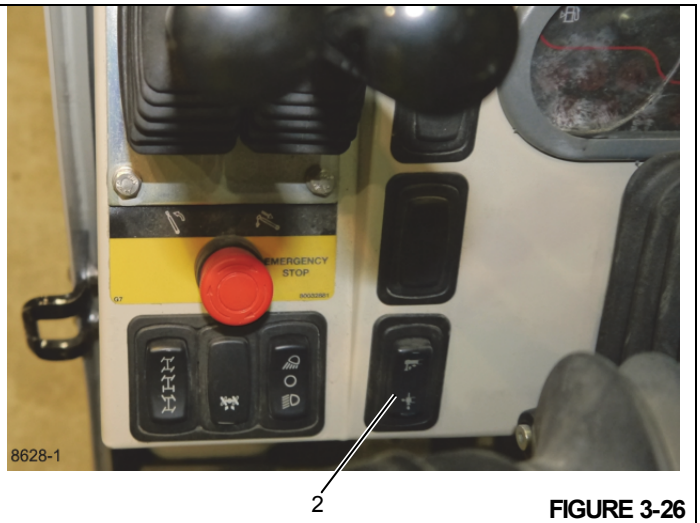


FIGURE 3-26

Lowering the Jacks

1. Place the Outrigger/Jack selector switches (1, Figure 3-26) in the jack position—push the bottom of the switch.
2. Engage the park brake.
3. Run the engine at idle speed (accelerator pedal released).
4. Push the top of the Extend/Retract Switch (2).
5. Press the accelerator pedal to increase the engine speed, which will accelerate the downward movement of the jacks (Figure 3-27). Release the accelerator pedal and the switch when the jacks are fully extended.

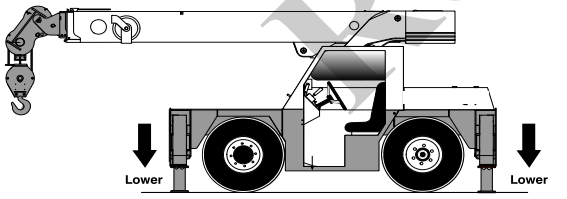


FIGURE 3-27

NOTE: The outriggers can not be extended or retracted when they are in the lowered position. Attempting to do this will cause damage to the outriggers.

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

The Outrigger Monitoring System (OMS) aids the operator by using an indicator (1, Figure 3-28) 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*, page 3-19. The OMS indicator only indicates the fully extended position of the outrigger beam and should not be used to deploy the beam.

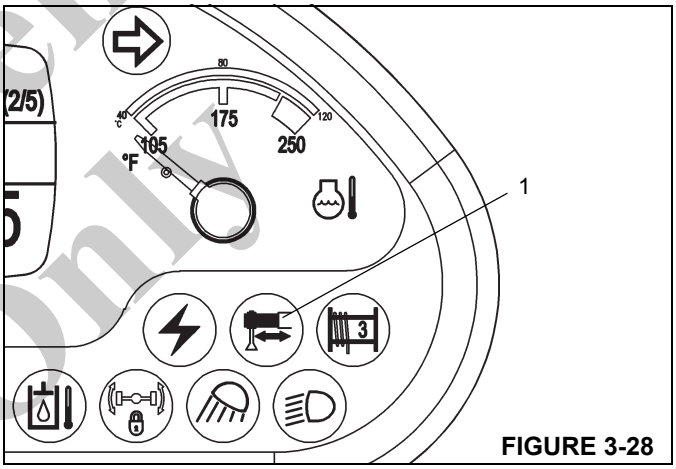


FIGURE 3-28

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

Each proximity switch senses the presence of it's respective outrigger beam until the beam reaches it's 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 (1, Figure 3-28) 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

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can only be made per the “outriggers retracted” or “on rubber” *Load Charts*.

Outrigger beam position monitor is not interfaced with the rated capacity limiter system (if equipped), the crane operator is responsible for selecting the correct load chart.

Raising the Jacks

1. Place the Outrigger/Jack selector switches (1, Figure 3-26) in the jack position—push the bottom of the switch.
2. Engage the park brake.
3. Run the engine at idle speed (accelerator pedal released).
4. Push the bottom of the Extend/Retract Switch (2).
5. Press the accelerator pedal to increase the engine speed, which will accelerate the upward movement of the jacks (Figure 3-29). Release the accelerator pedal and the switch when the jacks are fully retracted.

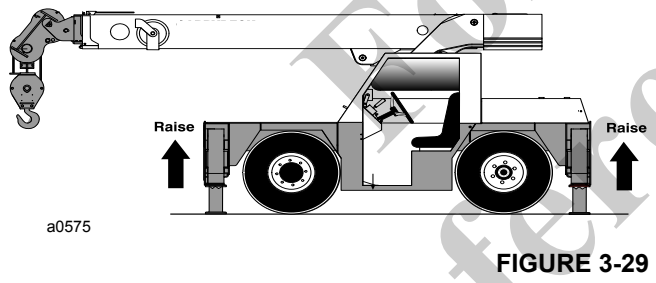

FIGURE 3-29

Retracting the Outriggers

1. Place the Outrigger/Jack selector switches (1, Figure 3-26) in the outrigger position—push the top of the switch.
2. Run the engine at idle speed (accelerator pedal released).
3. Push the bottom of the Extend/Retract Switch (2).
4. Press the accelerator pedal to increase the engine speed, which will accelerate the inward movement of the outriggers (Figure 3-30). Release the accelerator pedal and the switch when the outriggers are fully retracted.

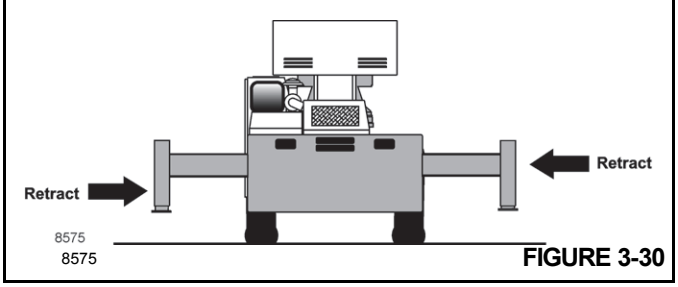

FIGURE 3-30

Operating the Boom Controls

Four levers in the operator’s cab control the boom functions. See Figure 3-1. These levers are connected to the main control valves by hydraulic pilot lines. The function of each control is shown in Figure 3-31.

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.

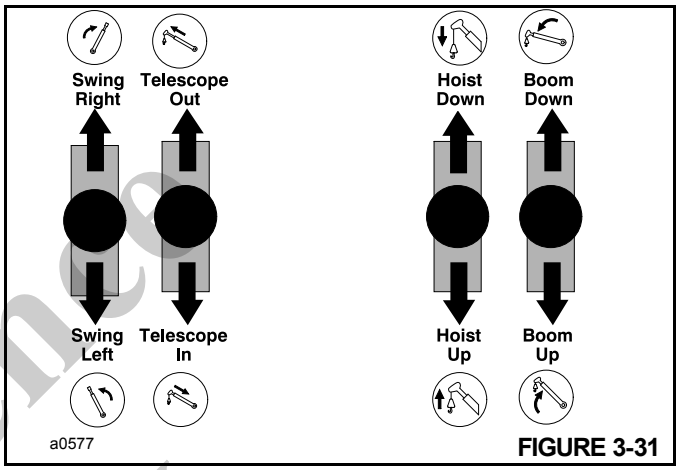

FIGURE 3-31

NOTE: The function speeds can also be controlled by engine RPM. The slower the RPM the slower the function speed.

Boom Swing Operation

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 3-32) until the desired swing speed is obtained. The

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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 to the Right (Clockwise)

Press the accelerator pedal to increase the engine speed to maximum RPM. Slowly push forward on the swing control lever (Figure 3-32) 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.

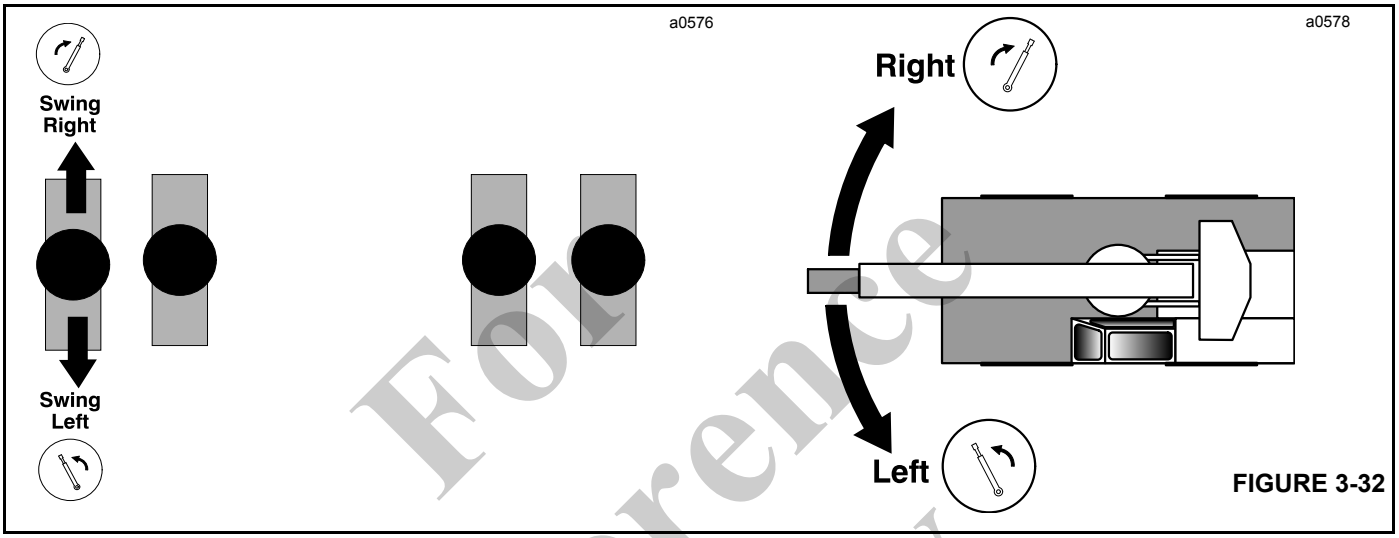

FIGURE 3-32

Boom Telescope Operation

WARNING

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 prevent the drop block from being pulled into the boom head. When the drop block touches the anti-double blocking bracket (Figure 3-33) 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.

To Extend the Boom

Press the accelerator pedal to increase the engine speed to maximum RPM. Slowly push forward on the telescope control lever (Figure 3-34) until the desired extend speed is obtained. The further the control is pushed forward the faster the boom will extend.

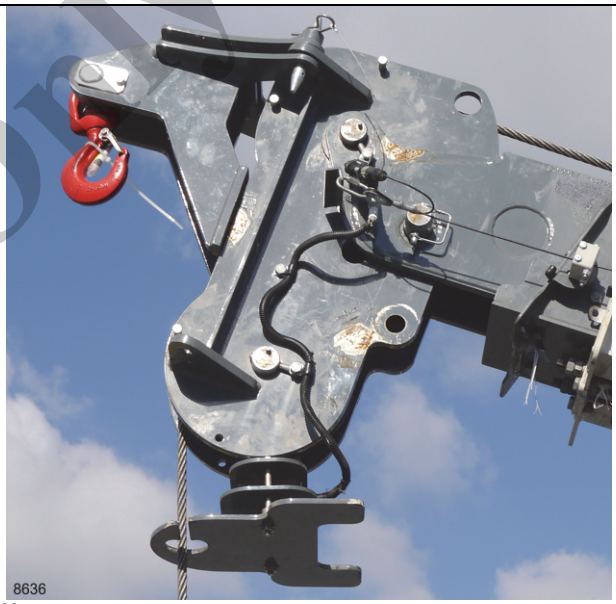

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FIGURE 3-33

To Stop Extension/Retraction

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

To Retract the Boom

Press the accelerator pedal to increase the engine speed to maximum RPM. Slowly pull back on the telescope control

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lever (Figure 3-34) until the desired retract speed is obtained. The further the control is pulled back the faster the boom will retract.

WARNING

When lifting at high boom angles with an extended boom, it is crucial to maintain proper side slide pad adjustment. Visually check the lateral straightness of the boom before raising the load. Lifting with a boom which is not visually straight may cause boom failure and could result in injury or death.

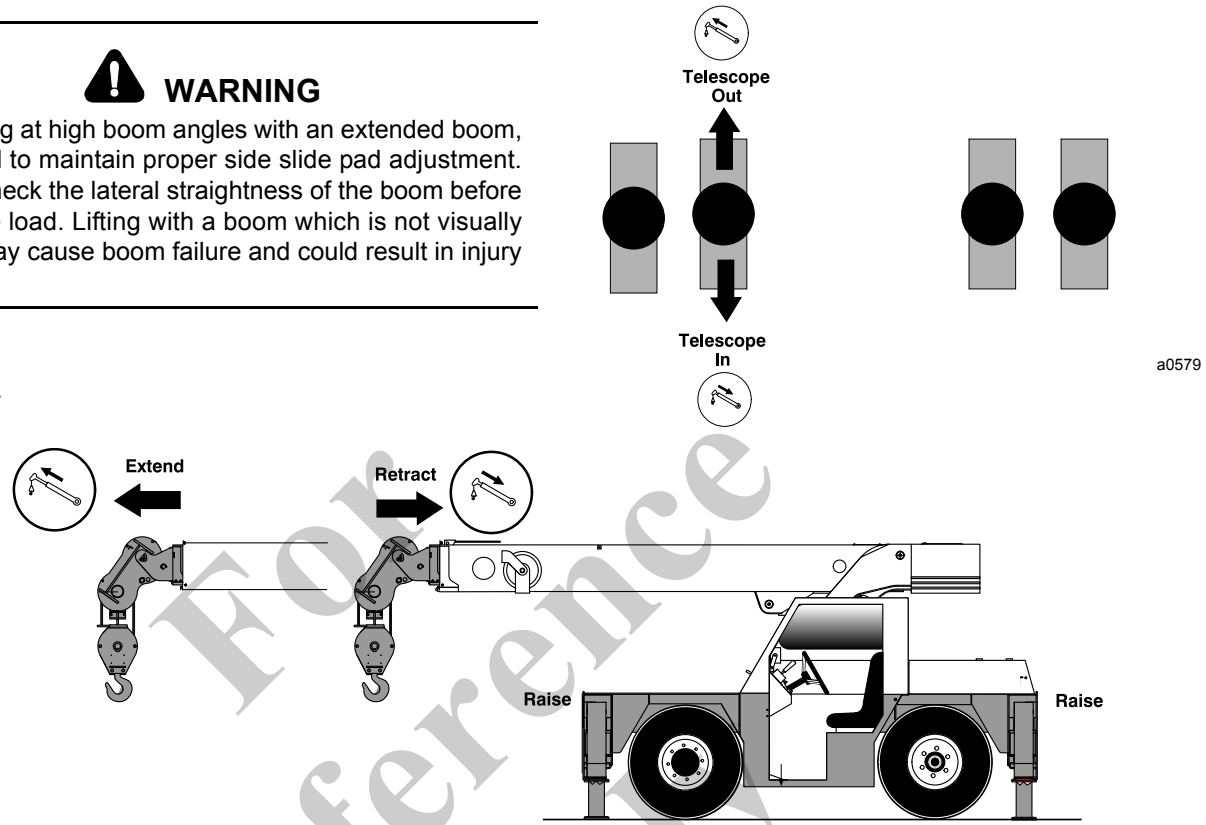
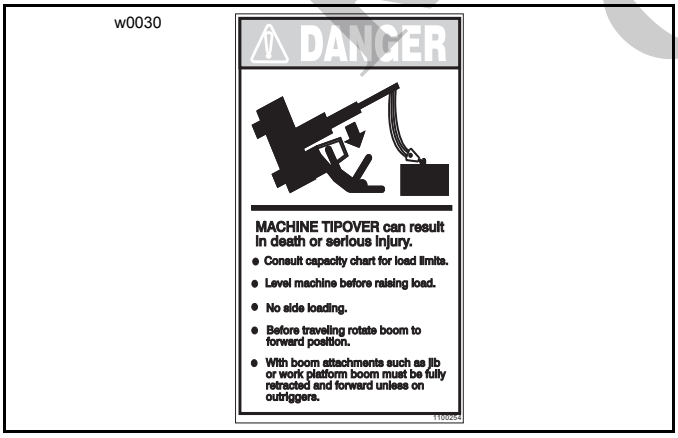
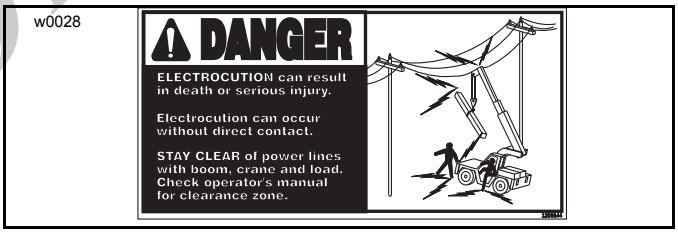


FIGURE 3-34

Boom Lift Operation



Know the capacity of the crane. The operator must be familiar with the crane's capacity chart before lifting a load. See *Capacity Chart*, page 4-1. A falling load or crane tip-over can cause injury or death.



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

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 3-35) until the desired raising speed is obtained. The further the control is pulled back the faster the boom will raise.

For Reference Only

To Stop Boom Movement

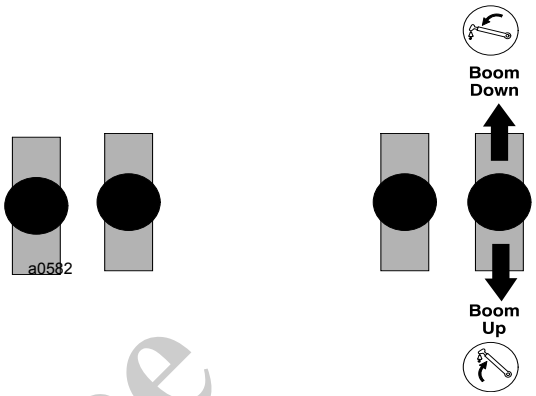
Slowly move the control lever to the neutral position and decrease the engine speed to idle.

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 3-35) until the desired lowering speed is obtained. The further the control is pushed forward the faster the boom will lower.

WARNING

When lifting at high boom angles with an extended boom, it is crucial to maintain proper side slide pad adjustment. Visually check the lateral straightness of the boom before raising the load. Lifting with a boom which is not visually straight may cause boom failure and could result in injury or death.



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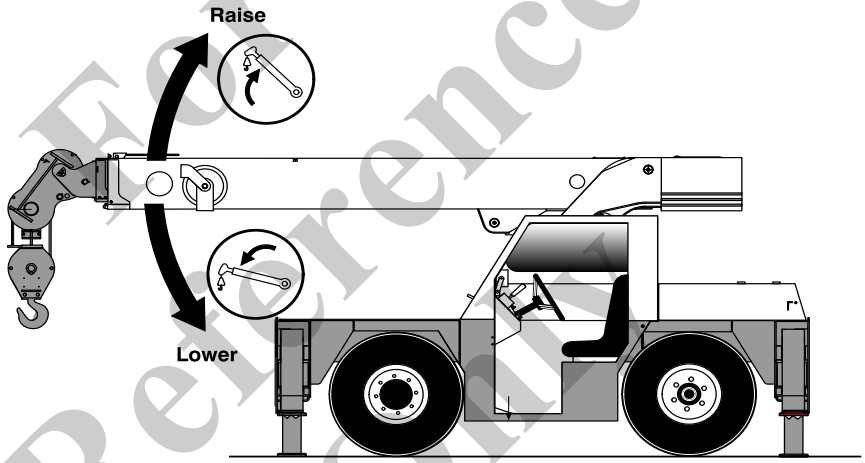
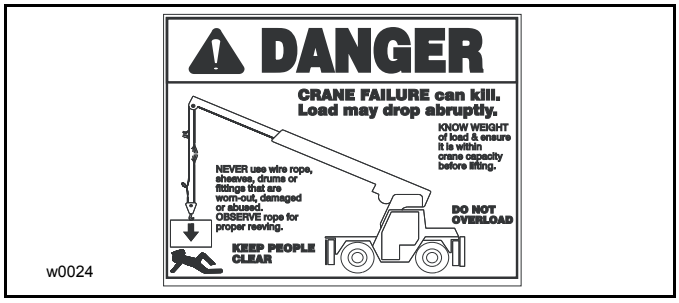


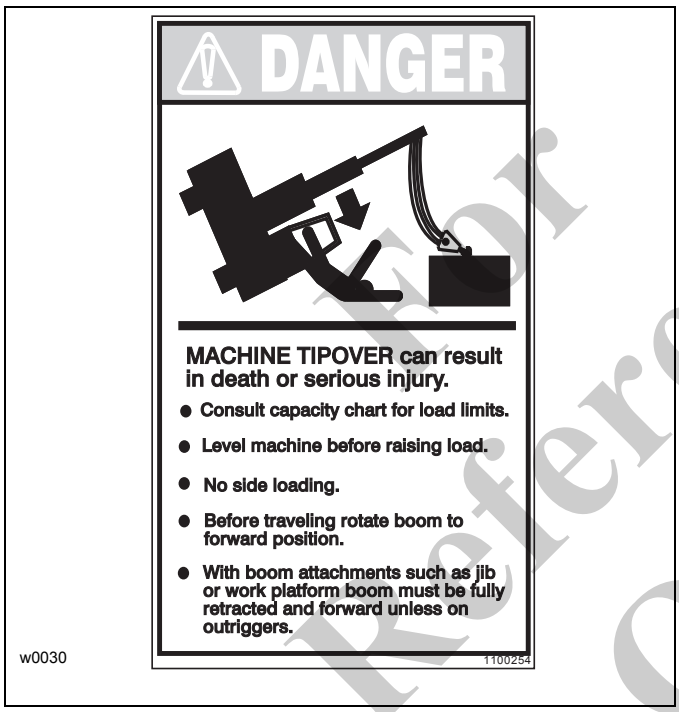
FIGURE 3-35

For Reference Only

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 *Using the Capacity Chart*, page 4-1. A falling load or crane 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 2-35). A moving load can cause injury or death and/or property damage.

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.

Do not let the hook block touch the boom head. An automatic cutout device is installed on this crane to prevent the hook block from being pulled into the boom head. When the hook block touches the anti-double blocking bracket (Figure 3-33) 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 hook 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 Hook Block

1. Press the accelerator pedal to increase the engine speed to maximum RPM.
2. Slowly pull back on the hoist control lever (Figure 3-36) until the desired raising speed is obtained. The further the control is pulled back the faster the hook block will raise

To Stop Hoist Rotation

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

To Lower the Hook Block

1. Press the accelerator pedal to increase the engine speed to maximum RPM.
2. Slowly push forward on the hoist control lever (Figure 3-36) until the desired lowering speed is obtained. The further the control is pushed forward the faster the hook block will lower.

WARNING

When lifting at high boom angles with an extended boom, it is crucial to maintain proper side slide pad adjustment. See Boom Adjustments in the *Service Manual*. Visually check the lateral straightness of the boom before raising the load. Lifting with a boom which is not visually straight may cause boom failure and could result in injury or death.

Hoist Rotation Indicator

The hoist rotation indicator is located on the top of the hoist controller. The indicator is electronically driven by a sensor attached to the hoist. A pulsating signal is sensed by the operator's thumb during hoist operation.

For Reference Only

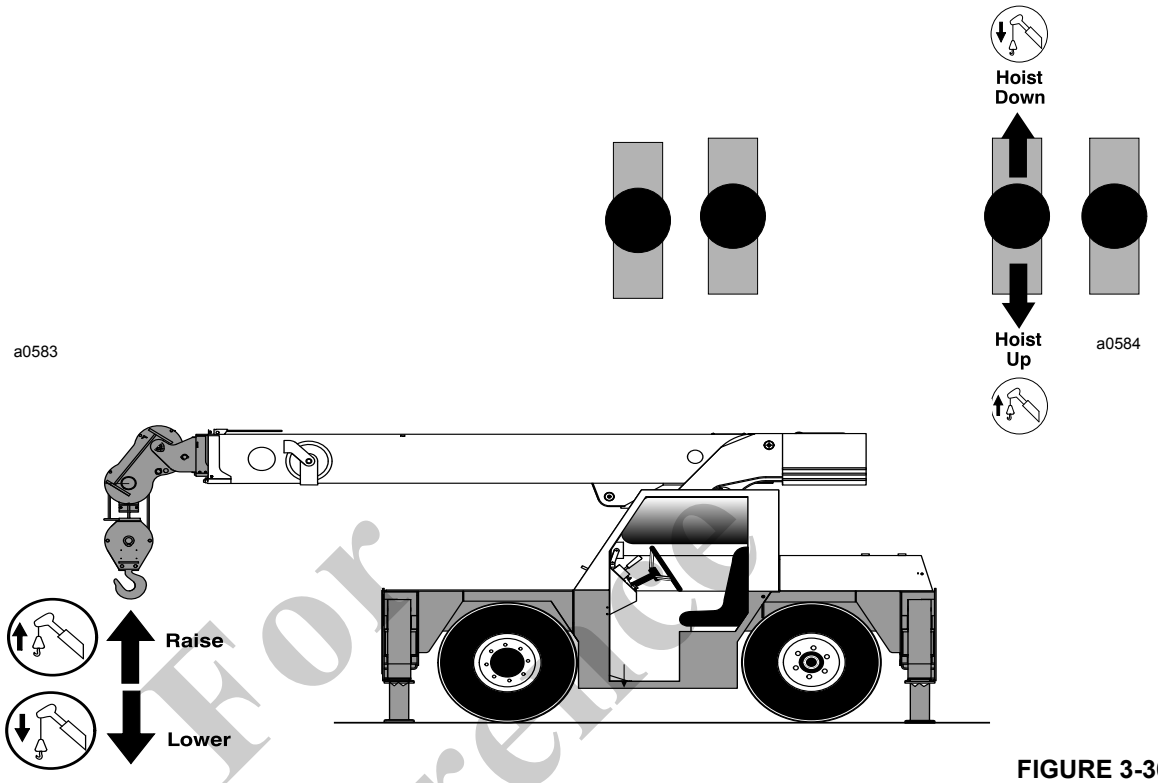


FIGURE 3-36

For Reference Only

Optional Controls Operation

Under Deck Winch

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.

To Extend the Wire Rope

Push and hold the top of the switch (Figure 3-37). Keep tension on the wire rope to prevent twisting of the wire rope on the winch drum. For fast unwind, release the free spool lever on the right side of the winch.

To Stop the Winch

Release the switch.

To Retract the Wire Rope

Push and hold the bottom of the switch (Figure 3-37).

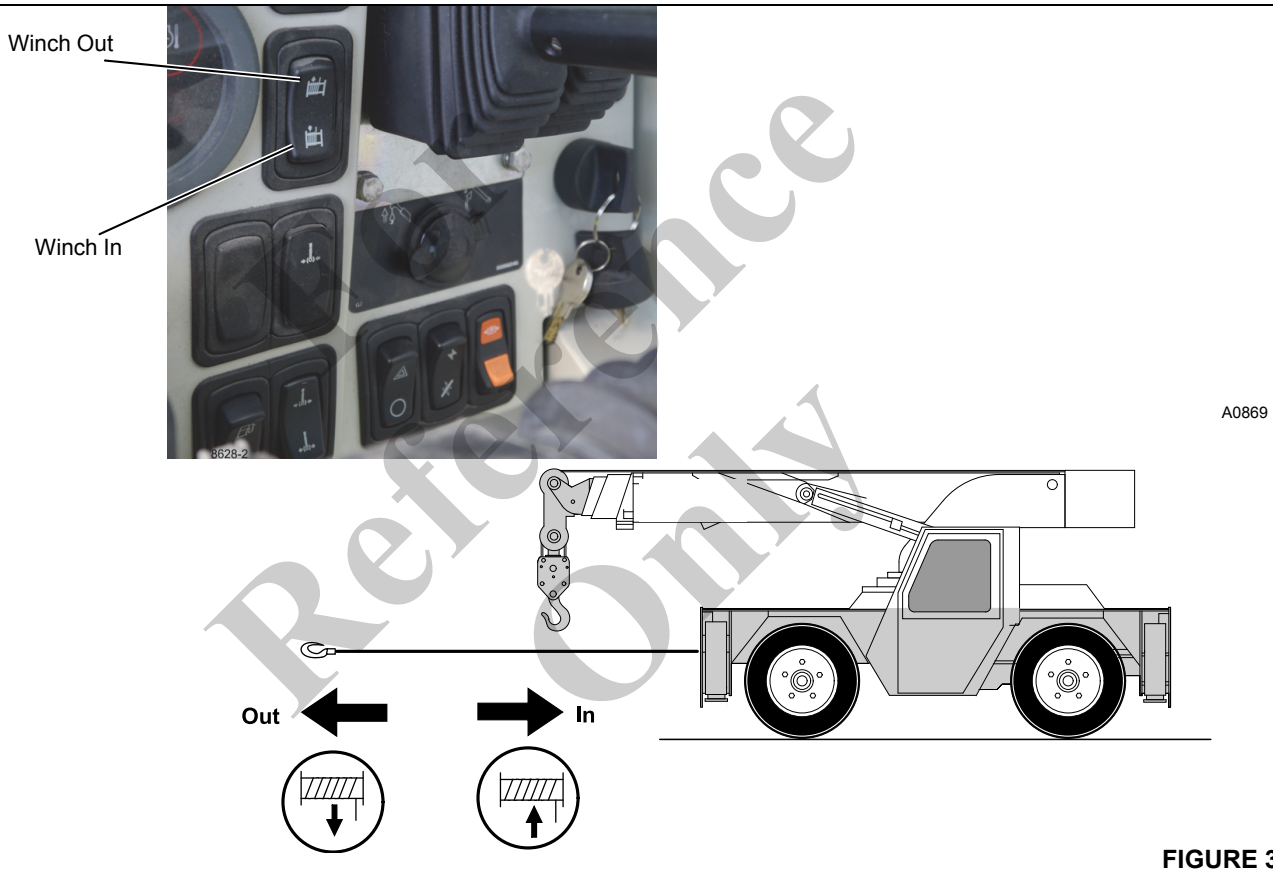


FIGURE 3-37

Reference Only

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:

WARNING

When lifting at high boom angles with an extended boom, it is crucial to maintain proper side slide pad adjustment. Visually check the lateral straightness of the boom before raising the load. Lifting with a boom which is not visually straight may cause boom failure and could result in injury or death.

   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 crane 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.

Travel on Slopes

Crane operators need to exercise caution whenever operating this crane on uneven surfaces. Travel on slopes is permitted as long as the following conditions are met.

- The slope side-to-side or fore-and-aft shall not exceed 15% (8.5 degrees), and travel must be on an improved surface or on hard-packed dry earth having a minimum 0.5 coefficient of adhesion.
- Travel must be limited to a forward direction only.
- Travel must not exceed a speed of 1 mph.
- All boom sections must be fully retracted.
- The boom extension must be in the stowed position or removed from the crane.
- The boom must be lowered to horizontal and positioned over the front of the crane.

For Reference Only

- The swing brake and turntable lock pin must be engaged.
- The hook block may be reeved over the main boom nose; the overhaul ball may be reeved over the main boom nose or auxiliary boom nose. Each must be secured at the tie down on the carrier to prevent swinging.
- Tires must be inflated to the recommended pressure for pick and carry operations.
- The hydraulic tank must be filled to the specified level; the fuel tank must be over half full.
- No loads may be supported by the boom (i.e., not pick and carry loads) while traversing a slope.
- All cribbing or other non-standard accessories must be removed from the crane.
- Avoid holes, rocks, extremely soft surfaces, and any other obstacles that might subject the crane to undue stresses and possible overturn.
- Travel must be conducted with the assistance of a ground person to warn the operator of any changing conditions in the terrain being traversed.

The owner/lessee must take appropriate measures to ensure that all persons operating or working with the affected models are in compliance with Manitowoc Crane Care's recommendations. The operator of the crane assumes responsibility for determining the suitability of traveling on a slope. Traveling on a slope should only be attempted under the controlled conditions specified in these guidelines, and must be conducted with the utmost diligence and care to ensure the safety of all personnel performing the operation and/or working around the crane.

Should the operator need to traverse slopes outside the criteria defined in the above guidelines contact Manitowoc Crane Care for further guidance.

Traveling with a Load (Pick and Carry)

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.

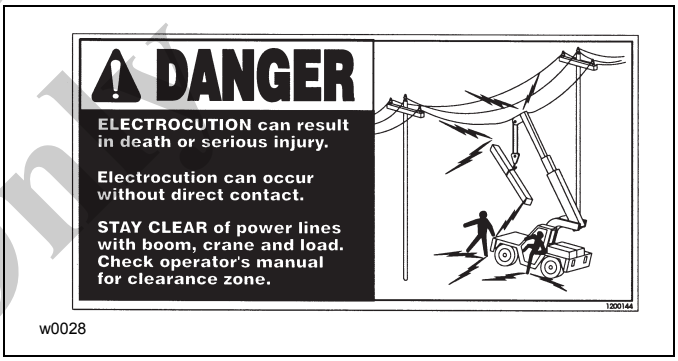
Elevating Personnel

Preparation and Setup

NOTE: When using the crane for lifting personnel, the crane must be inspected daily for anything hazardous to the person(s) being lifted.

- Be sure the platform is securely attached to the boom. Follow the manufacturer's instructions.
- Ensure the crane has a firm and level footing.
- Place the travel select lever in Neutral (N).
- Engage the parking brake.
- Extend and lower the outriggers.

Lifting Personnel



- Before lifting, make sure there are no overhead obstructions or electrical wires above the platform.
- A trained crane operator must operate the controls from the operator's cab. Using extreme caution, lift and lower personnel smoothly and **ONLY** at their request. The operator should always alert personnel in the platform, and in the work area, before moving the platform up or down.
- Always lower the platform to the travel position (boom fully retracted and lowered) before moving the crane.

NOTE: Make sure that required restraining items, such as railings, chains, cables, body belts with lanyards, etc. are in place and are properly used. Never use railings, planks, ladders, etc. on the platform for the purpose of achieving additional reach or height.

For Reference Only

See *ASME B30.5* (Latest Edition) for additional precautions and operating instructions for lifting personnel using a crane.

Capacity Limitations

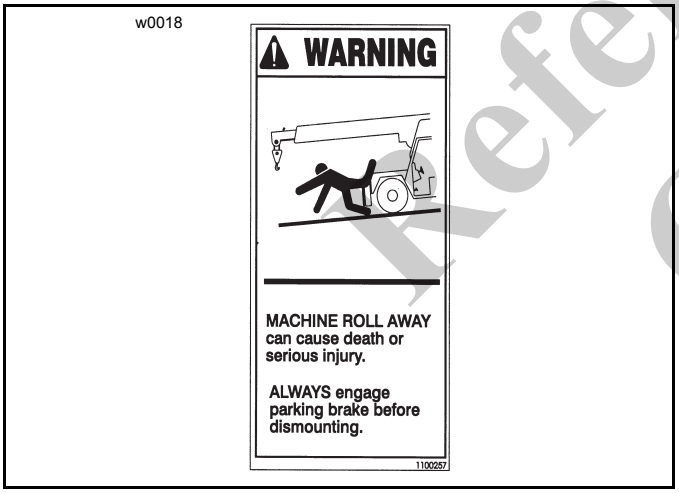
The combined weight of the platform and personnel **shall not exceed one-third the capacity of the operating radius** indicated on the capacity chart, located on the right side wall of the operator's cab. See *Using the Capacity Chart*, page 4-1.

Turning Clearances

The front end of the boom extends beyond the end of the frame. The operator must be aware of the maximum sweep of the boom when turning and allow for adequate clearance between boom and other objects.

Crane 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.



Battery Disconnect

The battery disconnect switch (Figure 3-38) is located on the right side of the crane near the rear tire. To disconnect the batteries, turn the battery disconnect switch to OFF. Turn the switch to ON to connect the batteries.

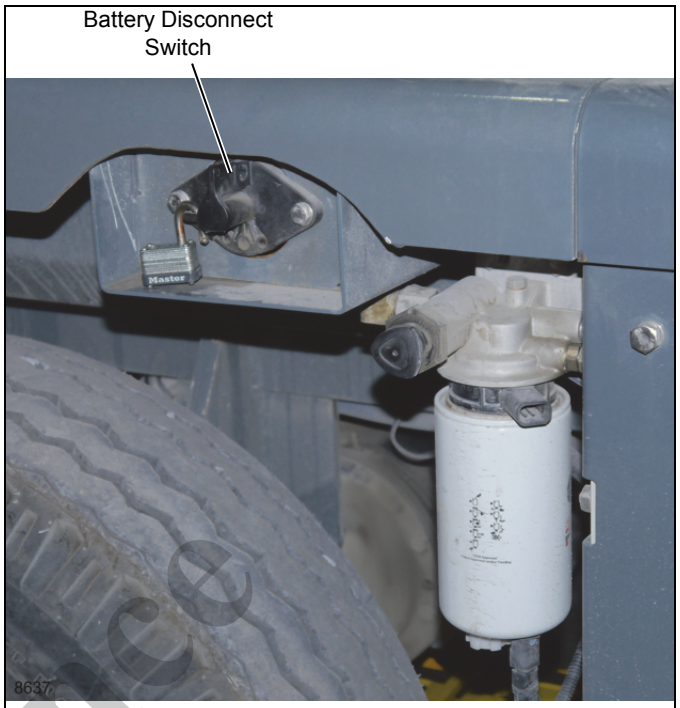


FIGURE 3-38

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 Crane

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 shaft must be disconnected to prevent damage to the transmission system.

For Reference Only

SECTION 4
CAPACITY CHART

SECTION CONTENTS

Using the Capacity Chart 4-1
Determine Operating Status 4-1
Determining Lift Capacity 4-1
Things to Observe When Using the Capacity Chart 4-1
Determining Lift Capacity at the Boom Extension . 4-2
Pick and Carry 4-2

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 give conditions under which these maximum lifts can be made.

Determine Operating Status

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 (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 23 feet (7 m). See sample chart in Figure 4-2.

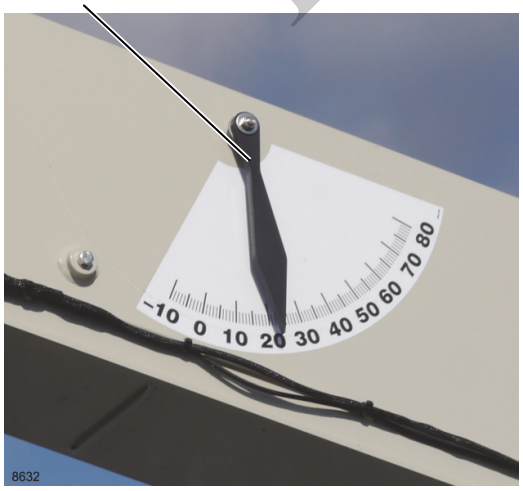


FIGURE 4-1

NOTE: To determine the exact lifting radius, use a tape measure and measure from the center of rotation of the mast to the center of the hook on either the drop block or the down haul weight, depending on which one 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.

Things to Observe When Using the Capacity Chart

1. The rated loads are the maximum lift capacities as determined by operating radius, boom length and boom angle. The operating 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 load applied.
2. The rated loads shown in the Capacity 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 training must be taken into account by the operator.

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3. The weights of all load handling devices such as hooks, hook blocks, slings, boom extension, etc., except the hoist rope, shall be considered as part of the load. The weights for these items is stated on the capacity chart.
4. Rating on outriggers are for outriggers fully extended.
5. Ratings on rubber depend on tire capacity, condition of the tires and proper inflation pressure of 8.62 bar (125 psi). Loads on rubber may be transported at a maximum speed of 4 km/h (2.5 mph) on a smooth level surface with the boom retracted to the shortest length possible and centered over the front. Do not use the boom extension with the crane on rubber.
6. For operating radius not shown on the Load Rating and Range Diagram Chart, use load rating of the next larger radius.
7. Combined boom and deck loads are not permitted on rubber. The maximum load that can be placed on the deck is stated on the load distribution chart in the load chart binder.
8. Do not induce any external side loads to the boom or the boom extension.

Determining Lift Capacity at the Boom Extension

The boom extension increases the length of the boom assembly by 3.66 m (12 ft).

The capacity of the boom extension is determined in two (2) steps. First, as with the main boom, check the main capacity chart after determining the operating radius. These capacities are based on main boom strength and machine stability. Second, check the boom extension (boom extension boom) structural capacities after determining boom angle. These limits are based on the boom extension structural strength. Use the lesser of these two capacities such that neither is exceeded.

NOTE: Exceeding the capacity is dangerous and voids the crane's warranty.

Pick and Carry

For pick and carry operation, boom is to be retracted to the shortest length possible and centered over the front.

For Reference Only

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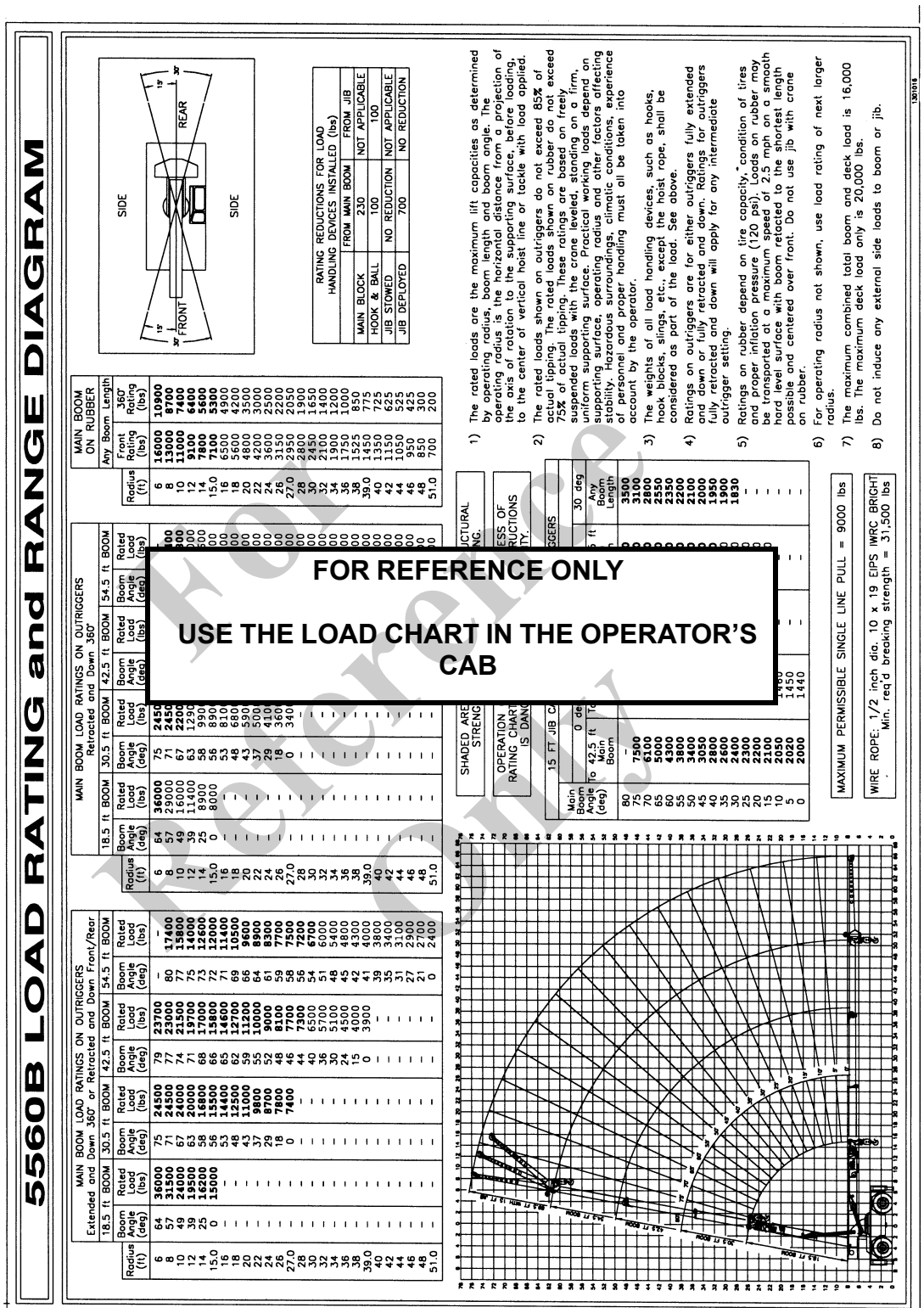

Load Rating and Range Diagram Chart- 4 Section Boom

FIGURE 4-2

For Reference Only

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SECTION 5
ATTACHMENTS

SECTION CONTENTS

Pivoting Boom Head. 5-1
Boom Head Positions 5-1
Changing the Boom Head Position (No Extension) 5-2
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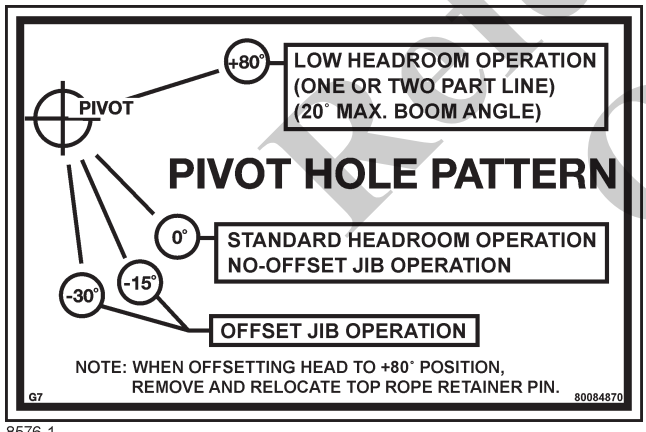
For Reference Only

PIVOTING BOOM HEAD

Boom Head Positions

The optional pivoting boom head, can be adjusted to four angle positions, two of which are used when there is no boom extension attached and two when a boom extension is attached.



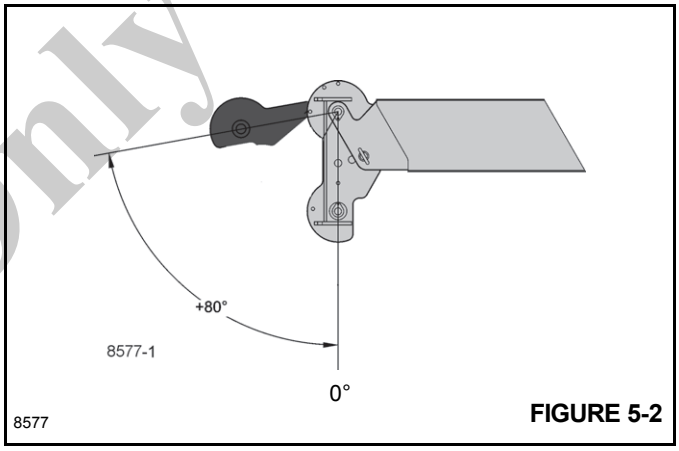
8576-1

8576-1 **FIGURE 5-1**

There are limitations to the boom elevation when the boom head is pivoted. Refer to Figure 5-1, Pivot Hole Pattern decal (also attached to boom head) for these limitations.

Positions When No Boom Extension is Attached

The 0° boom head position is the standard position. The 80° (Figure 5-2) position can be used when clearance requirements dictate a lower boom head profile. Both positions can be used with either single or two part line setups.



8577 **FIGURE 5-2**

Positions When Boom Extension is Attached

The minus 15° and minus 30° boom head angles are used to offset the boom extension. See Figure 5-3.

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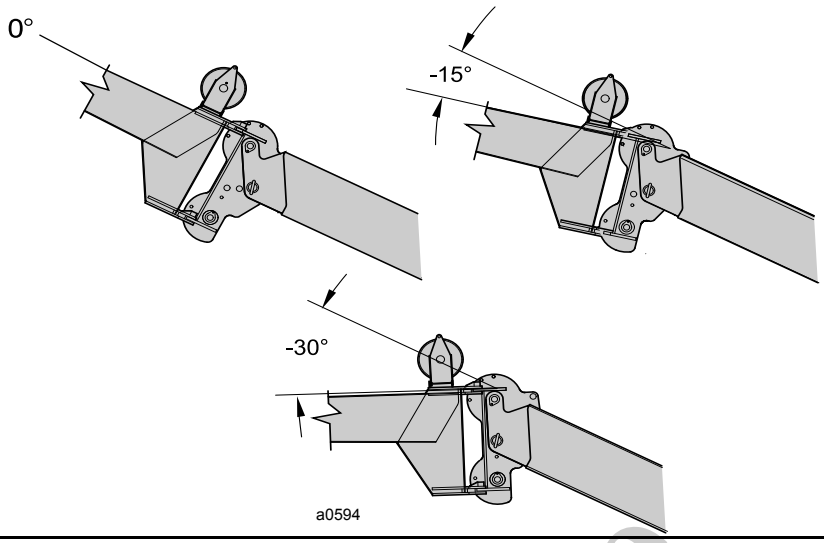


FIGURE 5-3

Changing the Boom Head Position (No Extension)

1. Lower and retract the boom.
2. Lower the block or ball to the ground to take weight off of the wire rope and boom head.
3. Remove the retaining clip from the rope retention pin, remove the rope retention pin from the top of the boom head (Figure 5-4).
4. Remove the lynch pin and the pivot lock pin (Figure 5-4).
5. Position the pin hole in the boom head to align with the hole for the desired angle (see Figure 5-2). Insert the pivot lock pin through the holes and install the lynch pin.
6. Install the rope retention pin and retaining clip into the top of the boom head (Figure 5-4).

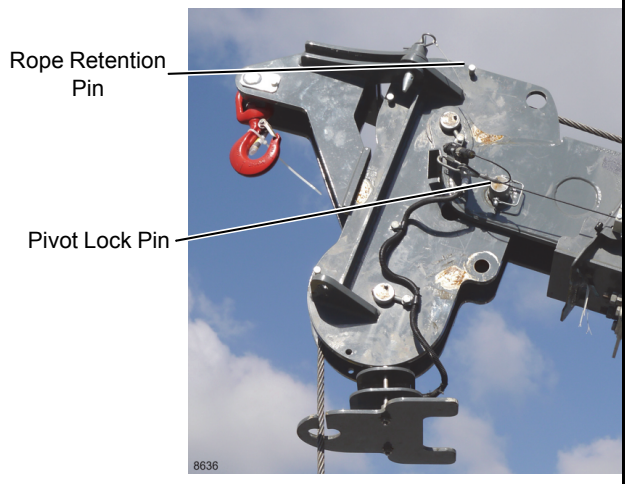


FIGURE 5-4

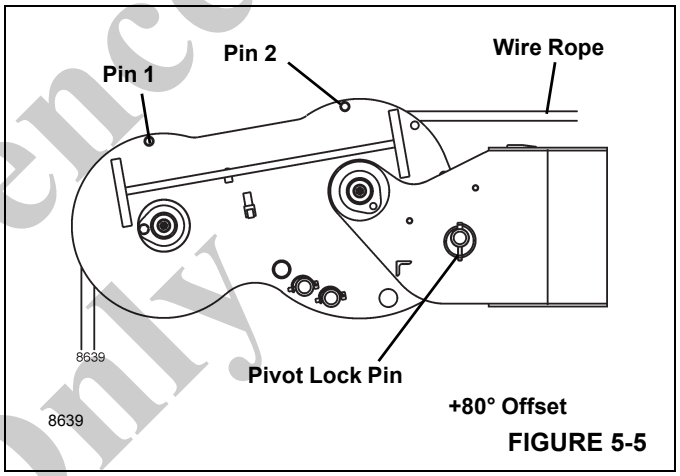


FIGURE 5-5

7. When offsetting boom head (Figure 5-5) to +80° run rope between pin #2 and sheave wheel. Install pin #1 in the lower hole.
8. After installing the rope retention pin and retaining clip into the boom head (Figure 5-5). Check that the wire rope is not contacting retention pin at the top of the boom head.
9. Using the hoist control, raise the block or hook ball off of the ground. Check that the wire rope is engaged in all the sheaves in the boom, hoist block and hoist drum.

For Reference Only

Adjusting the Optional Boom Extension Offset

WARNING

Crushing Hazard!

The boom extension is very heavy. Use another crane or hoist to support the extension from falling when the pivot anchor pin is removed and adjusting the extension angle.

A falling boom can cause serious injury or death.

The boom extension offset is adjusted by moving the boom head to a minus 15° or 30° (Figure 5-3). With the extension attached it is necessary to raise or lower both the extension and the boom head simultaneously.

1. Lower the hook and ball to the ground.
2. Provide adequate support at the end of the extension. Use another crane or hoist to support the extension.
3. Remove the retaining clip and rope retention pin from the top of the boom head (Figure 5-4).
4. With the extension supported, remove the lynch pin and pivot lock pin. It will be necessary to remove the weight on the pin in order to remove it.
5. Raise or lower the main boom until the desired offset angle is achieved. (Figure 5-3).
6. Install the pivot lock pin and lynch pin.
7. Install the rope retention pin and retaining clip into the top of the boom head (See Figure 5-4 and Figure 5-5).
8. Raise the hook and ball. Check that the wire rope is engaged in all the sheaves in the boom, hoist block and hoist drum.

HOOK BLOCK

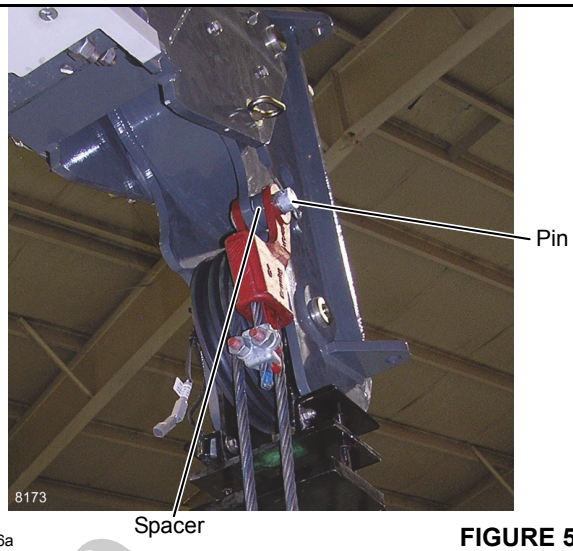
Removing the Hook Block

1. Lower the hook block to the ground to place slack in the wire rope.

CAUTION

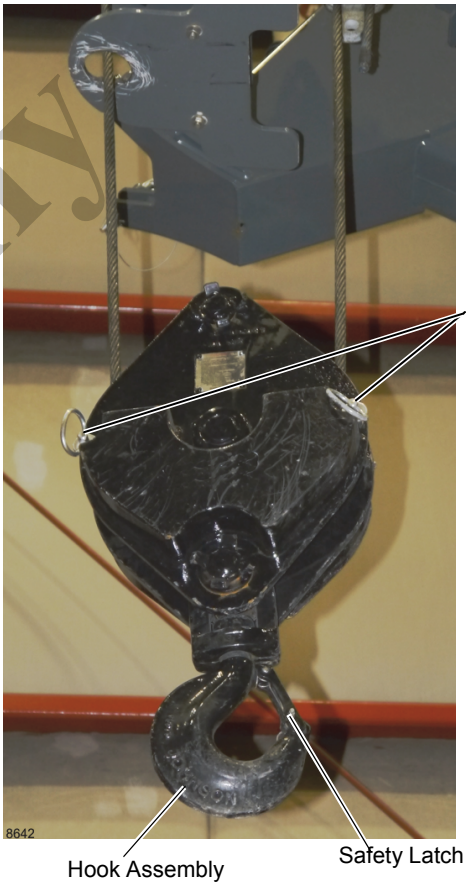
Ensure that the hook assembly's safety latch Figure 5-7 does not get damaged.

2. Remove the pin Figure 5-6 securing the rope wedge socket and spacer to the boom head.



p3026a **FIGURE 5-6**

3. Remove the two pins as indicated in Figure 5-7.
4. Pull the wire rope and dead end through the block.
5. Install the two pins.



8642 **FIGURE 5-7**

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Installing the Hook Block

1. Remove the pins and hook assembly from the hook block assembly. See Figure 5-7.
2. Thread the wire rope through the hook block so it is under the hook block sheave.
3. Install the hook assembly and two pins to the hook block assembly.
4. Attach the wire rope wedge assembly to boom head.
5. Lift the hook block off of the ground. Be sure the wire rope is engaged in the sheave grooves in both the boom head and hook block.

BOOM EXTENSION

Installing the Boom Extension

To use the boom extension it must be attached to the boom nose. The boom extension can be attached by performing the following procedure:

1. Completely retract the booms.
2. Install the boom extension (1, Figure 5-8) onto the boom nose.
   a. Remove the hair pin from the retaining pin (2) and remove the retaining pin from the rear bracket.
   b. Rotate the boom extension so the boom extension anchor fittings (3) engage the boom nose attachment fittings. Install the pins in the fittings and secure with the hair pins.
   c. Remove the hair pin from the retaining pin (5) and remove the retaining pin from the front bracket.
   d. Swing the boom extension around so the anchor fittings (4) engage the boom nose attachment fittings. Install the pins in the fittings and secure with the hair pins.
3. Rotate the mast sheave (6) up and secure with a retaining pin and hair pin.
4. Install the wire rope over the mast sheave and boom extension sheave removing the wire rope retaining pins (7) and hair pins.
5. Install the removed wire rope retaining pins.
6. Attach the down haul block to the wire rope.
7. Connect the anti-double blocking switch wires at the boom extension and disconnect them to the boom head switch.

Stowing the Boom Extension

1. Remove the down haul block.
2. Remove the three wire rope retaining pins (7) from the boom extension sheave and mast sheave. Remove the wire rope from the sheaves. Operate the hoist control to wind the wire rope onto the hoist drum, as necessary. 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. Remove the right side mast sheave retaining pin and fold the mast sheave down. Reinstall the retaining pin.
5. Remove the left side pins (4) from the anchor fittings and attachment fittings. Reinstall pins in the boom extension attachment fittings and secure with hair pins.
6. Swing the boom extension around to engage the front bracket. Install the retaining pin (5) into the front bracket and boom extension, secure with a hair pin.
7. Remove the right side pins (3) from the anchor fittings and attachment fittings. Reinstall pins in the boom extension attachment fittings and secure with hair pins.
8. Rotate the boom extension to engage the rear bracket and install the retaining pin (2) and secure with a hair pin.

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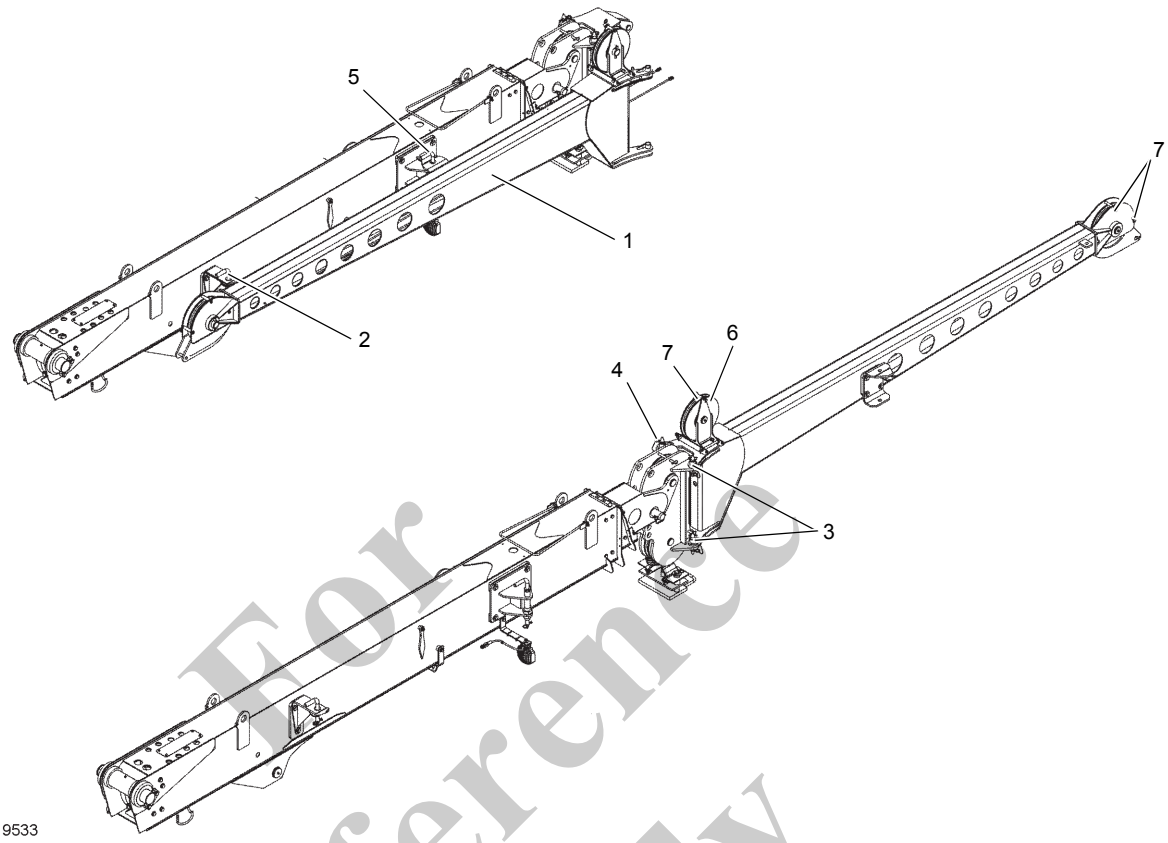

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FIGURE 5-8

For Reference Only

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.

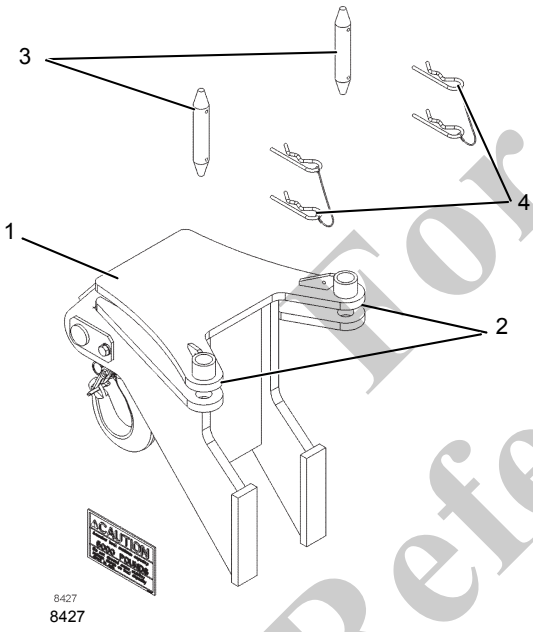

FIGURE 5-9

Installation

1. Using a suitable lifting device raise the searcher hook (1, Figure 5-9) 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.

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 5-10.

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

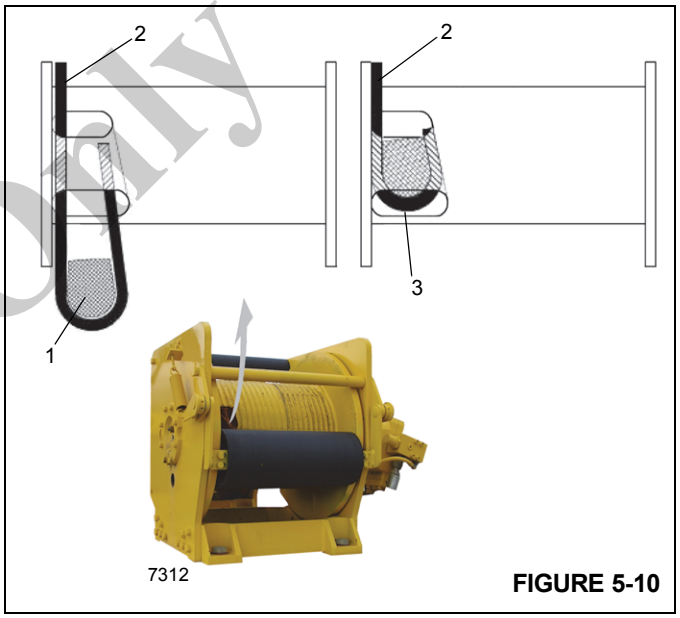

FIGURE 5-10

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

1. Inspect the wedge and socket. Remove any rough edges and burrs.
2. The end of the wire rope should be seized using soft, or annealed wire or strand. If the end of the rope is welded, the welded end should be cut off. Do not weld on size 6X19 rope. This will allow the distortion of the rope strands, caused by the bend around the wedge, to adjust themselves at the end of the line. Refer to SECTION 1 - INTRODUCTION in the *Service Manual* for wire rope procedures.
3. Make sure the live-end (Figure 5-11) 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.

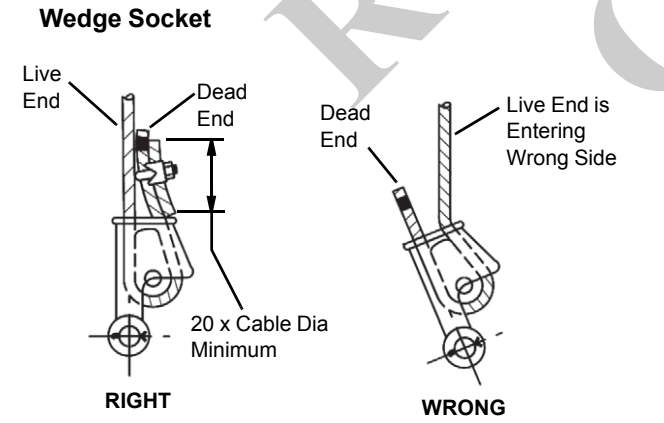

FIGURE 5-11

4. Insert the end of the wire rope into the socket, form a loop in the rope, and route the rope back through the socket allowing the dead-end (Figure 5-11) to protrude from the socket. Ensure the dead-end of the rope is of sufficient length to apply end treatment to the dead-end after the wedge has been seated.
5. Insert the wedge into the loop and pull the live-end of the rope until the wedge and rope are snug inside the socket. It is recommended that the wedge be seated inside the socket to properly secure the wire rope by using the crane's hoist to first apply a light load to the live-end.
6. After final pin connections are made, increase the loads gradually until the wedge is properly seated.
7. The wire rope and wedge must be properly secured inside the socket before placing the crane into lifting service. It is the wedge that secures the wire rope inside the socket. The dead-end treatment is used to restrain the wedge from becoming dislodged from the socket should the rope suddenly become unloaded due to the headache ball or hook block striking the ground, etc.

Sketches A through F (Figure 5-12) illustrate various ANSI approved methods for treating the dead-ends of wire ropes which exit a wedge socket assembly. While use of the loop-back method is acceptable, care must be exercised to avoid the loop becoming entangled with tree branches and other components during crane transport and with the anti-two-block system and other components during use of the crane.

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

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

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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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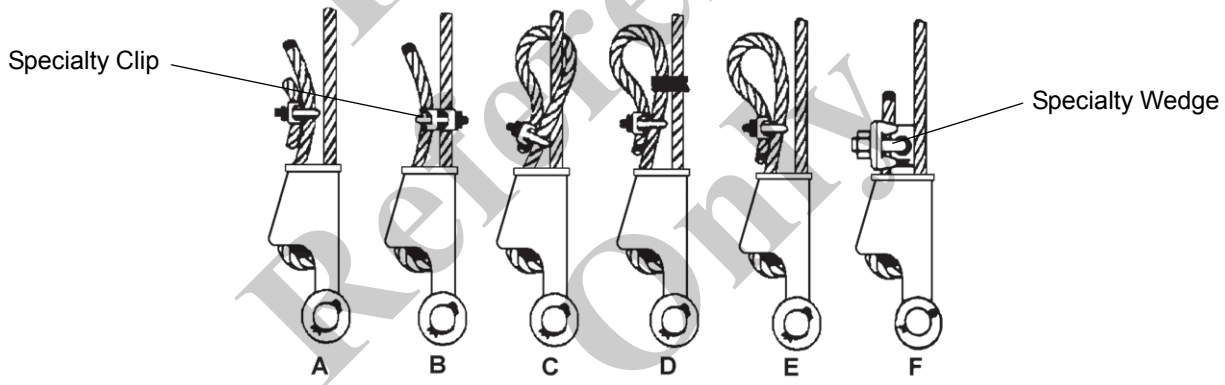

Wedge Socket

FIGURE 5-12

SECTION 6
MAINTENANCE

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INTRODUCTION

NOTE: 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.

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.

Preventive maintenance is necessary to keep the crane in good 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 application, 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.

COVERS - Keep all protective covers in place.

PARKING BRAKE - Check operation. Have crane repaired if required.

ENGINE - Check operation. Remove all dirt or debris, and all flammable materials before running engine.

LUBRICANTS

It is not the policy of The Manitowoc Company, Inc. to publish lists of approved lubricants or guarantee lubricant performance. The responsibility for the quality of the lubricants 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.

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 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 filters and sediment bowl.

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 for correct air pressure.

Wire rope cable clamps and connections

- Check for loose or missing parts.

Anti-Double Blocking 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

- Change the engine oil and filter.

Transmission

- Change the transmission oil filter.

Swing Gearbox

- Check and tighten mounting bolts.

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Hoist Gearbox

- Check and tighten mounting bolts.

Swing Gear Pinion and Swing Gear

- Lubricate.

Grease Fittings

- Apply grease to all grease fittings.

Boom Slides

- Lubricate.

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

NOTE: 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.

Lubrication Symbol Chart

LUBE SYMBOL	DESCRIPTION	LUBE SPECIFICATION	QUALIFIED PRODUCT
EP-MPG	Multipurpose Grease	6829003477	Citgo: Lithoplex Red MP Grease Chevron: Starplex EP 2 Phillips 66: Multiplex Red, NLGI Grade 2 Mobil: Mobilgrease XHP 222 Ipiranga: IPIFLEX LI-COMP EP 2
AFC	Anti-Freeze/Coolant	6829101130	Old World Industries, Inc. Fleet Charge SCA Pre-charged Antifreeze/Coolant Caterpillar DEAC Antifreeze/Coolant Fleetguard ES Compleat EG Antifreeze/ Coolant
HYDO	Hydraulic Oil	6829006444	Exxon Mobil 424 Phillips 66 PowerTran XP
EO-10W-30	Engine Oil for Dual Fuel	6829003480	Petro-Canada Supreme Mobil Super Pennzoil Conventional Castrol GTX Valvoline Premium Conventional
EO-5W-30	Engine Oil for Dual Fuel (Below -18 °C (0 °F))	6829003488	Petro-Canada Supreme Mobil Super Pennzoil Conventional Castrol GTX Valvoline Premium Conventional

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LUBE SYMBOL	DESCRIPTION	LUBE SPECIFICATION	QUALIFIED PRODUCT
EO-15W-40	Engine Oil for Tier 4 Diesel	6829104182	Conoco Fleet Supreme EC Mobil Delvac 1300 Super Mobil Delvac MX ESP
ASC	Anti-Seize Compound	6829003689	KOPR-KOTE; Jet-Lube, Inc. C5-A compound; LOCTITE, Corp
EP-OGL	Open Gear Lube Spray	6829102971	FUCHS CEPLATTYN 300 Spray
AGMA EP-4	Gear Lubricant	6829100213	Mobil: 600XP 150 Gear Oil Texaco: Meropa 150
LCC/SCA	Liquid Coolant Conditioner/ Supplemental Coolant Additive	6829012858	Pencool 3000 Caterpillar Cummins DCA2 Cummins DCA4

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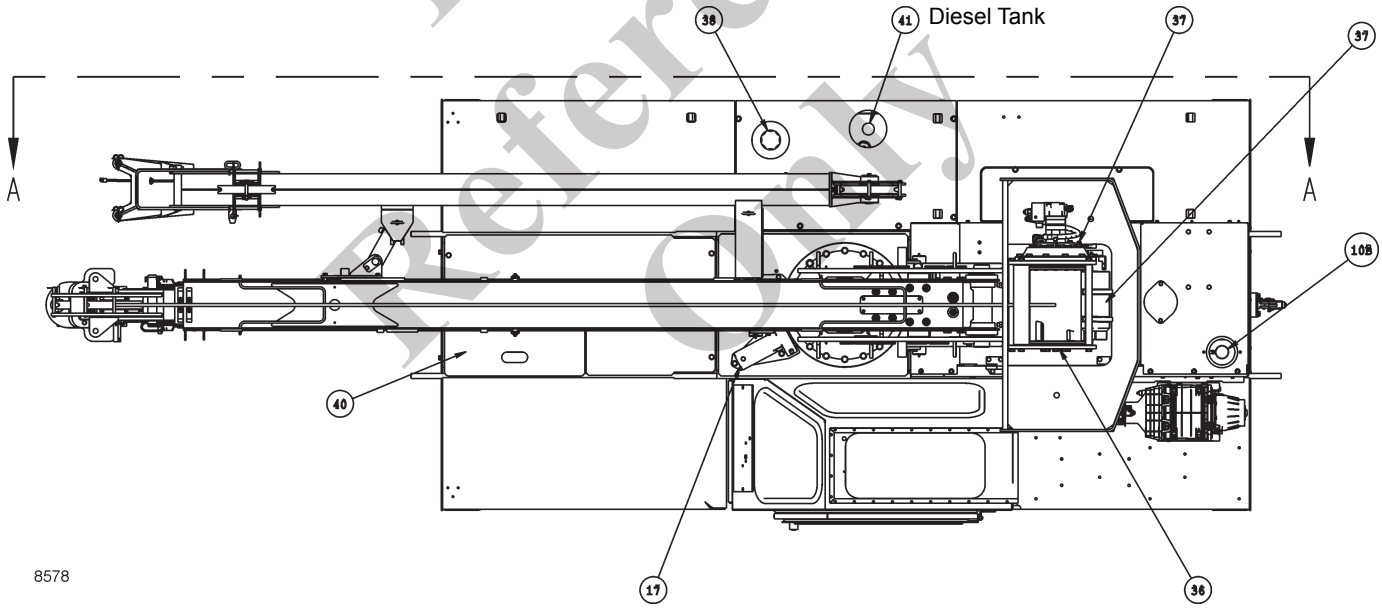

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FIGURE 6-1

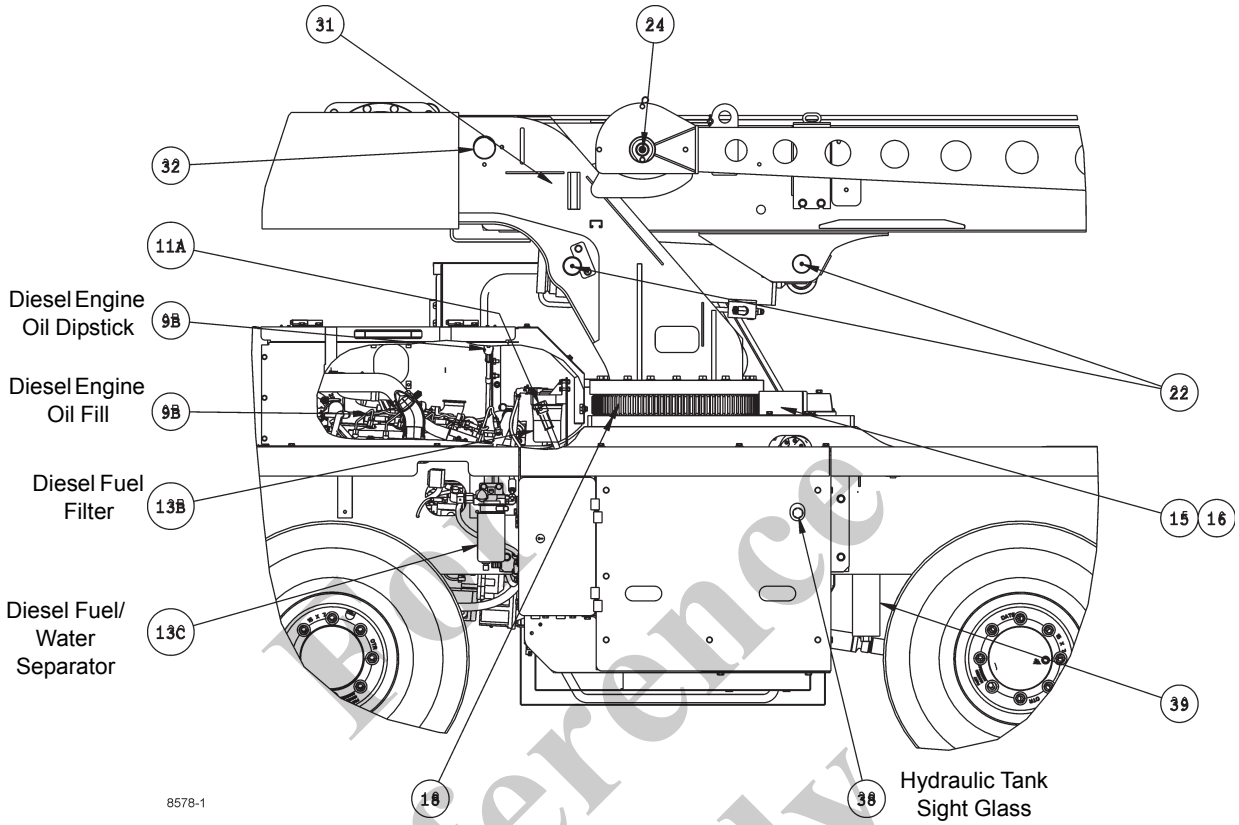

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FIGURE 6-2

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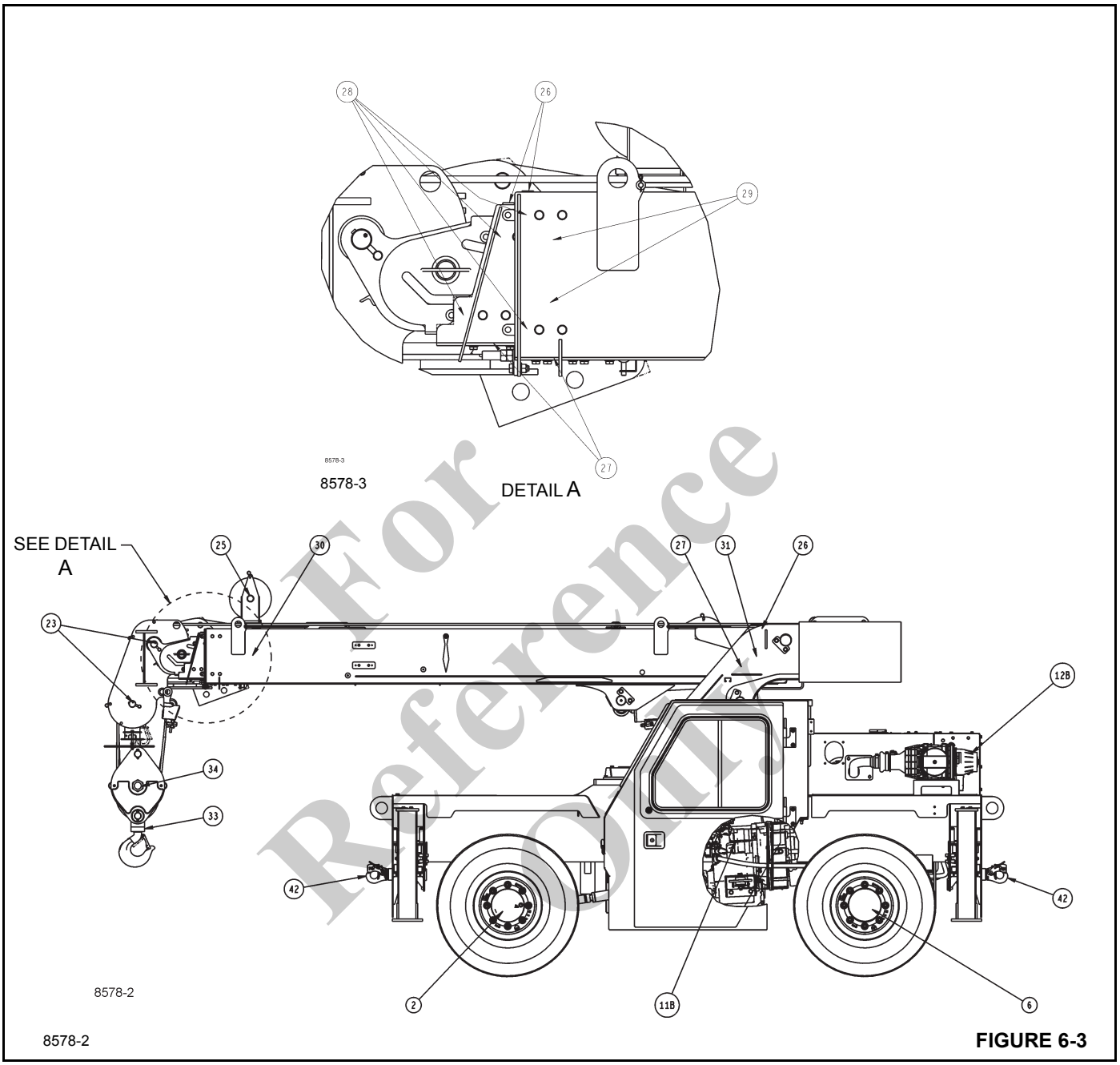

FIGURE 6-3

For Reference Only

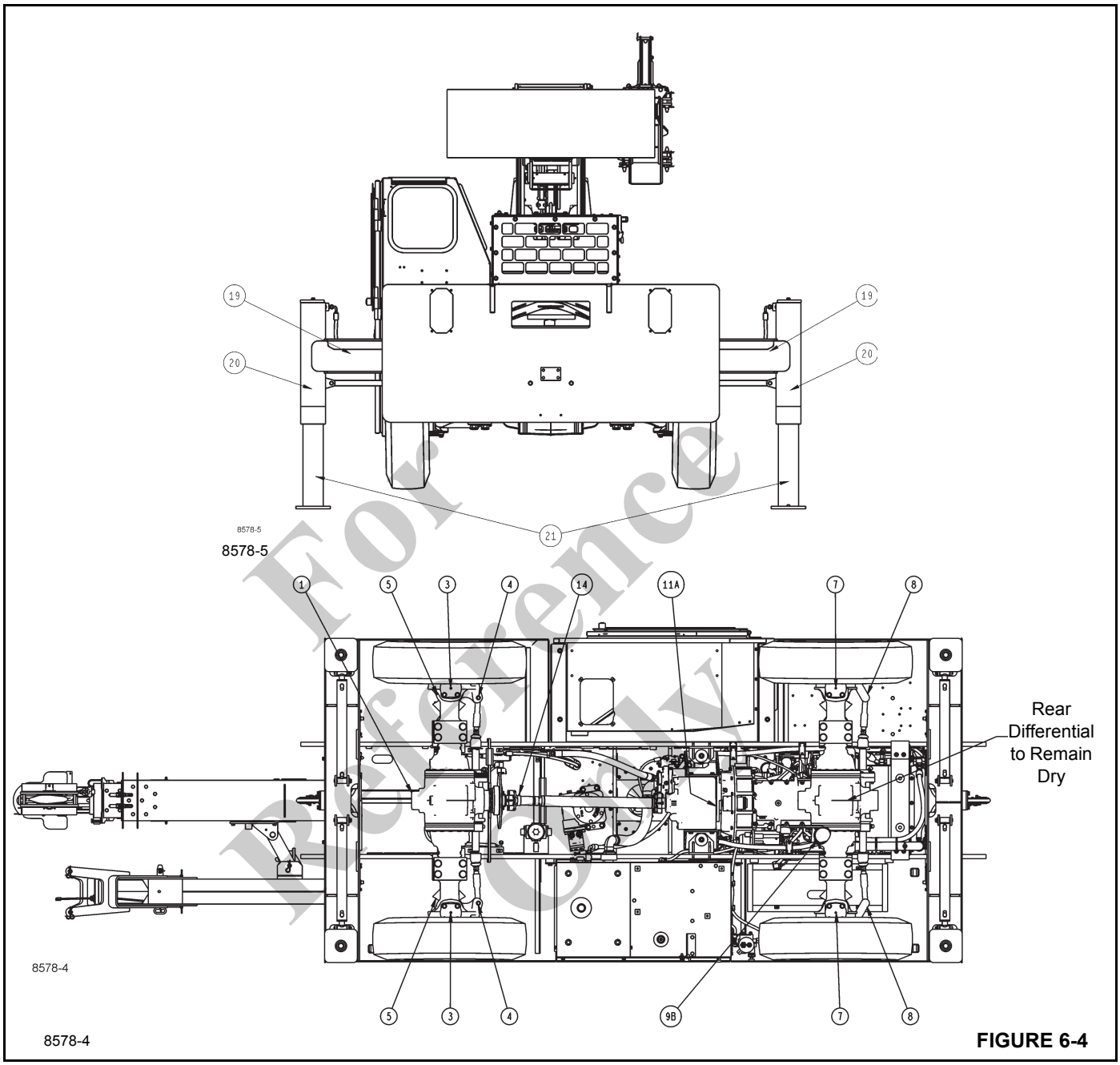

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FIGURE 6-4

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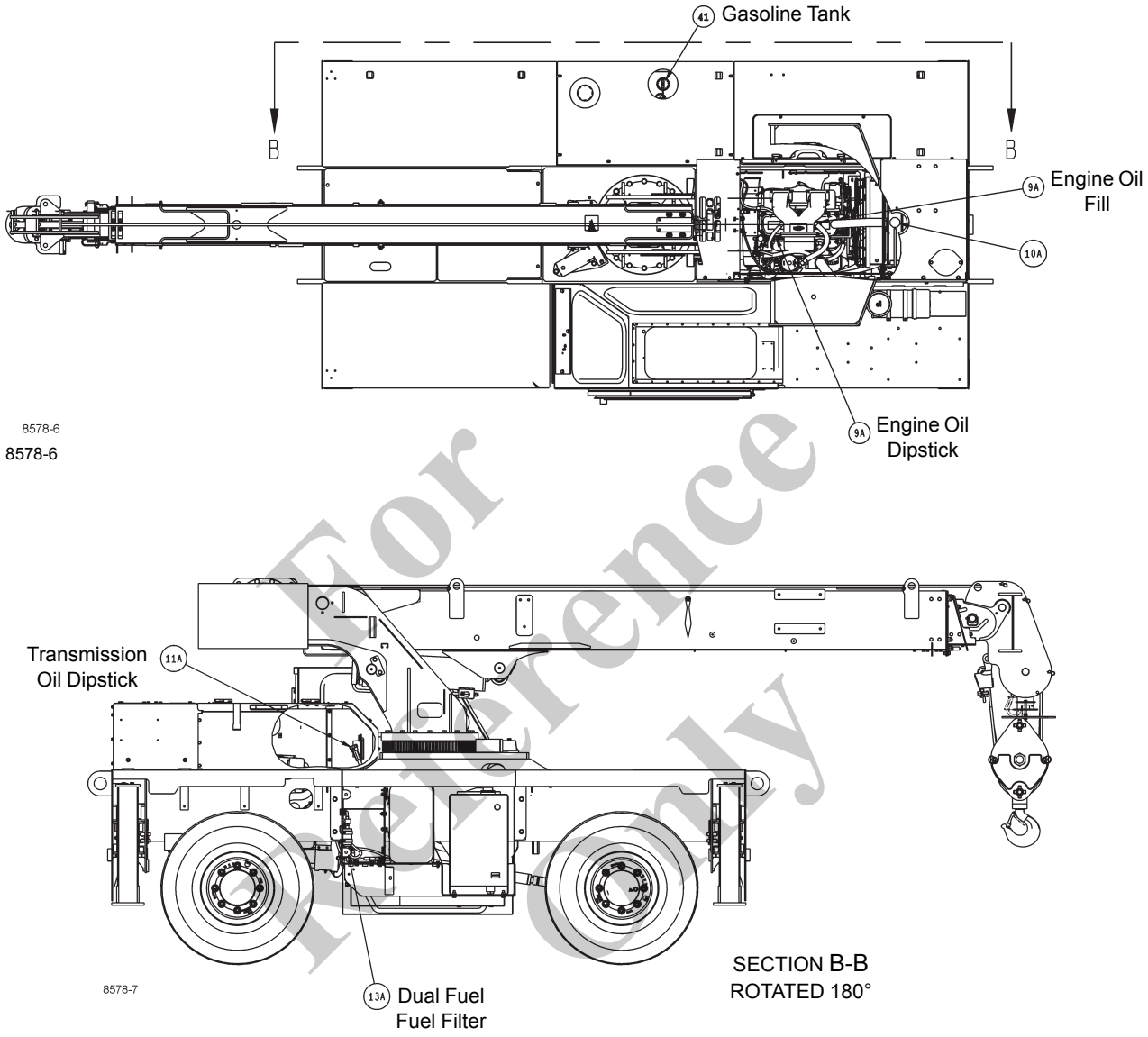

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FIGURE 6-5

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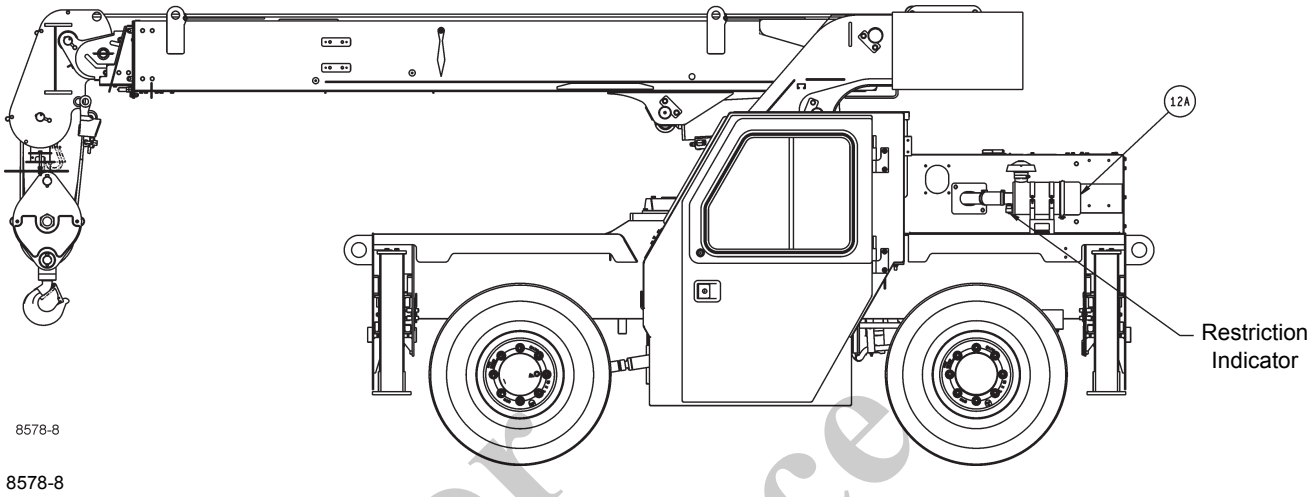

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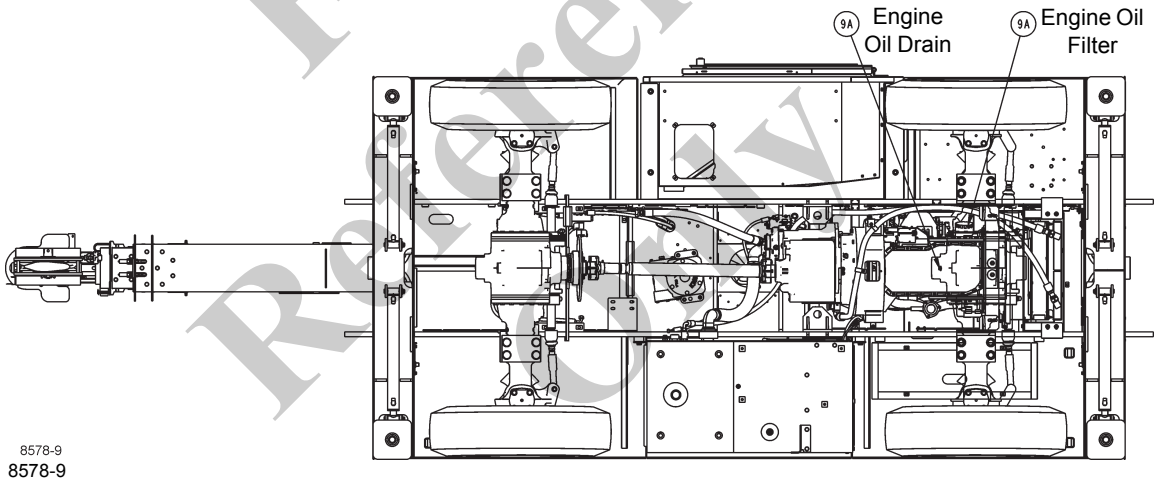

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FIGURE 6-6

For Reference Only

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Item Number	Location Name	Approximate Capacity	Lube Symbol	Instructions (See Notes)	Service Points	Service	Service Hours
FRONT DRIVE/STEER AXLE							
1	Differential	9.0 L [2.4 Gal]	HYDO	1, 2, 3	2	Drain & Fill	4000/2 Years
			HYDO	1, 2, 3	2	Check & Fill	500/3 Months
2	Planetary Hub Gears	0.8 L [0.8 Qts]	HYDO	1, 2, 3	2	Drain & Fill	4000/2 Years
			HYDO	1, 2, 3	2	Check & Fill	500/3 Months
3	Kingpin Bearings		EP-MPG	1, 4	4	Lube	500/3 Months
4	Steer Cylinder Bearings		EP-MPG	1, 4	4	Lube	500/3 Months
5	Universal Joints		EP-MPG	1, 4	2	Lube	500/3 Months
REAR STEER AXLE							
6	Hubs	0.8 L [0.8 Qts]	HYDO	1, 2, 3	2	Drain & Fill	4000/2 Years
			HYDO	1, 2, 3	2	Check & Fill	500/3 Months
7	Kingpin Bearings		EP-MPG	1, 4	4	Lube	500/3 Months
8	Steer Cylinder Bearings		EP-MPG	1, 4	4	Lube	500/3 Months
DRIVETRAIN							
9A	Dual Fuel Engine Crankcase	4.7 L [5.0 Qts]	See Below	1, 2	1	Drain & Fill	175/1 Month
	3.0L Dual Fuel		EO-10W-30	1, 2	1	Check & Fill	10/Daily
	3.0L Dual Fuel - Below 18°C		EO-5W-30	1, 2	1	Check & Fill	10/Daily
	Filter (Engine)		N/A	1	1	Change Filter	175/1 Month
9B	Diesel Engine	8.2 L [8.7 Qts]	EO-15W-40	1, 2	1	Drain & Fill	500/6 Months
	2.8L Diesel		EO-15W-40	1, 2	1	Check & Fill	10/Daily
	Filter (Engine)		N/A	1, 2	1	Change Filter	500/6 Months
	Engine Cooling System	See Values Below	AFC	5	1	Drain & Fill	See Service Manual
10A	Dual Fuel	4.7 L [5.0 Qts]	AFC	1,2,5, 6,7	1	Check & Fill	10/Daily
10B	Diesel	8.2 L [8.7 Qts]	AFC	1,2,5, 6,7	1	Check & Fill	10/Daily
	Engine Coolant System LCC/SCA	As Required	LCC/SCA		1	Test & Add	See Service Manual

For Reference Only

Item Number	Location Name	Approximate Capacity	Lube Symbol	Instructions (See Notes)	Service Points	Service	Service Hours
11A	Transmission & Torque Converter	16.7 L [4.4 Gal]	HYDO	1,2,8, 9	1	Drain & Fill	1000/6 Months
			HYDO	1,2,8	1	Check & Fill	10/Daily
11B	Filter (Transmission)		N/A	1,2,9	1	Change Filter	175/1 Month
12A	Air Cleaner Filter, Dual Fuel		N/A	10	1	Change Filter	See Note 11
12B	Air Cleaner Filter, Diesel		N/A	20	1	Change Filter	See Note 21
13A	Fuel Filter, Dual Fuel		N/A		1	Change Filter	500/3 Months
13B	Fuel Filter, Diesel		N/A		1	Change Filter	500/6 Months
13C	Fuel/Water Separator		N/A			Drain	10/Daily
	Filter (Fuel/Water Separator)		N/A		1	Change Filter	500/6 Months
14	Driveline Slip Joint		EP-MPG	1, 4	1	Lube	500/3 Months
TURNTABLE							
15	Turntable Gear Box		EP-MPG	1, 4	1	Lube	500/6 Months
16	Turntable Gear & Drive Pinion		EP-OGL	1, 11	1	Spray On	500/6 Months
17	Turntable Swing Lock		EP-OGL	1, 11	1	Spray On	500/6 Months
18	Turntable Bearing		EP-MPG	1, 4, 11	2	Lube	500/6 Months
OUTRIGGERS							
19	Outrigger Slide Box		EP-MPG	1, 12	8	Brush On	50/Weekly
20	Outrigger Jack Tube		EP-MPG	1, 13	4	Brush On	50/Weekly
21	Outrigger Cylinder		EP-MPG	1	4	Brush On	50/Weekly
LIFT CYLINDER							
22	Lift Cylinder Pivot Pins		EP-MPG	1, 4, 11	2	Lube	500/3 Months
BOOM							
23	Boom Nose Sheaves		EP-MPG	1, 4, 11, 14	2	Lube	250/3 Months
24	Boom Extension Sheaves		EP-MPG	1, 4, 11	1	Lube	250/3 Months
25	Not Used						
26	Boom Section Upper Wear Pads		EP-MPG	1, 15, 16, 17	6	Brush On	50/Weekly

For Reference Only

Item Number	Location Name	Approximate Capacity	Lube Symbol	Instructions (See Notes)	Service Points	Service	Service Hours
27	Boom Section Lower Wear Pads		EP-MPG	1, 15, 16, 17	6	Brush On	50/Weekly
28	Boom Section Side Wear Pads		EP-MPG	1, 15, 16, 17	8	Brush On	50/Weekly
29	Tele Cylinder Wear Pads		EP-MPG	1, 16, 17	8	Brush On	125/3 Months
30	Boom Extend Sheave		EP-MPG	1	1	Lube	250/3 Months
31	Boom Retract Sheave		EP-MPG	1	1	Lube	250/3 Months
32	Boom Pivot Shaft		EP-MPG	1	2	Lube	250/3 Months
33	Hook Block Swivel Bearing		EP-MPG	1	1	Lube	250/3 Months
34	Hook Block Sheaves		EP-MPG	1	1	Lube	250/3 Months
HOIST							
35	Hoist Winch			1, 18		Check & Fill	50/Weekly
		1.5 L [1.6 Qts]	AGMA EP-4	1,2,9,18	1	Drain & Fill	2500/12 Months
36	Hoist Drum Bearing		EP-MPG	1, 17	1	Lube	50/Weekly
37	Cable Follower		EP-MPG	1, 17	2	Spray On	250/3 Months
HYDRAULIC							
38	Hydraulic Tank	84.8 L [22.4 Gal]	HYDO	1, 2, 18	1	Check & Fill	10/Daily
39	Hydraulic Filter		N/A	19	1	Change Filter	See Note 20
MISCELLANEOUS							
40	Underdeck Winch		N/A		N/A	N/A	Not Required
41	Fuel Tank						
	Gasoline Tank	67 L [17.7 Gal]	N/A			N/A	N/A
	Diesel Tank	67 L [17.7 Gal]	N/A			N/A	N/A
42	Pintle Hooks		EP-MPG	1, 17	2	Lube	1000/6 Months

For Reference Only

NOTES:

1. Service by whichever interval occurs first.
2. Final fluid levels shall be adjusted by indicating arrows, dipstick markings or to filler plugs.
3. Caution: use of semi-synthetic lubricant is required to avoid damage to components during published service intervals.
4. Use grease fittings provided.
5. Capacities indicated are for a fully formulated mixture of 50% AFC and 50% water.
6. Engine coolant capacity listed is the combined capacity for the entire cooling system.
7. Verify heater core valves and petcock in top radiator tube, if equipped, are open then fill surge tank to bottom of filler neck. Run engine through two (2) thermal cycles. check level and refill as required.
8. Check with engine running at idle, transmission in neutral and oil at 82-93 °C [180-200 °F].

9. Change filter at first 50 to 100 hours, thereafter, at normal intervals. drain with oil temperature at 65-93 °C [150-200 °F].

10. Replace air cleaner element when indicator shows red (20" H2O).

11. All points requiring periodic lubrication shall be lubricated as required at assembly.

12. Brush lubricant on bottom of outrigger beams and on the inside, bottom of outrigger beams where the extension cylinder guide support travels.

13. Brush lubricant on I.D. of jack cylinder support tubes.

14. One fitting per sheave.

15. Spread grease on bottom plates, top plates and side plates of boom in area that the wear pads move on.

16. Extend boom for access through holes.

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

18. The hydraulic oil shall meet or exceed Manitowoc cleanliness specification 6829014631.

19. Replace hydraulic filter element when restriction indicator gauge on the filter head is red.

20. Replace air filter when amber engine warning flashes for first 30 seconds after key is turned to on position. ECM will also give fault code 5576. If filter is not replaced ECM will give a solid amber engine warning lamp, when restriction is greater than 25" H2O, after key is turned to on position. ECM will give fault code 3341 for this case, filter must be changed if this fault code is given. Engine performance will be reduced if filter is not replaced at proper service intervals.

For Reference Only

Service Check	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 reeving, clamps and connections	x						
Inspect the lifting hook	x						
Inspect safety devices	x						
Check controls operation	x						
Check engine crankcase oil level	x						
Check transmission oil level	x						
Check engine coolant level	x						
Check fuel level	x						
Check tire pressure	x						
Drain water from engine fuel filter	x						
Check air cleaner restriction indicator	x						
Check hydraulic oil level	x						
Inspect wire rope and sheaves		x					
Apply grease to all lubrication fittings		x					
Lubricate the boom slides		x					
Lubricate the boom cable sheaves		x					
Clean air cleaner duct cup		x					
Lubricate parking brake fitting		x					
Inspect engine fan belts			x				
Check wheel nut torque			x				
Lubricate the swing gear and pinion				x			
Lubricate the wire rope				x			
Inspect the boom chains				x			
Inspect all hydraulic hoses				x			
Replace engine crankcase oil *				x			
Replace engine oil filter *				x			
Clean radiator fins and core				x			
Clean battery and connections				x			
Torque critical bolts				x			

For Reference Only

Service Check	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 hub lubricant level (4)					x		
Check axle housing lubricant level (2)					x		
Check Hoist gearbox level					x		
Lubricate the outrigger slides					x		
Add grease to swing gearbox					x		
Replace fuel filter elements					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 *					x		
Check swing gear to pinion backlash						x	
Replace the transmission oil and filter						x	
Replace the axle wheel hub lubricant						x	
Replace the axle housing lubricant						x	
Replace the hydraulic oil						x	
Replace the hydraulic oil filter						x	
Check coolant for contamination						x	
Replace the hoist gearbox lubricant							x
Replace the engine coolant							x
Inspect the crane structure and booms for damage							x
Test the Rated Capacity Limiter (RCL)							x

-Maintenance should be performed using either the hourly or calendar dates, whichever occurs first.

-Under extremely dusty conditions,(*) items may require replacement more frequently.

For Reference Only

SCHEDULED MAINTENANCE

Daily (Walk-around) Inspection

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.

Inspections

Inspect the Anti-Double Blocking System

Test the anti-double block system daily before beginning operation to make sure it is functioning properly.

Raise the drop block until it hits 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 Hours of Operation (Weekly)” on page 6-20, for examples of damage that can be visually inspected for. If any damage is found, do not operate the crane. The wire rope must be replaced with a new rope before operation can resume.

Inspect Reeving, Clamps and Connections

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.

WARNING

Loads may fall if the wedge and socket is not installed properly or has damage. A falling load can injure or kill.

DO NOT operate the crane if any of the above are 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 is 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 above 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 ON position and view the fuel gauge on the instrument panel. If necessary, fill the tank with recommended fuel.

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. Level the crane, engage the parking brake and shut off the engine.
2. Lift the engine compartment cover and support in place using the furnished prop rod.
3. Remove the engine oil dipstick and check oil level. Oil should be visible within the crosshatched mark area on the dipstick.
4. If the oil is low, add recommended oil to bring the level up to the crosshatch area of the dipstick. When full, install the dipstick and close the engine compartment cover.

For Reference Only

Check the Transmission Oil Level

1. Check the oil level when the oil is 82° to 93°C (180° to 200°F). Level the crane, engage the parking brake and let the engine idle.
2. Lift the engine compartment cover and support in place using the furnished prop rod. Remove the dipstick (Figure 6-7) and check the oil level. Oil should be visible on the dipstick between the minimum and maximum marks with the oil cold.
3. If oil is low, add recommended oil to bring the level between the marks. **DO NOT OVERFILL**. Install the dipstick. Close the cover.

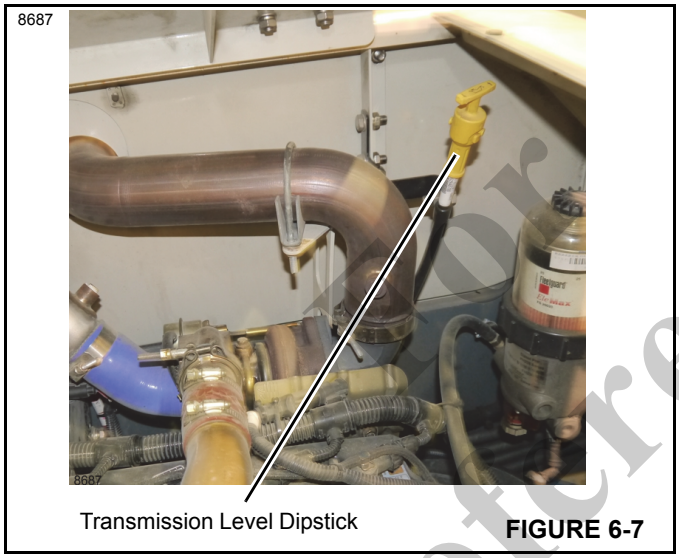
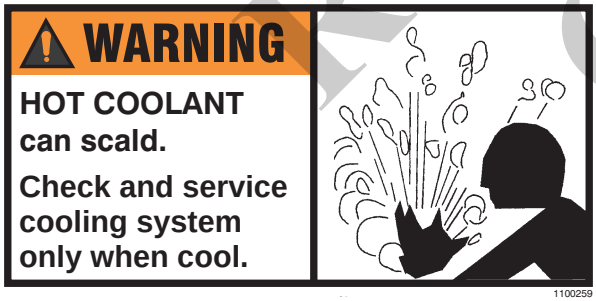


FIGURE 6-7

Check Engine Coolant Level



NEVER remove the radiator cap while the cooling system is hot. Check coolant level only when the coolant temperature is below 50°C (120°F). 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. Check that the surge tank (Figure 6-8) is at least half full. If coolant is low, fill the surge tank half way with 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.
3. If the tank is empty, **BE SURE THE ENGINE IS COOL** to below 50°C (120°F), 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.
4. If level is low, add 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.

NOTE: For more details on proper radiator checking and maintenance procedures, see the engine manual furnished with the crane.

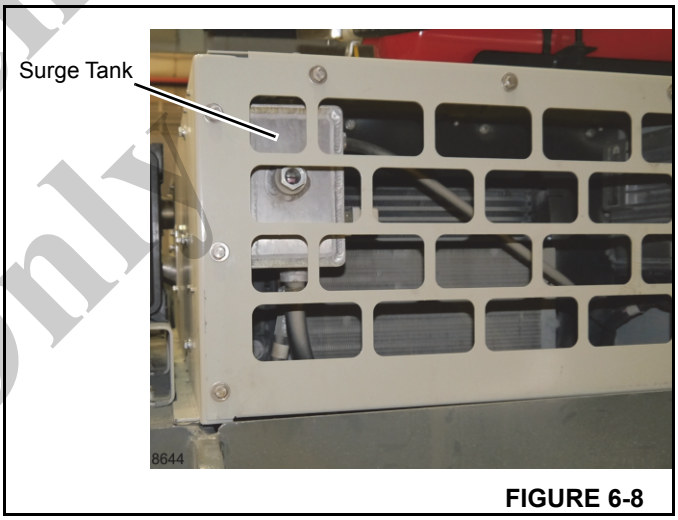


FIGURE 6-8

Drain Water from Engine Fuel Filter

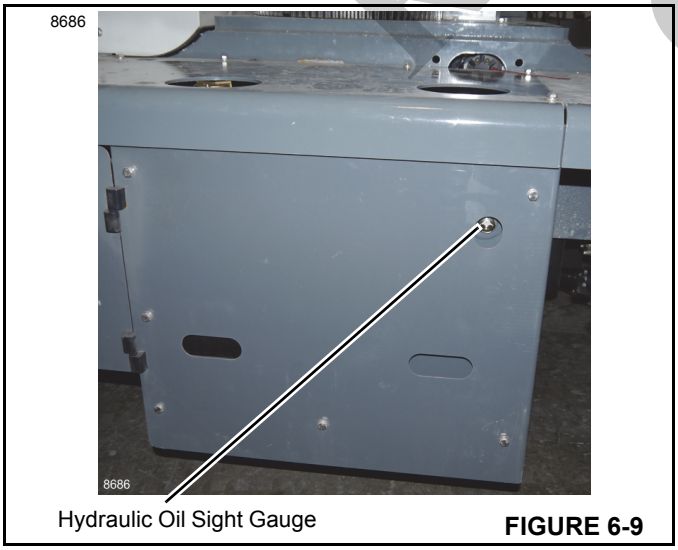
1. Shut off the engine and engage the parking brake.
2. See the engine manual furnished with the crane and follow the water draining instructions.

Check Hydraulic Oil Level

If the hydraulic oil is consistently low, check for leaks in the hydraulic system.

For Reference Only

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. Visually check the oil level on the hydraulic oil level sight gauge (Figure 6-9). The hydraulic oil should be 3 mm (0.125 in) from the top of the sight gauge. If low, fill tank with clean recommended hydraulic oil.



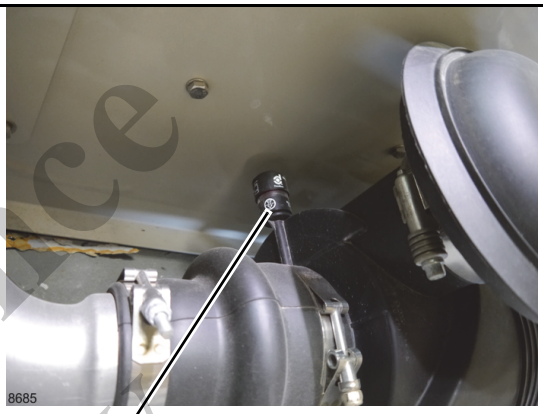
Hydraulic Oil Sight Gauge **FIGURE 6-9**

Check the Air Cleaner Restriction Indicator

The air cleaner is equipped with a filter restriction indicator (Figure 6-10). The air cleaner element needs cleaning or replacing if the indicator's colored piston has popped out and is visible when the engine is running at high idle.

To check the visual indicator the engine must be running. The filter restriction indicator is visible through the rear cab window.

Don't remove the element for inspection. Such a check always does more harm to your engine than the good your inspection can do. Ridges of dirt on the gasket sealing surface can drop on the clean filter side when the gasket is released.



Air Cleaner Restriction Indicator **FIGURE 6-10**

Remove the Element

NOTE: 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. Remove the housing cover.
2. Remove the element as gently as possible until you get it outside of housing. Accidentally bumping it while it is still inside the housing means dropped dirt and dust that may contaminate the clean side of the air cleaner housing, before the new filter element has a chance to do its job.
3. Remove the wing nut securing the safety element to the air housing. Remove the safety element.
4. Clean the inside of the housing carefully. Any dirt left inside the housing could cause damage to the engine. Use a clean, water-dampened cloth to wipe every surface clean. Check it visually to make sure it is clean before installing a new element.
5. Always clean the gasket sealing surfaces of the housing. An improper gasket seal is one of the most common

For Reference Only

causes of engine contamination. Make sure that all hardened ridges are completely removed.

Inspect 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 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.

Install the Element

1. Install the safety element over the stud in the housing and slide it all the way in.
2. Install and tighten the wing nut. Hand tighten it only. Install the element over the stud in the housing and slide it all the way in.
3. Make sure the gasket is seating evenly. If you don't feel the gasket is seating evenly for a perfect seal, you won't have protection. Recheck to see if the sealing surface in the housing is clean, or if the element is the right model number. It may be too short for the housing. Install and tighten the wing nut. Hand tighten only.
4. Install the air cleaner housing cover and fasten the latches.
5. Reset the air cleaner restriction indicator by pushing in the reset button (Figure 6-21).
6. If a cleaned air cleaner element was installed, start the engine and run at high idle. If the air cleaner restriction indicator's colored piston pops out and is visible again, shut down the engine 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).

NOTE: 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.

For Reference Only

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 the Air Cleaner Dust Cup

Squeeze the dust cup (Figure 6-11) to remove any accumulation of dust or debris.

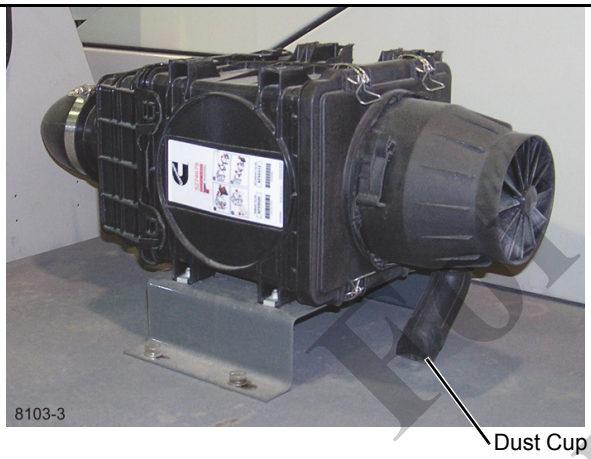


FIGURE 6-11

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. Order Wireco Report No. 107.

General Inspection

NOTE: Always wear gloves when working with wire rope to prevent 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 6-12 are present.
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.

NOTE: 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 a chain engaging 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.

Reference Only

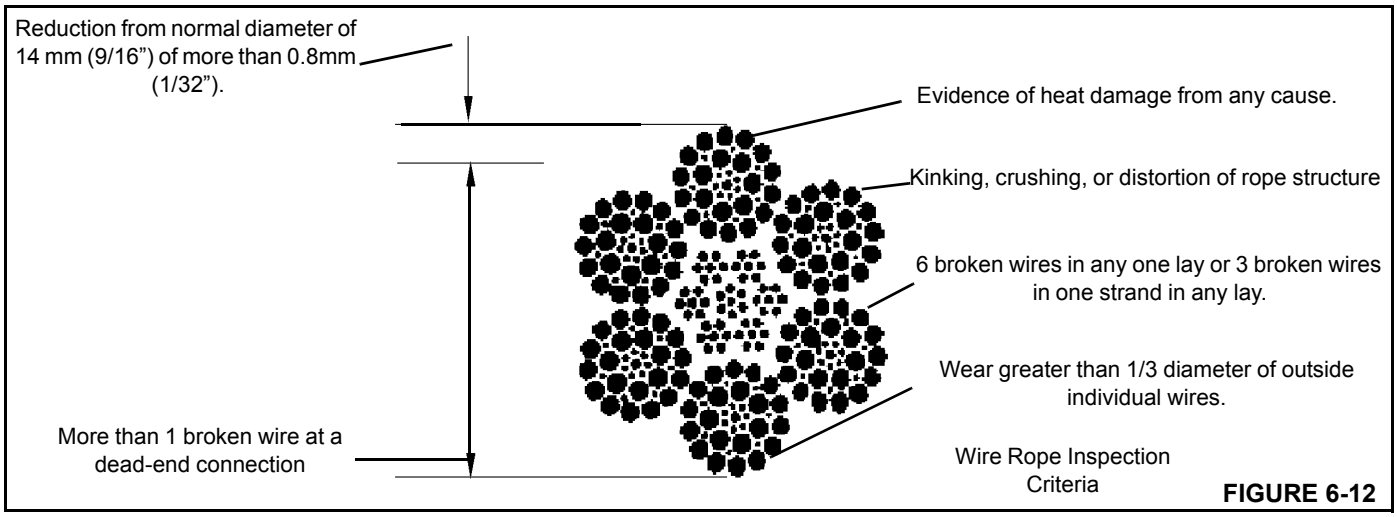


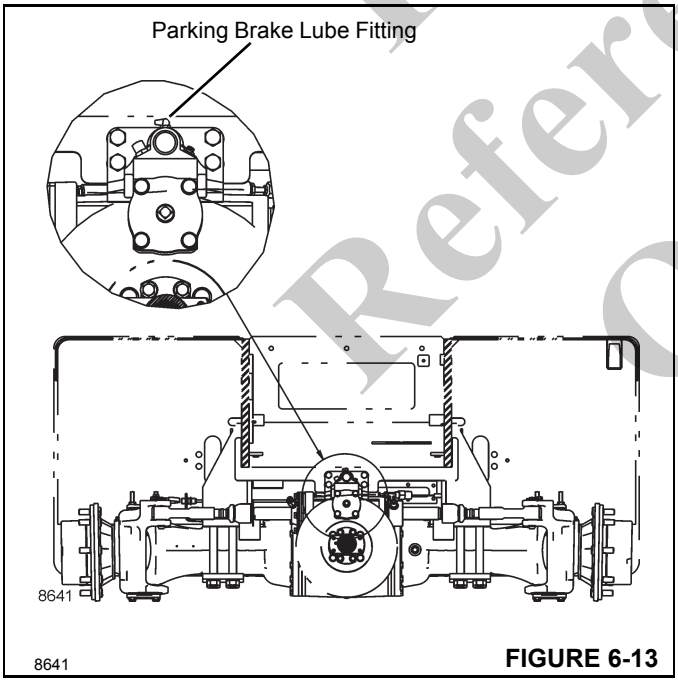
FIGURE 6-12

Grease Fittings

Lubricate all points indicated under the heading "Lubrication Points".

Lubricate Parking Brake

Apply grease to the fitting on the parking brake (Figure 6-13).



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Lubricate the Boom Slides

1. Extend the outriggers. 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 6-14) on the boom sections. Only use a small amount of lubricant for best results.
5. Apply bronze anti-seize, or equivalent, to the inner boom surface in front of and behind the slide block. Only use a small amount of lubricant for best results. Extend and retract the booms to distribute the lubricant along the slide path.

For Reference Only

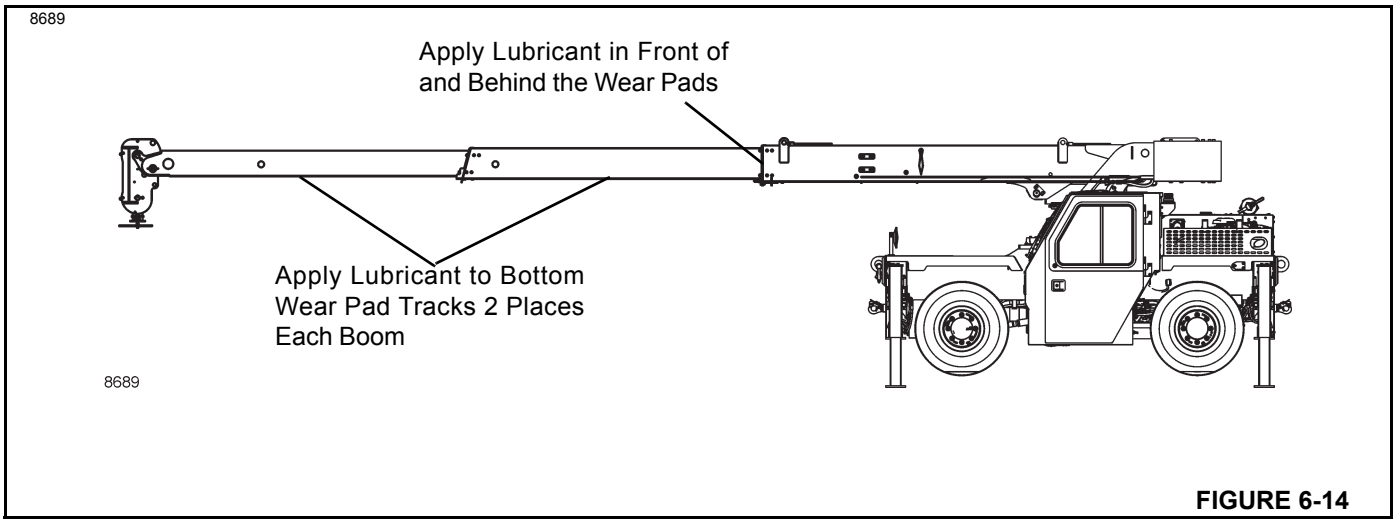


FIGURE 6-14

For Reference Only

100 Hours of Operation (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.

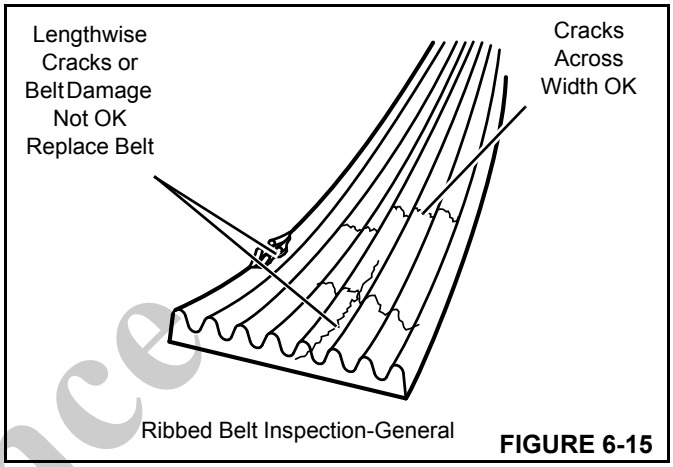
For additional engine maintenance guidelines, see the engine manual furnished with this crane.

Inspect the Fan Belts

Keep the engine and accessory belts properly tensioned for maximum engine performance and fuel economy. Proper belt tension minimizes slippage and increases belt life.

A belt that is too loose will see excessive vibration and increased wear. A belt that is too tight produces wear on the belt and the bearings of the pulleys it travels around.

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 should be replaced. See Figure 6-15.



Ribbed Belt Inspection-General **FIGURE 6-15**

Any ribbed belt showing signs of wear or that has material missing should be replaced. When a belt is replaced, check its tension again after 30 minutes of operation. New belts will stretch with use.

Check Wheel Nut Torque

Check the torque on each wheel nut in crisscross pattern. Wheel nut torque should be 475 ± 14 Nm (350 ± 10 lb-ft).

For Reference Only

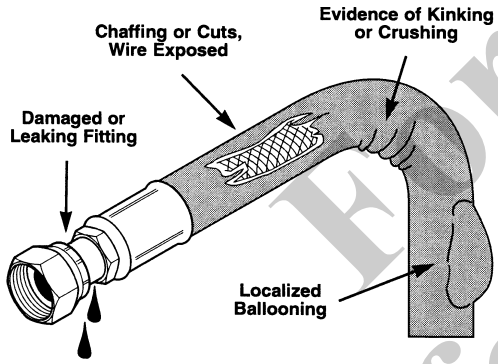
250 Hours of Operation (Monthly)

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 the Hydraulic Hoses

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.

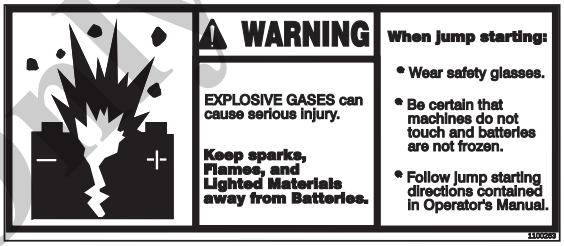


Check hoses carefully. Do not use your bare hands to check for leaks.
Tighten all connections to recommended torque.
Replace if any of the following are found:

- ***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.***

Clean Battery and Cables

1. Remove the battery compartment cover.



Battery Location **FIGURE 6-16**

For Reference Only

2. Tighten all battery hardware to keep the battery securely in place.
3. Disconnect the battery cables.
4. Sprinkle the battery with baking soda to neutralize the acid. Rinse with water. Be careful not to get water inside the battery.
5. Coat the battery posts with petroleum jelly and reinstall the battery cables.
6. Install the battery box cover.

Clean the Radiator

NOTE: To prevent personal injury, always wear safety glasses when using compressed air.

Clean the radiator fins by using compressed air or a water hose to remove all foreign materials. If these materials are not removed, the engine may over heat due to blocked air through the radiator fins and core.

Lubricate the Wire Rope

Apply lubricant to the hoist wire rope to prevent 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.

NOTE: To prevent personal injury from compressed air, always wear safety glasses when using compressed air for cleaning.

3. After cleaning the wire rope, 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 a temperature between 18° to 36°C (60° and 100°F). Use a brush or cloth to apply the oil.

NOTE: 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 pinion.

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Rotating gears can cause injury. Keep hands clear of rotating pinion and gear while the mast is rotating.

3. Spray the open gear lube onto the pinion and swing gear teeth (Figure 6-17).

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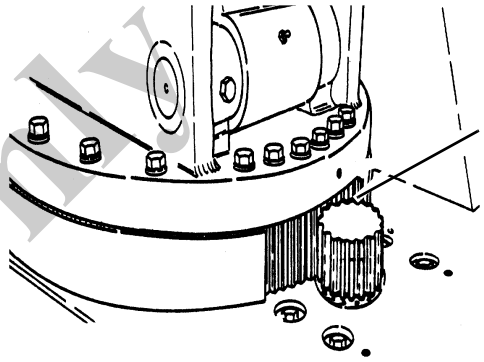


Swing Gear and Pinion Lubrication **FIGURE 6-17**

4. Start the engine and rotate the mast until a non-lubricated portion of the swing gear is exposed. Keep hands away from rotating pinion and gear.
5. Shut off the engine.
6. Apply open gear lube to the swing gear teeth.
7. Repeat steps 4, 5 and 6 until the complete swing gear is lubricated.

For Reference Only

6

Replace the Crankcase Oil and Filter

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.

NOTE: If 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 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.

Hot oils can cause personal injury.

1. Operate the engine until the water temperature reaches 60°C (140°F).
2. Shut off the engine.
3. Place a suitable container under the engine drain plug. Remove the oil 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.

NOTE: 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 engine operator's manual furnished with the crane).
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

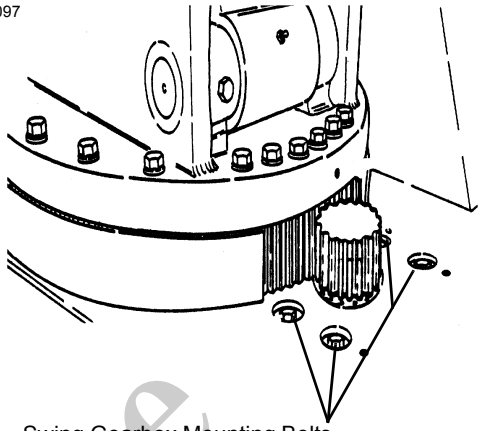
NOTE: Maintain correct torque on all bolts. Failure to do so may result in severe damage to the crane.

Hoist Gearbox Mounting Bolts

Torque the 3/4" mounting bolts (4) to 322 Nm (237 lb-ft).

Swing Gearbox Mounting Bolts

Torque the 12mm gearbox mounting bolts (4) to 110 Nm (81 lb-ft). See Figure 6-18. If the bolts are loose, check gear backlash.



Swing Gearbox Mounting Bolts

FIGURE 6-18

Mast Mounting Bolts

Because of the cyclic loading on the mast bolts, it is important that these bolts be checked at regular intervals. Refer to the Service Manual for the proper bolt torque procedure.

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.

The correct torque on each outside bolt (mast to swing bearing) should be 215 Nm (158 lb-ft). The correct torque on each inside bolt (swing bearing to frame) should be 381 Nm (282 lb-ft).

NOTE: Use only special Grade 8 bolts for replacement of the mast bolts. Order the bolts from your distributor, see your parts manual.

If a broken bolt is found, replace the bolt and also replace the bolt on each side of the broken bolt.

The proper bolt torque will not be obtained without the hardened steel washers under the bolt heads on the outer (mast) bolt circle.

Front Axle Mounting Bolts

Torque the 1" axle mounting bolts (8) to 782 Nm (575 lb-ft). See Figure 6-19.

For Reference Only

Front Axle Mounting Bolts **FIGURE 6-19**

500 Hours of Operation (3 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 the Tires

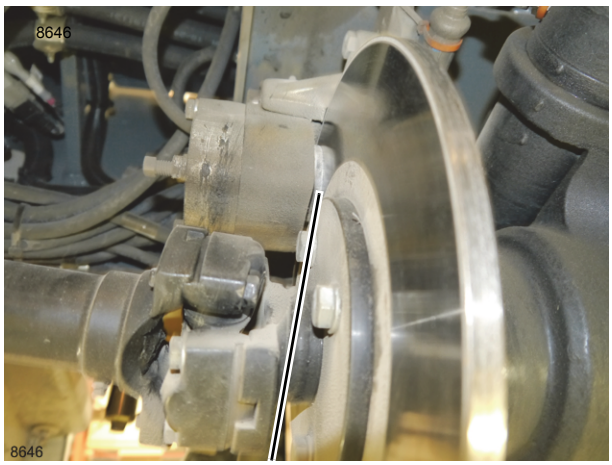
Inspect the tires for any signs of damage, such as cracks, large gouges, deterioration, etc. If damage is found, it must be carefully analyzed to determine if the tire is safe to use. Replace all tires that are unsafe.

Inspect Parking Brake Pads

NOTE: 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 and chock blocks are in place before climbing under the crane.

Inspect the thickness of the brake pads (Figure 6-20). Replace the brake pads if they are 0.71 mm (0.028 in) thick or less.

Check the surface condition of the brake disc. Replace the disc if badly warped, pitted or out of tolerance.



Parking Brake Pads **FIGURE 6-20**

Replace Fuel Filter

See the engine operator's 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's manual furnished with the crane.

Replace Air Cleaner Element

NOTE: 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.

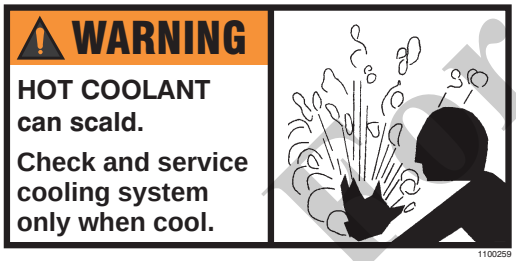
1. Remove the housing cover.
2. Remove the element as gently as possible until you get it outside of housing. Accidentally bumping it while it is still inside the housing means dropped dirt and dust that may contaminate the clean side of the air cleaner housing, before the new element has a chance to do its job.
3. Remove the safety filter.
4. Clean the inside of the housing carefully. Any dirt left inside the housing could cause damage to the engine. Use a clean, water-dampened cloth to wipe every surface clean. Check it visually to make sure it is clean before installing a new element.
5. Always clean the gasket sealing surfaces of the housing. An improper gasket seal is one of the most common causes of engine contamination. Make sure that all hardened ridges are completely removed.
6. Install the safety element. Make sure it is seated all the way.

For Reference Only

NOTE: The safety element must be replaced after two main element replacements.

7. Install the new element over the stud in the housing and slide it all the way in.
8. Make sure the gasket is seating evenly. If you don't feel the gasket is seating evenly for a perfect seal, you won't have protection. Recheck to see if the sealing surface in the housing is clean, or if the element is not the right model number. It may be too short for the housing.
9. Install the air cleaner housing cover and secure with the latches.
10. Reset the air cleaner restriction indicator by pushing in the reset button.

Add Rust Inhibitor to Engine Cooling System



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, following manufacturer's instructions.

Lubricate the Outrigger Slides

1. Extend the outriggers.
2. Clean the outriggers with a suitable solvent.
3. Apply Mobil EP grease, or equivalent, to the areas shown in Figure 6-21. Do not over lubricate.

Extend, retract, raise and lower the outriggers several times to spread the grease.

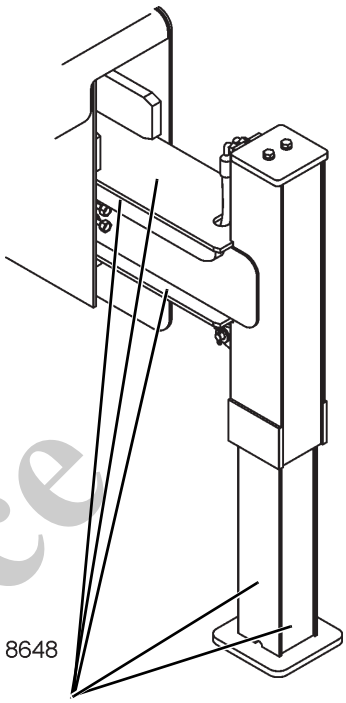


FIGURE 6-21

Add Grease to the Swing Gearbox

NOTE: 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 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 will be necessary to use a light to see the fitting.

For Reference Only

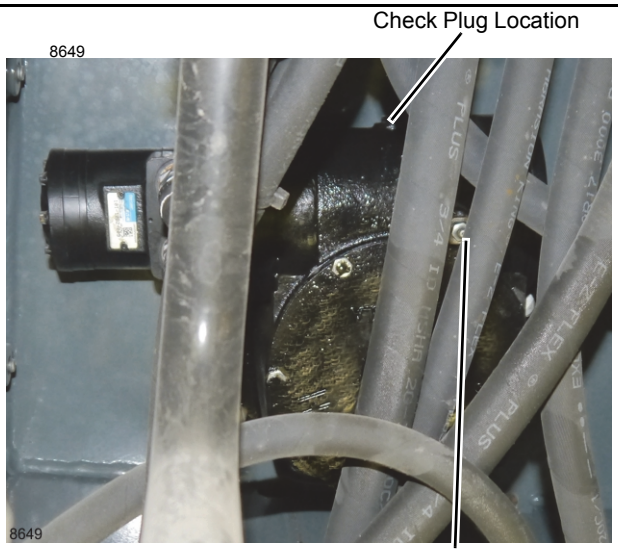


FIGURE 6-22

1. Engage the parking brake and shut off the engine. Remove the ignition key.
2. Clean the grease fitting and check plug (Figure 6-22).
3. Remove the check plug.
4. Apply Lithium Base, E.P. No. 2 bearing grease to the fitting. Fill gear box until grease exits the check plug hole. Install the check plug.

Check Axle Housing Lubricant Level

It is necessary to climb under the crane to check the axle housing lubricant. Be sure engine is shut off, the ignition key is removed and chock blocks are in place before climbing under the crane.

1. Clean around the axle housing fill/check plug (Figure 6-23) and remove the plug.

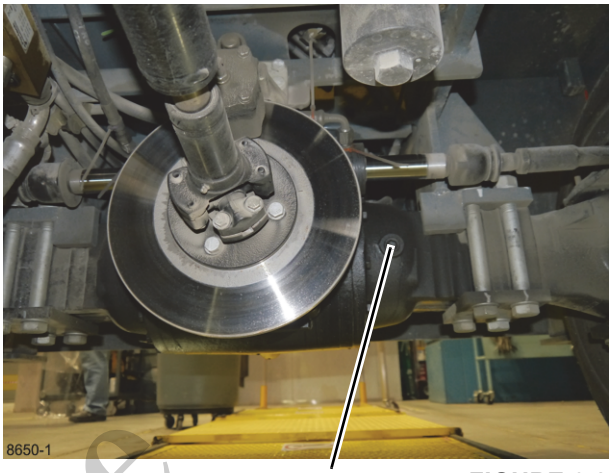


FIGURE 6-23

2. Check the lubricant level, which should be even with the bottom of the fill/check hole.
3. If necessary, add Mobil Fluid 424 to fill the housings until oil is level with the bottom of the fill/check hole.

Check Wheel Hub Lubricant Level

1. Using the outriggers, raise the tires slightly off of the ground.
2. Place the transmission in neutral and release the parking brake.
3. Turn one of the wheel hubs until the fill/check plug is horizontal with the ground (Figure 6-24).

FIGURE 6-24

4. Clean around the plug and then remove it.

For Reference Only

5. Check the lubricant level, which should be even with the bottom of the hole.
6. If necessary, add Mobil Fluid 424 to fill the hub to the recommended level.
7. Repeat Steps 1 through 4 for the other wheel hub.

Check Hoist Gearbox and Brake Lubricant Levels

1. Lower the boom to its lowest position.
2. Engage the parking brake and shut off the engine.
3. Clean around the gearbox oil level plug (Figure 6-25) and then remove the plug.
4. Check the lubricant level, which should be to the bottom of the oil level hole.
5. If necessary, add AGMA No. 4 EP gear lube to gearbox until it reaches the bottom of the oil level hole.
6. Reinstall the level plug.

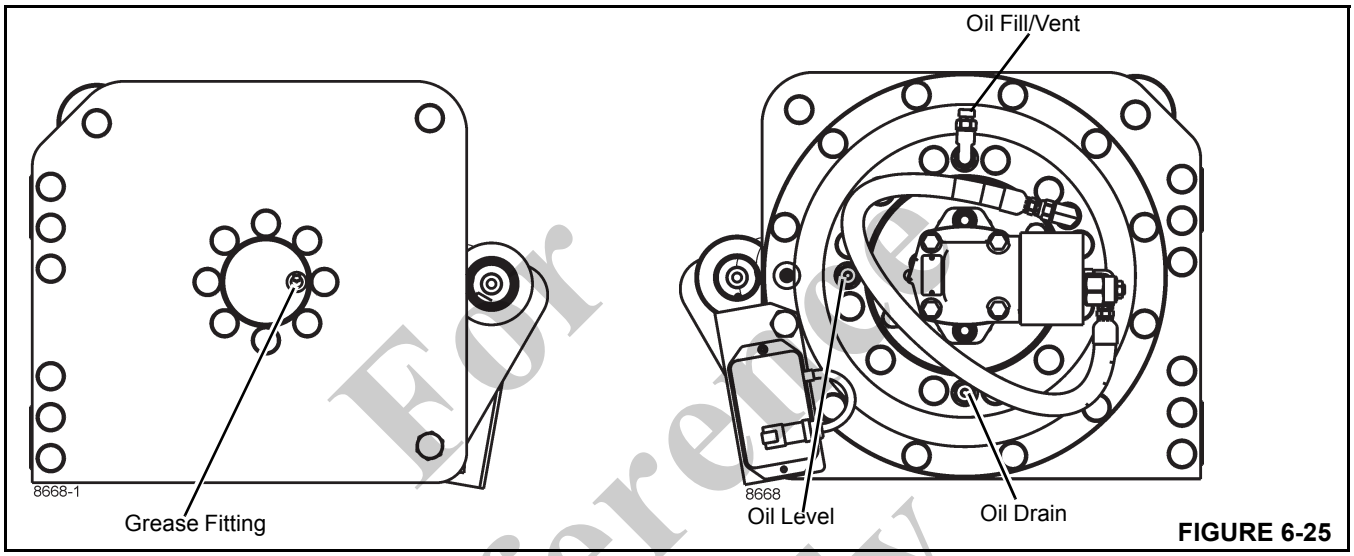


FIGURE 6-25

1000 Hours of Operation (6 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.

NOTE: 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.

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 years maintenance and one for emergency maintenance.

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 6-26). Remove the strainer and gasket and drain the oil into the container. Discard the gasket.
3. Place the container under the drain plug and remove the drain plug (Figure 6-26). Drain any oil left in the transmission into the container. Install the drain plug.

For Reference Only

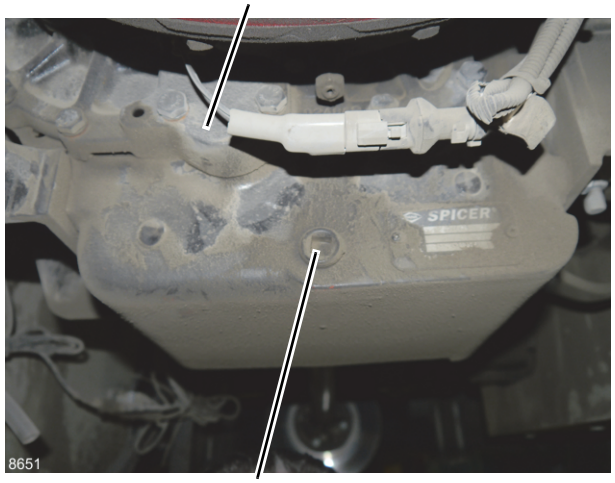


FIGURE 6-26

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 6-27). 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.

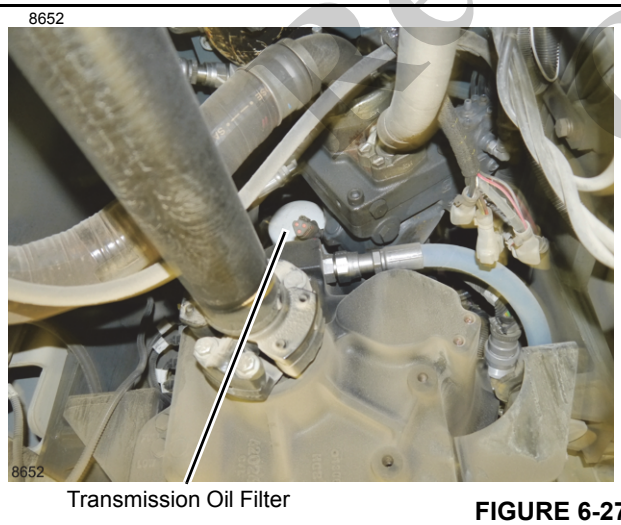


FIGURE 6-27

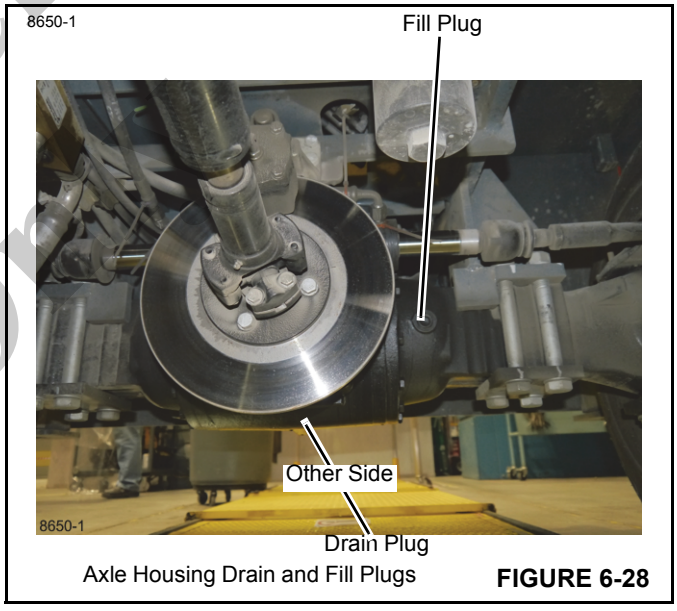
9. Fill the transmission with ISO 46/68 grade hydraulic oil, or equivalent, to the upper mark on the dipstick (approximately 13 liters [3.43 gallons]).
10. Start the engine and let it run at idle speed for a period not exceeding five minutes. This allows the oil to fill the transmission filter, torque converter and hoses.
11. With the engine idling and the transmission in neutral check oil level. If low, add oil to the upper mark on the transmission dipstick. **DO NOT OVERFILL.**

Replace the Front Axle Housing Lubricant

NOTE: It is necessary to climb under the crane to drain the axle housing lube. Be sure engine is shut off, the ignition key is removed and chock blocks are in place before climbing under the crane.

Rear axle center housing to remain dry.

1. Clean around the fill plug in the axle housing (Figure 6-28). Remove the plug.
2. Place a container under the axle housing drain plug. Remove the drain plug and drain the fluid into the container. Install the drain plug.



Axle Housing Drain and Fill Plugs

FIGURE 6-28

3. Fill the axle housing with recommended lubricant through the fill plug hole. Fill until the oil reaches the bottom of the fill hole.
4. Install the fill plug.

For Reference Only

Replace Axle Wheel Hub Lubricant

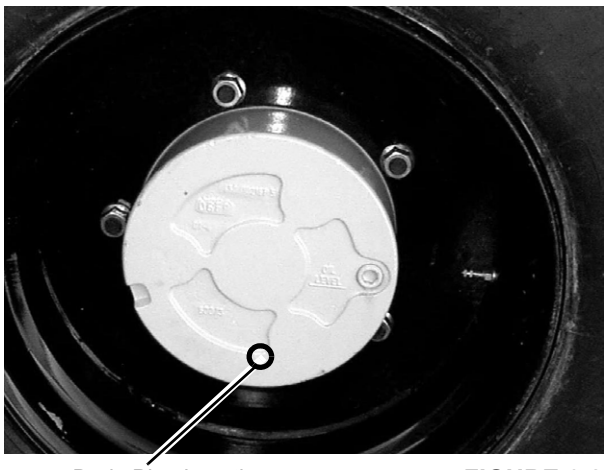


FIGURE 6-29

1. Using the outriggers, raise the tires slightly off of the ground.
2. Place the transmission in neutral and release the parking brake.
3. Turn one of the axle wheel hubs until the drain plug is located at the bottom of the wheel hub (Figure 6-29).
4. Clean around the drain plug and then remove it. Drain the wheel hub oil into a suitable container.

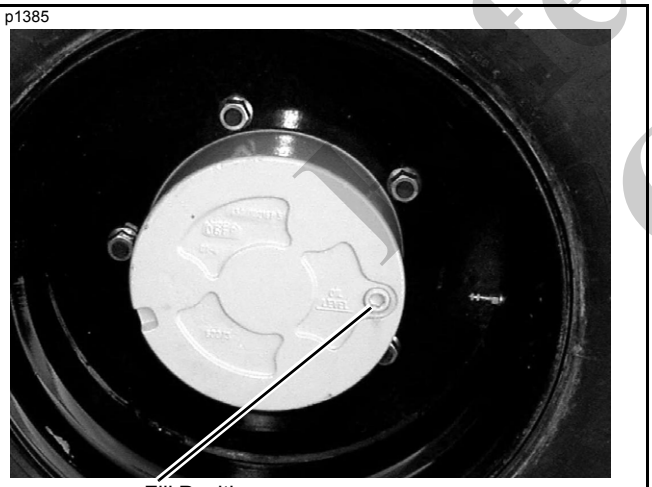


FIGURE 6-30

5. Turn the wheel hub until the drain hole is horizontal (Figure 6-30).
6. Fill the wheel hub with the recommended lubricant through the fill hole until the oil reaches the bottom of the hole.
7. Install the plug.
8. Repeat the above procedure for the other wheel hub.

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.

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.

NOTE: It is necessary to climb under the crane to drain the hydraulic oil. Be sure engine is shut off, the ignition key is removed and chock blocks are in place before climbing under the crane.

4. Level the crane, engage the parking brake, shut off the engine and remove the ignition key.
5. Place a suitable container under the hydraulic tank drain ports (Figure 6-31).

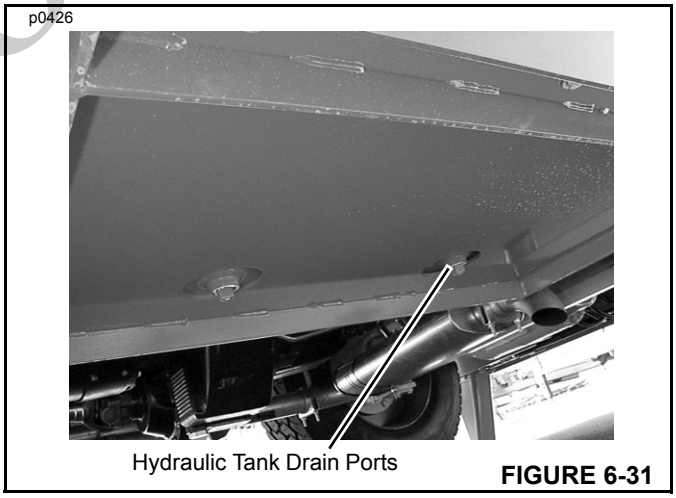


FIGURE 6-31

For Reference Only

FIGURE 6-32

6. When the tank is empty, disconnect the two hydraulic lines from the rear of the hydraulic oil tank (Figure 6-32). Remove the suction strainer from the suction port and clean it in a suitable solvent.
7. Clean the inside of the hydraulic tank and remove any sediment.
8. Install the fill strainer, suction strainer, suction hose and return line to the hydraulic tank.
9. Replace the hydraulic oil filter. See *Replace the Hydraulic Oil Filter*, page 6-33.
10. Fill the hydraulic tank with Mobil Fluid 424 hydraulic oil until level with the sight glass.
11. After the tank is filled, start the engine and operate each function until all the cylinders and lines are filled.
12. Fully retract and lower the boom and retract the outriggers. Check the hydraulic oil level. Oil must be level with the sight glass. Add hydraulic oil if necessary.
13. Visually check for leaks.

Replace the Hydraulic Oil Filter

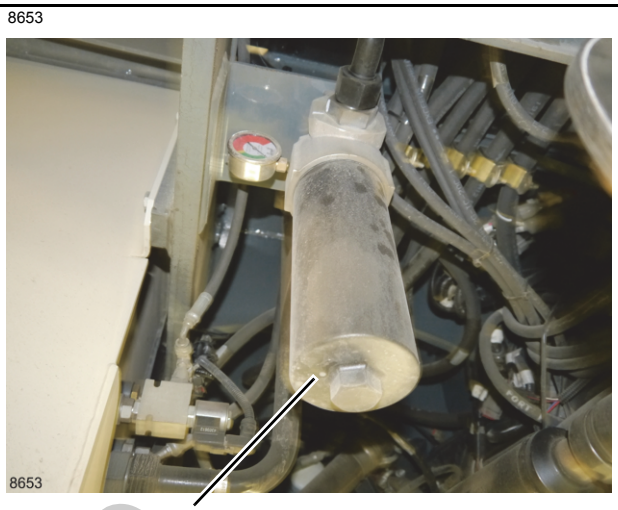


FIGURE 6-33

1. Engage the parking brake and shut off the engine.

NOTE: It is necessary to climb under the crane to replace the hydraulic oil filter. Be sure engine is shut off, the ignition key is removed and chock blocks are in place before climbing under the crane.

2. Locate the hydraulic oil filter under the crane (Figure 6-33).
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.
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.

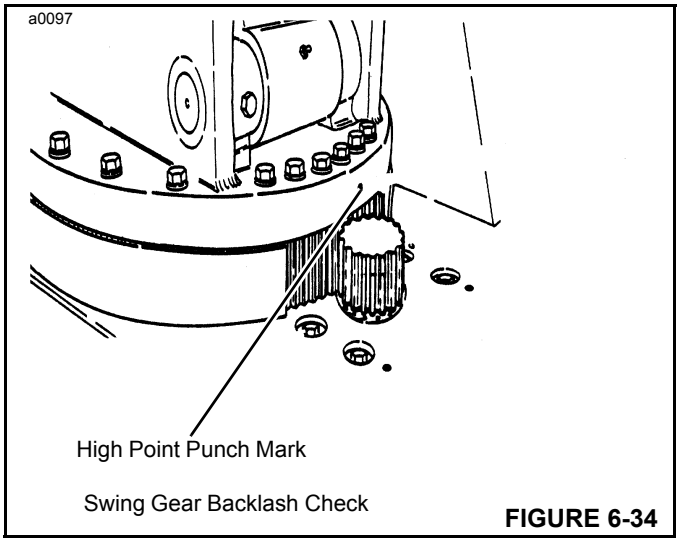
For Reference Only

Check Swing Gear/Pinion Backlash

1. Remove the cover to expose the swing pinion and ring gear.

Rotating gears can cause injury. Keep hands clear of rotating pinion and gear while the mast is rotating. 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 mast plate (Figure 6-34).

2. 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 the *Service Manual Section 6, Adjustments*.



Swing Gear Backlash Check

FIGURE 6-34

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 Hoist Gearbox and Brake Lubricant

1. Lower the boom to lowest position, engage the parking brake. Leave the engine running.

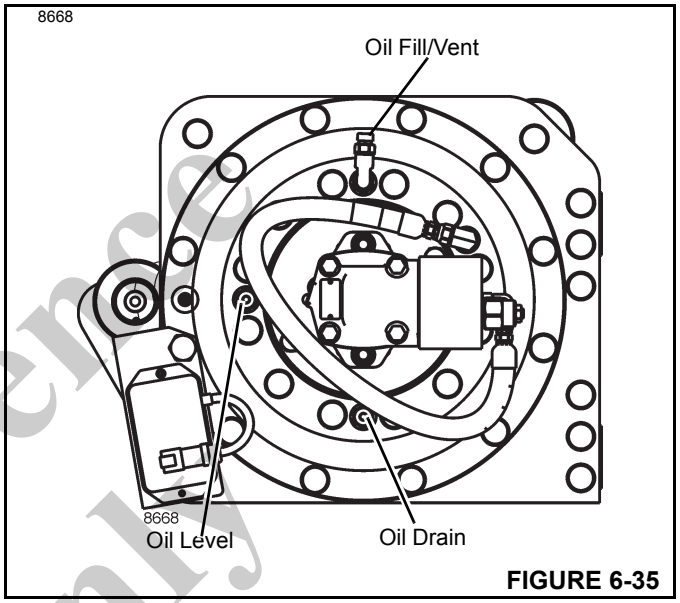


FIGURE 6-35

2. Clean around the oil fill/vent. Remove the oil fill/vent (Figure 6-35) and clean it in a suitable solvent.

3. Clean around the oil level plug (Figure 6-35) and remove the plug.

4. Place a suitable container under the drain plug.

5. Remove the drain plug and allow the fluid to drain into the container. Examine the oil for signs of significant metal particles. If any particles are found, the gearbox may require disassembly and repair.

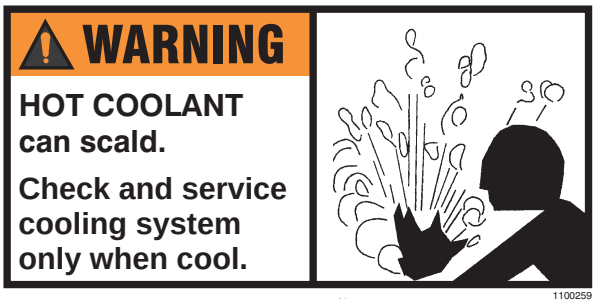
6. Install the drain plug.

7. Fill the gearbox through the fill hole until the fluid is even with the bottom of the oil level hole. Fill with AGMA No. 4 EP gear lube.

8. Install the oil fill/vent.

For Reference Only

Replacing the Engine Coolant



1. Open and prop in place the engine compartment cover.
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 Manitowoc distributor.
- 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.

Testing the Rated Capacity Limiter (Optional)

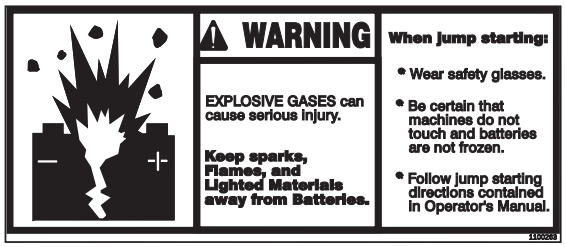
See the *Rated Capacity Limiter Manual* furnished with this crane and test the indicator according to instructions in the manual.

MISCELLANEOUS MAINTENANCE

Batteries/Charging System

NOTE: 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

Check the voltmeter reading on the instrument panel. Normal voltmeter readings are as follows:

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 Crane*, page 3-15) 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 gasing occurs or temperatures exceed 52°C (125°F), the charging rate must be reduced or temporarily stopped to permit cooling.

For Reference Only

Replacing the Battery

NOTE: The fluid in electric storage batteries contains sulfuric acid, which is **POISON** and can cause **SEVERE CHEMICAL BURNS.** Avoid all contact of fluid with eyes, skin or clothing. Use proper protective gear when handling batteries. **DO NOT** tip any battery beyond a 45° angle in any direction. If fluid contact does occur, follow the First Aid suggestions that follows.

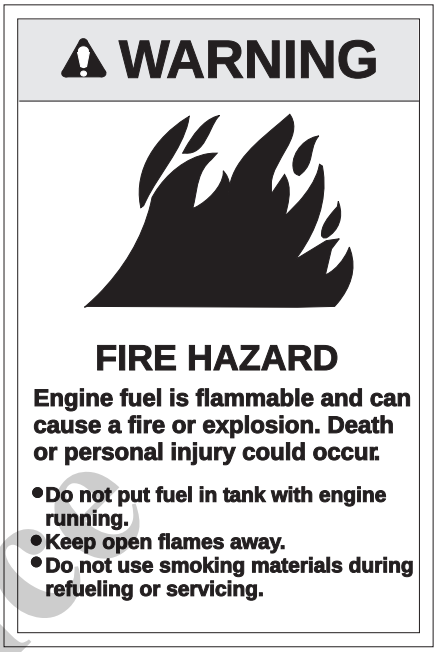
Battery Electrolyte First Aid

- **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.

Remove the battery very carefully to avoid spillage of battery fluid. Properly dispose of the battery.

Fuel System



Fuel Storage

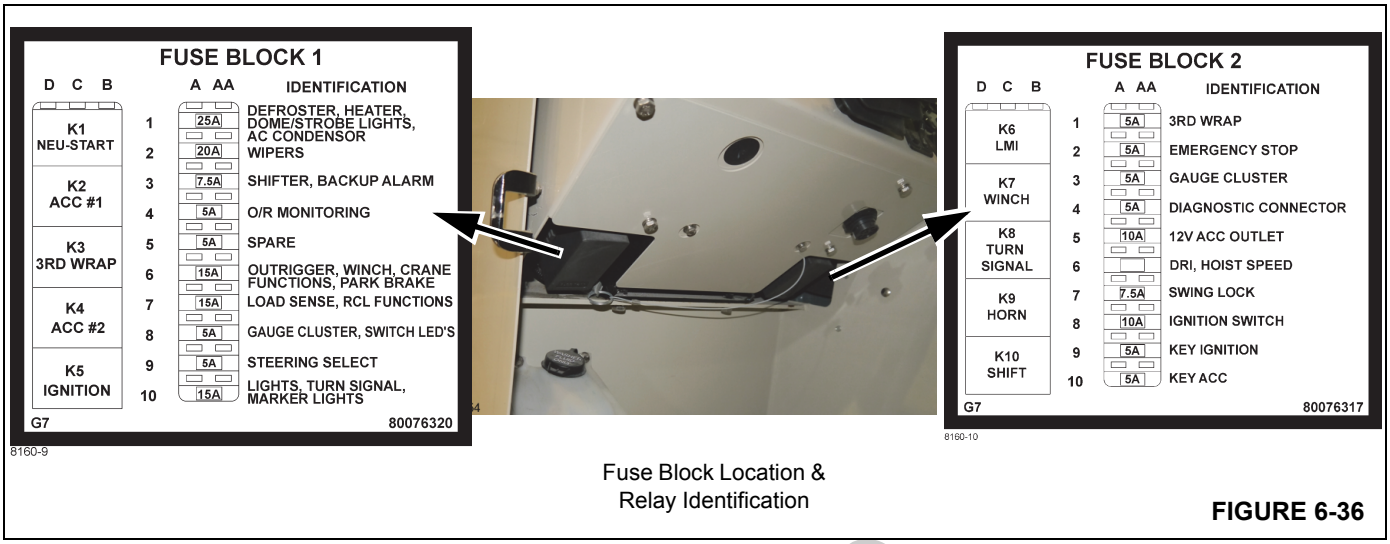
Storage of fuel for an extended period causes accumulation of sediment, dirt, water and other foreign materials in the fuel. Many engine problems are caused by dirty fuel and long storage periods.

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/Relay Replacement

Fuses and relays are located in two fuse blocks below the instrument panel and one in the battery compartment (Figure 6-36 and Figure 6-37).

For Reference Only



Fuse Block Location & Relay Identification

FIGURE 6-36

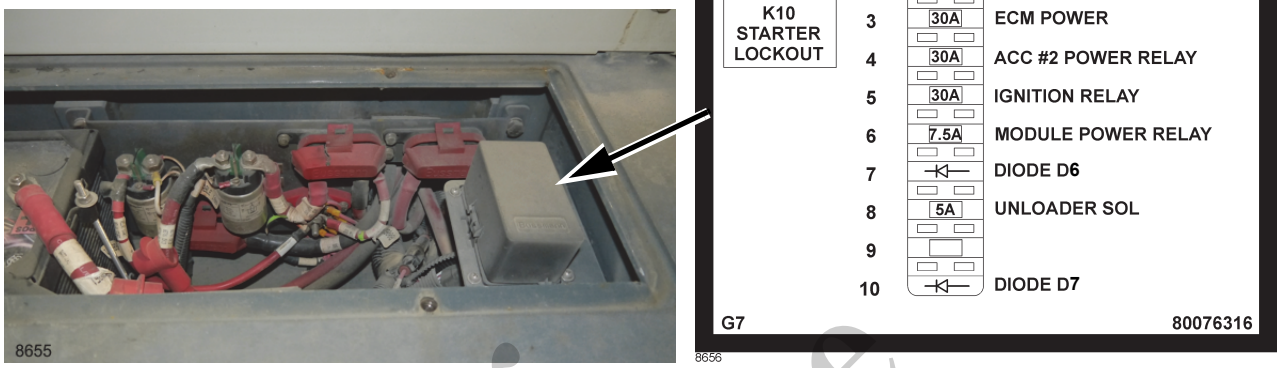
Fuse Box #1 Circuit Identification

Fuse	Amps	Circuit
FU1	25	Defroster, Heater, Dome/Strobe Lts., AC Condenser
FU2	20	Wipers
FU3	7.5	Shifter, Back Up Alarm
FU4	5	Outrigger Monitoring
FU5	5	Spare
FU6	15	Outriggers, Winch, Crane Functions, Park Brake
FU7	15	Load Sense, RCL Functions
FU8	5	Gauge Cluster, Switch LEDs
FU9	5	Steering Select
FU10	15	Lights, Turn Signal, Marker Lights

Fuse Box #2 Circuit Identification

Fuse	Amps	Circuit
FU1	5	3rd Wrap
FU2	5	Emergency Stop
FU3	5	Gauge Cluster
FU4	5	Diagnostic Connector
FU5	10	12V ACC Outlet
FU6	-	DRI, Hoist Speed
FU7	7.5	Swing Lock
FU8	10	Ignition Switch
FU9	5	Key Ignition
FU10	5	Key ACC

For Reference Only



Battery Box Fuse Block & Relay Identification

FIGURE 6-37

Fuse	Amps	Circuit
1	30	Fuse Block 1 Fuse 10 Fuse Block 2 Fuses 3 & 5
2	30	ACC #1 Power Relay
3	30	ECM Power
4	30	ACC #2 Power Relay
5	30	Ignition Relay

Fuse	Amps	Circuit
6	7.5	Module Power Relay
7	-	Diode D6
8	5	Unloader Solenoid
9		Not Used
10	-	Diode D7

For Reference Only

CARWELL® RUST INHIBITOR

Protecting Cranes from Rusting

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

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

Carwell is a treatment, not a coating. It contains no silicones, solvents, CFCs or anything that would be classified as hazardous under OSHA Regulation 29CFR 19 10.1200. The product is a liquid blend of petroleum derivatives, rust inhibitors, water-repelling and water-displacing agents.

Special equipment is used to spray a light film onto the entire undercarriage and various other areas of each new crane prior to shipment. When applied the product has a red tint to allow applicators to view coverage during application. This red tint will turn clear on its own within approximately 24 hours after application.

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

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

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

The most common causes of corrosion include the following:

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

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

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

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

Cleaning Procedures

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

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

CAUTION

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

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

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- Allow the crane to dry thoroughly. You can accelerate drying by using compressed air to remove excess water.

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

Inspection and Repair

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

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

CAUTION

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

For scratches and marks in highly visible areas:

- Sand to remove the scratch and feather outward from the mark to blend the repair into the original surface. Body putty may be applied as necessary to hide the defect; then sand smooth.
- Cover all bare metal with a primer that is compatible with the original paint finish and allow to dry thoroughly.
- Prepare the surface prior to applying the finish coat of paint.
- Apply a finish coat of paint using accepted blending techniques. Use of original paint colors is recommended to insure the best color match possible.

For scratches and marks in areas of low visibility:

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

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

Application

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

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

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

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

NOTE: Unit must be completely dry before applying treatment.

- Do not allow product to puddle or build-up on weather stripping, rubber gaskets, etc. Unit should not have puddles or runs evident anywhere.
- To ensure proper coverage of treatment, the product needs to be fogged on the unit.
- Use of pressure pots to apply the treatment to the unit being processed is recommended.
- Carwell treatment is available in 16 ounce spray bottles from Manitowoc Crane Care (order part number 8898904099).
- After application of the treatment is complete, wash or clean film residue from lights, windshield, grab handles, ladders/steps and all access areas to crane, as necessary.

Please contact Manitowoc Crane Care should you have any questions.

Areas of Application

Refer to Figure 6-38

- The underside of the unit will have full coverage of the rust inhibitor. These are the only areas that a full coat of the rust inhibitor is acceptable on the painted surfaces. Areas include; Valves, hose end and fittings, Swivel, pumps, axles, drivelines, transmission, slew ring fasteners and all interior surfaces of the frame.
- Frame application areas are; hose ends and fittings, all unpainted fasteners and hardware, all bare metal surfaces, outrigger pads, and back up alarm hardware.
- Superstructure applications are; hose end and fittings, wire rope on hoist roller tensioning springs on hoists, all

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unpainted fasteners and hardware, valves, slew ring fasteners and all bare metal surfaces.

- Boom applications areas are; pivot pins, hose end and fittings, boom extension pins and shafts, all bare metal surfaces, headache ball pins/ hook block pins and fasteners.
- All hardware, clips, pins, hose connections not painted will have treatment applied.

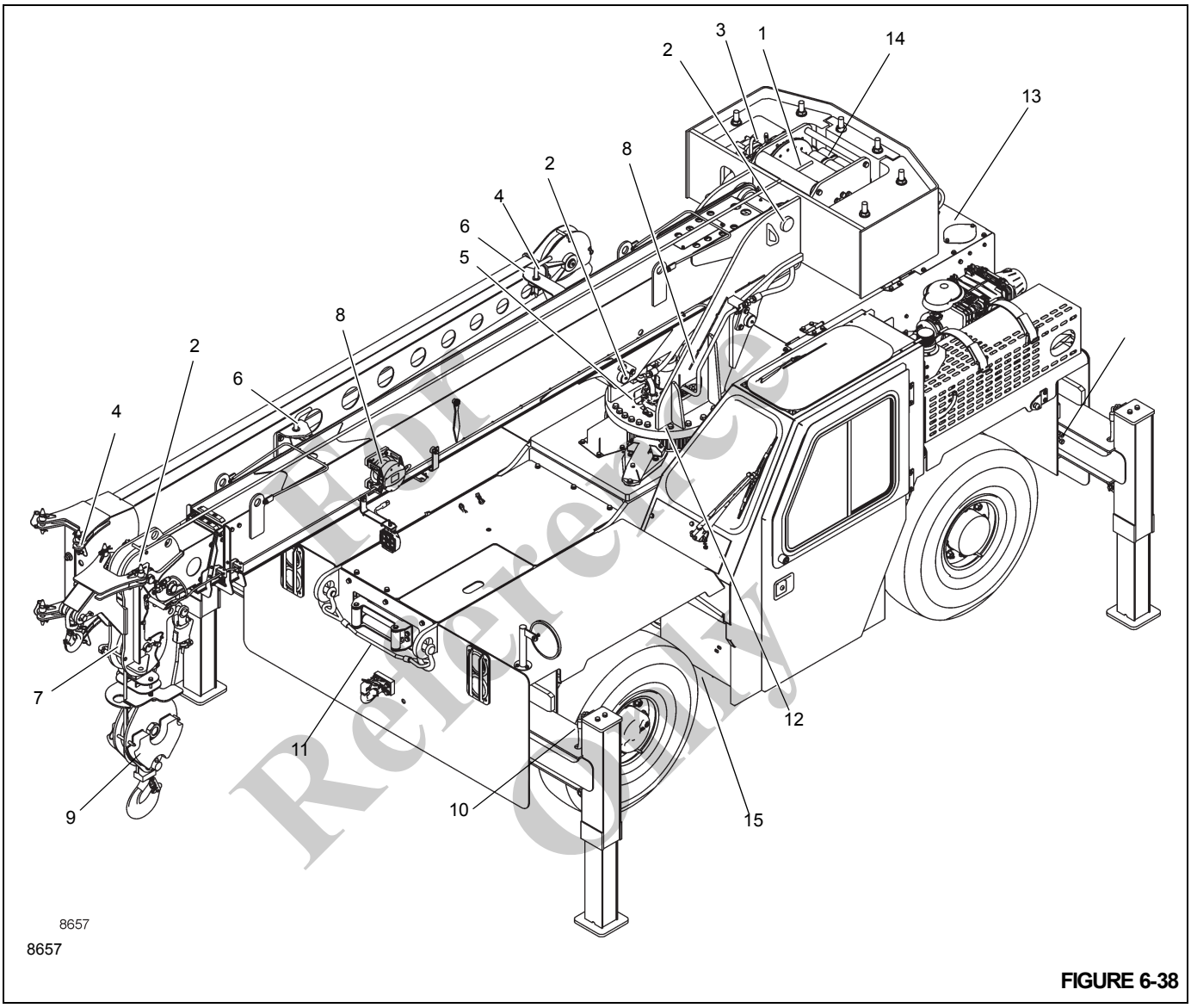

FIGURE 6-38

Item	Description
1	Hoist Tension Spring
2	Pivot Shaft
3	Hoist Hose Connections
4	Boom Extension Pins, Clips
5	Hose Connections inside turntable
6	Boom Extension Hanger Hardware

Item	Description
7	Boom Nose Pins, Clips
8	All Hardware, Clips, Pins, Hose Connections not painted O/R Pins, Clips
9	Headache Ball/Hook block
10	O/R Hose Connections
11	Hook block Tiedown Cable
12	Turntable Bearing Fasteners
13	Powertrain Hardware inside compartment

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Item	Description
14	Wire Rope
15	Entire underside of unit

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SECTION 7
ADJUSTMENTS

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

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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

CC/SF for use in naturally aspirated engines and in engines that operate in light duty service including standby and emergency operation (equivalent to MIL-L-2104B).

Sulfated Ash Limit of 1.85% by weight is recommended. Oils with higher ash count may produce deposits on valves that can progress to guttering and valve burning.

Do not use “break-in” lubricating oils in new or rebuilt engines. Use lubricating oils specified for normal engine operation.

Oil Viscosity Recommendations

The use of a multigrade lubricating oil improves oil consumption control and improves engine cranking in cold temperatures while maintaining lubrication at high operating temperatures. A multigrade oil is therefore recommended. The use of single grade lubricating oils is not recommended, except for synthetic oils used in Arctic conditions.

Viscosity Grades

Arctic Operation

NOTE: SAE 5W viscosity grade synthetic oil may be used when operating the engine in ambient temperatures below -23°C (-10°F) provided they meet the minimum viscosity at 100°C (212°F).

When there is no provision to keep the engine warm when operating in ambient temperatures consistently below -23°C (-10°F), use a lubricating oil that meets the following requirements:

Parameter (test method)	Specification
Performance	API classification -Naturally aspirated -API classification CC/CD-Turbocharged
Viscosity	10,000 mPa•s Maximum at -35°C (-31°F) 4.1 mm (0.16 in) Squared minimum at 100°C (212°F)

Parameter (test method)	Specification
Pour Point (ASTM D-97)	Maximum of 5°C (41°F) below the lowest expected ambient temperature.
Sulfated ash content	Maximum at 1.85% by weight (ASTM D-874)

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.

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GENERAL SPECIFICATIONS

Engine

Tier 4 Final Diesel

Make and model ..... Cummins QSF2.8 -4 Cyl. Diesel Tier 4 Final

Type of Aspiration ..... Turbocharged

Horsepower ..... 74 hp @ 2500 rpm

Low idle speed ..... 900 rpm

Maximum engine speed ..... 2500 rpm

Tier 3 Diesel

Make and model ..... Cummins QSF2.8 -4 Cyl. Diesel Tier 3

Type of Aspiration ..... Turbocharged

Horsepower ..... 72 hp @ 2400 rpm

Low idle speed ..... 900 rpm

Maximum engine speed ..... 2400 rpm

Dual Fuel

Make and model ..... KEM GM 3.0L

Type of Aspiration ..... Naturally

Horsepower ..... 78 hp @ 2500 rpm (Gasoline)
..... 63 hp @ 2500 rpm (LPG)

Low idle speed ..... 900 rpm

Maximum engine speed ..... 2500 rpm

Tires

Size 10.00-15

Type ..... Bias Ply

Air pressure ..... 862 kPa (125 psi)

Wheel nut torque ..... 475 Nm ± 14(350 lb-ft ± 10)

Electrical System

Rating ..... 12 VDC negative ground

Number and type of batteries:

Standard Battery ..... One-maintenance free

Battery ..... 150 amp/hr

Battery rating ..... 150 amp/hr

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Alternator ..... 120 amps-Diesel
..... 105 amps-Duel Fuel

Fuel Tank

Capacity ..... 66.9 L (17.7 gal)

Hydraulic System

Primary Pump ..... Piston, 65 cc - CW
Swing Motor ..... Single section, gerotor-type
Hoist Motor ..... Gerotor
Hydraulic Filter ..... Return line filter with full flow by-pass protection and service indicator. Replaceable cartridge with filtration rating of 16/14/12 (5 micron).
Hydraulic Cylinders ..... Double-acting cylinders for lift, telescope, steering and outriggers
Hydraulic Tank ..... 84.8 L (22.4 gal.) capacity, steel construction with internal baffles

Boom

Reach (from center line of rotation)

3 Section Boom ..... 10.12 m (33.2 ft)

Boom Extension - Fixed (optional) ..... 3.66 m (12 ft)

Boom Elevation ..... 0° to 70°

Mast Rotation - 360°

Mast Bearing (Diameter) ..... 581.66 mm (22.9 in)
Swing Drive Mechanism ..... Hydraulic motor driven worm drive gearbox
Swing Speed ..... 2.1 rpm

Wire Rope

Wire Rope (Main Hoist):

Diameter ..... 14 mm (9/16 in)
Type ..... Std & CE: 6 X 19 EEIPS IWRC, Bright 44.5 kN (10,000 lb) line pull
..... AUS: 35 X 7 EEIPS+ WSC Rotation Resistant 41.6 kN (9,350 lb) line pull

Wire Rope (Optional Below Deck Winch):

Diameter ..... 9.5 mm (.38 in)

Length ..... 30.5 m (100 ft)

Weight

Crane Gross Vehicle Weight ..... 8,065 kg (17,780 lb)

Torque Converter

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

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Transmission

Type.....Dana
Model.....T12000
Type.....2WD Powershift

Travel Speeds

Two-Wheel Steer

Tier 4/Dual Fuel

1st gear .....4 km/hr (2.5 mph)
2nd gear .....8.7 km/hr (5.4 mph)
3rd gear .....22 km/hr (13.7 mph)
4th gear .....32.2 km/hr (20 mph)

Tier 3

1st gear .....3.5 km/hr (2.2 mph)
2nd gear .....7.7 km/hr (4.8 mph)
3rd gear .....19.3 km/hr (12 mph)
4th gear .....28 km/hr (17.4 mph)

Front Axle Drive

Type .....International Transmissions Limited
Model SD55
Ratio.....18:1

Rear Axle Non-Drive

Type .....International Transmissions Limited
Model S55

Operating Dimensions

Two-Wheel Steer

- Outside turning radius
  (center line outside tires) .....5.05 m (16’ 7”)
- Outside turning radius
  (end of boom extension, 33.2’ boom) .....6.50 m (21’ 4")

Four-Wheel Steer

- Outside turning radius
  (center line outside tires) .....3.18 m (10' 5")
- Outside turning radius
  (end of boom extension, 33.2’ boom) .....4.65 m (15' 3")

Boom Angle

Maximum.....70°
Minimum.....0°

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Outriggers

Type ..... Hydraulic
Construction ..... Welded box

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